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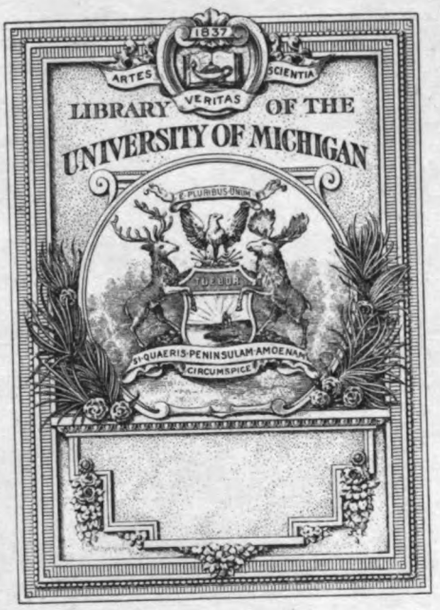


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SUPPLEMENT TO "THE ELECTRICIAN," OCTOBER 25, 1901.

# THE ELECTRICIAN:

107822

A WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

## VOLUME XLVII.

(Second Series.)

FROM APRIL 26, 1901, TO OCTOBER 18, 1901.

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LONDON:
Printed and Published for the Proprietors by GEORGE TUCKER, at the Offices of "THE ELECTRICIAN," Salisbury-court, Fleet-street, E.C.

1901.

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SUPPLEMENT TO "THE ELECTRICIAN," OCTOBER 25, 1901.

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# VOL. XLVII.

(Second Series.)

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# Supplement to Volume XLVII.

October 11, 1901 ... ... ... ... TRAMWAY TRACTIVE EFFORT AND POWER DIAGRAM.



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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,197. [Vol. No. 1. XLVII.] FRIDAY, APRIL 26, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

THE Paper on "Patent Law Reform," read by Mr. ALEXANDER SIEMENS at the Society of Arts on Wednesday, brought forward several startling proposals which, as the LORD CHIEF JUSTICE, who was in the chair, observed, evoked "a chorus of disapprobation" from the eminent legal authorities and patent experts who took part in the discussion. The author, in his reply, pleaded guilty to the impeachment, softly advanced by several speakers, that his scheme of patent law reform was drawn up in the interests of the manufacturer, not of the inventor. Indeed, he gloried in the fact, and this really explained what had seemed so preposterous in the Paper. "The mere inventor," said Mr. SIEMENS, "is an intolerable nuisance;" it is the hard-working manufacturer, forsooth, who has patiently devised and developed all the really useful inventions that have helped the world onwards. Apparently Mr. SIEMENS does not consider the telephone, the microphone, the dynamo, the storage cell, the arc and glow lamps and a host of other scientific inventions by non-manufacturing inventors, to be "really useful inventions." So it is the manufacturer who is to have the assured reward. Chapter and verse were cited from the time of JAMES I. to show that the original idea in creating letters patent for inventions was "to encourage manufactures and the introduction of new industries into the country." Precisely—"manufactures," not necessarily and primarily the manufacturer.

REGARDING patent law from so remarkable a standpoint, Mr. SIEMENS advocated that all patents which are not being commercially worked within four years from the date of granting the patent should become void; and that unlimited compulsory licences should be obtainable by manufacturers from patentees, whether these latter were or were not themselves working the patent. Other details were elaborated on this basis. With regard to anticipation of invention, no prior patent more than 15 years old, he considered, should be held to invalidate a patent. Our readers who are familiar with the history of electrical invention, to cite one series of examples, will readily perceive how such regulations would play into the hands of the capitalist and manufacturer, and would inflict hardship upon the inventor, especially upon the poor inventor, and upon him who sows invention in order to reap a far distant harvest.

DURING the discussion, the proposal of the Board of Trade Committee that the British Patent Office should ear-mark specifications of patents which had been anticipated was criticised. Much has been said and written in the press against this proposal, but most of the objections have arisen from misapprehension as to the nature of the proposal. It has been said, for example, that to deal with a specification in this way would destroy the market value of the patent. Mr. LLOYD WISE, who originated this and other items of the scheme which forms the basis of the Committee's recommendations, explained that no specification would be officially ear-marked until the patentee had refused to amend it himself according to the advice of the Patent Office. If the invention was genuine and honest the inventor would not object, but would be glad of an opportunity to amend it in such a manner as to indicate that he was aware of the existence, and admitted the prior claim of an earlier patent pointed out to him by the Patent Office. Of course, this is not designed to afford any guarantee. Lord ALVERSTONE concurred, and added that it was only the bogus inventor that would refuse to amend his specification, and who accordingly, in the public interest, would have to submit to an official notification of the prior patent being embodied in his specification.

WE give a detailed description, in this issue, of the Poulsen recording telephone, or "telegraphone," now on view in this country. The extreme simplicity of the instrument and its ease of adjustment, combined with a purer and more perfect articulation than any phonograph has produced hitherto,

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promise for it a successful future; and we trust that the instrument as well as the company who are to undertake its manufacture or sale in this country will shortly emerge from its experimental stage and assume working proportions. As soon as the small details of the application of the apparatus to exchange instruments have been duly worked out, Mr. POULSEN's ingenious and beautiful invention is likely to prove of great practical utility as a recording telephone; and should he also be able to apply it satisfactorily as a telephonic relay, he will have made the greatest invention in telephony since the discovery of the microphone. We look forward to further developments with interest.

A NOVEL use of the electric current for laboratory purposes is described by R. K. MEADE, of Lafayette College, in a recent issue of the *Journal* of the American Chemical Society. This is the preparation of standard sulphuric acid for use in volumetric analysis, by electrolysis of solutions of copper sulphate. The disadvantage of the older method of preparing the normal or decinormal solutions of sulphuric acid used by chemists, has been the difficulty of obtaining the desired strength without repeated dilutions and checks of the solution in course of preparation. The author points out that in most cases chemists have avoided this labour by using solutions only approximately correct. This entails the use of a factor to correct the results obtained, and time is, therefore, lost in calculation when employing such solutions. By weighing out the calculated amount of crystallised copper sulphate required for a decinormal or normal sulphuric acid solution, and by electrolysing this with a platinum anode and copper cathode under suitable conditions, the whole of the copper can be removed and the sulphuric acid alone left in solution. The decomposition values for sulphuric acid and copper sulphate are 1·67 and 1·24 volts respectively, so that decomposition of the former will occur towards the end of the operation. As, however, this produces only hydrogen and oxygen, and the acid is continually reformed at the anode, no loss occurs; and the electrolytic decomposition can be left over-night without any ill-effect upon the accuracy of the method. It is this fact that gives the new method its chief advantage over the older method of procedure. In laboratories provided with the necessary electric apparatus and fittings, it is simply necessary to weigh out the calculated amount of copper sulphate, and to leave the solution of this over-night under the conditions described above, on the bench reserved for electrolytic analyses. In the morning the whole of the copper will be deposited, and after dilution to one litre, a normal or decinormal acid solution will be obtained sufficiently accurate for all ordinary volumetric work. The use of electrolytic methods by chemists for metal determinations is extending, and this new method of preparing standard acids will serve to popularise electrolysis still further, and will increase the number of laboratories in which electricity is recognised as a most valuable aid in analytical work.

THE true interpretation of the clause, in all provisional orders, relating to the enforcement of penalties for default in complying with the Board of Trade Regulations under the Electric Lighting Acts, has frequently been a question for discussion. Whereas a penalty is enforceable in the event of the "undertaker" failing to supply current or failing to supply it at a proper pressure, a distinct statement is made to the effect that no penalty shall be inflicted if the default be occasioned by inevitable accident or if it is of an unimportant nature. In Dublin in November, 1898, the Sun Insurance Co. summoned the Corporation of Dublin for making default in supply, but the summons was dismissed without costs on the ground that the accident was due to the breakdown of a cable, which could not have been foreseen. On the other hand, just a year ago, the Marylebone Vestry took out a summons against the Metropolitan Company for default in supply, and although the magistrate, Mr. PLOWDEN, exculpated the company from blame, a fine was inflicted. On the same day a summons against the London Electric Supply Corporation by the London County Council for a similar offence was dismissed by Mr. PAUL TAYLOR because no evidence was given to show negligence on the part of the company; while a case against the same company brought by the occupier of a public house for the same offence a few days later and heard by Mr. KENNEDY, was successful chiefly on the ground that the company should not have accepted this consumer at a time when there was reasonable doubt whether it could supply current to him later.

IN May last, the Killarney Electric Light Co. was mulcted in 5s. fine and 5s. costs on each of 28 summonses for failing to supply current on 28 occasions during the previous March, the defence being that the failure was due to an accident to a steam alternator, and the inability to obtain delivery from contractors of plant long on order. Last week, finally, summonses by the occupiers of the "Windsor Hotel" against the Westminster Company for supplying at too variable a voltage, were dismissed by Mr. SHEIL on the ground that the default in the various instances was either due to an inevitable accident or else was unimportant. Although we feel every goodwill towards the Westminster Company, and are especially gratified that it should have won its case against one of the refractory consumers who refused to accept supply at 200 volts pressure, we should be glad if an appeal were to be made to the Divisional Court against Mr. SHEIL's decision, so that the interpretation of the law as to penalties for supply failures and pressure variations might be settled once for all by a higher tribunal.

Wigan Corporation Electricity Works.—The formal opening of these works, which have been running for some time past, took place on Wednesday.

Glasgow Corporation Electric Tramways.—On Wednesday the Pinkston generating station for the electric tramways was formally and successfully inaugurated amidst great festivities.

Röntgen Society.—The next ordinary meeting will be held on Thursday, May 2nd, at 20, Hanover-square, at 8 p.m., when the following Paper will be read:—"Some X-Ray Improvements," by J. Cadett.

South-Western Polytechnic.—Particulars will be found in an advertisement of a special summer course of electric lighting plant tests to be given at this Polytechnic on May 16, 23, and 30, and June 6, 13 and 20.

Cable Communications Committee.—At a meeting of this committee held on Tuesday under the presidency of Lord Balfour, Mr. S. R. French, C.M.G., Postmaster-General and General Manager of Telegraphs in Cape Colony, gave evidence.

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| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Bali—Macassar | April 14, 1901 |
| Cayenne—Pinheiros | April 21, 1901 |

Ascension-Sierra Leone Cable.—A new submarine telegraph cable has been laid by the Telegraph Construction and Maintenance Co. (Ltd.), on behalf of the Eastern Telegraph Co., between Ascension and Sierra Leone. The line was opened for traffic on Wednesday.

French Cable Enterprise.—The French Government have been seeking to obtain from the Moorish Government permission to land a cable at Tangier, connected with Oran, Algeria, and it is stated that the French Minister to Morocco has informed the Diplomatic Corps that the line is being laid. The connection would be of importance in view of French political aims regarding Morocco.

"Climat."—This is the name of a new polyglot meteorological journal published in St. Petersburg under the editorship of Mr. Nicolas Demtchinsky. It is printed in Russian, French, English, and German, and is primarily devoted to weather forecasting, the editor's theory being based essentially on the hypothesis that the lunar phases exert an influence on the weather. The publication will appear on the 1st and 15th of each month, and contains actual forecasts in addition to articles on the subject from the pen of the editor and others. Its price is 16s. yearly.

Edison's New Storage Battery.—Mr. Edison has recently patented a new storage battery in which powdered copper is used as the positive electrode, finely-divided cadmium for the negative, and the electrolyte is a 10 per cent. solution of pure caustic soda, the whole being enclosed in an airtight compartment. During the charge cuprous oxide is formed and water decomposed, and during the discharge the water is reformed and the cadmium is oxidised. Thin sheets of asbestos are placed between the electrodes moistened with the electrolyte, as only a small quantity of liquid is required.

Wireless Telegraphy.—In response to the complaints of a number of leading shipping companies, including the White Star, Cunard and American Lines, the Board of Trade has instructed the Marconi Company to erect a signalling station on the mainland close to the Fastnet Rock, at the western extremity of Ireland. All vessels fitted with wireless transmitting apparatus will henceforth be able to report to the shore when many miles outside the Fastnet, and this will, of course, abolish the waste of time and labour caused by the necessity for incoming steamers to pass inside the Fastnet in order to report to Lloyd's station on the mainland.

Submarine Signalling.—The *Morning Post* for yesterday describes experiments, carried on by the United States authorities with assistance from the British Government, on a system of submarine signalling by electric bells. A bell which is placed below the surface of the water, when rung acts on a delicately-adjusted receiver hung from the ship's side and rings a bell on the bridge. It is claimed that by placing two bells at fixed points the pilot can easily find his position with the help of charts from the time elapsing between the action of the two bells. Experiments so far have been successful up to within 10 miles of the bells.

Obituary.—Mr. T. Barlow, deputy controller of the Central Telegraph Office, died suddenly on Thursday evening last. The deceased was present at Her Majesty's Theatre on the previous night to witness the performance of "Twelfth Night," and became seriously ill during the performance. He was removed to Charing Cross Hospital, where he died within a few hours. Mr. Barlow was in his 62nd year, joined the staff of the Magnetic Telegraph Co. in 1854, and entered the service of the Government in 1870.——The death also is announced of Mr. J. W. Logan, M.I.M.E., well known in South Africa as the representative of Messrs. Davey, Paxman and Co.

Projected Moving Platform for Paris.—According to the *Engineer* for April 19th there is a project on foot for the construction of a movable electric platform on the north side of the Seine. It will be underground, and its length will be about 6 miles. The route proposed passes under the Avenue de l'Opera, the boulevards, Boulevard Sebastopol, the Rue Turbigo and the Rue de Rivoli. The new scheme embraces four platforms instead of three, as was in use at the exhibition. The first platform will be stationary, the second will have a velocity of 1½ metres a second, the third 3 metres, and the fourth 5 metres, or 16½ft.

Electrical Safety Devices for Pillar-Boxes.—The *Western Electrician* of Chicago for March 30th describes a safety device, which is now in operation in Washington, and is designed to secure the Post Office mails from organised bands of thieves possessed with duplicate keys. At the central post office there is a clock with mechanism which prints the number of the pillar-boxes when they are opened and closed. The locks are electrically controlled from the post office by means of a secondary blocking device which is released just before the postman is due to arrive. The postman can also signal to the post office from the pillar-boxes. The whole arrangement is the invention of Mr. Frederick Williams, of Boston.

Power Transmission Schemes in France.—*The Engineer* for April 19th mentions that several French syndicates have planned the development of the water power of the Rhone, and extensive plants are to be erected within the next three years between Pyrimont and the Swiss frontier. The first of these projects is that of Malpertuis, 2½ miles below Bellegarde, where the river falls 30ft. to 35ft., with perpendicular banks only 160ft. apart. By building a tunnel 1·2 miles long a total fall of 51ft. to 55ft. can be secured, equivalent to 25,000 H.P. at low water. Near Bellegarde another tunnel would secure a fall of 80ft. to 85ft., developing 30,000 H.P.; and about 8 miles from the Swiss frontier is a narrow gorge only 80ft. wide, and a dam built here would give a fall of 65ft., or 30,000 H.P. at low water.

The National Physical Laboratory.—An advertisement in our issue this week announces that the committee of the National Physical Laboratory is about to consider the appointment of additional members of the staff, and applications are requested as follows:—(1) A superintendent of the engineering department at a salary of £400 per annum. (2) One or two assistants in the physics department at salaries of from £200 to £250 per annum. (3) An assistant in the physics department specially for chemical investigations at a salary of £200 per annum. The appointments are to date from September 29th next, and applications are to be made not later than May 24th. Applications are also invited for a small number of junior assistantships at salaries ranging from £100 to £150 per annum. Further particulars are given in the advertisement.

South-Western Polytechnic.—On Saturday last, on the occasion of the annual conversazione, Sir William Preece, F.R.S., distributed the prizes and certificates to the students of the day and evening classes at the South-Western Polytechnic. On account of the large and continued increase in the number of students attending, new buildings, costing some £10,000, have had to be erected, and Sir William Preece formally opened these, after having made a few remarks upon the question of technical education. In London, he said, there was no municipal patriotism, for he knew of no instance in which a Londoner had given a large sum of money for the establishment of colleges, simply because he was a Londoner. During the evening, in addition to exhibitions in the engineering and physical laboratories, several interesting lectures were delivered. Among them were the following:—"Production of High Temperatures," by Prof. Coleman; "Wireless Telegraphy," by W. H. Eccles, B.Sc.; and "Modern X-Ray Photography," by F. J. Addyman, B.Sc.

Federal Post and Telegraphs in Australia.—An interesting ceremony to signalise the inauguration of the federation of the post and telegraph offices of the Commonwealth took place on March 1. Shortly before noon the operators in the telegraph office left their desks and gathered in the middle of the room. By an arrangement with all the Federating States, the operators in Melbourne, Sydney, Brisbane, Perth, and Hobart assembled at the same time. The lines connecting the cities with Adelaide were kept clear, and at noon exactly the signal



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letter "X" was sent to each. The time of a bar was then ticked through, and the National Anthem sung by the whole of the operators in the capitals of the Commonwealth. The operators then filed into another apartment and were joined by the officials of other branches of the department and by Sir Charles Todd, who has been associated with the South Australian telegraph system since its establishment. In South Australia there are now 692 post-offices open, whose receipts last year aggregated £134,766. There are 16,937 miles of telegraphs and telephones, which during the same period yielded a revenue of £136,753. The capital cost of the post-offices, telegraph stations, and telephones in South Australia, according to a recent return furnished by Sir Charles Todd, amounts to £1,450,000, and this sum will be credited by the Commonwealth to the State.

The Existence of Bodies Smaller than Atoms.—Prof. J. J. Thomson explained his views on this interesting subject in a discourse, illustrated with fascinating experiments, before the Royal Institution on Friday evening. After a feeling reference to the death of Prof. Rowland, who was an eminent worker in this field, he proceeded with his lecture, commencing with an experiment to show the deflection of cathode rays by an electrostatic field. He then followed the same lines of argument as in his famous British Association address of 1899 (see *The Electrician*, Vol. XLIV., pp. 228, 258 and 303), illustrating it with one or two experiments, the demonstration of the C. T. R. Wilson cloud effect being particularly appreciated. Having thus put forward his view as to the actual existence of positive and negative electricity, the positive electricity being variable and the negative invariable, Prof. Thomson pointed out that this was in a way a return to the old fluid theory of electricity. This fluid theory had certainly always remained with us in the columns of the lay newspapers, but it seemed that it was now to get more reputable quarters. He next explained the experiment he had made to determine whether the mass of the electrified ion was or was not of electrical origin. He led a stream of cathode rays into an alternating electrostatic field so that the stream impinged on two targets, one of lead and the other of aluminium. If the mass were of electrical origin, less heat would have been developed at the aluminium than at the lead target, owing to the relative transparency of the former, but by careful measurements in a tube in which one target was replaceable, so that the differences between observations should be observable when one target was lead and the other aluminium and when both were of the same metal, the heat generated in the two cases was identical within the limits of accuracy of his experiment. In introducing an experiment with radium rays, Prof. Thomson referred to the fact that Prof. Curie had succeeded in shooting negatively electrified particles through 4mm. of glass. The experiment shown was the deflection of radium rays by an electromagnet, this being demonstrated by a gold-leaf electroscope shown in the lantern. Prof. Thomson concluded with a cathode ray hypothesis of auroræ. Assuming that the sun emitted these negatively electrified bodies, one might take it that they followed the lines of magnetic force when they approached the earth. At the equator they would be horizontal, but as they approached the poles they would be deflected until they met thicker layers of the atmosphere, with the result that the aurora effect was observable at some distance from the poles.

"Traction Tangentielle."—Assume that the field or stator of an induction motor be developed along a straight line and that the rotor be developed in the same way. We shall have a magnetic field moving along the line, and the squirrel-cage rotor will resemble a ladder with copper rungs and sides, which, being held so that its distance from the moving field is invariable, will tend to travel along it. This ideal system of traction, in which no contact is necessary between the train and the electric line is being seriously experimented with in Belgium by MM. Rosenfeld and Zelenay, assisted by M. Julien Dulait, who is head of the well-known firm Electricité et Hydraulique. A mile of experimental track is being laid down, and a concession for 20km. of track on the State railways has been promised by the Belgian Government in order to permit of the system being tried under proper working conditions. We understand that a large amount of experimental work has already been carried out, and that it is particularly intended to develop the system for high-speed railways, such as the proposed line between Brussels and Antwerp. In the form the system has taken up to the present, according to an article by M. Léon Gerard in the *Bulletin* of the Société Belge d'Electriciens, a car runs on an ordinary standard track, but between the rails is a second pair of rails at a slightly higher level on which runs the small locomotive connected mechanically to the car by a chain, and running underneath it between the wheels. The auxiliary track is of about 70cm. gauge, and between its rails are rectangular stators 10 metres long with gaps of 40 metres between them, so that there are 10 of these in each 500 metre section. The stator coil is of smaller size than the exposed polar surface in each case. An air-gap of 10mm. is employed, and it is calculated that with a 150kw. stator and efficiency of 84 to 87 per cent. can be attained, provided the peripheral speed of the moving element of the combination is 27 to 35 metres per second, corresponding to 97 to 125km. (60 to 78 miles) per hour. The generating station supplies three-phase current at 15,000 volts, which is transformed down to 5,000 by stationary transformers, at which pressure it is distributed to the stators by three wires. The line is divided into 500 metre sections, and as the car passes on to each section it completes the circuit of a low-pressure current supplied from the same sub-stations, and thereby actuates a switching gear, by which means only the section on which the car is travelling is supplied with current. This is to prevent the waste of energy by currents flowing through those sections of the line which are not in use. We hope to be able to give a detailed description of the scheme when it is further advanced.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), April 26th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Thermodynamical Correction of the Gas Thermometer," by Prof. Callendar, F.R.S. (2) "On the Production of a Bright-line Spectrum by Anomalous Dispersion, and its Application to the Flash-Spectrum," by Prof. R. W. Wood.

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture I., on "Polyphase Electric Working," by A. C. Eborall.

**SATURDAY, April 27th.**

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

*10:30 a.m.* Visit to the works of Messrs. Easton, Anderson and Goolden, Erith, Kent. Train for Erith leaves Charing Cross 9:42 a.m.

**MONDAY, April 29th.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture II., on "Alloys," by Sir W. C. Roberts-Austen F.R.S.

**WEDNESDAY, May 1st.**

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

*7:30 p.m.* Meeting at 28, Victoria-street, S.W. Paper to be read: "The Application of Power to Machine Tools," by C. B. Nixon.

**THURSDAY, May 2nd.**

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Papers to be read: (1) "An Instrument for Measuring the Permeability of Iron and Steel," by C. G. Lamb, B.Sc., and Miles Walker. (2) "A Watt-Hour Meter," by F. Holden. (3) Exhibition of Poulsen's Telegraphone.

**FRIDAY, May 3rd.**

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture II. on "Polyphase Electric Working," by A. C. Eborall.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel, when the Northcott Prize Paper, by W. Powrie, entitled, "How May the Best Efforts of Employers and Employed be Exerted for their Mutual Advantage and for the National Benefit?" will be read and discussed.

**SATURDAY, May 4th.**

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

Visit to the Davies-street Works of the Westminster Electric Supply Corporation.

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# THE TELEGRAPHONE.

The ingenious recording telephone invented by Valdemar Poulsen, and named by him the telegraphone, has been alluded to on more than one occasion in our columns. We referred to it on its first appearance at the Paris Exhibition*; in Mr. Gavey's recent Institution Paper, and the discussion which followed it†, its construction and possibilities were

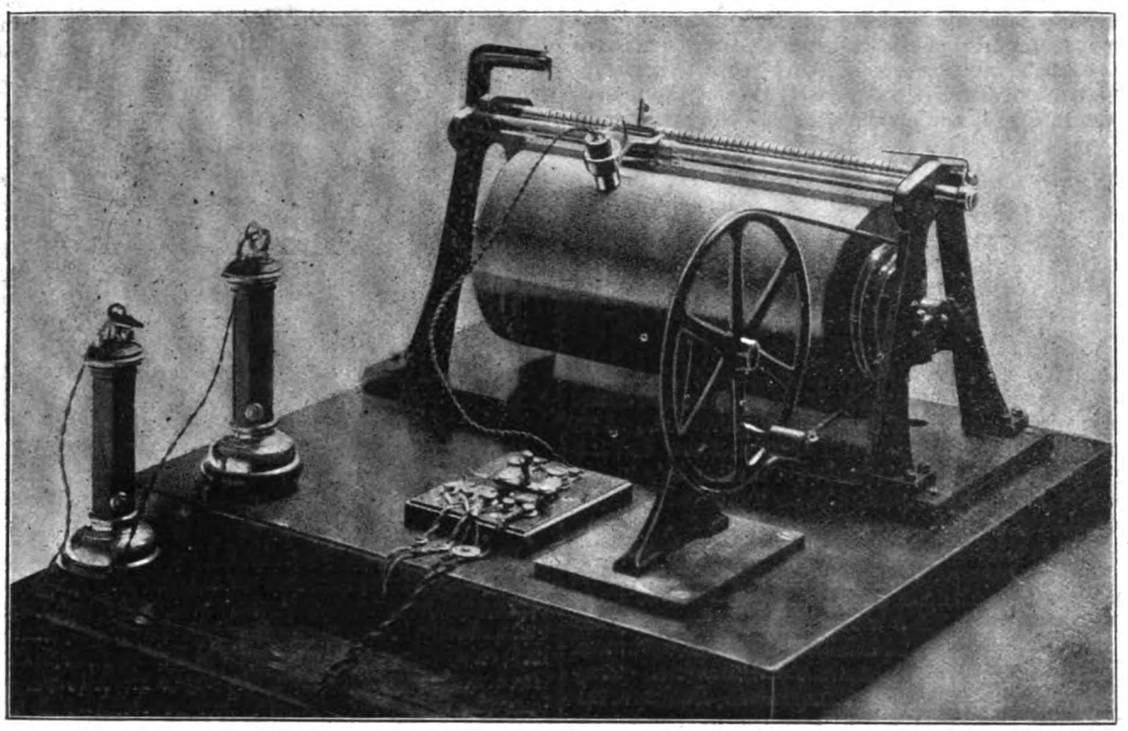

FIG. 1.—GENERAL VIEW OF THE POULSEN TELEGRAPHONE.

enthusiastically commented on, and we have also published‡ an article on the instrument written for us by Mr. Poulsen himself. The instrument is on view now at the offices of the Telegraphone Syndicate, 2, Angel-court, Throgmorton-street, London, E.C., and we have been enabled to examine it more closely than hitherto and to photograph it.

The purpose for which the instrument is intended, and the principle underlying its construction, may be briefly summarised. An ordinary phonograph will record a message spoken into it, and will repeat it when required at a future time. Its action is a purely mechanical one, however, and no means are provided for combining it with a telephonic receiver so that speech *from a distance* may be recorded. The Poulsen telegraphone, however, receives the speech in the form of an oscillatory electric current just as a telephone does, and is connected to the telephonic transmitter by a wire, which may be inches, yards, or miles long, just as in the case of an ordinary telephone circuit terminating in a receiver instead of in a recording telephone. It will thus enable telephonic messages to be received and automatically recorded *verbatim* and *vivâ voce* in the absence of the person to whom they are addressed, and also for a telephone subscriber to leave stock messages in his own voice to be employed in his absence.

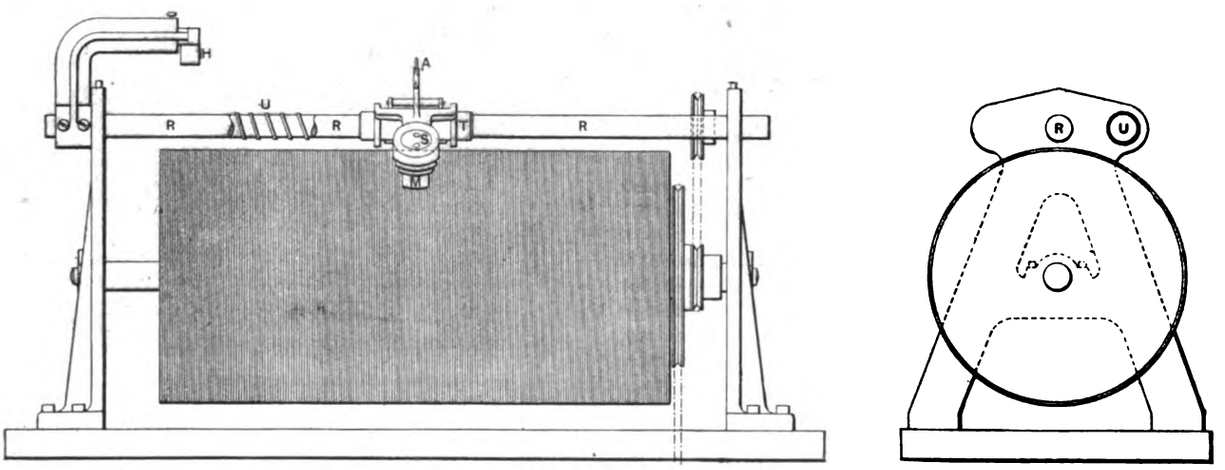


FIG. 2.—ELEVATION AND END ELEVATION OF TELEGRAPHONE.

A spiral of steel wire wound on a cylindrical drum receives the record in the form of magnetisation induced on it by a small two-pole electromagnet which replaces the telephone receiver in an ordinary telephone circuit, as explained above. This magnet travels along horizontally, touching the wire, while the cylinder revolves, as in a phonograph. The same

* *The Electrician*, Vol. XLV., pp. 29, 427 and 441.
† *The Electrician*, Vol. XLVI., pp. 169, 210 and 204.
‡ *The Electrician*, Vol. XLVI., p. 208.

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magnet serves for re-transmitting the speech; it is then simply connected in series with a telephone receiver while the cylinder is turned and the magnet travels along as before, and the voice is heard in the telephone. For obliterating the record the same magnet is again employed, a continuous current being passed round its coils by the microphone battery, when, by turning the wire past the magnet as before, all trace of the record is removed. In a form of instrument intended for longer messages, a flat steel ribbon is employed, and run off from one reel to another across the poles of the electromagnet. As in the case of a phonograph, the cylinder may be turned by hand, by clockwork, or by a motor.

The extreme simplicity of the instrument, and the absence of delicate parts and adjustments as compared with a phonograph, are important features. A general view of the instrument is given in Fig. 1, and an elevation and end elevation of

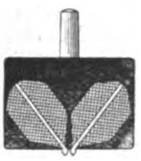

FIG. 3.—SECTION OF MAGNET.

it in Fig. 2. The cylinder on which the wire is wound is 140mm. in diameter and 265mm. long. On it are 150 turns of steel piano wire, 1mm. diameter and at 1·2mm. pitch. The instrument in the figure is fitted with a hand-wheel, but the same type is employed with motor drive. It takes 3½ min. for the magnet to travel from one end of the cylinder to the other, but, of course, longer cylinders could be employed.

The shape and actual size of the electromagnet itself is shown in Fig. 3. As seen, it is double-pole, the two cores being iron wires placed at an angle, and the ends of these embrace the steel wire on the cylinder, so that the wire completes the magnetic circuit. The coils of the magnet are wound with 0·1mm. wire, and have a resistance of 100 ohms. They are embedded in insulating compound, as shown. Details of the carrier are seen in Figs. 5 and 6, and drawn to scale in Fig. 4.

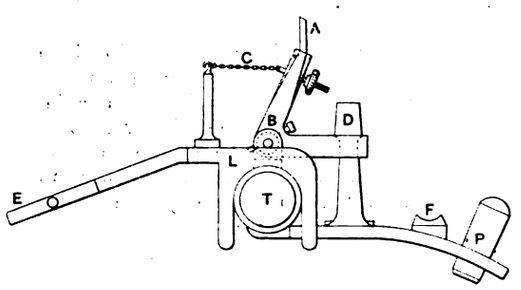


FIG. 4.—DETAILS OF CARRIER. END ELEVATION. ⅔ SCALE.

The traversing gear for the magnet is of the simplest possible description. The magnet (M in Fig. 2) merely rests by its own weight on the cylinder, being carried on the end E (Fig. 4) of a brass piece, L, which merely rests on the sleeve T moving along the rod R (Fig. 2). This horizontal motion is imparted by the simple expedient of a projecting-piece, or "plough," resting between the turns of wire on the cylinder. A plug inserted in the socket S (Fig. 2) connects the magnet through a flexible cord to the switch for making the hearing, speaking, and obliterating connections. When the carrier, travelling from right to left, reaches the end, the tongue A comes in contact with a slanting steel striking-piece H, fixed to the frame of the instrument. This gradually turns down the lever B, which lifts the magnet from the wire by means of the chain C, and B at the same time catches in under the catch-piece D, fixed at the extremity of a flat spring, lifting the guide P from the wire and causing the guide F to engage in the threaded shaft U (Fig. 2), which is always turning. Thus the traveller is carried back at a quick rate to the right-hand end of the instrument without it being necessary to reverse the direction of the hand-wheel. When the carrier arrives at the extreme right-hand, the catch-piece D knocks against a projecting rod fixed to the frame of the apparatus, which releases the lever B, and causes both the magnet and the guide-piece P to drop on the wire again, so that the carrier resumes its forward motion. It would be a good idea to introduce in connection with this a change-over switch, so that the return of the carrier automatically changes the connections from "receive" to "speak," in order that one record cannot be printed on the top of the other.

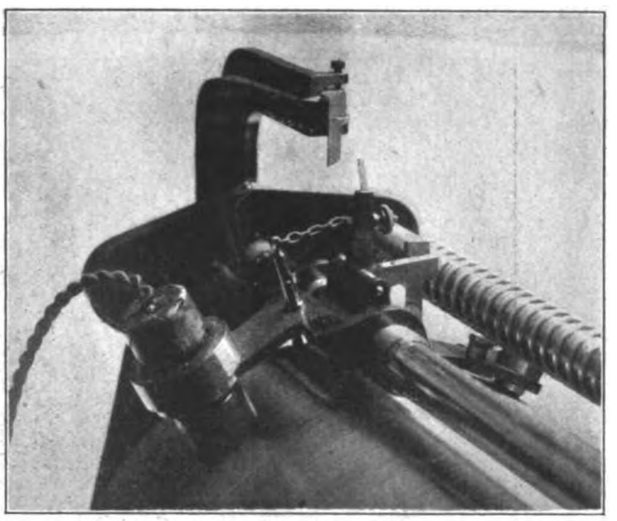

FIG. 5.—DETAILS OF CARRIER AND RETURN GEAR (SIDE VIEW).

We tested the instrument, and found its articulation perfect; and, moreover, the troublesome grating sound and other extraneous noises heard in the Edison phonograph were quite absent. The impression will last a considerable time; in fact, a song sung into one of the instruments in Copenhagen three weeks ago was faithfully reproduced to us. It is also fairly hardy, for a permanent magnet held close to the wire with the intention of effacing from it a speech on the Budget proposals did not at first accomplish its purpose, although the

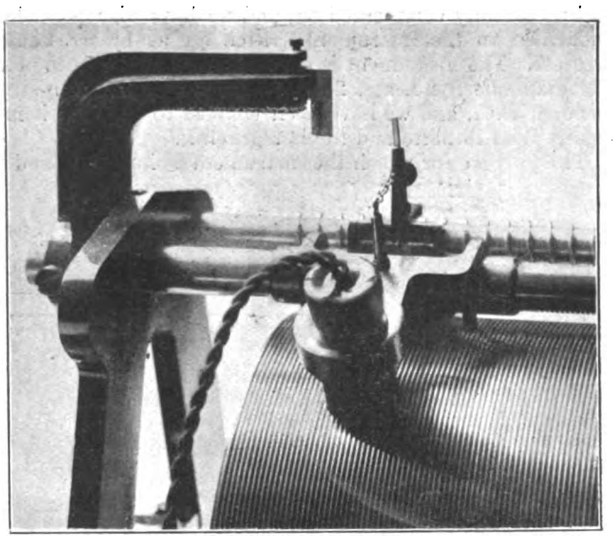

FIG. 6.—DETAILS OF CARRIER AND RETURN GEAR (FRONT VIEW).

stronger field produced by the instrument's own electromagnet coupled to the three dry cells used for the microphone circuit immediately applied the closure. However, the time a record will last, and the amount of rough usage to which it may be subjected, have still to be determined, we believe.

To enable longer records to be taken, and to give facilities for the transport of records, should the instrument be employed as a correspondence-phonograph, a pattern of instrument shown in Fig. 7 is being evolved. In place of a wire wound on a cylinder, a coil of thin flat spring, 3mm. wide and a

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small fraction of a millimetre thick is wound off from one reel to another across the poles of two electromagnets more or less similar to the electromagnet of the other instrument. These touch the lower side of the strip only. The first is traversed by a continuous current, and effaces the previous record, while the second magnetises the strip to correspond with the new message spoken into the microphone to which it is connected. The ribbon is then run back again, the magnets both connected to receivers, and the coil of ribbon run past them. In this instrument, although speech was loud and intelligible, articulation was not quite so clear. This may have been due to the lateral motion of the strip with respect to the poles of the electromagnets, as so far as we could see the only arrangement to keep its position constant is a brake-brush pressing against the side of the drum from which the spring is being wound off. However, as the instrument shown is evidently merely an experimental one, it is hardly fair to criticise its detail. It is noticeable that in spite of the thinness of the steel ribbon, the successive layers have no effect on one another when rolled up after they have received the record.

To demonstrate the manner in which the telegraphone can be employed for the multiple transmission of the same message, musical performance, &c., we were shown a long endless steel ribbon on two pulleys. This passes over a series of electromagnets, the first of which is employed as obliterator, the next is connected to a microphone circuit to convey the record to the steel tape, and the remaining magnets are connected to telephone receivers at a distance. Multiple telephonic transmission, it is true, is already accomplished in the case of ordinary "electrophone" or "theatrophone" connections; but, of course, in this case it can be extended to a far greater number of lines, and it is also evident that an inductive disturbance in one line will not affect the others unless it is intense enough to re-act on the steel ribbon. Almost an indefinite number of instruments may be connected to it, as the energy is supplied, not by the magnetised strip, but by the strip's motion, *i.e.*, by the motor.

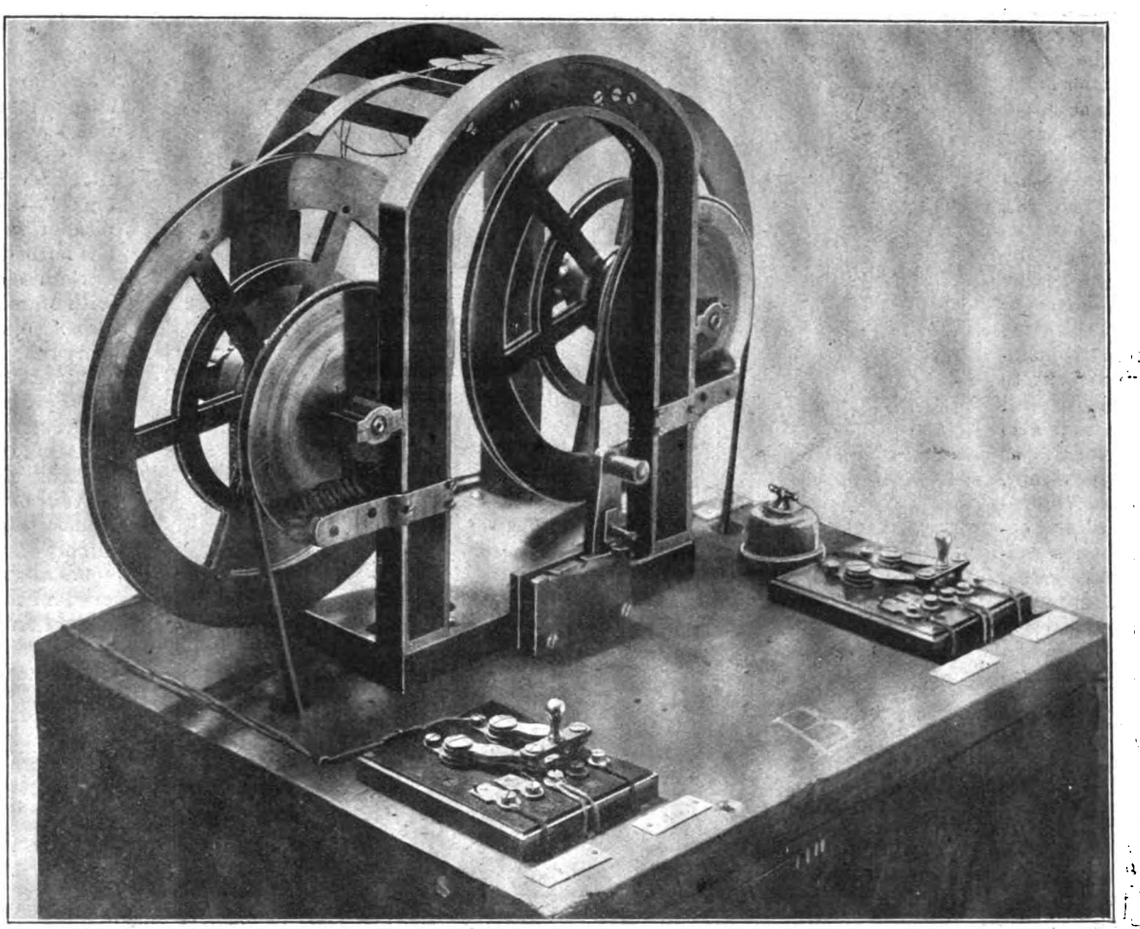

Fig. 7.—Steel Ribbon Telegraphone.

This leads to the idea of the telephonic relay, referred to by Mr. Gavey in his recent Paper, and illustrated in *The Electrician*, Vol. XLVI., p. 210. We understand, however, that this has not yet been put into practice in such a way as to obtain definite results. But it ought not to be long before the practical manufacture for sale of recording telephones on the Poulsen principle has duly commenced.

## FERRANTI-WESTINGHOUSE GENERATORS AT MANCHESTER.

Among the recent additions to the equipment of the Dickinson-street station of the Manchester Corporation electricity works are two continuous current sets, each consisting of a Westinghouse multipolar generator direct-coupled to a Ferranti steam engine. Each set is rated at 750kw. Our illustrations show the general appearance and construction of these machines. Owing, however, to the present crowded condition of the Dickinson-street machinery room, we found it difficult to select a good [point] from which to take the photograph reproduced in one of the illustrations. The high pressure engine only is visible in this view, the low pressure side being hidden by the end of the new three-phase switchboard gallery. The two figures taken together, however, indicate the solidity of construction of these generating sets.

The engines are of the vertical cross compound type, running at a speed of 160 revs. per min. They are thoroughly enclosed, and are automatic in all respects. There are only two main bearings on each engine, these being spherical, so

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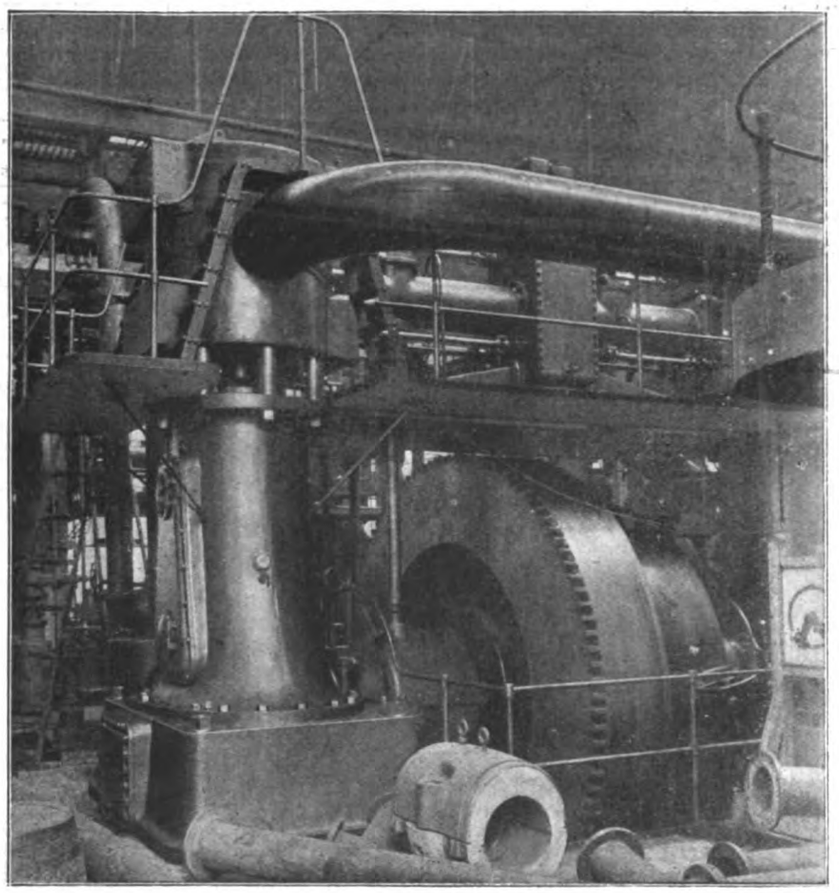
as to secure accurate alignment under all conditions. All the chief bearings are lined with white metal, and lubricated by oil under pressure, supplied by valveless oil pumps driven from the crank shaft. There are four valves to each cylinder, arranged in the cylinder ends and actuated by the Ferranti positive cam gear. The whole of this valve gear is contained in a box carried on a heavy girder between the two cylinders, thus securing a straight drive for the valves in the cylinder ends. This gear is actuated by means of a vertical shaft driven by accurately-cut bevel wheels on the crank shaft, and is so arranged that by means of a relay cylinder the governor can control the point of cut off in the cylinders from zero up to 65 per cent. of full stroke. There is also an additional or emergency governor, arranged to control the speed of the engine through a balance throttle valve, this latter governor being arranged to come into action at a higher speed than the main or automatic expansion governor. The engine is fitted with knock-out gear, vacuum breaker, and other special fittings, according to Mr. Wordingham's specification.

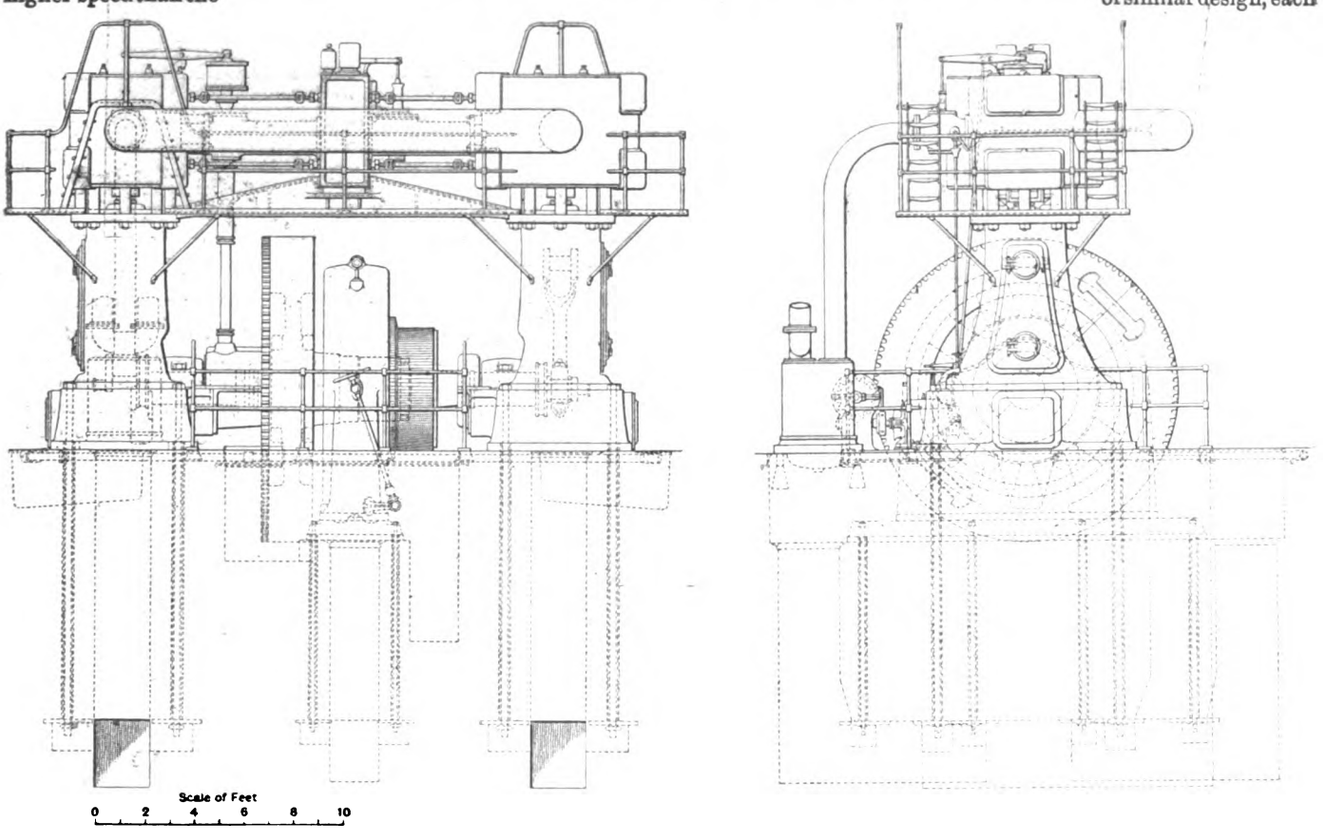


75KW. FERRANTI-WESTINGHOUSE GENERATING SET AT MANCHESTER ELECTRICITY WORKS.

A heavy flywheel is provided, and held to the crank shaft by means of shrinkage rings and T's. The armature of the generator is drawn on to an extended portion of the flywheel boss so as to ensure the armature and the flywheel acting as one mass, thus relieving the crank shaft of the severe strains due to short-circuits when engaged on the traction loads. So much for those who say that the "flywheel craze"—as they are pleased to call it—has burned itself out.

Both sets are fitted with Messrs. Körting Bros.' ejector condensers, supplied with water from the overhead water mains in the station. There are also two Drysdale centrifugal pumps, driven by Westinghouse motors, to supply water for the condensers in the event of the ordinary supply failing.

The generators are of similar design, each




750KW. FERRANTI-WESTINGHOUSE GENERATING SET.

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having 20 poles, and being over-compounded for 500 to 550 volts for the traction work, and giving 410 volts for the supply networks. The general design consists of a circular yoke carrying inwardly projecting pole pieces of laminated soft steel. The field casting is divided vertically and set upon guide plates to afford facility for immediate inspection or removal of armature or field coils without the necessity of removing the out-board bearing or dismantling the engine. The armature core consists of punched discs of annealed steel, held together by cast end plates. This core is pressed firmly upon an iron spider, which also carries the commutator. Ventilating spaces are arranged through the spider and armature core. A notable feature is that all the brushes of the same polarity are maintained at the same potential. These machines, on account of their large capacity, have parallel-wound armatures. Great difficulty has frequently been experienced in the operation of large multipolar direct-current machines with parallel-wound armatures, owing to the difficulty of securing the same magnetic strength in all the poles. The potential generated in the conductors under one pole sometimes exceeds, or is less than, that generated in the conductors similarly situated under another pole of the same polarity, the result being a slight difference of potential between brushes of similar polarity, which causes currents, sometimes of considerable magnitude, to flow from one brush to another and from one section of the armature winding to another. This difficulty is obviated by the following ingenious method of balancing:—A number of points in the armature winding, which are normally of equal potential, are connected together by leads through which currents may pass from one section to the others with which it is connected in parallel. These currents are alternating in character and lead or lag with reference to their respective E.M.F.s, and thus magnetise or demagnetise the field-magnets so as automatically to produce the necessary balance between them. The method of balancing is also of great advantage in eliminating the sparking at the brushes and other wasteful heating which occurs when an armature becomes decentralised, due to wear of the bearings or from other causes. When, on account of the armature being out of centre, the air-gap on one side is greater than that on the opposite side, the potential generated in the coils on the side having the smaller air-gap is considerably higher than that generated in the coils under poles of the same polarity on the opposite side; consequently, a current corresponding to this difference of potential flows from one section of the winding to another through the brushes and connecting leads. By the balancing method adopted, however, the armature could be considerably out of centre and no injurious results occur, as the balancing currents do not flow through the brushes, but through the specially provided connections. In addition to this, the fact that the currents in these conductors are alternating currents, which are "leading" in some coils and "lagging" in other coils, enables a very small current to effectually balance the circuits. This method is also advantageous in preventing any heavy magnetic pull on one side of the armature.

## COMBINED TROLLEY AND CONDUIT TRAMWAY SYSTEMS.*

BY A. N. CONNETT.

(*Concluded from page 940, Vol. XLVI.*)

*Special Considerations for a "Mixed" Line.*—The first decision to be made for a line partly conduit and partly overhead is whether the plough shall be carried continually on the car, or removed and replaced at each junction point of the two systems. The latter is the simpler method. A roomy manhole containing a man to do this work is all that is needed; but it needs no argument to prove that it is an undesirable and expensive method to adopt. One is then impelled to a method whereby the plough is always carried on the car as the trolley is, to effect which the plough must be raised or lowered at the junction points of the two systems. The most natural and the neatest solution is to raise the plough through the slot with no special arrangement in the latter. This has been successfully done in Berlin and Brussels. In the former city the plough is equipped with a wheel at its lower extremity, which runs up an inclined plane; and the contact-shoes working on horizontal axes pass through the slot by being depressed to a vertical position. The wheel then runs in the groove of the wheel rail, and it is raised clear of the track by the turn on a crank given by the motor-man. At the same time the conductor loosens the bow sliding-trolley, and the operation is complete. The entire change can be made without stopping the car. No more perfect contrivance to accomplish this purpose could be devised. In Brussels the plough is raised by the motor-man, the inclined-plane feature being discarded. A wheel-trolley is used so that a stop is necessary to catch the trolley wire.

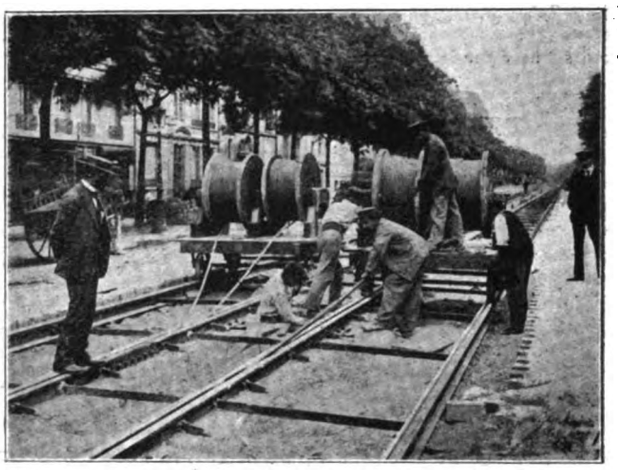

FIG. 20.—METHOD OF LAYING FEEDER CABLES IN CONDUITS, PARIS.

Both of these systems involve the use of what the French call "clapets," which in English may be called "flappers." These are hung on horizontal axes around which is a coil spring, one end of which is fastened to the fixed axis and the other to the flapper. The springs make the flappers press against the conductor-bars. The contact may be made on the vertical or the upper face of the bars according to the way the road is designed. The flappers are not thick—in fact, the whole construction of the plough is very much cramped, for it must pass through the 1¼in slot. The plough of this form is withdrawn easily, but it has to be specially weighted to make it descend, for it has only its own weight to overcome the tension of the flapper springs, so that they will take the vertical position necessary to pass through the slot.

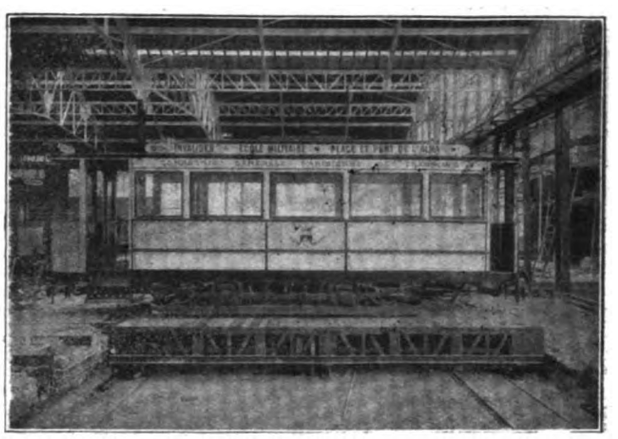

FIG. 21.—CAR EQUIPPED WITH PLOUGH-APPARATUS (FIG. 19).

There could be no good reason for not adopting one of the above plough designs for a side-slot conduit with 1¼in. slot—for a centre-slot, with ⅜in. width, their use is out of the question—if no other complications were involved; but the plough is one of the most difficult problems connected with the conduit system. The successful installation of two bare conductors in an open slot-conduit is not as serious a matter as to take the current from these bars through the slot to the car motor. A plough must be strong enough mechanically to resist the shocks and wear-and-tear of ordinary usage, while not so strong but that it will yield before injuring the conductor-bar system in case of an accident. At the same time, it must be electrically efficient under the most difficult conditions imaginable; bare collectors of current are connected to leads, which

* Paper read before the Institution of Mechanical Engineers, March 15.

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must be covered with insulation and mechanically protected by metallic wearing-plates, the total width of which do not exceed ½in., with a ¾in. slot, this being the ordinary condition with a centre-slot conduit. The plough is often drenched with water and covered with slime and mud, which run down its sides from the open slot. The conditions are certainly severe for an apparatus to carry successfully a 500 volt circuit. No form of plough yet designed is so perfect that any of its advantages may be sacrificed to gain other features, which can by any means be dispensed with. In the author's opinion the design of the plough should have the first consideration, and the conduit and special apparatus connected with a road should be built "around" the plough as the base.

The flapper form of plough construction is weak mechanically. The friction of, and shocks due to, uneven joints in the conductor-bars tend to twist the flappers about their horizontal axes. At the points where the bars are interrupted, such as at slot switches or at

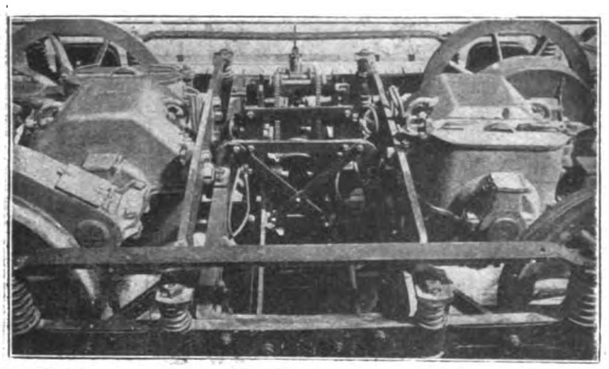

FIG. 22.—TRUCK OF CAR (FIG. 21) EQUIPPED WITH PLOUGH-APPARATUS.

crossings, the shocks of this nature are very considerable. In actual practice the flappers are often wrenched off at these places. When released from their fixed position against the conductor-bars the flappers take a position which is variable, depending upon the tension of the coil springs, which, naturally, cannot always be the same. A warped surface extension-piece has to be fastened to the ends of the conductor-bars, to guide the flappers to their normal position against the bars, These pieces give considerable trouble, and their use should be avoided, if possible. This form of construction does not permit the use of a fuse to connect the contact-shoe with its lead; consequently, a short-circuit in the body of the plough, not being protected by the car fuses, would short-circuit the line, and thereby stop the car traffic until the faulty plough could be discovered and raised out of the slot. The author believes it to be indisputable that other forms of plough are much more efficient, but

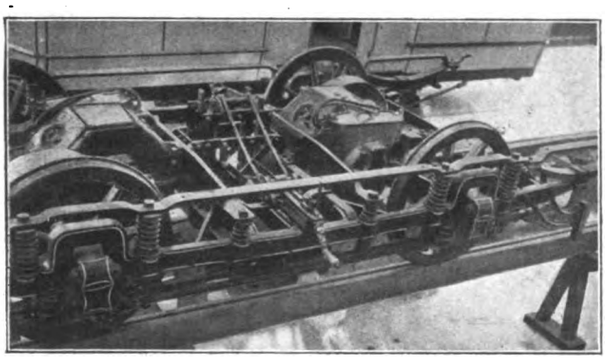

FIG. 23.—ANOTHER VIEW OF THE SAME.

none of them have the advantage of being able to be withdrawn from or lowered into the conduit without a special trap construction at a fixed point. Nevertheless, if the reasoning above given is true, one of these types of plough should be adopted, and it could be only a question of choosing the best existing one and improving it.

In the light of present experience, the best plough is one having soft cast-iron shoes, pressed lightly against the vertical faces of the conductor-bars by semi-elliptic springs horizontally placed. The shoes preferably should be carried by horizontal links, which take all the shocks to which they may be subjected, leaving the springs free to do the work only of pressing the shoes outwardly. In this way the risk of deforming the springs is avoided. The links should be constructed so as to limit the outward course of the shoes. The conductor-bars at switches and crossings are simply curved slightly outwardly. The shoes are connected to the leads by copper fuses. This plough construction is simple; in actual results it has proved itself to be efficient. It certainly is an improvement upon the "flapper" type. The trap construction in its simplest form would be one in which the lids required to be lifted before the arrival of the car, and to be put back in place after its departure. This would be rightly considered a crude and laborious operation. Fig. 18 shows a form of trap which is operated after the car has reached its position. One throw of the lever opens the trap, which is so counter-weighted that the effort necessary for this is almost inappreciable. This trap construction has given excellent results in France, where 40 of them are in operation. Where the flapper form of plough is used the plough is lifted by means of an apparatus similar to a brake-staff, which is placed on the platforms. The plough is connected to this staff by means of cables, which are guided by conveniently located sheaves. On account of the width of slot of the side-slot conduit, made necessary by the fact that it must be wide enough for the wheel flanges, the flapper form of plough has only been adopted for this construction of conduit. The ploughs are raised in guides attached to the side frames of the truck. In Brussels and Berlin the ploughs are not mounted on slides permitting a lateral motion across the car. The two slots of a double-track construction being located on the interior rails, it is necessary to carry two ploughs with a raising and lowering mechanism for each. If the requirements of the road demand cross-over switches from one track to another, a third conduit is necessary for a short distance at such points. The deviation of the slot to the centre with the necessary plough-carrier construction entirely obviates the difficulty of two ploughs and of a third conduit. The use of the slides seems to the author to be a valuable feature of conduit electric railroads for the various reasons that have been given in the Paper. Therefore, the following explanation of a raising and lowering device for the plough which will permit this sliding feature is given in detail. Fig. 19 gives three views of such an apparatus. A are the side bars, B the top bar of the truck, and C the brake-rods, which must be placed outside the wheels, as here shown. D is the plough shown in position on the side-slot conduit; it slides from this position to that of (1) on the centre slot, or of (2) the position of the slot of the other track when crossing from the

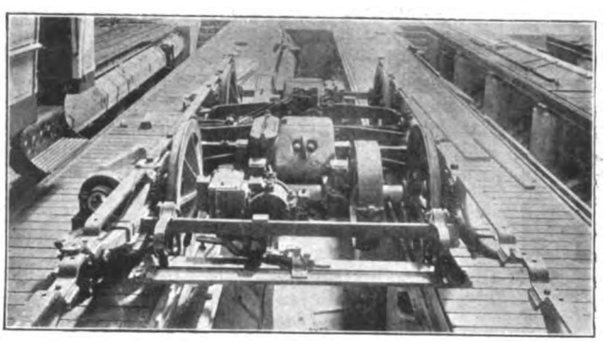

FIG. 24.—ANOTHER VIEW OF THE SAME.

interior conduit on one track to the similarly placed conduit on the other track. The slide-ways are shown by the bars E. The bars F prevent the plough raising or tilting in the conduit, except in the central position (1), where the casting G, held in position by the lock H, performs the same function. The sliding-bars are held in position by the steel castings I. The projecting central piece J, braced as shown, holds the plough in its raised position. The whole apparatus is supported by the channel beams K, which are bolted to the side-barf of the truck. In this way the vertical variation in height is limited to the small movement in the journal-box springs of the truck. The plough is raised in the following manner:—The fixed screw L is turned by means of a removable crank placed at M; the block N makes the course from one end of the screw to the other. In the figure the block is in its position with the plough raised. This piece carries the two rollers O, over which heavy link chains run. The latter are stationarily fixed at one end P, and at the other end to the casting G. The piece G is raised by an amount which is twice that of the course of the block N. The latch R automatically locks the block N in place when it reaches the end of its course. This prevents the trepidation of the truck from lowering the plough when it is in its raised position for the overhead-trolley section of the road. The box S covers the double-pole switch which puts the car leads in circuit, with the overhead or the conduit line as the case may be. This is done automatically with the raising or lowering of the plough by means of the rod T, which is moved by the block N when this is near the end of its course in each direction. Fig. 21 is a photographic view of a car equipped with this plough apparatus. It is given to show that externally the whole apparatus is nearly invisible. Figs. 22 and 23 are side views of the truck alone so equipped, and Fig. 24 is an end view of the same truck. The author is indebted to Mr. E. W. Mix, the chief engineer of the Société des Établissements Postel-Vinay, of Paris, for his invaluable assistance in the design and manufacture of the apparatus above described. That it has been successful is largely due to his efforts.

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It is a good plan to form the piece M so that it will only fit a controller-handle, which can only be removed from the controller on the "off" position. In consequence, if the handle is used to raise or lower the plough there can be no movement of the controller until the operation is finished. Generally there are two traps at the junction-points of the two systems, one for each track. The conductor of the car can operate the trap, but it is preferable to have a man specially stationed for the purpose, if the car traffic is at all frequent. In practice the operation is as follows: When the car has stopped with the plough over or under the trap—a mark on the track gives to the motor-man the exact position to stop—the motor-man gives his controller-handle to the trap-man who opens the trap, and lowers or raises the plough, closes the trap, and returns the handle to the motor-man. At the same time the conductor lowers the trolley from or raises it to the trolley wire. The whole operation takes on the average 10sec. when the men become accustomed to it. If these junction-points coincide with regular stopping places to load or discharge passengers the loss of time due to this operation is inappreciable. The only arcing at the conductor-bars and at the automatic switch S, is that due to the lighting circuit. This

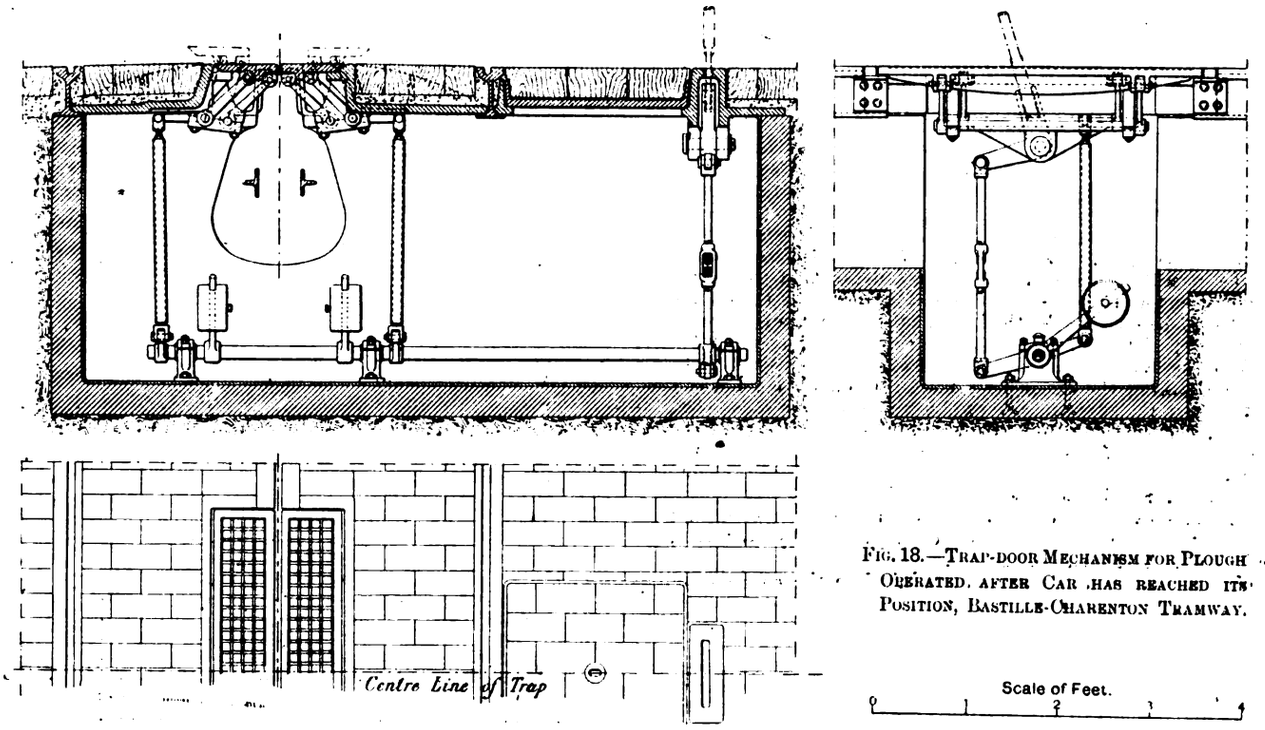


FIG. 18.—TRAP-DOOR MECHANISM FOR PLOUGH OPERATED AFTER CAR HAS REACHED ITS POSITION, BASTILLE-CHARENTON TRAMWAY.

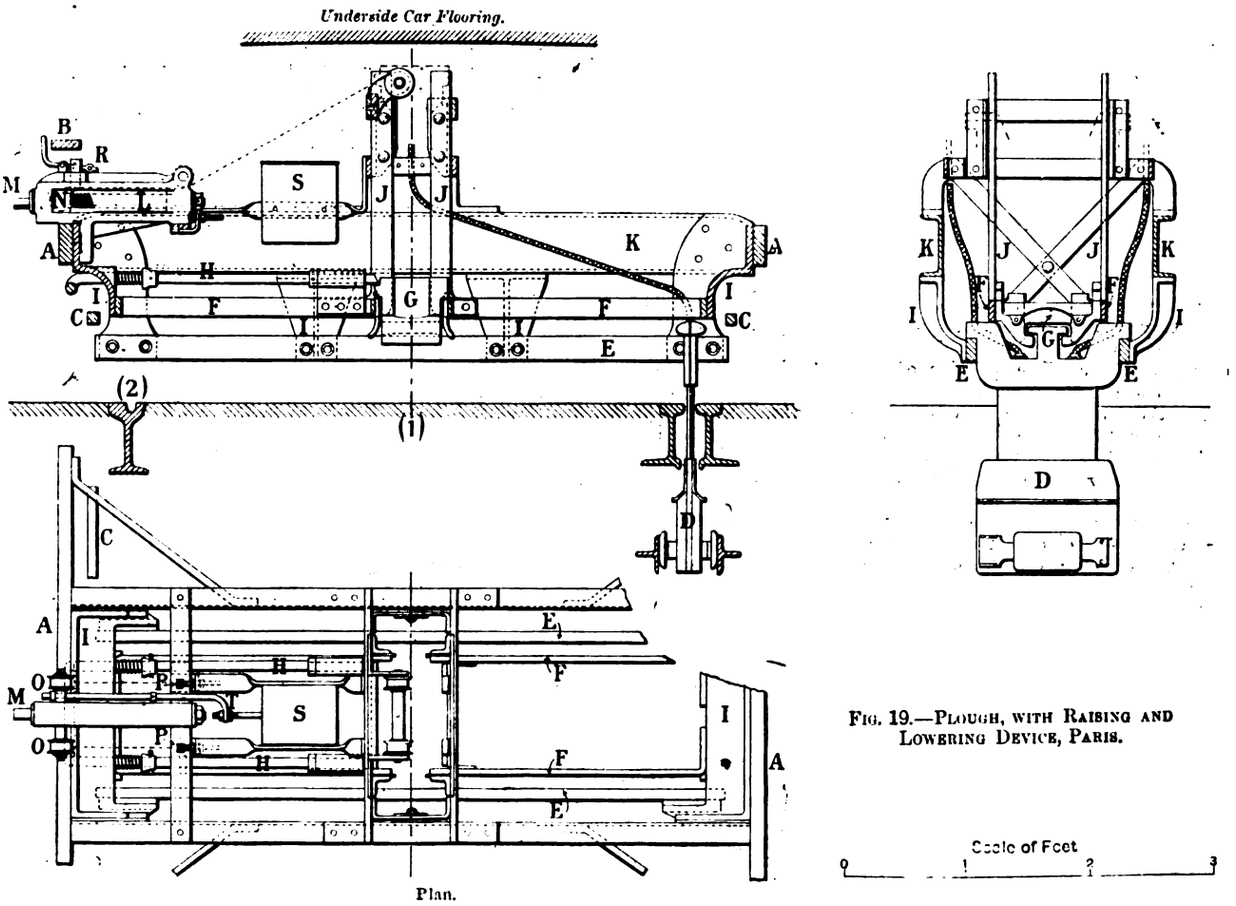


FIG. 19.—PLOUGH, WITH RAISING AND LOWERING DEVICE, PARIS.



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is too small to have any injurious effect upon the plough-shoes, and the construction of the switch with a quick break is such as to remove any danger there also. If electric heaters should be used requiring rather large currents it might be necessary to cut them out of circuit during this operation. The car wiring for the mixed system is only slightly more complicated than for one system alone. The conduit-circuit being completely insulated the ground-wire must be removed from the controller. Two wires are run from the controller to two points on the double-pole switch S. These two points are thrown in by the switch with one pair of points connected to the two plough leads or with another pair connected to the trolley-pole and the earth.

In the electrical apparatus the only special precautions to take due to the use of conduit is, first, to have the field coils insulated for 500 volts. With an overhead line the difference of potential between the field and the carcass of the motor is that due to the drop in the fields. But with the conduit it can happen that one pole of the conduit circuit is grounded, and that the fields are directly connected with the other pole. This would give 500 volts difference of potential between the carcass of the motor and the field winding. All standard motors should stand this condition, but it should not be omitted to be specified by the buyer. Second, when electric brakes are used, special insulation precautions are vitally necessary for the brake coils. A grounded conductor bar can subject these to 500 volts pressure during the entire time the car is on the conduit section. Not only is the annoyance due to burning up of the coils to be considered, but also that due to the short-circuiting of the line. An interruption of this kind is overcome by lowering the line voltage by means of a rheostat at the station, so that a current the amount of which is controllable at the switchboard may be sent through the fault. This excessive current will burn the plough fuses, thus clearing the line at the expense of leaving the faulty car "dead," to be hauled in by the succeeding one.

With a combined trolley and conduit line the conduit section should have a separate circuit. It may be possible to operate it successfully with a grounded return, but few engineers would care to propose it. It is much better to increase the operating factor of safety by having both sides of the circuit insulated. In case the conduit section or sections are reasonably close to the power-station, this may be done with a separate dynamo located there for the conduit circuit or by means of a motor generator. If the cost of the leads to the conductor rails from the station is excessive, the motor-generator set may be stationed near the conduit section, and operated from the overhead circuit. The proper solution may be one of many different ones depending upon the local circumstances governing a specific case. As a result of actual tests it has been found that the conductor bars of mild steel electrically connected with two bonds at each joint have a carrying capacity of about one-eleventh of copper bars of the same cross section. These bars can be largely increased in electrical carrying capacity by attaching to them bare copper cables for this purpose. It can be readily seen what an economy this method affords over that of laying insulated cables in ducts. Fig. 20 is a view of the method of laying these cables as employed in Paris. The cables there shown have a cross section of 250 sq. mm., or about 500,000 circular mils. The cables are electrically connected to the bars at very short distances apart to avoid electrolytic action between the two metals.

*Cost of Conduits*.—The question of the cost of conduits must be treated in a general way, local circumstances being such a large factor in the determination of cost that no other method is possible. Some notes as to details of cost will be found in Appendices I. and II. The side-slot conduit can be built for about £500 less per mile of single track than the centre-slot. In the special work there is an economy in the side-slot also as ordinarily built, as there are fewer frogs with three rails than with four. But if the slot is deflected to the centre, at has been recommended in the Paper, the economy cannot be realised; on the contrary, the cost will be somewhat greater, due to the cast-steel deflecting pieces and the bent slot-rails. It is generally stated that a conduit road costs twice as much as an overhead-trolley road. This statement may be misleading, owing to the fact that an overhead-trolley road may be very variable in its cost, depending upon pavement requirements, overhead construction adopted, and many other local conditions, such as the regulations for the return current by the rails. But the construction of the conduit part of a road is quite independent of these factors—that is, for an overhead-trolley road which would cost £5,000 per mile of single track it is quite probable that the same road with the conduit construction would cost £11,000 for the same length—that is, the conduit properly speaking would cost £6,000 in excess of an overhead trolley road. If the overhead trolley line should have a first cost of £10,000 per mile of single track, there is no reason why the use of a conduit on such a line would double the cost, as in the first instance. Roughly speaking, the cost of a conduit in this latter case would be £16,000. To arrive at an approximate comparison of the cost of the two constructions, it is fair to assume that the cost of paving and of the wheel rails is the same in both cases. For the conduit there should be added per mile of single track approximately the following material and labour:—105 tons of slot-rail, 40 tons of conductor rails, 210 tons of cast iron, £120 excess for bolts, &c., porcelain insulators £35, 1,400 cubic yds. excess excavation, 1,200 cubic yds. of excess concrete, £600 excess labour for track laying, £400 sewer connections. Crossings, turnouts, and special track work in general cost 200 per cent. more on an average for the conduit than for ordinary track. A cost which is wholly indeterminate is that of removing sub-surface obstructions. This, as has been explained, can be often reduced by varying the conduit depth to suit special cases.

Considering alone the items above enumerated they will amount to between £5,500 to £6,000. Deducting the cost of an average overhead construction, it can roughly be said that a conduit road will cost from £5,000 to £5,500 more per mile of single track than a trolley road under the same conditions, to which should be added the increased cost of special track work and the removal of underground obstacles. Under ordinary conditions the difference in cost will vary between the limits of £7,000 and £9,000.

## APPENDIX I.

*Details of cost in United States*.—Table I. gives the actual cost per single-track mile of the conduit roads installed by the author in 1895-6 for the Metropolitan Railway Co., of Washington, D.C.

*Cost of Metropolitan Railway Co., Washington, D.C.*

Straight track ..... 101,660ft.
Curved track ..... 9,190ft.

110 850ft.—say 21 miles of single track.

| | | | | | |
|---|---|---|---|---|---|
| Rails and splice bars— | | | | | |
| Wheel-rail | £5 | 15 | 0 | per ton. | |
| Slot-rail | 6 | 8 | 6 | ,, | |
| Guard-rail for curves | 9 | 10 | 0 | ,, | |
| Conductor-rail | 8 | 8 | 0 | ,, | |
| Joints complete | | 4 | 10 | each. | |
| Per mile single track | | | | £1,858 | 6 8 |
| Cast-iron (yokes, insulator frames, covers, &c.), 215·5 tons at £5. 15s. 7d. | | | | 1,245 | 8 2½ |
| Bolts, tie-bars, clips, &c. | | | | 312 | 10 0 |
| Bonds for conductor rails | | | | 97 | 18 4 |
| Track laying (all labour and hauling) | | | | 589 | 3 4 |
| Temporary track | | | | 33 | 6 8 |
| Excavation of all kinds, except for cable ducts, 2,507 cubic yds. at 3s. 10¾d. | | | | 488 | 6 10 |
| Sewer pipes laid and brickwork for duct manholes | | | | 99 | 7 6 |
| Cable ducts:— | | | | | |
| 10,616ft. 12-way duct at 4s. 9½d. | | | | | |
| 41ft. 8 ,, ,, 3s. 6½d. | | | | | |
| 21,354ft. 4 ,, ,, 2s. 2½d. | £4,894. 3s. 9d. | | | 233 | 1 1 |
| 113ft. 2 ,, ,, 1s. 5d. | | | | | |
| Excavation for cable ducts, 9,207 cubic yds. at 3s. 4d. = £1,534. 10s. | | | | 73 | 1 5½ |
| Concrete, first grade, for conduit (1 barrel Portland cement, 12 cubic ft. sand, 22½ cubic ft. broken stone), 765 cubic yds. per mile at £1. 9s. 2d. | | | | 1,115 | 12 6 |
| Concrete, second grade, for paving base, &c. (1 barrel Cumberland cement, 10 cubic ft. sand, 20 cubic ft. broken stone), 514 cubic yds. per mile at 18s. 1d. | | | | 464 | 14 10 |
| Stone paving, using old setts— | | | | | |
| 42,126 sq. yds. at 3s. 3d. | £6,845 | 9 | 6 | | |
| Asphalt pavement— | | | | | |
| 91,716 sq. yds. at 6s. 0¼d. | 27,705 | 17 | 6 | | |
| | 34,551 | 7 | 0 | 1,645 | 6 0 |
| Special track work and curves | | | | 783 | 6 8 |
| Extra bills of street contractor | | | | 239 | 11 8 |
| Removal of sub-surface obstructions | | | | 656 | 13 4 |
| Total cost per mile of single track | | | | £9,945 | 15 1 |

The metallic structure cost less at that date than it would now. The temporary track is a very low item, the authorities having permitted a flat strap-rail to be laid on the pavement (mostly asphalt) by means of flat tie-bars with special seats at their extremities. It should be stated that this city is an exceptionally favourable one for the construction of conduit roads, the streets being wide and with little traffic upon them, and the supervision being that of the thoroughly trained engineers of the United States Army.

The author has been given a pamphlet containing some diary notes kept by Mr. William C. Gotshall, engineer in charge of construction of the Second Avenue Railroad Co., of New York. The pamphlet concludes with the following estimate of the cost of this road per mile of single track. It should be stated that this estimate is not Mr. Gotshall's, but the work of the compiler of the pamphlet:—

*Total Cost per Mile of Single Track, Open Conduit System, Second Avenue Railroad Co, compiled from Diary of W. C. Gotshall.*

| | | | |
|---|---|---|---|
| Labour, digging trough, removing old track, repairing concrete, removing excess dirt, hauling all track work, £1. 10s. 11½d. per linear foot | £8,173 | 0 | 0 |
| Insulators, 5s. 8d. each | 199 | 9 | 7 |
| Ironwork, excluding yokes, 7s. 4d. per linear foot | 1,375 | 7 | 0 |
| Cost of iron yokes, 224·7 tons at £5. 4s. | 1,168 | 8 | 10 |
| Concrete ⅔ cubic yd. per linear foot, 8s. 2d. per yard | 808 | 10 | 0 |
| Haulage on yokes and iron work | 117 | 1 | 8 |
| Total, without paving | £11,841 | 17 | 1 |

The above total does not include cost of feeder duct.

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In comparing this cost with that of the Washington conduit it should be borne in mind that the items of cost of special track work, feeder ducts, paving, bonds, sewer connections, temporary track, are not included in this estimate, while they are in the Washington costs (Table I.).

The cost of concrete is put down at 8s. 2d. per cubic yard. This low cost is evidently an error of compilation. Other information in the pamphlet seems to prove that this cost should be from two and a-half to three times this amount.

APPENDIX II.

*Estimated Cost in England.*—The author ventures to submit the following estimate of cost per single-track mile in England at ruling prices of material and under fair average conditions. The construction here figured upon is a centre slot conduit with yokes spaced 3ft. 6in. centre to centre; the yokes of the same weight and general dimensions of those used on the Paris lines. Yokes need not be inordinately heavy, but they should by all means be close together to preserve the slot width, a much more important matter for a conduit electric than for a cable road.

*Estimated Cost of Single-Track Mile of Conduit Electric Tramway in England for Average Conditions (December, 1900).*

| | | | | | | |
|---|---|---|---|---|---|---|
| Wheel-rails, 90lb., 141 tons per mile at £7 | £987 | 0 | 0 | | | |
| Joints, 0·67 ton at £8 | 5 | 8 | 0 | | | |
| Slot-rails, 66lb., 105 tons at £8 | 840 | 0 | 0 | | | |
| Conductor-rails, 28lb., 44 tons at £8 | 352 | 0 | 0 | | | |
| | | | | £2,184 | 8 | 0 |
| Haulage, 290·67 tons at 4s. | | | | 58 | 2 | 0 |
| Bolts, washers, keys, &c., 4·16 tons at £18 | 74 | 18 | 0 | | | |
| Tie-bars, 13·5 tons at £15 | 202 | 10 | 0 | | | |
| | | | | 277 | 8 | 0 |
| Insulators complete with clip, 755 at 6s. 2d. | | | | 232 | 16 | 0 |
| Cast yokes and insulator pit covers:—Yokes, 210lb. each, spaced 3ft. 6in. centre to centre, 210lb. × 1,510 = 317,100lb. = 141·5 tons. Insulator pit covers, 117lb. each. 755 × 117 = 88,335lb. = 39 tons. Total 181·5 tons at £10 | | | | 1,815 | 0 | 0 |
| Haulage, 181·5 tons at 4s. | | | | 36 | 6 | 0 |
| Bonds | | | | 110 | 0 | 0 |
| Concrete for tube, 1 cement, 2½ sand, 5 stone, 0·2 cubic yd. per 1 linear ft. 5,280 × 0·2 = 1,056 at £1. 8s. | | | | 1,478 | 8 | 0 |
| Concrete for paving, 1 cement, 3 sand, 6 stone, 0·10 yd. per 1 linear ft. × 5,280 = 528. 528 × £1. 4s. | | | | 633 | 12 | 0 |
| Wood paving, 6,373 sq. yds. at 11s. | | | | 3,505 | 3 | 0 |
| Excavation, 2,950 cubic yds. at 5s. | | | | 737 | 10 | 0 |
| Sewer connections and manholes for same | | | | 400 | 0 | 0 |
| Plate laying, including average amount of special track work, 5,280 at 3s. | | | | 792 | 0 | 0 |
| Temporary track (one track laid and re-paved on side of street with turnouts) at £1,350 per mile of street (divided into two tracks for double track construction) | | | | 675 | 0 | 0 |
| Special track work of cast-steel construction with hardened centres | | | | 1,128 | 0 | 0 |
| Obstructions (necessarily very indefinite) | | | | 1,000 | 0 | 0 |
| Feeder ducts | | | | 800 | 0 | 0 |
| Extras and contingencies | | | | 630 | 0 | 0 |
| | | | | £16,493 | 13 | 0 |

Certain costs, notably those for temporary track, feeder ducts, obstructions, special track work and curves, must be largely hypothetical, but the author believes that for average conditions and for this type of construction this figure will be reasonably safe, except for the item of sub-surface obstructions. This may be small or again inordinately large, depending upon local circumstances. In closing, the author wishes to emphasise one point, the transmission system for a conduit road being wholly an insulated one can be calculated for the most economical drop of potential, which is not the case of an overhead line with rail return. Considerable saving, either in copper or boosters, or both, can so be effected, which should be put to the credit of the conduit system in any estimate of the cost of such a system.

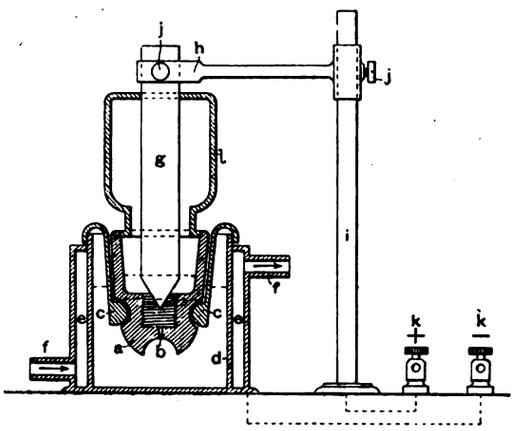
## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Resistance of Pure Metals.*—E. van Aubel criticises the various values put forward by Dewar and Fleming for the resistivity of bismuth, nickel, and tin. Nickel prepared from nickel carbonyl shows very nearly twice the resistivity found by Fleming for electrolytic nickel. This discrepancy is so serious that it may well be asked whether the chief conclusion arrived at by the English physicists—viz., that the resistivities of all metals converge upon the absolute zero of temperature and there become zero themselves—can be maintained. In other metals, too, there are divergencies from this supposed rule—for the resistance of platinum, silver, copper, and iron would have to disappear at −258, −248·4, −223, and −223deg. respectively.

[E. van Aubel, *Phys. Zeitschr.*, March 23, 1901.]

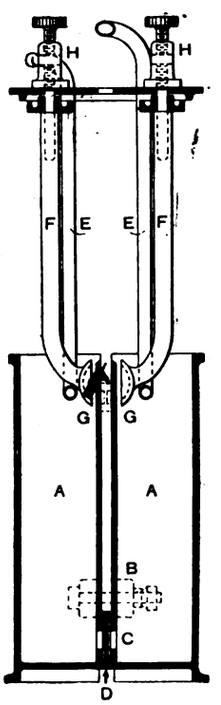
*New Electrolytic Interrupter.*—In consequence of the rapid deterioration of all the interrupters hitherto devised, including the mercury-jet and the Wehnelt interrupters, John Härden was led to devise the pattern illustrated in the diagram, where *a* is a cup insulator of porcelain in which the inner mantle is removed and a hole *b*, 1·5mm. wide, is bored through the bottom. By means of a ring, *cc*, of lead the insulator was suspended in a cylindrical lead vessel *d*, surrounded by a cooler *e*, in which water circulated through *ff*. The vessel *d* formed the cathode, while a strip of lead, *g*, represented the anode, and could be mounted at any height desired. The electrolyte was dilute sulphuric acid. To prevent the latter spurting out, an inverted bottle *l* with a




wide neck and a perforated bottom was placed over the insulator. The arm *h* and the stand *i* were of brass coated with lead. The number of interruptions was 70 to 80 per second, and the spark-length 40cm. After several weeks continuous use the apparatus has shown no sign of wear, and if it did, the cup could easily be replaced by another.

[J. Härden, *Elektrotechn. Zeitschr.*, March 21, 1901.]

*Improved Simon Interrupter.*—To obviate the disadvantages attending the wearing out of the perforated wall in the Simon




interrupter, E. Ruhmer divides the electrolytic vessel into two semi-cylindrical portions AA, joined by means of screws B and communicating through a narrow channel, C, which is further narrowed by the introduction of a perforated porcelain plate, D. The electrodes FF are of lead, having the terminal portions GG widened out so as to nearly cover the channel C when let down into position. They are kept cool by the circulation of water through EE.

[E. Ruhmer, *Der Mechaniker*, No. 6, 1901.]

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*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London

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## THE EDUCATION AND TRAINING OF ENGINEERS.

Once again the question has been raised as to the most suitable method of educating and training youths for an engineering career. Mr. W. H. Maw, in his presidential address to the Institution of Mechanical Engineers, last Friday, devoted considerable time to a discussion of the subject, weighing our British system and finding it wanting. It may be disputed whether, in fact, there exists any specifically British system, or whether there are not in vogue in this country several programmes, each forming an irregular kind of system under the ægis of its own coterie of professors. Be that as it may, the system with which Mr. Maw dealt in his address is that in which the three stages of education and training are taken in the order: (1) School, (2) technical college, and (3) workshops. Broadly speaking, this is the course which best commends itself to us in general circumstances. We must protest, however—as we so often have had to protest to innumerable private correspondents—that there is no hard-and-fast rule. Frequently we receive letters asking advice as to the proper steps which the writer should take on behalf of himself or a son in order to qualify as an electrical engineer. In the vast majority of cases the scanty information afforded us makes the problem absolutely indeterminate. Each individual case must be judged on its own merits, both as to the intellectual and material means available and as to the end in view. General advice according to a hard-and-fast system is far more likely to do incalculable harm than to do any real good.

Mr. Maw, however, aims not so much at giving advice to individual aspirants to the profession, as at suggesting certain modifications in the educational system to which we have referred. His first criticism is that there is not a sufficiently easy and gentle transition between each stage and the next one. "To use a railway metaphor," he says, "the technical college may be regarded as a kind of cross-over road, diverting the student from the line of scholastic training to that of

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independent thought and action," and he advocates that this transition should be without "shock, with its consequent loss of energy." By the way, we may observe that shock, in mental affairs, is quite as likely to stimulate beneficially as to cause loss of energy; the really thoughtful youth often gains by the sudden change in the conditions of working, when passing from school to college or from college to workshop. "Shock" of this kind is often a stimulus to greater freshness of thought. A more serious criticism of Mr. MAW's suggestion, however, is that it is impossible to arrange the curriculum of a public school to suit specially the subsequent career of each of the scholars; nor, if possible, would it be judicious to do so. Mr. MAW does not stand alone among educational reformers in forgetting, or at any rate ignoring, the fact that the fitness of a boy for an engineering or other specific career is not usually manifested until he is well on with his school studies; indeed, in a too numerous class the special bent is even more belated in revealing itself. Parents, we know, sometimes unwisely settle beforehand in their own minds on what career they will start their sons; but such cases may be left out of consideration, as they tend naturally to swell the mass of educational failures. Given, then, a boy entering the upper half of a public school, how is the headmaster or the boy's parents to decide whether to develop his classical studies, in preparation for a possible seat on the Woolsack, or his scientific and mathematical studies, in preparation for a possible career as an engineer. At best, they can only do so on broad lines; and Mr. MAW is doubtless aware that most of our public schools provide both a "classical" and a "modern" side. At the age and degree of intelligence at which a boy usually enters the upper half of such a school, it ought to be possible to discover whether of these two "sides" is the better suited to his bent; but it is rarely possible to decide anything more definite. Extremely fortunate it is, too, that it is impossible to decide more definitely at so early a stage; it would be nothing less than calamitous for specialisation to be introduced before the public school general education is completed. This stage of education should be on the broadest and most liberal lines, unhampered by the fetters of specialisation.

Passing from the school to the technical college, Mr. MAW considers that towards the end of the college course of studies there should be a finer degree of specialisation than is now customary:—

> This means that our college authorities must take a wider view of their responsibilities than many of them at present do. It would also probably mean, in the future, that certain colleges would acquire a reputation for certain branches of work; and, in order that full effect might be given to this development, it might possibly be desirable that arrangements should be made whereby a student could, after passing through the early stages of his course—and after arriving at some decision as to the character of his future career—be transferred from one college to another for the completion of his special instruction.
>
> For some branches of our work, our colleges, as they exist, afford an admirable training. Thus the principles of steam-engine construction and working are usually very fully taught, and the student is rendered familiar with modes of testing both materials and motors, and other kindred matters. The result is that a student, entering works where steam engines are built, at once feels more or less at home; and he acquires a knowledge of shop work much more quickly and easily than he would have done had he not had his previous college experience. But the young engineer who enters some less-known branch—say, for instance, the construction of ordnance, of textile or milling machinery, or even of machine tools, such as are used in advanced practice—finds himself on far less familiar ground, and greatly in want of preliminary special training. In fact, he feels himself in the position which I have already referred to as so undesirable—namely, that he has spent time acquiring knowledge which is of little immediate practical use to him, and that he has done this at the expense of not learning things which he badly wants to know. Of course, it is quite impossible for the educational equipment of our technical colleges to comprise plant relating to more than a very restricted number of branches of mechanical engineering work, while the knowledge of a staff of professors and the variety of the training they are capable of imparting are necessarily finite; but, notwithstanding this, it will, I believe, be found possible to do much more than is now generally done to give a special character to the final stages of a college course, and to encourage students to take a wider view than most of them now do of the possibilities of the career upon which they are entering.

The foregoing scheme of Mr. MAW's is quite impracticable; no technical college could adopt it and live—unless heavily subsidised. Nor is it the function of a technical college to give instruction in those refinements of detail which differentiate the work of a machine-tool manufacturer from that of a maker of weaving looms or printing presses. College students are not prepared to specialise to that extent as a rule. Besides, there is as much difference between one kind of textile machinery and another kind as there is between a gas engine and a cannon. The proper function of an engineering college is, not to teach a heterogeneous mass of separate trades, but to educate and instruct prospective engineers in principles and their application. Principles, broad principles—let technical colleges take care of the principles, and the workshops will take care of the practice. There are, of course, certain broad sub-divisions which it is necessary to make, such as the usual division into civil, mechanical, and electrical engineering; but the excessive refinements of specialisation advocated by Mr. MAW tend to create mental machines rather than broad and intelligent thinkers, and the inevitable result of that is to stereotpye and stagnate the branch of engineering to which it is applied. We hold that a thorough knowledge of the properties of engineering materials, in relation to stress, strain, and other related conditions, and a thorough grasp of the principles of structural design, are as calculated to fit a student to enter the workshops of a maker of textile mills as to enter a bridge-building yard. To go beyond this is to arrogate to the technical college a function that properly belongs to the final, or workshops, stage; and this dislocation of functions cannot take place without proportionate injury to the efficiency of the technical college as a factor in the education and training of engineers.

## OBITUARY.

### HENRY AUGUSTUS ROWLAND.

We deeply regret to announce the death last week, at the age of 53 years, of Prof. H. A. Rowland, professor of physics at the John Hopkins University, U.S.A. His death removes from the ranks of physicists one of their most brilliant thinkers and versatile experimenters.

Henry Augustus Rowland was born at Honesdale, Pa., on November 27, 1848. His father, the Rev. H. A. Rowland, was a distinguished pastor in the Presbyterian Church of America. At the age of 21, Rowland graduated as a civil engineer at Troy, and shortly afterwards engaged in railroad surveying. In 1892 he returned to his *alma mater* as instructor in physics, being appointed assistant professor two years later. During this period of his life he commenced researches on magnetism, and completed his now famous experiments on magnetic permeability, which, however, were not published until somewhat later. The scientific journals of America at that time did not appreciate his researches, and rejected his articles, but he sent the latter to Clerk Maxwell, who, at once recognising their merit, communicated them to the *Philosophical Magazine*. Thus, gradually becoming known in scientific circles, Prof. Rowland succeeded in obtaining the chair of physics and the directorship of the physical laboratory at the newly-founded John

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Hopkins University at Baltimore, a position which he retained continuously until his lamentable death.

Professor Rowland's researches extend over almost the entire range of physical science, and are too numerous to mention in detail here. But the work for which he is probably best known is in connection with the construction of his diffraction gratings for optical work. Although he liberally published to the entire world the details of the intricate method by which he succeeded in ruling, with practically absolute parallelism, as many as 15,000 lines to the inch in these gratings, no one has yet succeeded in attaining the same degree of skill in their manufacture as did the inventor himself. In connection with the development of the machine tools for the ruling of these delicate gratings, it became necessary to investigate closely the theory and construction of screws, and this led to a valuable article on the subject which was contributed by Rowland to the ninth edition of the "Encyclopædia Britannica." It is almost superfluous to state that Prof. Rowland was a prominent member of the chief scientific societies throughout the world. He was a Foreign Member of our own Royal Society, and Member of the Institute of France and of the Royal Society of Göttingen. The French Government made him a Chevalier of the Legion of Honour.

## THE NERNST LAMP.

We have received from the Allgemeine Elektricitäts Gesellschaft a circular describing the 100 and 200 watt Nernst lamps which this company intends shortly to place on the English market. This lamp, which is called "Model A," is intended to replace groups of glow lamps. It consists essentially of a filament, support, pendant, globe, and series resistance, and when lighting up of a parallel resistance for heating the filament, and a cutout for breaking the circuit of this resistance when the filament is sufficiently heated to act as a conductor. The filament can be easily replaced without damage if the porcelain disc fixed to it only is handled. The screw $s$ (Fig. 1) must first be loosened, when the whole burner can be withdrawn and a new one put in, a mistake being impossible, as the wire $a_1$ (Fig. 2) only fits into the tube $a$, and the wire $b_1$ into $b$; the operation is finished by the contacts $c_1$ and $c$ being brought together and the screw $s$ tightened. The general appearance of the lamp is shown in Fig. 3, and 100 watt lamps are at present made for 110 or 220 volts, but the 200 watt lamps have, so far, only been manufactured for 220 volt circuits.

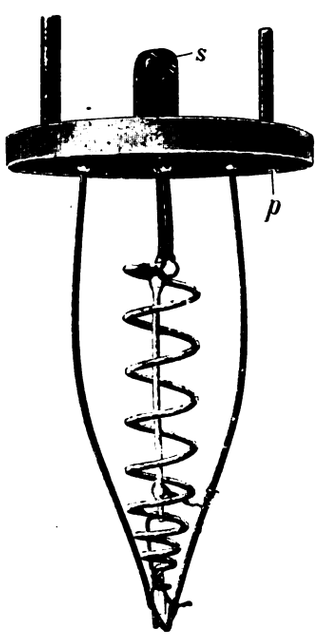


Fig. 1.—Nernst Lamp Burner Model "A." Three-quarter full size.

Fig. 2.—Nernst Lamp Model "A," with Globe and Hanger removed. One-quarter full size.

The makers in the following figures compare the yearly cost of carbon filament and the Nernst lamps:—

"Model A."—One 100 watt 65 c.p. Nernst lamp replaces four 50 watt 16 c.p. glow lamps.

At a price of 55pf. (6·6d.) per kilowatt for 600 hours yearly consumption the cost of four carbon filament lamps is:—

$$\frac{200 \times 600 \times 55}{1{,}000} = \text{M66}$$

Replacing four lamps at 55 pf. = 2·20

68·20 (£3. 8s. 2d.).

Nernst lamp $\frac{100 \times 600 \times 55}{1{,}000} = \text{M33}$

Replacing two burners at M2 4

37 (£1. 17s.).

That is, there would be a saving in the year of 45·75 per cent. The makers also give figures for the 200 watt lamp showing a saving of 51·7 per cent. over 8·5 incandescent 16 c.p. lamps.

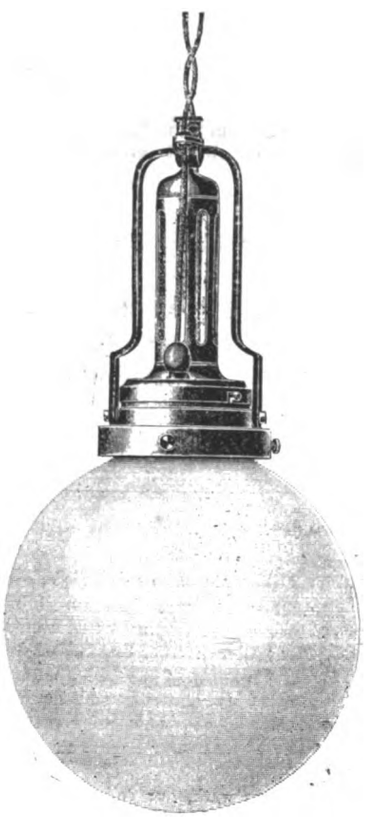

Fig. 3.—Nernst Lamp Model "A." One-quarter full size.

The first cost of the lamp is M12·50 for the 100 watt size and M14·50 for the 200 watt size.

The company is also working on 40 to 80 watt lamps, "Model B," and one of these may be seen at the show-rooms of its London office, the Electrical Company, 122, Charing Cross-road. The lamp is smaller, being 5½in. long, and the globe about 2½in. diameter, and at present they have candle-powers of 25 and 50 respectively. The company hopes to place these shortly on the market, but at present they are only to be had on hire in Berlin, where, according to Mr. Hammer (in a recent Paper before the American Institute of Electrical

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Engineers) a royalty of M3 a year is charged and 30pf. (3·6d.) for renewals. Mr. Hammer carefully watched 54 of these lamps installed in the Café Bauer, where he considered they had a much more pleasing effect than either carbon incandescent lamps or Welsbach mantles; but at the same time he noticed that from two to five lamps were usually out. Fig. 4 is a diagram showing the connections of a lamp, the electromagnet A being drawn to scale. When the current is switched on, the heating resistance B, which is made of fine platinum wire, about 46 to 50 B.W.G., wrapped on porcelain and then dipped in liquid porcelain, is in parallel with the filament C, which, of course, is almost a perfect insulator. As the filament gets heated it becomes a conductor, current passes through it and the electromagnet in series, the steel spring is attracted over, and the heating resistance circuit is broken at E. When the current is switched off the spring flies back, re-making contact at E.

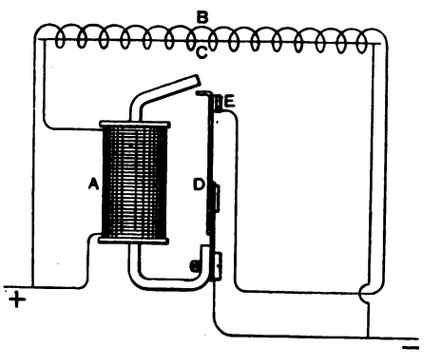


FIG. 4.—Nernst Lamp. Diagram of Connections.

The lamps are being made both for alternate and direct-current circuits, but so far they have only been manufactured with Edison sockets.

## THE APPARENT RESISTANCE OF A BALLISTIC GALVANOMETER OF THE MOVING COIL TYPE, AND A METHOD OF ALLOWING FOR THE DAMPING CURRENT.

BY DAVID ROBERTSON, B.SC.

(*Concluded from page 904, Vol. XLVI.*)

It is also necessary to take account of this phenomenon when using this type of galvanometer for condenser work if a shunt is employed. Suppose (see diagram on Fig. 4) that a quantity Q is discharged from the condenser, and that it would have produced a deflection $d_1$ if there had been no damping currents. The other letters stand for the same quantities as before. Then, making our former assumptions,

$$kd_1 = Q\frac{S}{G+S},$$

$$kd_2 = \frac{qd}{G+S}.$$

$$\therefore \quad kd = k(d_1 - d_2) = \frac{QS - qd}{G+S};$$

$$\therefore \quad Q = kd(G + q/k + S)/S. \quad . \quad . \quad . \quad (IX)$$

The correction still appears as the addition $q/k$ to the galvanometer resistance. This equation gives us a linear law between $d$ and $d/S$ when S is varied, viz.:

$$d = Q/k - G'd/S. \quad . \quad . \quad . \quad . \quad . \quad (X.)$$

Experiments were made with a shunted condenser, and the results are given in Fig. 4. They are in close agreement with those obtained by the method of equation III., and the curves are practically identical with those in Fig. 1. The values of G' given by these results, as well as those from the first method, are given in Table I.

When using an Ayrton-Mather shunt for condenser work the resistance of the galvanometer is not required when it is only the relative multiplying powers that are required, but the apparent resistance must be allowed for if the absolute multiplying power is to be calculated. For search-coil work it is in just the same position as an ordinary shunt.

The fact that the damping current lasts throughout the whole time of motion may be taken account of as follows:—

Let I = Moment of inertia of moving system.
$\tau$ = Controlling torque exerted by suspension with unit twist.
$q$ = Product of turns in coil and lines cut per unit angle of motion—*i.e.*, = Deflecting torque exerted by unit current in coils.
T = Time of complete vibration of coil (to and fro).
Q = Quantity of electricity passed through it.
$\omega$ = Angular velocity which it gives to the coil.
C = Current in coil at any time $t$.
E = E.M.F. in coil due to its motion.
R = Total resistance in galvanometer circuit, including its own (actual).
$\theta$ = Angular deflection of the coil from its zero position at any instant.
All in absolute measure.

We shall still assume that the quantity (Q) of electricity sent through the galvanometer from the outside source (search-coil or condenser) is all passed before the coil has moved appreciably from its zero position, and that the damping current is in phase with the E.M.F. producing it—*i.e.*, with the motion of the coil. During the passage of Q,

Deflecting torque $= qC$,

Angular acceleration $= qC/I$,

Angular velocity produced $= \omega = \int_0^t \frac{qC}{I}\,dt = \frac{qQ}{I}$. (XI.)

For the damping current,

$$C = \frac{E}{R} = \frac{q\frac{d\theta}{dt}}{R} = \frac{q}{R}\frac{d\theta}{dt}.$$

And the torque exerted is $qC = \frac{q^2}{R}\frac{d\theta}{dt}$.

The torque due to the suspension is $\tau\theta$, and hence the total torque opposing the motion is the sum of these, or,

$$-I\frac{d^2\theta}{dt^2} = \tau\theta + \frac{q^2}{R}\frac{d\theta}{dt}.$$

$$\therefore \quad \frac{d^2\theta}{dt^2} + \frac{q^2}{RI}\frac{d\theta}{dt} + \frac{\tau}{I}\theta = 0. \quad . \quad . \quad . \quad (XII.)$$

Let $2a = \frac{q^2}{RI}$, $\quad b^2 = \frac{\tau}{I}$. $\quad . \quad . \quad . \quad (XIII.)$

Then $$\frac{d^2\theta}{dt^2} + 2a\frac{d\theta}{dt} + b^2\theta = 0. \quad . \quad . \quad . \quad (XIV.)$$

When $a > b$ the solution is

$$\theta = A_1\epsilon^{(-a+\sqrt{a^2-b^2})t} + A_2\epsilon^{(-a-\sqrt{a^2-b^2})t}.$$

But $\theta = 0$ when $t = 0$. $\quad \therefore A_1 = -A_2 = A.$

$$\therefore \quad \theta = A\epsilon^{-at}\{\epsilon^{\sqrt{(a^2-b^2)}t} - \epsilon^{-\sqrt{(a^2-b^2)}t}\}. \quad . \quad . \quad . \quad (XV.)$$

$$\frac{d\theta}{dt} = A\epsilon^{-at}\left\{(-a+\sqrt{a^2-b^2})\epsilon^{\sqrt{(a^2-b^2)}t} + (a+\sqrt{a^2-b^2})\epsilon^{-\sqrt{(a^2-b^2)}t}\right\}$$

And $\frac{d\theta}{dt} = \omega$ when $t = 0$.

$$\therefore \quad A = \frac{\omega}{2\sqrt{a^2-b^2}} = \frac{qQ}{2I\sqrt{a^2-b^2}}. \quad . \quad . \quad (XVI.)$$

$\frac{d\theta}{dt} = 0$ when $(-a+\sqrt{a^2-b^2})\epsilon^{\sqrt{(a^2-b^2)}t} + (a+\sqrt{a^2-b^2})\epsilon^{-\sqrt{(a^2-b^2)}t} = 0.$

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**Table II.**—*The Function* $F=\left\{\frac{b+\sqrt{a^2-b^2}}{a}\right\}^{\frac{-a}{\sqrt{a^2-b^2}}}=\left\{\left[1+\sqrt{1-(b/a)^2}\right]a/b\right\}^{\frac{-1}{\sqrt{1-(b/a)^2}}}$.

| $b/a$. | $(b/a)^2$ | $1-(b/a)^2$ | $\sqrt{1-(b/a)^2}$ | $1+\sqrt{1-\frac{b^2}{a^2}}$ | $\mathrm{Log}\left(1+\sqrt{1-\frac{b^2}{a^2}}\right)$ | $\mathrm{Log}\ b/a$. | $\log b/a-\mathrm{Log}\left(1+\sqrt{1-\frac{b^2}{a^2}}\right)$ | Log F. (See eqn. XIX.) | F. | $F\div(b/a)$. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | $\bar{1}\cdot56571$ | $0\cdot36788=\frac{1}{\epsilon}$ | 0·36788 |
| 0·9 | 0·81 | 0·19 | 0·4359 | 1·4359 | 0·1571242 | $\bar{1}\cdot9542125$ | $\bar{1}\cdot7971183$ | $\bar{1}\cdot53457$ | 0·34243 | 0·38048 |
| 0·8 | 0·64 | 0·36 | 0·6000 | 1·6000 | 0·2041200 | $\bar{1}\cdot9030900$ | $\bar{1}\cdot6989700$ | $\bar{1}\cdot49828$ | 0·31498 | 0·39373 |
| 0·7 | 0·49 | 0·51 | 0·7141 | 1·7141 | 0·2340362 | $\bar{1}\cdot8450980$ | $\bar{1}\cdot6110618$ | $\bar{1}\cdot45534$ | 0·28533 | 0·40761 |
| 0·6 | 0·36 | 0·64 | 0·8000 | 1·8000 | 0·2552725 | $\bar{1}\cdot7781513$ | $1\cdot5228788$ | $\bar{1}\cdot40360$ | 0·25328 | 0·42213 |
| 0·5 | 0·25 | 0·75 | 0·8660 | 1·8660 | 0·2709116 | $\bar{1}\cdot6989700$ | $1\cdot4280584$ | $\bar{1}\cdot33956$ | 0·21855 | 0·43710 |
| 0·4 | 0·16 | 0·84 | 0·9165 | 1·9165 | 0·2825088 | $1\cdot6020600$ | $\bar{1}\cdot3195512$ | $\bar{1}\cdot25756$ | 0·18095 | 0·45238 |
| 0·3 | 0·09 | 0·91 | 0·9539 | 1·9539 | 0·2909023 | $1\cdot4771213$ | $\bar{1}\cdot1862190$ | $\bar{1}\cdot14689$ | 0·14025 | 0·46750 |
| 0·2 | 0·04 | 0·96 | 0·9798 | 1·9798 | 0·2966213 | $1\cdot3010300$ | $1\cdot0044087$ | $2\cdot98388$ | 0·096356 | 0·48178 |
| 0·1 | 0·01 | 0·99 | 0·9950 | 1·9950 | 0·2999429 | $\bar{1}\cdot0000000$ | $2\cdot7000571$ | $\bar{2}\cdot69353$ | 0·049378 | 0·49378 |
| 0·05 | 0·0025 | 0·9975 | 0·9987 | 1·9987 | 0·3007585 | $\bar{2}\cdot6989700$ | $2\cdot3982115$ | $2\cdot39613$ | 0·024896 | 0·49792 |
| 0·01 | 0·0001 | 0·9999 | 0·99995 | 1·99995 | 0·3010192 | $2\cdot0000000$ | $3\cdot6985808$ | $\bar{3}\cdot69887$ | 0·0049989 | 0·49989 |
| 0·005 | 0·000025 | 0·999975 | 0·9999875 | 1·9999875 | 0·3010273 | $3\cdot6989700$ | $3\cdot3979427$ | $\bar{3}\cdot39791$ | 0·0024998 | 0·49996 |
| 0·001 | 0·000001 | 0·999999 | 0·9999995 | 1·9999995 | 0·3010298 | $\bar{3}\cdot0000000$ | $\bar{4}\cdot6989702$ | $\bar{4}\cdot69897$ | 0·0005000 | 0·50000 |
| 0·0005 | 0·00000025 | 0·99999975 | 0·999999875 | 1·999999875 | 0·3010300 | $\bar{4}\cdot6989700$ | $4\cdot3979400$ | $4\cdot39794$ | 0·0002500 | 0·50000 |
| 0·0001 | 0·00000001 | 0·99999999 | 0·999999995 | 1·999999995 | 0·3010300 | $\bar{4}\cdot0000000$ | $\bar{5}\cdot6989700$ | $5\cdot69897$ | 0·0000500 | 0·50000 |
| 0 | 0 | 1 | 1 | 2 | 0·3010300 | −infin. | −infin. | −infin. | 0 | 0·50000 |

**Table III.** *The Function* $F=\epsilon^{\frac{-a}{\sqrt{b^2-a^2}}\tan^{-1}\frac{\sqrt{b^2-a^2}}{a}}=\epsilon^{\frac{-1}{\sqrt{(b/a)^2-1}}\tan^{-1}\sqrt{(b/a)^2-1}}$

| $b/a$ | $(b/a)^2$ | $\left(\frac{b}{a}\right)^2-1$ | $\sqrt{\left(\frac{b}{a}\right)^2-1}$ | $\tan^{-1}\sqrt{(b/a)^2-1}$ | | $\mathrm{Log}\ F=\frac{-\tan^{-1}\sqrt{\frac{b^2}{a^2}-1}}{\sqrt{\frac{b^2}{a^2}-1}}\times0\cdot4343$ | | F | $F\div(b/a)$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Degrees. | Radians. | | | | |
| 1 | 1 | 0 | 0 | 0° | 0 | −0·0 = | Log 1 | 0·367879 | 0·367879 |
| 1·2 | 1·44 | 0·44 | 0·663325 | 33°33·44′ | 0·585686 | −0·3834623 | $\bar{1}\cdot6165377$ | 0·413559 | 0·344633 |
| 1·4 | 1·96 | 0·96 | 0·979798 | 44°24·92′ | 0·775195 | −0·3436044 | $\bar{1}\cdot6563956$ | 0·453310 | 0·323793 |
| 1·6 | 2·56 | 1·56 | 1·249000 | 51°19·08′ | 0·895668 | −0·3114361 | $\bar{1}\cdot6885639$ | 0·488162 | 0·305101 |
| 1·8 | 3·24 | 2·24 | 1·49666 | 56°15·06′ | 0·981766 | −0·2848847 | $\bar{1}\cdot7151153$ | 0·518938 | 0·288299 |
| 2·0 | 4·00 | 3·00 | 1·73205 | 60° | 1·047198 | −0·2625747 | $\bar{1}\cdot7374253$ | 0·546293 | 0·273146 |
| 2·5 | 6·25 | 5·25 | 2·29129 | 66°25·31′ | 1·159281 | −0·2197317 | $\bar{1}\cdot7802683$ | 0·602932 | 0·241173 |
| 3 | 9 | 8 | 2·82843 | 70°31·73′ | 1·230960 | −0·1890092 | $\bar{1}\cdot8109908$ | 0·647129 | 0·215710 |
| 4 | 16 | 15 | 3·87298 | 75°31·35′ | 1·318116 | −0·1478061 | $\bar{1}\cdot8521939$ | 0·711531 | 0·177883 |
| 5 | 25 | 24 | 4·89898 | 78°27·78′ | 1·369438 | −0·1214007 | $\bar{1}\cdot8785993$ | 0·756135 | 0·151227 |
| 6 | 36 | 35 | 5·91608 | 80°24·34′ | 1·403346 | −0·1030181 | $\bar{1}\cdot8969816$ | 0·788827 | 0·131471 |
| 7 | 49 | 48 | 6·92820 | 81°47·21′ | 1·427449 | −0·0894797 | $\bar{1}\cdot9105203$ | 0·813805 | 0·116258 |
| 8 | 64 | 63 | 7·93725 | 82°49·15′ | 1·445478 | −0·0790907 | $\bar{1}\cdot9209093$ | 0·833507 | 0·104188 |
| 9 | 81 | 80 | 8·94427 | 83°37·23′ | 1·459452 | −0·0708645 | $\bar{1}\cdot9291355$ | 0·849445 | 0·094383 |
| 10 | 100 | 99 | 9·94987 | 84°15·65′ | 1·470629 | −0·0641904 | $\bar{1}\cdot9358096$ | 0·862600 | 0·086260 |
| 50 | 2,500 | 2,499 | 49·9900 | 88°51·24′ | 1·550794 | −0·0134727 | $\bar{1}\cdot9865273$ | 0·969454 | 0·019389 |
| 100 | 10,000 | 9,999 | 99·9950 | 89°25·62′ | 1·560794 | −0·0067788 | $\bar{1}\cdot9932212$ | 0·984512 | 0·009845 |
| 500 | 250,000 | 249,999 | 499·9990 | 89°53·11′ | 1·568792 | −0·0013595 | $\bar{1}\cdot9986405$ | 0·996875 | 0·001994 |
| 1000 | 1,000,000 | 999,999 | 999·9995 | 89°56·49′ | 1·569781 | −0·0006818 | $\bar{1}\cdot9993182$ | 0·998431 | 0·000998 |
| Infin. | (Infin.)² | (Infin.)² | (Infin.) | 90° | 1·570796 | −0 | 0 | 1 | 0 |

That is, when $(a-\sqrt{a^2-b^2})\epsilon^{\sqrt{(a^2-b^2)}t}=(a+\sqrt{a^2-b^2})\epsilon^{-\sqrt{(a^2-b^2)}t}$.

or

$$\log_\epsilon(a-\sqrt{a^2-b^2})+\sqrt{(a^2-b^2)}t=\log_\epsilon(a+\sqrt{a^2-b^2})-\sqrt{(a^2-b^2)}t$$

or
$$t=\frac{1}{2\sqrt{(a^2-b^2)}}\log_\epsilon\frac{a+\sqrt{a^2-b^2}}{a-\sqrt{a^2-b^2}}\quad\ldots\quad\text{(XVII.)}$$

Putting this value in XV., and the value of A from XVI., we get, as the extent of the first swing,

$$\theta_1=\frac{qQ}{2I\sqrt{a^2-b^2}}\left\{\frac{a+\sqrt{a^2-b^2}}{a-\sqrt{a^2-b^2}}\right\}^{\frac{-a}{2\sqrt{a^2-b^2}}}\left\{\left(\frac{a+\sqrt{a^2-b^2}}{a-\sqrt{a^2-b^2}}\right)^{\frac{1}{2}}-\left(\frac{a+\sqrt{a^2-b^2}}{a-\sqrt{a^2-b^2}}\right)^{-\frac{1}{2}}\right\},$$

$$=\frac{qQ}{2I\sqrt{a^2-b^2}}\left\{\frac{(a+\sqrt{a^2-b^2})^2}{b^2}\right\}^{\frac{-a}{2\sqrt{a^2-b^2}}}\left\{\frac{a+\sqrt{a^2-b^2}}{b}-\frac{a-\sqrt{a^2-b^2}}{b}\right\},$$

$$=\frac{qQ}{bI}\left[\left\{\frac{a+\sqrt{a^2-b^2}}{b}\right\}^{\frac{-a}{\sqrt{a^2-b^2}}}\right]\quad\ldots\quad\text{(XVIII.)}$$

Denote the part within the square brackets by F, then

$$F=\left\{\left(1+\sqrt{1-\frac{b^2}{a^2}}\right)\frac{a}{b}\right\}^{\frac{-1}{\sqrt{1-\frac{b^2}{a^2}}}}$$

$$\therefore\quad\log F=\frac{\log\frac{b}{a}-\log\left(1+\sqrt{1-\frac{b^2}{a^2}}\right)}{\sqrt{1-\frac{b^2}{a^2}}}\quad\ldots\quad\text{(XIX.)}$$

The value of F may be calculated from this equation. A set of such calculations is made on Table II., and are shown in part of Fig. 5.

When $a<b$, the solution of Equation XIV. is

$$\theta=\epsilon^{-at}\{A_1\sin\sqrt{(b^2-a^2)}t+A_2\cos\sqrt{(b^2-a^2)}t\},$$

$\theta=0$ when $t=0$, $\quad\therefore A_2=0$.

$$\therefore\quad\theta=A\epsilon^{-at}\sin\sqrt{(b^2-a^2)}t.\quad\ldots\quad\text{(XX.)}$$

$$\frac{d\theta}{dt}=A\epsilon^{-at}\{-a\sin\sqrt{(b^2-a^2)}t+\sqrt{(b^2-a^2)}\cos\sqrt{(b^2-a^2)}t\}.$$

But $\frac{d\theta}{dt}=\omega$ when $t=0$.

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$$\therefore \quad A = \frac{\omega}{\sqrt{b^2 - a^2}} = \frac{qQ}{I\sqrt{b^2 - a^2}} \quad \ldots\ldots\ldots \quad \text{(XXI.)}$$

$$\frac{d\theta}{dt} = 0 \text{ if } a \sin \sqrt{(b^2 - a^2)}t = \sqrt{(b^2 - a^2)} \cos \sqrt{(b^2 - a^2)}t.$$

Hence, the amplitude of the first swing is

$$\theta_1 = \frac{qQ}{I\sqrt{b^2 - a^2}} \left\{ \epsilon^{-\frac{a}{\sqrt{b^2 - a^2}} \tan^{-1} \frac{\sqrt{b^2 - a^2}}{a}} \right\} \left\{ \frac{\sqrt{b^2 - a^2}}{b} \right\}$$

$$= \frac{qQ}{bI} \left[ \epsilon^{-\frac{a}{\sqrt{b^2 - a^2}} \tan^{-1} \frac{\sqrt{b^2 - a^2}}{a}} \right] \quad \ldots\ldots \quad \text{(XXIII.)}$$

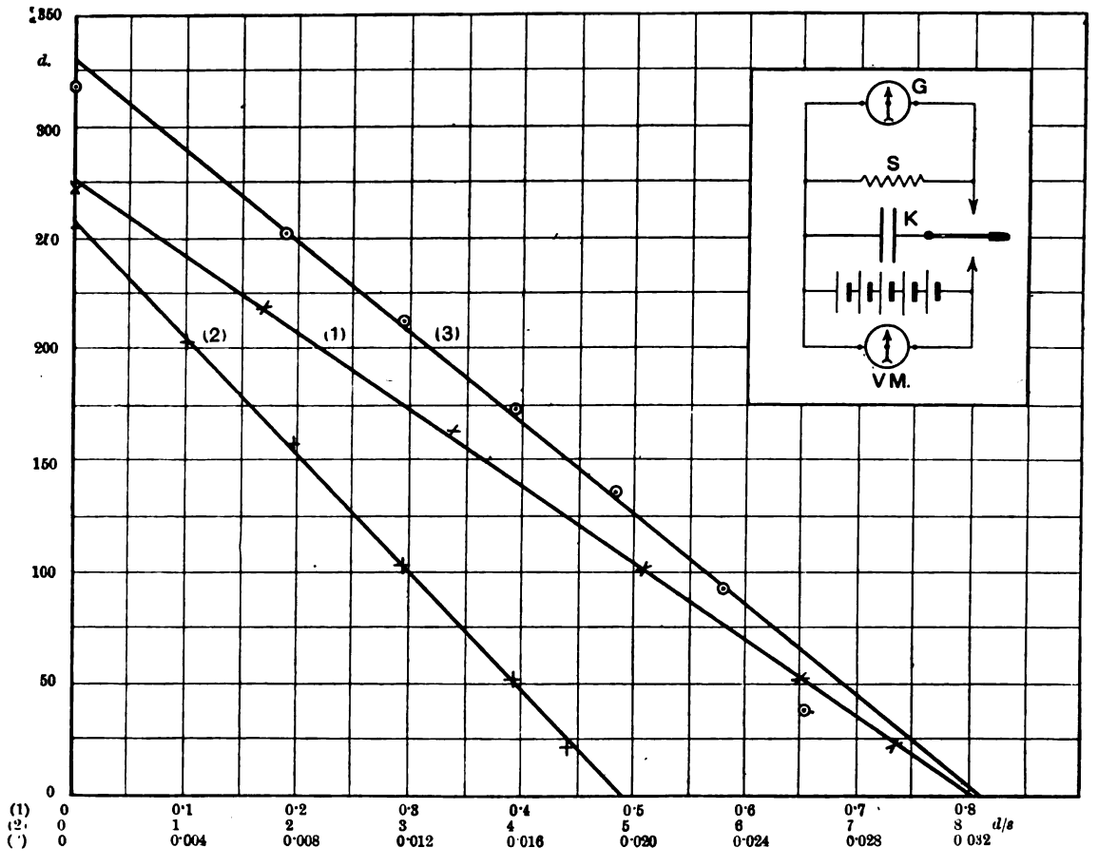


FIG. 4. Curves of $d$ and $d/S$ for finding G′ from Experiments with a Shunted Condenser (see Equation X.). Values of Q:—(1) 3·67; (2) 16·67; (3) 0·5 microcoulombs.

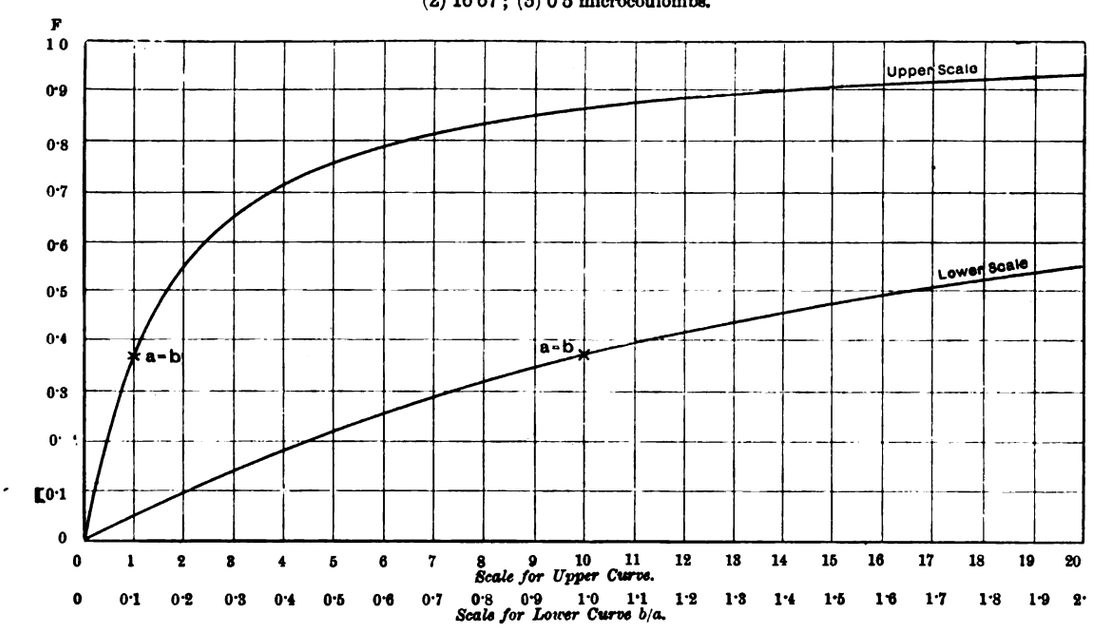


FIG. 5.—The Function F for the Solution of the Differential Equation $\frac{d^2\theta}{dt^2} + 2a\frac{d\theta}{dt} + b^2\theta = 0$ (see Equations XVIII. and XXIII. and Tables II. and III.).

Or, if $\tan \sqrt{(b^2 - a^2)}t = \frac{\sqrt{b^2 - a^2}}{a}$,

$$\text{or} \quad t = \frac{1}{\sqrt{b^2 - a^2}} \tan^{-1} \frac{\sqrt{b^2 - a^2}}{a} = \frac{1}{\sqrt{b^2 - a^2}} \cos^{-1} \frac{a}{b}. \quad \text{(XXII.)}$$

Again, denoting the factor inside the brackets by F, we have,

$$\text{Log}_{10} F = -\frac{\tan^{-1} \frac{\sqrt{\frac{b^2}{a^2} - 1}}{\sqrt{\frac{b^2}{a^2} - 1}}}{} \times 0{\cdot}4343. \quad \text{(XXIV.)}$$

F

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Values of F from this equation are given in Table III., which also shows the method of calculating them. They are continuous with those on Table II. and are also plotted on Fig. 5. No break is observable at $b/a = 1$, where they merge into one another.

The ratio $b/a$ is proportional to R, the total resistance in circuit, since $a = q^2/2RI$, and $b\ (= \sqrt{\tau/I})$ depends only on the construction of the instrument. Hence F is proportional to $\theta_1/Q$, and is therefore analogous to $Rd$ in the experiment with a search coil shown in Fig. 1 and equation III. $\frac{F}{b/a}$ will then be proportional to $d$ in that experiment. Hence Fig. 6, which displays the calculated values of F and $\frac{F}{b/a}$, gives the true form of the curve of $Rd$ and $d$ which our first assumptions gave as a straight line. As R denotes the whole resistance

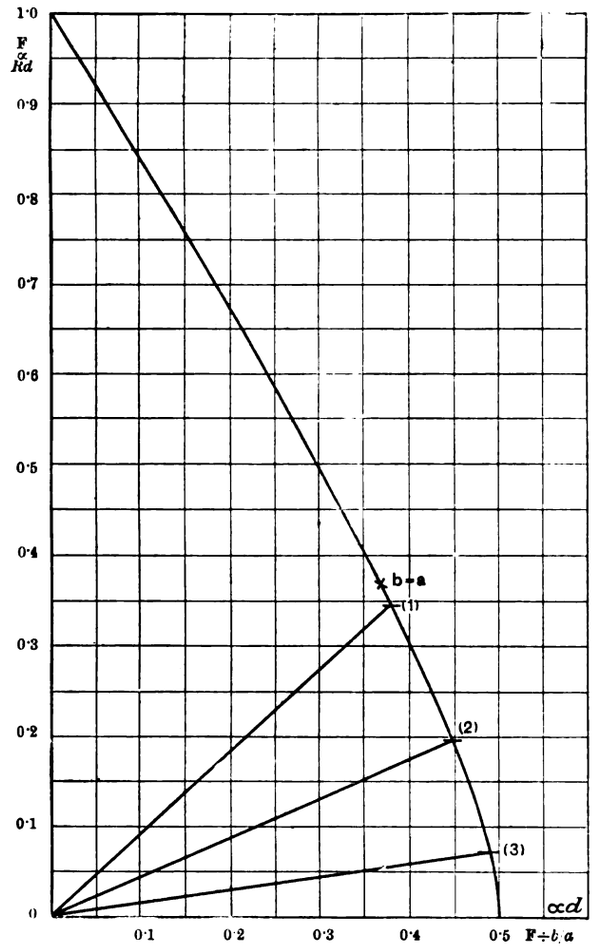


FIG. 6.—Curve of $Rd$ and $d$, taking account of the Duration of the Damping Current (see Tables II. and III.).

in circuit this time, while in the former it only stood for the external resistance, the two are not quite identical. Since R cannot be less than the internal resistance of the galvanometer, the condition $F = 0$ cannot be realised experimentally, but the smallest value of F will be that corresponding to there being no external resistance, or $R = G$ in Equations XIII. and XIX. or XXIV. We may find the proper value of $b/a$ thus. When $b/a = 1$ the galvanometer is just deadbeat. If the resistance is a little greater than what corresponds to this the motion will be periodic. We may therefore find the value of the total resistance for $b/a = 1$, by determining the resistance which will just make the motion deadbeat and no more. The value of $b/a$ for any other resistance in circuit will then be the ratio of that other total resistance to the total resistance which just makes it deadbeat. Thus if $R_0$ be the external resistance for $b/a = 1$, then for the lowest points on Fig. 1, for which the total resistance is G, $b/a = G/(G + R_0)$. These have been found experimentally, and are given in Table I. The corresponding points on Fig. 6 are also marked, and numbered to agree with the other curves. If these points are joined to the origin by straight lines, the intercepts on the ordinates between these lines and the curve are proportional to the ordinates of the respective curves in Fig. 1, or those of Fig. 1 might be re-drawn with the total resistance included in R instead of the external only to agree with the curve of Fig. 6. It will be seen that the curve of Fig. 6 does not differ much from a straight line in its central and upper portions.

Similar considerations also apply to moving needle galvanometers, but as the needle has but few lines, and most of them do not reach the coil, their effect is in general quite negligible.

## ELECTRICITY WORKS ACCOUNTS.

### Dover Electricity Supply Co. (Ltd.).

For an undertaking situated on the seaboard, and enjoying the advantages of a combined traction and lighting load, it must be confessed that the results of working at Dover hardly fulfil reasonable expectations. Last year, in commenting on the 1899 costs, we found occasion to credit the concern with the material reduction which was shown in the expenses, and with the resulting improved financial results. Unfortunately, instead of further improvement there are distinct signs of a retrogression in the 1900 accounts now before us. The total works costs, after making allowance for the increased fuel prices, may be said to have remained constant at the rather high value of 2·2d. per unit, while the management charges, although still low, have gone up by 0·05d. per unit. Amongst the generating costs the baneful item is still that of fuel, which, at 1·21d. per unit, is abnormal, even under the unfavourable conditions prevailing last year.

From the directors' report we learn that a contract with the Admiralty harbour contractors has been entered into for the supply to them of power during the next few years.

During last year the lamp connections increased by 18·2 per cent., and the output exceeded that of 1899 by 17 per cent.

We repeat the following particulars :—

| Year | Equiv. lamp con. | Units sold. Total. | Sold for traction. | Sold for public lighting | Total rev. per unit. | Total cost per unit. | Working profit. Total. | Working profit. % to mean capital. | Ord. div. |
|---|---|---|---|---|---|---|---|---|---|
| 1896 | 7,904 | 154,200 | — | 87,984 | 4·42d. | 5·13d. | -£456 | -0·92 | Nil. |
| 1897 | 10,137 | 234,074 | 27,116 | 78,624 | 5·38d. | 4·17d. | 1,778 | 3·13 | Nil. |
| 1898 | 20,000 | 423,057 | 179,844 | 83,459 | 4·36d. | 2·92d. | 2,533 | 3·80 | Nil. |
| 1899 | 22,000 | 523,829 | 244,287 | 84,192 | 4·07d. | 2·59d. | 3,239 | 4·43 | 3% |
| 1900 | 26,000 | 613,093 | 269,707 | 82,232 | 3·98d. | 2·65d. | 3,386 | 4·19 | 3½% |

### Folkestone Electricity Supply Co. (Ltd.).

The Folkestone undertaking appears not only to have suffered severely by the high coal prices, but in other respects to have been less fortunate in its cost-sheet last year than in 1899.

While many of the items of expenditure still present most excellent figures there has been a general failure to maintain the good results achieved in the first complete year of working. Of the generating costs, oil and stores and repairs and maintenance are below the 1899 averages in company stations of similar output and load-factor, but the other two items of fuel and wages mar the total result. On the whole, however, the works costs are by no means unsatisfactory, and it is to the increase in the amount rendered in the official accounts, under "rates, taxes, and insurance" £261, as compared with £105 in 1899, that the rise in the collective management and property charges is due.

Another dividend of 4 per cent. was declared, leaving £345 carried forward, but nothing appears to have been

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| | DOVER. | FOLKESTONE. |
|---|---|---|
| *Undertaking Worked by* | Dover Electricity Supply Co. (Ltd.) | Folkestone Electricity Supply Co. (Ltd.) |
| *Date of Commencement of Supply* | April, 1895. | November, 1898. |
| *System of Supply* | High-pressure alternate-current sub-stations.[a] | Three-wire continuous-current. |
| *Chief Engineer* | L. W. Woodman. | T. Hesketh. |

| YEAR ENDED | DEC. 31, **1899.** | DEC. 31, **1900.** | DEC. 31, **1899.** | DEC. 31, **1900.** |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 627,398 | 744,352 | 373,393 | 515,566 |
| „ **SOLD (TOTAL)** | 523,829[b] | 613,093[h] | 303,116 | 381,776 |
| „ sold to consumers | 183,440[c] | 261,154[c] | 209,931 | 291,800 |
| „ sold for public lighting, &c. | 84,192 | 82,232 | 93,185 (estimated) | 89,976 |
| „ used on works | 9,342 | 12,112 | 70,277 | 133,790 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 31·9 | 29·0 | 18·9 | 23·8 |
| Maximum supply demanded | 273kw. lighting, 175kw. | 294kw. lighting, 187kw. | 529 kilowatts | 322·6 kilowatts |
| Number of public lamps | 40 [traction | 40 [traction | 64 arcs | 66 arcs |
| Number of consumers | 200 | 270 | 80 | 298 |
| Connections to mains in 8-c.p. lamps | 22,000 | 26,000 | 17,834 | 24,190 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 16,400 | 21,100 | 16,020 | 16,020 |
| **CAPACITY OF PLANT IN KILOWATTS** | 525 | 675 | 513 | 513 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £75,000 / £143 | £100,000 / £148 | £50,000 / £97·5 | £100,000 / £195 |
| Share | 50,000 / 95·2 | 75,000 / 111 | 50,000 / 97·5 | 50,000 / 97·5 |
| Loan (including Debenture charges) | 25,000 / 47·6 | 25,000 / 37·1 | — / — | 50,000 / 97·5 |
| **RECEIVED (TOTAL)** | 75,000 / 143 | 76,695 / 114 | 49,963 / 97·4 | 75,000 / 146 |
| Share | 50,000 / 95·2 | 51,695 / 76·6 | 49,963 / 97·4 | 50,000 / 97·5 |
| Loan (including Debenture charges) | 25,000 / 47·6 | 25,000 / 37·1 | — / — | 25,000 / 48·8 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | nil / — | 23,305 / 34·5 | 37 / 0·072 | 25,000 / 48·8 |
| Share (unissued) | nil / — | 23,285 / 34·5 | nil / — | nil / — |
| Share (uncalled) | nil / — | 20 / 0·003 | 37 / 0·072 | nil / — |
| Loan (including Debentures) | nil / — | nil / — | — / — | 25,000 / 48·8 |
| **REPAID (TOTAL)** | nil / — | — / — | — / — | — / — |
| **RESERVE OR SINKING FUND** | —[d] / — | —[g] / — | — / — | } 400 / 0·78 |
| **DEPRECIATION FUND** | 416 / 0·793 | 666 / 0·987 | — / — | |
| **EXPENDED (TOTAL)** | 75,899 / 145 | 85,559 / 127 | 62,968 / 123 | 75,150 / 146 |
| Lands and buildings | 15,252 / 29·1 | 16,972 / 25·1 | 10,879 / 21·2 | 14,296 / 27·9 |
| Plant | 39,752 / 75·8 | 44,062[i] / 65·3 | 25,068 / 48·9 | 26,156 / 51·0 |
| Mains | 20,206 / 38·5 | 23,825 / 35·3 | 25,873 / 50·5 | 32,214 / 62·8 |
| Miscellaneous | 685 / 1·30 | 700 / 1·04 | 1,148 / 2·24 | 2,484 / 4·84 |
| **BALANCE OF CAPITAL ACCOUNT** | −899[e] / −1·71 | −8,864[e] / −13·1 | −13,006[a] / −25·4 | −150[a] / −0·292 |
| **REVENUE—** | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold |
| **TOTAL** | £8,885 / 4·072d. | £10,161 / 3·980d. | £5,777 / 4·575d. | £7,881 / 4·953d. |
| Revenue from supply | 7,281 / 3·336d. | 8,579 / 3·359d. | 4,144 / 3·282d. | 5,829 / 3·664d. |
| „ meters, &c. | 180 / 0·083d. | 159 / 0·062d. | 166 / 0·132d. | 120 / 0·075d. |
| „ public lighting | 1,179 / 0·541d. | 1,185 / 0·464d. | 1,441 / 1·141d. | 1,550 / 0·974d. |
| „ sale of lamps, &c. | 150 / 0·069d. | 188 / 0·074d. | 20 / 0·016d. | 4 / 0·003d. |
| „ miscellaneous sources | 95 / 0·044d. | 50 / 0·020d. | 5 / 0·004d. | 378 / 0·238d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £5,646 / 2·587d. | £6,775 / 2·652d. | £3,472 / 2·750d. | £4,888 / 3·073d. |
| **WORKS COSTS** | 4,845 / 2·220d. | 5,697 / 2·230d. | 2,350 / 1·861d. | 3,423 / 2·151d. |
| *Generation of electricity* | *4,404 / 2·018d.* | *5,157 / 2·020d.* | *1,904 / 1·508d.* | *2,948 / 1·854d.* |
| Fuel (including cartage, &c.) | 2,580 / 1·183d. | 3,102 / 1·215d. | 1,138 / 0·902d. | 1,795 / 1·128d. |
| Oil, waste, water, stores | 145 / 0·066d. | 185 / 0·072d. | 74 / 0·059d. | 140 / 0·088d. |
| Wages at station | 1,047 / 0·480d. | 1,062 / 0·416d. | 559 / 0·443d. | 721 / 0·453d. |
| Repairs and maintenance at station | 493 / 0·226d. | 620 / 0·243d. | 134 / 0·106d. | 293 / 0·184d. |
| *Distribution of electricity* | *266 / 0·122d.* | *316 / 0·124d.* | *120 / 0·095d.* | *212 / 0·133d.* |
| Wages, &c. | 247 / 0·113d. | 261 / 0·102d. | 100 / 0·079d. | 191 / 0·120d. |
| Repairs, renewals of mains, &c. | 19 / 0·009d. | 56 / 0·022d. | 21 / 0·017d. | 21 / 0·013d. |
| *Public lighting* | *175 / 0·080d.* | 224[j] / *0·088d.* | *326 / 0·258d.* | *263 / 0·165d.* |
| Attendance | 68 / 0·031d. | } 224[j] / 0·088d. | 260 / 0·206d. | 62 / 0·039d. |
| Renewals | 108 / 0·050d. | | 66 / 0·052d. | 200 / 0·126d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 801 / 0·367d. | 1,078 / 0·421d. | 1,122 / 0·889d. | 1,465 / 0·921d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *137 / 0·063d.* | *165 / 0·065d.* | *145 / 0·115d.* | *267 / 0·168d.* |
| *Management* | *664 / 0·304d.* | *913 / 0·358d.* | *977 / 0·774d.* | *1,198 / 0·753d.* |
| Salaries | 336 / 0·154d. | 495 / 0·194d. | 771 / 0·610d. | 806 / 0·507d. |
| Stationery, &c. | 70 / 0·032d. | 120 / 0·047d. | 81 / 0·064d. | 189 / 0·119d. |
| Establishment charges | 190 / 0·087d. | 206 / 0·081d. | 110 / 0·087d. | 174 / 0·109d. |
| Law charges, &c. | 68 / 0·031d. | 92[k] / 0·036d. | 15[b] / 0·012d. | 29[b] / 0·018d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £3,239 / 4·43% | £3,386 / 4·19% | £208 / 3·99% | £2,993 / 4·33% |
| Sum carried to Depreciation Fund | 500 / 0·683% | 400 / 4·95% | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | nil / — | — / — | 400 / 0·765% | — / — |
| Net interest on loans (incl. Debenture charges) | 1,414 / 1·93% | 1,281 / 1·59% | 47 / 0·090% | 734 / 1·06% |
| **BALANCE FROM LAST ACCOUNT** | — / — | 54 / 0·067% | 405 / 0·775% | 86[d] / 0·125% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 1,326 / 1·81% | 1,760 / 2·18% | 2,042 / 4·67% | 2,345 / 3·40% |
| *Deficit* | — / — | — / — | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | 3% / — | 3½% / — | 4% / — | 4% / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 63·6% | 66·7% | 60·1% | 62·1% |
| Expenditure per kilowatt capacity | £10. 15s. 0d. | £10. 0s. 7d. | £6. 15s. 5d. | £9. 10s. 7d. |
| **REVENUE PER KILOWATT CAPACITY** | £16. 18s. 0d. | £15. 1s. 0d. | £11. 5s. 0d. | £15. 7s. 2d. |
| Expenditure per 8-c.p. lamp capacity | 6s. 10½d. | 6s. 5d. | 4s. 4d. | 6s. 1½d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 10s. 9¾d. | 9s. 7½d. | 7s. 2½d. | 9s. 10d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 8s. 0¾d. | 7s. 9¾d. | 6s. 5¾d. | 6s. 6¼d. |
| Price charged for lighting, per unit | 7d. (1½ hrs.) to 3d.[f] | 7d. (1½ hrs.) to 3d.[l] | 7d., 4d. and 2d. | 7d., 4d. to 2d. |
| Price charged for power, per unit | 6d. (1 hr.) to 3d.[f] [ann. | 6d. (1 hr.) to 3d.[m] | 7d. (1 hr.) to 1d.[e] | 7d. (1 hr.) to 1d.[e] |
| Price charged for public lighting | £29. 10s. per lamp per | — | 3·72d. | — |

DOVER.—REMARKS—*a* With continuous-current plant for the tramway supply. *b* Includes 244,287 units to tramways. *c* Exclusive of output to tramways. *d* The suspense account has a debit balance of £3,813. *e* Over-expended. *f* On maximum demand system. *g* Debit balance of £3,471 in suspense account. *h* Inclusive of 269,707 units for traction. *i* Inclusive of £1,579 on street lamps, £7,928 on traction machinery and £1,672 on accumulators. *j* Includes carbons £96. *k* Including auditing £48. *l* On maximum demand system or uniform charge of 6d. *m* Maximum demand system, 2½d. for lighting consumers.

FOLKESTONE.—REMARKS—*a* Over-expended. *b* To auditing. *c* Maximum demand system. *d* After deducting preliminary expenses incurred in 1897 and 1898, £63.

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placed to reserve. An excellent improvement in the load-factor took place, its value being 13·5 per cent. The output was higher by nearly 26 per cent., and the lamp connections advanced by 35·6 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 16, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | April 19, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Eastbourne (Company) | May 4, 1900 | Southport (Municipal) | July 7, 1899 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Stafford (Municipal) | Aug. 17, 1900 |
| Folkestone (Company) | April 27, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | April 19, 1901 |
| Hanley (Municipal) | July 27, 1900 | Westminster (Company) | Mar. 29, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | Oct. 26, 1900 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Woolwich (Company) | Jan. 18, 1899 |
| Kens'gton & Knightsbr'(Co.) | Mar. 16, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Great Yarmouth (Mun.) | Dec. 28, 1900 |

## NOTES ON SOME SYSTEMS OF LAYING UNDERGROUND CABLES.*

BY ARTHUR DEVEY.

The usual systems of laying may be divided into headings, as follows:—1st, laying cable direct in the ground, armoured or unarmoured; 2nd, pipe or conduit systems; 3rd, solid systems.

The first system is much in favour where first cost is a consideration. It is usual to lay armoured cable; however, the town of Bray is one case where plain lead-covered cable has been used with satisfactory results, the cables being laid in puddled clay, and covered with boards 7in. wide by 1in. thick. They are still in perfectly good condition. Leith is another example; here, however, the cables are laid in sand and covered with steel plates.

It is usual to cover the cables with timber to indicate their presence. The best covering is probably an inverted three-sided wood trough. Some engineers, however, use inverted V troughs, and others boards about 6in. wide; in any case the timber should be thoroughly well tarred by dipping into a tank of boiling tar, and it should be of a good thickness—at least 1in. At the cable joints, if in boxes, the armour should be taken into the glands, and the iron of the box should be bonded to the armour of the cable; or, if wiped lead sleeves are employed, then they should be protected with wood troughs filled up solid with bitumen, or, preferably, by cast-iron troughs and covers which can be bonded to the armour of the cables on each side. Laying direct in the ground has the advantage of being a very flexible system, and the work can be carried out whatever the weather may be. Its disadvantage is that the outer layer of jute sooner or later rots off, exposing the iron or steel armour, which in turn gets eaten away.

Turning to pipe or conduit systems, their advantages lie in the fact that cables can be replaced in case of need without disturbing the surface of the streets; also that spare ways can be laid for future extensions. Their disadvantages are, however, numerous. They are not flexible, and unless the pipes or conduits are laid practically straight and level, it is exceedingly difficult to get the cables in and out; and, of course, if a cable cannot be got out easily in case of need, then the only real advantage of a pipe or conduit system is reduced to its spare ways. Another serious disadvantage lines in the fact that if a fault occurs on the cable, it is necessary to draw out the whole of the faulty length and to draw in a new length, which means keeping a large stock of cable on hand. There is also the making of two joints, whereas on the other systems it is simply necessary to open out the ground at the place where the fault has occurred and have the fault made good, which can very often be done without putting any new cable in at all. If the faulty cable should be, say, one of the centre ones in a nest of 15 or 20 pipes or conduits in a drawn-in system, then the work of repair is exceedingly onerous, and may require several days to carry out, or even be impossible if the cables are jointed straight through the box. Yet another disadvantage is, that it is practically impossible to keep a pipe or conduit system dry, while a still greater one is the risk of explosions from gas leaking into the pipes or boxes. It is advisable that all box lids should be ventilating, and in important streets it would pay to have air blown through the pipes or conduits at stated periods. Strict injunctions should be issued that before any work is done in a box, the workmen must make sure that there is no gas present. A very good plan is to open the boxes on each side of the one where the work is to be carried out, allowing the air to circulate for, say, 10 minutes; but even after that has been done, it must not be taken for granted that all the gas has gone. Another method, due to our friends across the "herring-pond," is to pump the gas out with an inverted umbrella. The umbrella is lowered into the manhole while closed, then suddenly withdrawn, this opening the umbrella and so pumping out the gas.

Boxes, if large, are nearly always built of brick with concrete bottoms. These should be at least 6in. thick, and the walls should be 9in. brickwork up to 6ft. square, and 14in. brickwork for 6ft. square or over. They should always be connected to the sewer through a trap. A notable exception is the large 6ft. box of the Glasgow Corporation electric light department, which is a solid cast-iron chamber and guaranteed gas and water-tight. Small boxes are either of bricks or iron, and very often the bottoms are just the plain earth; the idea being that the water can drain away through it. These boxes should have ventilating but water-tight lids. The lids should never be less than 2ft. square for pavement boxes, and for road boxes they should be perfectly circular, 2ft. in diameter, and the frames should be at the very least 15in. deep. If the frames are not deep enough, then it is practically impossible to get a proper covering of concrete on the top of the box, as there must be an inch or two of sand for the bedding of the setts, and these latter are usually about 7in. in depth. In any case the setts over the roof of any street box should always be thoroughly laid in pitch. Manholes should be roomy, and cables should be taken round the sides attached to proper supports, and not jointed straight through the centre of the manhole. All covers should be locked, and the pipes should always be bonded to each other across all brick boxes, and all iron lids and frames should be well earthed.

The diameter of any way should exceed that of the cable by a full clear half inch, and by preference more if possible, and it is not advisable to have longer runs than 150 yards as a maximum. The number of boxes in consequence is very considerable, and in large towns and busy streets it is extremely difficult at times to find room for them or even for the pipes, especially when the gas and water people demand at least 18in. clearance all round off their pipes. In consequence, where there are numerous ways, it is very often necessary to fan out the ways of one layer into those of the next layer, which naturally does not improve the drawing-in of the cable. As regards the water mains, this is not such an out-of-the-way demand as they will always be with us; but as regards the gas mains it is a different question, as we all hope they will disappear by degrees, although possibly they might be utilised by their enemy. Such apparently has been the case already, as it is said that electric light mains have been surreptiously drawn into gas mains in a certain Scottish town, without, of course, the gas engineer's knowledge or consent.

The various units of the pipe or conduit should be as long as possible so as to minimise the number of joints, and these units should be capable of being easily cut into short lengths, so as to get round bends or obstacles. The system should always be laid so that there is a fall from one manhole to the next, so that all water may drain away easily.

Cast-iron pipes have been much used in the past, and still are in fashion to a certain extent, their advantages being fairly good mechanical protection to the cables, although, of course, they will not stand a wedge. They require careful caulking, as if by accident or on purpose lead is allowed to run into the interior of the pipe, it is exceedingly troublesome and expensive to get it out. Sometimes, however, turned and bored joints are used, as also red lead and yarn joints; but lead joints are the usual and best ones. Workmen are also given to pricking iron pipes to see if they are dead, and if no gas or water comes out of the hole, it is taken for granted that the pipe

* Abstract of a Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

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is empty, and the next step is to promptly apply a 14lb. sledge hammer to the pipe. On the other hand a damaged iron pipe is easily repaired by means of a split sleeve, whether in the straight or in a bend. It is better also to use vertical cast pipes in preference to bank pipes, these latter having core screws which very often are not tight, and which also are liable to project into the interior of the pipe, seriously damaging the cable when it is drawn in. The usual size for underground work is 3in. bore and 9ft. lengths. This size is best laid down in double lengths, jointed on the bank; they should be only laid in triple lengths in exceptional circumstances, as in lowering the lengths into the trench the joints are liable to get loosened.

Riveted sheet iron pipes lined with cement have been used considerably in the States and in this country lately. for tramway work chiefly. They are 8ft. long by 3in. bore, the thickness of cement lining being about $\frac{1}{8}$in.; these have to be surrounded on all sides by concrete; they will not, of course, stand any serious knocking about, as the sheet-iron is so thin, and being surrounded by concrete, if laid near the surface, navvies are very liable to put a wedge or a pick through them and into the cable, as they think the concrete surrounding them to be the ordinary concrete of the street; they, therefore, should never be laid at less than 2ft. 6in. from the surface of the road, and should always have a layer of loose earth on top of the concrete. No bends are made with these pipes, the consequence being that boxes have to be built at every right angle corner or sharp bend.

Ordinary drain-pipes, except that they are made with rounded edges at both spigot and faucet ends, are also used; their disadvantages are the numerous joints and bad mechanical protection.

Doulton's conduits, which are used so extensively throughout the country, are so well known that they do not require describing. Care must be taken in making the joints to prevent the bitumen or cement running into the inside of the conduits, and so blocking them up more or less. With cement joints, stoneware bearers and wood mandrels are used; with bituminous joints, cast-iron bearers and expanding indiarubber mandrels are required. These conduits are made with square ways from 1$\frac{1}{2}$in. square up to 4in. square, and usually 3ft. long. An advantage in using them is, that a large number of ways can be got into a small trench.

Conduits are also made, from three ways upwards, in cement blocks; they are very easily broken when lying on the trench side, and require very careful laying. They are said to be expensive for a small number of ways, but economical where there are many ways to be provided. It is stated that the hardened cement has no deleterious action on the lead of the cable, and that the blocks harden and improve with age. As the ways, which are round and 3in. diameter by 1 metre long, must be exactly opposite each other at every joint, iron rods along the sides are used to obtain this result, mandrels being placed in the ways whilst the joints are made with cement; the iron rods are also supposed to keep the ducts in position, should the ground sink after the laying of the conduits. They are exceedingly heavy, ranging from 165lb. for the three-way block to 1,310lb. for the three-way block, these weights being exclusive of the iron jointing rods and the bears; they, therefore, come very expensive as regards cartage; the large sizes also require a derrick to lower them into the trench, and as regards speed in laying them they are not comparable with iron pipes—at any rate, for the smaller sizes. They, however, of course require a smaller trench than iron pipes. Cement bearers are employed for all sizes of the ducts except the smallest, *i.e.*, the three-way duct; these, necessarily, have to be carefully aligned and levelled. The earth must be well rammed between them, and levelled so that the cement blocks may bed throughout their length.

In London, for the new telephone system, the Post Office are using glazed octagonal earthenware ducts, laid in concrete and cement; they are made in two lengths, namely 18in. and 24in., and are 3$\frac{1}{4}$in. internal diameter, the short ones being used for entering the manholes. The method of laying is as follows:—A bed of concrete 6in. thick is first laid, then a layer of cement $\frac{1}{2}$in. thick, then a tier of ducts, then another layer of cement $\frac{1}{2}$in. thick, and so on, all insterstices between the ducts being filled up with cement. When all the tiers are laid, the sides and top are covered with concrete about 6in. thick. They are laid at a minimum depth of 3ft. from the top of the concrete to the surface of the road. These ducts are very largely used in the States, and apparently have given satisfaction there. The boxes are of 14in. brick work and usually 8ft. long, with varying widths according to the number of ducts entering them. Cast-iron pipes are used for crossing roads and for distribution.

Wire and cement ducts are simply arches of wire gauze plastered with cement. They are 3in. by 3in. inside measurement, and are laid on a flat concrete bottom with smooth cement surface, and then they are covered all round with concrete in the same way as the octagonal ducts before mentioned.

Pump-log ducts are made of square wood blocks 4$\frac{1}{2}$in. square by 8ft. long, with a 3in. hole bored through the middle of them, and provided with spigot and faucet ends 3in. long; these joint the ducts together and keep the proper alignment of the way. These ducts should, of course, be treated with a preservative before laying, and are very cheap where timber is cheap.

The Brookes semi-solid system consists of lap-welded wrought-iron tubes about 15in. long; they are connected together by an ordinary screw socket; every other length is connected together by means of a tee-coupling closed at the top with an ordinary plug; these are necessary for filling the pipes with the semi-solid oil, which becomes liquid at about 300°F., and when cold is similar in consistency to indiarubber solution. It is important that the cables and the interior of the tubes should be absolutely free from moisture, and that all joints should be thoroughly tight. The cables used with this system are not lead-covered; the insulation is of strong fibrous material, which gets impregnated with the oil used for filling the pipes.

Any system of conduits, of which the various units are only of short lengths, is always very liable to get damaged through the ground sinking underneath it; this can, of course, be guarded against by concreting the bottom of the trench first, but naturally at a very much enhanced cost.

All pipes or conduit systems should be properly ratted before any cable is drawn in, and a matter of great importance is the placing of the drum of cable over the drawing-in-hole, so that the cable shall be fed in without any possibility of kinks or strains arising; at the drawing-out hole jockey pulleys are required to prevent the rope or chain chafing. A chain is usually preferable to a rope: it lasts much longer, requires less power, and does not stretch. Petroleum jelly should be used for greasing the cables; this is much better than soft soap, and is but little more expensive. The cables for drawing into pipes should be preferably juted, or at least braided, as the lead is thereby protected from accidental damage. The clips for attaching the cable to the hauling rope or chain are of various kinds, according to the different kinds of cable. When an ordinary plain barrel winch is used the rope always rides up to one end, necessitating stopping every few minutes, and slacking out the rope to allow it to be got back to its proper place. A grooved barrel winch has been made to do away with this inconvenience, and has been found to work perfectly with either a rope or a chain. It is said that steam winches have been used by the Yankees for hauling in cables, but the advantages seem more than nullified by the disadvantages, such as increased liability to the cable being damaged.

The third system known as the "solid" system seems to be the chief favourite for the moment, although it is curious to note that the Yankees consider it absolutely antiquated and out of date, they pinning their faith to conduit systems. Its advantages are its flexibility, combined with at least quite as good mechanical protection as iron pipes, whilst there is no danger to be feared from gas. The system is that of a cable laid centrally in a three-sided trough. V troughs have been occasionally used but are not to be recommended. The trough, which may be of iron, earthenware, or wood, is then filled up solid with bitumen, a cover is then placed on top, and the whole thing buried. There should never be more than one cable in each trough; and as much as possible troughs should never be laid one on top of another. As the dangerous part is the cover, the use of iron troughs appears to be hardly necessary, except when required to comply with the Board of Trade regulations; they are expensive, and if light are fragile, and if heavy are troublesome to handle. Earthenware troughs have the disadvantage of not being more than 24in. long at the outside, and very often only 18in. long, thus requiring numerous joints; they are also easily broken and damaged and are not convenient for getting round curves. Those made half round, with faucets for jointing purposes, also require special bedding. Wood troughs well dipped in tar, so that the wood is thoroughly saturated (tarring with a brush is useless) appear to be the best in all respects. It is important that the tar used should have no action on lead. The joints can be securely made by means of projecting pieces of wood placed underneath and on each side so as to form a sort of faucet. An important point, whatever the trough is made of, is that the trough should be amply large enough so that the average thickness of bitumen should be $\frac{1}{2}$in. all round as a minimum. Another important point is that the bitumen should get well underneath the cable; to allow this the cable must be supported at intervals, one way being to sling the cable by pieces of very strong thin twine attached to pieces of wood laid across the tops of the troughs, the twine to be withdrawn before the bitumen is thoroughly set hard; another way is to placed shaped wood blocks with the apex on top on the bottom of the troughs, these being placed in position after the cable has been drawn in.

As regards covers, cast-iron are expensive and heavy and liable to rust, bricks make too many joints and are very liable to be knocked off; if used, they require being placed together as tight as possible and being cemented together with the same bitumen as used for the troughs, and, of course, are no good for troughs over 4$\frac{1}{2}$in. wide external dimension. Wood covers, if 1in. thick at least and well tarred, are by far the best, as they will resist a pick, and a navvy can be made to remember that he is to go carefully when he finds wood, whereas with bricks he is liable to take them for old foundations, &c. The wood covers should be 1in. wider than the troughs,

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so as to allow ½in. lap over on each side, it is also better to nail them on here and there to prevent them shifting.

The most convenient size for the bitumen boiler is one of 160 gallons capacity, mounted on two wheels and not on four wheels; it is better to have two or three of this size on a trench than to have a bigger boiler. Oil is added to the bitumen to render it less brittle, and for use on hills it is advantageous to mix fine sawdust with it for thickening purposes; it is essential, however, that the sawdust should be thoroughly dry and free from pieces of wood. The boiler should always be thoroughly emptied and cleaned out every time the fire is drawn, as otherwise rapid deterioration of the bottom of the boiler ensues.

It is advisable to use juted or braided cables in all cases in preference to plain lead-covered ones, whether for drawing into a pipe or conduit system or whether for laying on the solid system; the extra cost is not much, and it is certainly worth it, owing to the protection the jute or braiding gives to the lead against mechanical damage. In one town in England, double-juted cables have been drawn into a pipe system, and even armoured cables have been at times drawn into them.

The best system would be probably armoured cable laid solid in wood troughs, with a minimum thickness of bitumen of 1in. all round, the troughs and covers to be of 1in. thickness also; if wiped lead sleeves are used for the joints, they should be enclosed in cast-iron troughs with cast-iron covers, both enclosed in a wood trough and wood cover, so that there would be continuous metallic armour and continuous wood trough from end to end. The cast-iron troughs and lids should be bonded to the armour of the cable, and if boxes are used they should be of the compound gland type, and also bonded to the armour, which should be taken inside the glands. Such a system will be expensive, but it should be a guarantee against damage of all kinds, whether mechanical or electrical, and therefore would prove cheapest in the long run.

## THE ACTION OF MAGNETISED ELECTRODES UPON ELECTRICAL DISCHARGE PHENOMENA IN RAREFIED GASES.*

BY C. E. S. PHILLIPS.

A preliminary account of this investigation has already been laid before the Society.† The present Paper deals more particularly with the conditions necessary for the production of a luminous ring in rarefied gases and under the influence of electrostatic and magnetic forces. The cause of the luminous phenomenon is traced to the action of the magnetic field upon electrified gaseous particles within the rarefied space, and experimental evidence is given to show that the rate of change of the magnetic lines is an important factor. Numerous experiments relating to the loss of positive electrification from a charged body when placed in a rarefied space, and in the neighbourhood of a magnetic field, are also described in detail.‡

An apparatus similar to that referred to in a previous communication was generally found most suitable for observing the formation and behaviour of the luminous ring. It consisted of a small spherical glass bulb 2·5in. in diameter, and provided with short projecting necks for the purpose of carrying two oppositely placed soft iron rods. These rods were pushed one through each of the short tubes, cemented in position, and arranged to have their pointed ends within the bulbs and $\frac{1}{16}$in. apart. The cores of two electromagnets were then butted against the external ends of the rods for the purpose of magnetising them when required. When the gas within the bulb had been rarefied to a pressure of about 0·005mm. of mercury, a discharge from an induction coil was sent through it for a few seconds, the rods (now used as electrodes) meanwhile remaining unmagnetised. But when the discharge was stopped, and the magnets were excited, a luminous ring appeared within the bulb, in a plane at right angles to the magnetic axis, between the pointed ends of the electrodes, and in rotation about the lines of magnetic induction.

The luminosity of the ring was found to be intermittent, its spectrum showed no peculiarity, and it was not possible to obtain satisfactory photographs of the revolving glow. In oxygen the ring appeared a little brighter, but in hydrogen or carbonic dioxide the luminiosity seemed about the same as in air.

Two or more rings could be made to appear by placing an electrified platinum circle of wire equatorially within the bulb. When the platinum circle was negatively electrified, the luminous ring was repelled by it. In this manner the ring itself was invariably shown to be negatively electrified. Its direction of rotation was found to be that of the current induced in a loop of wire when the loop is suddenly moved up to a north magnetic pole—clockwise, looking through the loop at the pole. The outside of the glass bulb was always negatively electrified when a luminous ring appeared in the interior. This pointed to the removal of a layer of positively electrified gas from the inner surface of the bulb through the action of the magnetic field. Although such radial streams of positive ions so produced might account for the luminosity of the ring through their collisions with an accumulation of negative ions at the more central part of the bulb, they would not have produced rotation of the luminous ring in the direction already observed. The incoming radial streams of positive ions were studied in detail with an apparatus more suitable for examining the diselectrifying action of the magnetic field. Those experiments established two facts—viz, that the loss of positive electrification from charged bodies is brought about by the magnet, through the concentration of negative ions which occurs at the strongest part of the magnetic field immediately the electrodes are magnetised, and also that the luminosity of the ring itself is due largely to the collisions between the incoming streams of positive ions and this accumulation of negatively electrified gas between the pointed ends of the electrodes. A potential difference is thus set up within the bulb between the negative gas-mass at the centre and the positively electrified layer of ions residing upon the inner surface of the glass, which rapidly reaches a value sufficient to give rise to a discharge through the residual gas. It is then that the positive ions stream inwards, accompanied by a corresponding outward moving whirl of negative ions.

Experiments upon the effect of causing the magnetic field either to slowly or rapidly reach its maximum value as well as diminish either slowly or rapidly to zero, have shown that the rate of change of the magnetic lines plays an important part in the actions here described. A very rapidly growing field would diselectrify a positively charged body, whereas, when the magnets were slowly increased in strength there was no diselectrification in such cases. In certain experiments, the act of suddenly destroying the magnetic field produced diselectrification, while if the current were slowly diminished in the coils of the electromagnets there was no evidence of any such effect.

Both the luminous ring and the diselectrification phenomena are attributable to the same causes. The direction of rotation of the ring, however, forms a difficulty, on the assumption that a rapidly moving ion is equivalent to a current along a flexible conductor. Incoming streams of positive ions would give a direction opposite to that observed, and if the rotation were produced by the changing strength of the magnetic field upon the negative ions, then also would the direction of rotation be opposite to that actually obtained. The viscosity of the gas would tend to annul any sudden twist which the changing magnetic field might give to the cloud of negative ions within the bulb, although the reaction set up between the magnets and the ions under such conditions would be sufficient to cause the negative particles to be thrown forward, and to concentrate in a manner consistent with the experimental results given. It is not clear, however, why the sudden cessation of the magnetic field should also produce such a concentration of negative ions. But we have already seen that under those conditions diselectrification is easily produced; moreover, a luminous ring that has grown dim can usually be momentarily brightened by suddenly destroying the magnetic field.

A pause was sometimes noticed between the excitation of the magnets and either the formation of the ring or the loss of charge from a positively electrified body.

This result showed that the steady magnetic field itself so modified the paths of moving negative ions within the bulb that a concentration of them at the strongest part of the field took place for this reason also.

The direction of rotation of the luminous ring can be accounted for in the following manner:—

When the potential difference between the accumulation of negative ions at the centre of the bulb and the layer of electrified gas upon the inner surface of the glass is such that a shower of incoming positive ions occurs and the luminous ring appears, the outer portion of the ring will be more positive than the surrounding negatively electrified cloud of gaseous particles. These will, therefore, be attracted inwards, and in that way give a rotatory motion to the luminous gas mass in the direction actually observed.

* Abstract of a Paper read before the Royal Society, March 14.

† Roy. Soc. *Proc.*, Vol. LXIV., p. 172.

‡ Roy. Soc. *Proc.*, Vol. LXV., p. 320.

**New Automatic Stop Valve.**—Several of our American contemporaries describe a new 4,500 H.P. Corliss engine, made by the Westinghouse Machine Co., in which is employed a novel automatic stop valve to shut off steam should the speed of the engine exceed a predetermined limit. The mechanism consists of a pivoted weight let into the crank-cheek, and held in position at normal speed by a spiral spring, which, when the speed becomes excessive, throws outward and operates a small three-way valve, which admits steam on the top of a piston in the automatic valve, and so closes the valve. By throwing the three-way valve the other way, the steam is admitted to the under-side of the piston, which is thus reset.

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# LEGAL INTELLIGENCE.

## Metropolitan Electric Supply Co. (Ltd.) v. Ginder.

This case came on for trial on Friday last before Mr. Justice Buckley in the Chancery Division, to restrain defendant from taking his supply of electric current from any company other than the plaintiff company for a period of not less than five years from the date of agreement.

Mr. ASTBURY, K.C., for plaintiffs, explained that the agreement entered into between plaintiffs and defendant was dated Nov. 16, 1898. The supply was to be for not less than five years, and the charge was 4½d. per unit. That agreement was purely negative, because the company was bound by Act of Parliament to supply all that was required. In September, 1900, defendant ceased to take current from plaintiffs, and began to take it from the County of London and Brush Provincial Electric Light Co., which company had concurrent powers to supply current in the Holborn (London) district. As soon as plaintiffs heard of this breach they notified defendant. In an interview with plaintiffs' representative defendant stated that he had no reason for ceasing to take the light other than that the County of London Company's representative had prevailed upon him to do so, at the same time promising, in the event of litigation, to "see him through." This action was being defended by the County of London Company's solicitor, and he (Mr. Astbury) thought there could be no doubt as to how the litigation had really arisen. During the interview referred to defendant never suggested that he had any complaint concerning the quality of the light supplied by the plaintiffs. Defendant continued to take current from plaintiffs till Feb. 25, 1901, when he notified plaintiffs of his intention to change his source of supply. Defendant now represented that he had entered into no agreement for a period of five years, and that he had continual cause for complaint with plaintiffs' supply. Other consumers who were on the same circuit would give evidence on this point. It would be impossible for the light to go out in one place and not in another unless owing to bad fittings, for which the company were not responsible.

Evidence was then given by large consumers of electric current that the service of the Metropolitan Company was satisfactory, and that only on one occasion (the time of the fire at the Sardinia-street station) had there been failure of supply. The witnesses included Mr. E. Swanborough, manager of the Royal Music Hall, Holborn; Mr. J. C. Ackerman, manager of the restaurant adjoining the music hall; Mr. Gates, proprietor of the Vienna Café, 24 to 28, New Oxford-street; Mr. Camerer Kuss, watch and clock maker, 36, New Oxford-street; and Mr. H. Heath, 240 and 302, Holborn.

Mr. EADY, K.C., for defendant, raised the question as to whether the agreement upon which the plaintiff company based its case was a legal one. He said the agreement gave an undue preference to other consumers to the prejudice of defendant. In another sense it gave defendant an undue preference over certain other persons taking the plaintiffs' supply of electric light. He held that it was an agreement illegal by statute. The statute required a company to enter into an agreement on certain terms. This was an agreement outside the statutory power of the plaintiffs, and was not binding at all. It gave one person undue preference over another. The act says all consumers must be supplied on the same terms.

Mr. ASTBURY: I submit that there is no ground for such a contention. The fourth schedule to the Confirmation Electric Lighting Act of 1889, sec. 1, says: "Where the undertakers charge any consumer by the actual quantity of energy supplied to him they shall be entitled to charge him at the following rate per quarter:—For any quantity up to 20 units, 13s. 4d., and for each unit over 20 units 8d." Secs. 19 and 20 of the Act of 1892 say:—"Where a supply of electricity is provided in a part of an area for private purposes, then, except in so far as is otherwise provided by the terms of the licence, order, or special act authorising such supply, every company or person within the part of the area shall on application be entitled to a supply on the same terms on which any other company or person in such part of the area is entitled, under similar circumstances, to a corresponding supply." The act takes into account the circumstances and the amount of the supply. It goes on to say: "The undertakers shall not, in making any agreements for a supply of electricity, show any undue preference to any local authority, company, or person, but, save as aforesaid, they may make such charges for the supply of electricity as may be agreed upon under the existing limits of prices imposed by or in pursuance of the licence, order, or special act authorising them to supply electricity." That limit is 8d. In these circumstances the objection is groundless.

His LORDSHIP ruled that the objection was hopelessly irrelevant.

Mr. REGINALD W. TODD, chief engineer to the Metropolitan Electric Supply Co., said defendant's supply of electricity went over the same network of mains as that for the other witnesses who had been examined, and defendant's light could not have gone out through the fault of the company without the lights of the other witnesses doing the same. It was possible for his light to have failed and for the others to have continued, but if it had done so the company would have known of it. All these lights were supplied by the company's works at Sardinia-street, and were driven by the same dynamos.

By Mr. ASTBURY: Is it possible that the dynamos could fail to send energy down those mains in such a way that one person upon the mains could get light and other persons upon the same mains could not get light?—It is possible by the burning out of a section of the mains.

That was obviously not the cause, because the light came on again. Except when a section of a main burns out is it possible for the light to go out in one house on that main and the lights of houses on other parts of the same main to continue burning?—No, it is not possible.

From November, 1898 has any section of Ginder's main ever burned out?—No. There had been absolutely no complaint brought to him from November, 1898, until February 25 of this year of any failure to supply light to any house by the mains which fed Ginder's premises.

During the winter 1899, and up till February, 1901, was any complaint made regarding the pressure?—On three occasions. On November 16, and early in January of this year the pressure was slightly low.

Would the decrease in the pressure have put the lights out and caused only a red glow?—Certainly not. There was only a decrease of pressure to the extent of 10 per cent.

Cross-examined by Mr. EADY, Witness said the high-voltage continuous current was supplied to the whole of the company's district about the middle of 1900. At one time it was a matter of notoriety that the Metropolitan Company had not sufficient current to satisfy their obligations. That, however, did not apply to their mid area. In 1898 or 1899 if they had worked they could have augmented the current in the Holborn district or their West area—that would be on the alternating supply, but not on the continuous supply.

The hearing was then adjourned. On Saturday the case was resumed, and Mr. Todd's cross-examination continued.

By Mr. EADY: The reasons you gave when you were unable to fufil your statutory obligations were that you had not sufficient current, and that you were doing all you possibly could at Willesden, where you had great trouble with your generating engines?—Yes.

In 1899, when you had to buy from other concerns a very large amount of current, and in 1900, when you had to buy some current, were you using all your available current?—We had always spare current at Holborn. We had spare current at Sardinia-street station, but we were limited by the size of our mains as to the amount of the current we transmitted.

Is it a fact that within the last two years you have received complaints from persons in the Holborn district as to the electric supply?—We have received complaints, but I do not know of any case where the fault was due to our supply. On Jan. 5, 1898, there was an extinction at 3:20 p.m., and the main was disconnected on account of an earth fault. On Nov. 17, 1900, the pressure fell about 10 per cent., and on Jan. 8 last the pressure also was low. The light would not have been so strong on these dates.

Take a 16 c.p. lamp made for 100 volts. What pressure would that lamp stand without bursting?—For a short time it might stand 120 volts.

Is it possible to do injury to it at less than 110 volts?—The effect of 110 volts, if maintained, might blacken the lamp.

What is the least voltage that would destroy a 100 volt lamp in a few minutes?—130 to 140 volts.

Are you quite sure that a voltage under 110 could not injure a lamp if it only lasted a few moments?—Yes.

And are you sure from the reading of your log that the pressure in Ginder's premises between six and seven o'clock on the night he speaks of broken lamps could not have exceeded 103 volts?—It was impossible that it could. He had no instance of any case where the voltage was less than 100½. The Metropolitan Company had not purchased any current to assist the direct supply since November, 1899.

Mr. JOHN PAGE, superintendent of the canvassing and contract department of the plaintiff company, said one of their canvassers was named Wright. The agreement Ginder signed was left with him to be read at his leisure and returned by post, when it was reported that Ginder's supply was discontinued in 1900. About that time he informed defendant that the company would hold him liable for breach of contract. Later, defendant said he was quite satisfied with the light.

Did he suggest that there was anything wrong with your supply to him?—No.

Did he say anything about the terms upon which the rival company—the County of London Company—were to give the supply?—No; but he stated their canvasser had told him the County of London Company would see him through any action we might bring against him.

It was the duty of Mr. Wright to report to you any complaints he receives from consumers?—Yes.

Has he ever reported any complaints made by defendant?—Never.

Have you received complaints from other customers as to defective supply?—No. We have been practically free from such complaints at the Sardinia-street station. The supply has been most satisfactory.

Cross-examined by Mr. EADY: Is there any written acceptance by the company of defendant's contract?—No.

Is it the practice of the company not to sign any part of the printed agreement themselves?—Not unless we are asked to. There are some signed by the company. If anybody wished it the secretary would give his signature directly.

Your printed form has been altered. That which Ginder signed said, "the consumer will take the whole of the electrical energy for a period of not less than five years." Since then there has been added the words, "and shall take from no other company or person"?—Yes.

When were these new forms introduced?—When the others were out of print. The new forms were printed subject to the approval of our solicitor. I do not know the circumstances under which the words were added.

Ginder's stipulation was for five years, and the price was to be 4½d. per unit. What was the ordinary price for current at the date of his contract of Nov. 16, 1899?—For private houses it would be 6d. per unit, and for trade purposes 6d. and 5d. To get the 5d. rate a custumer would have to consume 5 units per 8 c.p. lamp per quarter.

Upon what terms was it reduced to 4½d. per unit?—It was reduced subject to a consumer entering into a contract for a term of years. That was the only element that made the difference.

What governed the length of the term of contract?—My discretion chiefly. It was about 1897 that contracts were first entered into for a term of years, but the instructions respecting contracts were different now.

Are there many of your customers who are paying 4d. per unit?—In the Holborn district about 50.

Are there any cases where you charge more than 4½d. when the light is used for trade purposes?—Yes.

Are there houses where you charge only 4½d. though no contract has

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been entered into?—Certainly not more than half-a-dozen, and they are particular persons we know.

Why do you charge them 4½d. without a contract for a term of years and compel others to make a contract if they want the light at 4½d.?—The former are old customers, in whom we have perfect confidence.

At the close of plaintiffs' case, Mr. EADY, for defendant, submitted there was no contract between the plaintiffs and the defendant that the latter would not take electrical energy from anybody else but the plaintiff company.

His LORDSHIP: You must address me on that. At present I think there is.

Mr. EADY: I submit there is not in express terms. It is not so expressed in language. Of course, in one sense a contract to do a particular thing involves the negative not to do anything inconsistent with it.

His LORDSHIP: What do you understand the meaning of the word "whole" is?

Mr. EADY: I understand it to mean the whole, or all. The consumer agrees to take the whole of the electric energy——

His LORDSHIP: If he takes part from somebody else could he not be restrained?

Mr. EADY: Not by injunction, I submit. It is not a breach which will be restrained by injunction. That is a point which will have to be considered. I say in the first place that there can be no injunction, and in the second that plaintiffs have proved no damage. I say so far as the contract is concerned it now appears that the plaintiff company supplied other persons on better terms than they did defendant. I say we are entitled to be supplied on the same terms as anybody else because under their statute they cannot give any undue preference.

His LORDSHIP: Suppose the facts are so, you say that by the contract you ought to pay less, or that the contract is bad altogether?

Mr. EADY: The first question is, whether the contract when it was entered into was good or bad. Plaintiffs cannot enter into any contract which would give any undue preference.

His LORDSHIP: You say that if anybody paid 4d. you ought not to pay anything higher, and that your contract was bad altogether.

Mr. EADY: Yes. I say, further, that if the contract was good when it was entered into, better terms were made by plaintiffs with other persons, and that defendant is entitled to the benefit of those better terms.

His LORDSHIP: You say, further, that if the contract is good you are entitled to pay less?

Mr. EADY: Yes. We also say that the contract is bad on the ground that there was no consideration whatever for the contract for a term of years. Under the statute the plaintiffs are bound to supply current to anybody who applies for it on the current terms. If they were supplying it to other people for 4½d. there was no contract on our part to take it for five years. There was no consideration for our taking it for five years. Then there is a further question, that by reason of the defects in the light the contract cannot be enforced against us.

His LORDSHIP: I want to understand that point. Let us assume that the contract is a good contract, and that the light supplied is bad. On what ground do you say that the contract is at an end?

Mr. EADY: On the ground that the plaintiffs could not get specific performance of it. I also say, and put it as high as this, that it is a reason or excuse for our getting the current elsewhere.

His LORDSHIP: As a legal proposition excuse will not do. You are either bound or not by the contract.

Mr. EADY said he would call his evidence first and address his lordship afterwards.

DEFENDANT, in answer to Mr. Eady, said he took possession of the "Red Lion," Holborn, on Nov. 1, 1898. The house was already installed with the electric light and current was being taken from plaintiffs. This arrangement he continued. The first suggestion as to a contract was made soon after. A paper was left for him to sign and he signed it. He did not think the words "five years" were mentioned to him or he would not have signed the contract. Sometimes the light was fair and sometimes very bad. The light was seldom sufficiently good to enable a person to read a newspaper in the bar. It was a matter of frequent complaint. He had no reason in asking plaintiffs to disconnect except the poor quality of the light supplied. During the time he took plaintiffs' current he used generally to light 27 lamps; now he only used 13 of the 27 lamps and had sufficient light. There had been no alteration in the lamps or fittings. If he was restrained by injunction from taking current from anybody else but the plaintiffs he would not attempt to use electric light at all.

The proceedings were then adjourned till Monday, when defendant, cross-examined by Mr. ASTBURY, said he had nine lamps immediately over the counter, and frequently the light was so bad that customers could not tell whether they were being supplied with ale or stout. He bought the electric lamps from different places. One lot came from the John Bull Lamp Co., Covent Garden. He had also burned Ediswan lamps of 16 c.p. On one occasion the filaments of four lamps were burst by a sudden flare of light; 22 lamps were burning in the premises at the time. The remainder continued to burn all right.

Are you going to pay the costs of this action if you lose?—I shall have to pay the greater part of them.

Is Mr. Morse, who is acting in this case, the County of London Company's solicitor?—I believe so. I was advised to go to him because he knew about electric light.

You have not exactly got an agreement from the County of London Company that they shall pay for the defence of this action, but you have got some understanding from them?—I have been told that they will assist me.

From whom did you get the undertaking?—From Mr. Renwick, the secretary.

To what extent has the County of London Company agreed to assist you?—I do not know.

Have they agreed to pay all the costs?—No, they have not.

Have they agreed to pay any?—They have not.

Replying to further questions, witness admitted having a letter from the company to say that they would assist him in the action. That letter was in the possession of his wife's solicitor. The letter was written from the office of Mr. Morse, the County of London Company's solicitor, but he could not say when it was it written.

Mr. ASTBURY asked for the production of the letter written by Mr. Morse to defendant, and for a copy of the answer from defendant to Mr. Morse, but they were not in court.

To Witness: Is it a fact that as soon as you got an undertaking from the County of London Company's solicitor you left it to Mr. Morse to defend this action as he thought best?—That is so.

Do you suggest that the 13 lights you are now using in the bar give more light than the old 27 lights did?—Yes. They are better than the 27 when the light was bad. When the supply of the Metropolitan Company was good it was all right.

Can you give me any other date when you saw the light go out or flare up?—I never kept a note of dates. Mr. Renwick had told him that he did not think his agreement with the Metropolitan Company was binding. That was in February, and Mr. Renwick further told him that if there was any trouble in the matter he would be assisted.

Evidence was then given for the defence as to the quality of the light supplied to the defendant by the plaintiffs.

Mr. J. MILLS said that from Jan. 11 to May, 1900, he was manager of defendant's public-house. He could not say that the light was so bad that it was impossible to read a newspaper in the bar by it. He was an old-fashioned man, and preferred gas to the electric light. When the whole of the 27 lights were used the light was very unsatisfactory.

Mr. H. T. CULLIFORD, photographer, said that his establishment was lighted by electricity, and current was formerly supplied by the Metropolitan Company. About 30 of the 50 lamps were generally used. They changed from the Metropolitan to the County of London Company in October, 1900, and the light was four times as good as that previously supplied. It was true that in June, 1900, the Metropolitan Company disconnected his supply because his account was not paid, but the Metropolitan Company had never applied for payment of their account.

Mr. W. H. HINCHCOE, partner in a firm of tailors, said his firm were customers of the plaintiff company by contract. The light was very indifferent, and had been so always. They had had it for about seven years. It was constant and regular, except for occasional breakdowns, but it was always generally bad. He could not say whether his firm had ever made any complaint to any responsible person connected with the plaintiff company as to the light.

Further similar evidence having been given, the Court again adjourned.

On Tuesday, Mr. Justice BUCKLEY gave judgment. He said the contract entered into by defendant and the plaintiff company on Nov. 16, 1898, had as its first article the following:—"The consumer agrees to take the whole of the electric energy required for the premises mentioned below from the company for a period of not less than five years." On Sept. 3, 1900, defendant wrote asking that the service be disconnected. When defendant saw plaintiffs' representative he said he had been pressed by the canvasser of the County of London Company to leave plaintiff company, and the canvasser was such a nuisance that he had to do something. Defendant did not then say anything by way of complaint as to the light supplied by plaintiffs. After the letter from plaintiffs' solicitors defendant asked to be reconnected with the Metropolitan Company, and matters went on all right till February, 1901, when defendant finally abandoned the plaintiff company, and took his supply from the County of London Company. On March 16, 1901, a writ was issued, and an order was afterwards asked for an interim injunction to restrain defendant from taking his supply from any company other than the plaintiffs'. Defendant on that motion had filed an affidavit declaring that on Feb. 1, 1901, the electric light had suddenly gone out and then suddenly flared up and destroyed five lamps. He had, he said, written to the plaintiffs complaining of this. He had, he further said, made frequent complaints to representatives of the plaintiff company. Defendant had been asked to give particulars of the occasions upon which he alleged the light had been deficient, and he gave particulars in general terms except the date Feb. 1, 1901. He (his lordship) was perfectly satisfied that at 6:20 p.m. on Feb. 1, 1901, there was not in the plaintiffs' works any such breakdown or sudden alteration of voltage as to account for the incident which was said to have taken place at defendant's premises. Plaintiffs' engineer had been called and a sheet had been produced which recorded the voltage at the Sardinia-street works between six and seven on the evening of Feb. 1. The voltage for the time in question was a continuous voltage of 120, and it had been proved in Court that the result of that would be just about the best possible for a good light, and which would be about 101 or 102. With that evidence he was entirely satisfied. If the incident described by defendant ever took place it was due, perhaps, not to the fault of the plaintiff company, but to defendant's fittings. Altogether, the evidence defendant had tendered concerning the supply of light was conflicting, and in many cases grossly exaggerated. Against his evidence there was that of consumers like the manager of the Royal Music Hall, the manager of the restaurant adjoining the music hall, of Mr. Gates, who had a large café in Holborn, and of Mr. Kuss. These witnesses said they had no serious cause of complaint as to the light supplied by the company. Therefore, on the question as to whether the light supplied by plaintiffs was reasonably such that the parties contracting were entitled to receive he found the facts in favour of plaintiffs. It was further proved that the defendant Ginder was not really the person defending the action at all. He was solicited by the County of London Company to break his contract with plaintiffs, and he did so, and his solicitor obtained from Mr. Sydney Morse, solicitor for the County of London Company, a letter, the exact terms of which had not been disclosed, but the substance

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of it was that the County of London Company would assist him in the action. The action, therefore, was really one between the two lighting companies, and not between the plaintiff company and Ginder. One of the defences raised was that the contract entered into was affirmative and not negative. In the case before him the consumer agreed to take the whole of the electric energy required for his premises from plaintiffs. The company was bound to supply that energy under Act of Parliament. The only question was as to price, and that was fixed at 4½d. per unit. There was no affirmative contract in this case. Ginder said he would take the whole of the electric energy. He could burn gas if he liked, but if he used electric energy he must take it from no other company. It was argued that the contract was invalid in so far as it gave graduated rates, and that it bound parties for a term of years. He thought that point was entirely answered by the language of the order. The order, sec. 46, provided that where an occupier of premises required a supply of energy he should enter into a written contract with the undertakers to receive and pay for the supply of energy for a period of at least two years. Sec. 52 further set forth that the undertakers might make any agreement with the consumer as to the price to be charged. There was thus an express statutory authority to obtain a contract from the consumer that he would continue to receive the supply for at least two years. Secs. 19 and 20 of the Electric Lighting Act, 1882, provided that undue preference must not be given to any particular consumer. It was said that there were contracts with other consumers which were different in their terms. The instances given were three. One party entered into a contract in March, 1898, for five years at 4½d. per unit, another had a contract for two years at 4½d. per unit, and a third was for two years at 4½d. In another case there was a contract for three years at 4½d. per unit. Mr. Gates, in 1895, paid 7½d., but no term of years was fixed. In October, 1899, he entered into a contract for one year at 4½d. and in October, 1900, for two years at 4d. Sec. 19 said "every person within such area is entitled to a supply on the same terms at which any other person in the area is entitled under similar circumstances to a corresponding supply." That last expression, "under similar circumstances," gave a latitude to the company to make bargains with customers where the circumstances differed and the supply did not correspond. Gates was a very different customer to Ginder. He was a large consumer, and he was a consumer who used day current as distinguished from night current. It was to the advantage of the company to get customers to take a day supply, because they obtained some return for running their plant during the daytime, which otherwise would prove unproductive. The 20th section of the order gave direct statutory authority to make the charge within 8d. per unit. He thought the facts of the case showed that there had been no undue preference. Mr. Page, the company's canvasser, had told them that he took the circumstances of each case under consideration when fixing the price. He found that the contract had been established. Therefore he would grant the injunction to restrain the defendant during the remainder of the five years' contract entered into in 1898 from taking electric energy required for his premises from any other person or company than the plaintiffs. He, however, reserved liberty to defendant to discontinue taking that supply if it were not efficient and such as plaintiffs were bound to give under Act of Parliament. The plaintiffs would be awarded costs.

Mr. EADY asked his lordship if he would suspend the injunction for 14 days if the defendant appealed.

His Lordship agreed.

## London County Council v. Metropolitan Electric Supply Co. (Ltd.).

In the Chancery Division, on Wednesday, before Mr. Justice Farwell, an action was heard as between the London County Council and the Metropolitan Electric Supply Co. The point raised was as to the interpretation of a clause in the Council's act defining the conditions under which the Council, having taken over for the Holborn to Strand improvement scheme, should acquire the Sardinia-street works of the company, and whether the plant to be supplied in re-instatement of the plant hitherto possessed by the company should be plant not only capable of generating and supplying 4,000kw., but should include additional plant to enable the company to furnish that supply, even if the plant which ordinarily could produce that output of electric energy were temporarily put out of work for repairs or stopped by accidents.

Mr. HALDANE, K.C., for the London County Council, said the question was one simply of construction, and his lordship would have decided it simply on the motion, had he not felt—as they all felt—that certain facts should be before the Court before the question of construction was decided. The London County Council was making a great improvement in the form of a new street extending from the Strand to High Holborn, and in the construction of that new street had to take a piece of ground which formed the site of a station of the defendant company. When the bill was before the Parliamentary Committee a clause was negotiated which now required interpretation. The company had an establishment on a site in Sardinia-street which was going to be taken by the County Council. The machinery, plant, and works, at the time the act was passed, were capable of generating 3,600kw. and no more. By sec. 55 of the act it was provided that the Council should not enter upon or use any part of the company's present site until they had provided, at their own expense, a site and buildings for a new generating station. The clause was a re-instating clause. The County Council were simply to give the company what the company had had before. The company were to make the station themselves, and the obligation of the Council was to pay, in terms defined by a later clause. What the company had to do was to erect a station—not plant—for transforming, transmitting and conveying electric energy. His lordship would observe the word "transforming." The company had great works at Willesden, and it either now did or proposed to send current at a very high potential into London and there transform it into low pressure current suitable for local use. Therefore it was put in that it was to be a transforming station, and he thought that it would be found that the company did the whole of its work by transformers instead of generating the energy at their different stations. The Council was to pay a sum equal to the cost and expenses of erecting and fitting up a new generating station upon a new site with new plant. The parties were fighting as to the plant and as to the capacity and supply of electric energy to the amount of 4,000kw., and the County Council were to pay the company the costs of any loss sustained in consequence of the change. The defence had taken a ground new from that which was taken on the motion. The plaintiffs agreed that there must be a plant capable of sending out continuously 4,000kw., and certainly any plant constructed by a skilled engineer would generate a little more than the actual amount required. At a station of this kind the average amount of electricity taken by the public was very much less than the capacity of the machines. The reason was, that in the mornings and during daylight the electricity was not flowing and the machines were at rest. The result was that when they specified for machines of an output of 4,000kw. what was meant was that those machines were to be capable of producing that quantity for a prolonged time yet not continuously, and in practice that did not occur—or but rarely. Therefore, in this case, 4,000kw. was not only sufficient but more than necessary for what was required. His learned friends were contending, not for extra capacity, but for extra plant. They wanted six machines instead of four, and 5,000kw. instead of 4,000kw. They said that they must have spare plant. The County Council contended that the meaning of the clause was inclusive of spare plant, while the company contended that it was exclusive. The County Council said the company never had from their station at Sardinia-street so much as 3,650kw., including all spare plant.

His LORDSHIP: All I am concerned with is the question as to supply and generating, and whether generating and supply mean the same thing.

Mr. HALDANE said that that was so, and that his lordship required expert information on the subject.

His LORDSHIP: But supposing you had a week's fog?

Mr. HALDANE: Well, they could supply 4,000kw. continuously and easily. They had their accumulators, which could be charged; and even if the plant were not running perfectly smoothly they could resort to their accumulators.

His LORDSHIP: But there is a limit to their power.

Mr. HALDANE: Oh, yes, but with machinery of this capacity they could supply, even without accumulators, the necessary 4,000kw. continuously for a week or even more. The case for the Council was this: They asked that it might be declared that, according to the true construction of sec. 55 of the London County Council Improvements Act of 1899 they were only bound to pay a sum equal to the cost of fitting up a generating station and new plant capable of putting out 4,000kw. and no more. The defence proposed that the Council should pay for four high-pressure generators at a cost of £12,000, each producing 1,000kw., and two other high-pressure generators, producing 500kw. each, at a cost of £6,000. The defendants said that they must have spare or extra plant to the extent of 25 per cent. or upwards of the minimum plant necessary to supply their customers. The assistance of the experts was only to enable his lordship to understand the nature of the machinery; but really there could be nothing except to consider the words of the obligation to construct new plant and machinery for generating and supplying not less than 4,000kw. Did that imply a contract to furnish in addition what was now claimed as "spare plant"?

His LORDSHIP: It seems to me that it is 4,000 and nothing more, but in a technical sense it may mean something different.

Mr. BUTCHER, K.C., for the company, questioned the relevancy of admitting evidence in connection with the operations at the existing station. Mr. Haldane had stated that the Council were to give the company simply what they had before. As a matter of fact, it had been a case of bargaining between the two parties. The Council had been taking away the company's works; forcing the company to go elsewhere. The company, on their part, demanded a *quid pro quo*, and had said that the Council must not take away the company's rights unless something were given that would be satisfactory to them. There was also inconvenience of removing, the possibility of not getting a proper site elsewhere; and all these things were considered in the negotiations between the parties.

His LORDSHIP said he did not think he need hear evidence on these matters. All he had to consider was the question of plant of a capacity to generate and supply the electrical energy stipulated for. It was immaterial to consider what the company had before.

Mr. CHARLES GADSBY said he was an electrical engineer and had had 18 years' practical experience. On the instructions of the London County Council he had inspected the station of the defendant company at Sardinia-street. A 1,000kw. dynamo made by a good firm would stand extra work for a short time—1,250 kw. for a couple of hours. That was exceptional user. They would not expect so to use it for a whole day. There was usually a margin of one or two machines which could be put into operation when it was necessary to withdraw one of the others for repair. That was a question for the engineer in charge. In the case of a station with a single dynamo, if there were to be a spare, they would require to have another dynamo of the same power. There were statutory provisions in the case of electric lighting undertakings for giving continuous electric supply when necessary, and that under penalties. He had designed works for electric lighting in his former capacity as engineer to the Brush Company. He had never had full charge of an electrical station, as he had been more connected with the manufacturers of the plant than with the companies whose stations they were building. In a properly-equipped electric lighting station it was usual to have machinery, not necessarily running, but in readiness, so as to allow of overhauling and repairing of other machines—a margin to enable them to carry out repairs and to provide against accidents. Even in fogs in



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London he did not think that the full supply was required for two or three days continuously. In his opinion the plant capacity should exceed the output. The plant capacity was one thing, the output was another ; and in well-regulated stations the plant capacity was in excess of the output required. In the present state of the development of electrical knowledge 50 per cent. margin was not unusual, but 50 per cent. is not a necessary margin ; 20 per cent. was nearer the mark.

Mr. ALEXANDER SIEMENS said he had had some 30 years' experience in designing and constructing electrical machinery. He had supplied electrical machinery to stations such as the defendant company's. If there came to his firm an order for plant of a capacity to generate and supply electric energy for an output of not less than 4,000kw. he should understand that the total ordinary full output of the plant was to be 4,000kw. There might be a difference of opinion as to how it was to be sub-divided. That was a matter of arrangement. He should not consider himself under an obligation to supply spare plant. He should not expect anybody to put a 4,000kw. plant into a station which had to supply anything like 4,000kw. As manufacturers they only got stated the plant capacity, not the station capacity. The plant which they delivered for the full ordinary load capacity of 4,000kw. would produce more than 4,000kw. on an emergency. First-rate plant would bear the strain of producing its full ordinary load an indefinite time. It was a rule that plant should be made big enough to enable it to give more. He drew a distinction between plant capacity and station supply for the public. If he had an order to design electric lighting works for the purpose of making a general supply of 10,000kw. the amount of plant capacity he should supply would depend entirely upon what the station was to be used for. At London electric lighting stations, speaking generally, there was no spare plant. He did not agree that in every well-equipped lighting station there was a considerable amount of spare plant. An accident to the plant might, of course, happen, and it was better to have some spare plant.

Cross-examined by Mr. BUTCHER: Supposing the County Council were bound to supply a plant capable of producing a maximum output of 4,000kw., they would have to supply a plant capable of producing more?—A maximum output is a maximum output. If you want a continuous supply you would want six times the plant capacity.

I put it to you that electricians are in the habit of allowing 50 per cent. of plant capacity for accidents, breakdowns, &c.—I am not aware of it.

Prof. W. E. AYRTON said it was not possible for an electrical station to have a continuous or uniform output. It varied enormously. It was not usual in electric light stations to have plant, called spare plant, to meet a contingency. What happened was this: As the demand increased until the maximum output was equal to the total capacity of the plant, when the engineer knew that other customers were coming on in the following year he ordered more plant. That plant would probably arrive in the summer, and then he might have plant which might be called extra, or spare plant. During the next winter he might be using the whole of his plant again, and therefore there was no fixed amount of spare plant. There was no distinction between generating and supplying. The dynamos simply generated what they supplied. He had never designed a station, but he knew all about them. He had to teach the designing of stations. When an accident occurred a company was liable to be prevented from supplying the maximum amount required. He thought the words "generate and supply" meant practically the same thing.

This closed the plaintiffs' case.

Mr. Butcher, K.C., for the defendants, called Mr. ROBERT HAMMOND, who said he had been engaged in electrical engineering for more than 20 years. If he were asked to fit up a generating station with plant of a capacity to generate and supply electric energy of not less than 4,000kw., he should consider it necessary to provide a certain amount of spare plant. Putting down plant for 4,000kw. in his opinion involved putting down a sufficient plant to secure the supply of 4,000kw. at all periods. He thought provision should be made for sufficient plant to take the place of plant laid off for repairs, and also to take the place of a set of plant which would need repair. In designing such a station he should put down six units each of 1,000kw. That would enable the engineer to have one set of plant entirely removed—both engines and boilers from the commission. Leaving 5,000kw., and then if an accident happened at the time of top load to a machine there would be a spare plant ready to take on the supply. That was his own practice. The ordinary practice certainly in laying down new works was to make a large provision of plant to ensure against breakdown.

By Mr. HALDANE: In providing for the supply of lamps do you make provision on the assumption that the whole of the lamps are going at once?—No, the proportion varies very considerably in different districts. One usually reckons about 60 or 63 per cent. in the London districts. In a district where there are many theatres, and where there is a constant load, you would get a higher ratio than where only private houses.

Mr. S. Z. DE FERRANTI said he was a manufacturer of machinery for electric lighting. If he were asked to fit up a new generating station and new plant of a capacity to supply electrical energy to the extent of 4,000kw., he should consider the best way would be to put down four plants of 1,000kw. each to supply the demand, and would then require another plant to act as a stand-by. Speaking from his experience, that was the usual custom at the most successful stations.

Sir W. H. PREECE said he was consulting engineer to the Post Office and other public bodies. If he were asked to advise a company as to erecting a new generating station, with new plant of a capacity to supply and generate electrical energy of not less than 4,000kw., he should advise a plant of 6,000kw. It was necessary to have a spare plant for public supply for emergencies.

Mr. H. DICKINSON gave similar evidence.

Counsel then addressed his lordship on the law.

Yesterday (Thursday) his lordship delivered the following

**JUDGMENT.**

Mr. Justice FARWELL said the London Council, under the provisions of their Act of 1899, were making a new street leading from Holborn to the Strand, and under the powers contained in their act they had taken the premises belonging to the defendant company in Sardinia-street, where they had a generating station, from which they supplied their district surrounding. The act in question contained a section providing for compensation to be paid to the defendants by plaintiffs for taking their premises and displacing them. The determination of the question in dispute depended upon the construction of that section. The defendant company had this station as a generating station, and had acquired, and intended in future to use, in addition, a generating station at Willesden for transmitting energy to their stations in London, if necessary, and transforming there. Under the provisions of the act the Council had to provide a site on which the defendants should be able to reinstate their buildings, machinery and works, and there was a certain power in the defendant company to purchase the freehold interest if they accepted from the Council the lease which they held in the land taken from the Council. The value of this section of the act, which, after all, was an agreement between the parties, confirmed by the legislature, was this: The defendant company were to be compensated by being put, as nearly as possible, in the same position as before the Council displaced them. They were to have a site provided by the Council adjacent to the site from which they were displaced. Although the site was definitely fixed for the purpose there was, in one sense, an element of indefiniteness because the defendant company might change their minds as to the position. The defendant company contemplated not merely replacing their generating station but having a larger station for generating than formerly, and for transforming and transmitting from such transformers. His lordship then referred to the sections in the Act of 1899 bearing on the dispute, and said that the matter as to the compensation to be paid by the Council to defendants was to be settled by arbitration. An arbitrator had been appointed and the Council came to the Court asking for a declaration for the guidance of the arbitrator as to the basis on which he should assess the sum to be paid for compensation, and that depended upon the construction to be put upon the words of sub-section 7 of the Act. The question was whether the generating station was to be of a certain capacity and so on, or whether it was to have a plant of a certain capacity and so on. He came to the conclusion on the evidence that the generators were made so as to leave a small margin of supply in case of need. According to defendants' witnesses to have a station which was effectual to supply 10,000kw. it was necessary to have a plant in the station of a greater capacity than 10,000kw. The claim by the defendants was in effect not for 4,000kw. machinery but for 6,000kw. machinery. His lordship said he came to the conclusion that what was understood was that the generators—plant and machinery—should be of a capacity to generate and supply energy of not less than 4,000kw., and not that the station should be a station which, according to the advice of possibly conflicting experts, would have to be fitted up in accordance with experts' opinion as to what was desirable for a 4,000kw. station. That disposed of the case. There would be costs for the plaintiffs of the action and of the motion.

## Finchley Urban District Council v. Finchley Electric Lighting Co.

On Friday last (before Mr. Justice Kekewich) a motion was in the paper to restrain defendants from breaking up certain roads for the purpose of laying pipes to contain electric cables without the consent of the plaintiffs as the highway authorities.

Mr. WARRINGTON, K.C., said defendants had given an undertaking not to open the roads without the consent of plaintiffs or without first giving notice of their intention to do so.

Mr. BUCKMASTER, for defendants, said he preferred that form of undertaking, as circumstances might arise which would entitle defendants to open the roads without the consent of the plaintiffs.

Mr. JUSTICE KEKEWICH said that if the roads were opened without consent, upon notice a fresh writ would have to be issued.

## Hawkes v. Leyton District Council.

This case came on for hearing yesterday, before Mr. Justice Buckley, in the Chancery Division. It was a motion by plaintiff, Elijah Hawkes, to sequestrate the Council of Leyton for breach of an order made by the Court in February, 1900, restraining them from carrying on their electric supply works at Leytonstone so as to cause a nuisance by noise and vibration to plaintiff as owner and occupier of the premises in the Cathall-road where the works are situated.

Mr. ASTBURY, K.C., for the plaintiffs, explained that when the case was last before his lordship he came to the conclusion that the gas engines in defendants' works required very careful watching to prevent them becoming a nuisance. Defendants undertook to stop the back-firing in the exhaust pipes and explosions as far as possible, and not to run the engines between the hours of 11 p.m. and 7 a.m. Mr. Astbury read affidavits representing that, notwithstanding the injunction, the nuisance still existed.

Mr. H. TERRELL, K.C., for defendants, maintained that the alterations made at the works had the result of remedying any nuisance and that the engines, excepting on one or two occasions, were not run after 11 p.m. or before 7 a.m. He could call witnesses who lived near the works and who had experienced no annoyance. No doubt considerable vibration was occasioned by the numerous trains passing to and fro.

Evidence was afterwards given, and the further hearing adjourned.

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### Liverpool Mortgage Insurance Co. v. British Electric Works Co. (Ltd.)

In the Chancery Division, on Wednesday, an application was made to Mr. Justice Cozens Hardy for the appointment of a receiver and manager of the British Electric Works Co. (Ltd.), of Birmingham. The action was taken on the ground that the debenture security had become enforceable. One of the provisions of the trust deed was that the company should keep up its stock-in-trade to the value of £30,000, and if they did not the security became enforceable. The trustees had certified that the value of the stock-in-trade was now below £30,000.

Counsel for the company said he was instructed to consent to the application. There were actions pending by unsecured creditors, and one of these creditors would obtain judgment on Friday.

Mr. Justice COZENS HARDY said he would appoint a receiver and manager, but he was not to act as manager for more than two months without the further leave of the Court.

### Chamberlain and Hookham (Ltd.) v. Bradford Corporation.

In the Court of Appeal on Wednesday, before Lords Justices Collins and Stirling, this case was mentioned by Mr. Moulton, K.C., who applied for leave to introduce certain fresh evidence in an appeal which had been set down in the action. Learned counsel stated that in the Court below a point had been made as to the magnetic strength of two magnets. They were unable at the time to measure the strength of the magnets, but since the trial measurements had been made of exactly similar magnets, and in their opinion there had been a mistake of 20 or 30 turns. All he now asked was that before the appeal came on, and without prejudice to any question, one witness on either side might be examined with reference to the strength of these magnets. He might name Mr. J. Swinburne as a very suitable person, and he supposed his learned friend would desire either Prof. Ewing or Prof. Adams.

Mr. BOUSFIELD, K.C., said he saw no objection, and their lordships directed the motion to stand over until the hearing of the appeal.

### Alleged Default in Electricity Supply.

At the Westminster (London) Police Court on Friday last, the magistrate, Mr. Sheil, had to deal with no less than 80 summonses against the Westminster Electric Supply Corporation brought by Messrs. John R. Cleave & Co., of the "Hotel Windsor," Victoria-street, Westminster, for "wilfully making default in complying with the regulations of the Board of Trade as to the supply of electrical energy." The prosecutors' case was that under the corporation's Lighting Order of 1889, Messrs. Cleave & Co. as customers of the defendants are entitled to a supply of electric current at a constant pressure of 100 volts, with no variation exceeding 4 per cent. either way. This provision is qualified however by the further important regulation, relied upon by the corporation, "that no penalties shall be inflicted if default is occasioned by inevitable accident, or is of so unimportant a character as not materially to affect the value of the supply."

Under this qualifying regulation the magistrate now dismissed several of the summonses, though Messrs. Cleave & Co. had given evidence that their supply of current fluctuated beyond the limits of allowance.

Mr. AVORY (for the prosecution) then selected a particular summons for a day in October last when the voltage was alleged to have been over 110 for a period of 40 minutes, and when it was further alleged that 17 lamps at the hotel were broken and several fuses burnt out.

Evidence having been tendered on this point,

Mr. SHEIL asked witnesses as to the duration of the current variation, at the same time declaring that he should not hold short fluctuations of, say, five or six minutes to be offences to be penalised.

For the defence, on the summons selected, Mr. WALLACE, who appeared for the defendants, pleaded the occurrence of an "inevitable accident"—an electrical breakdown at the Army and Navy Stores, on the same circuit as the "Hotel Windsor."

Mr. SHEIL ultimately dismissed this summons also, and suggested the adjournment of the remainder of the summonses.

The prosecution accepted this suggestion, and the summonses were accordingly adjourned.

### Lironi v. Moon, Loughlin & Co.

At the Manchester Assizes, on Monday, before Mr. Justice Darling and a special jury, Mr. Victor Lironi, electrical engineer, brought an action against Messrs. Moon, Loughlin & Co. for damages for breach of agreement and arrears of salary. It was stated that plaintiff entered defendants' employment in September, 1898, under a five years' agreement, and was dismissed in October, 1900. Under the agreement his salary was to be £250 in the first year, and £300 in succeeding years, in addition to one-fifth of the profits of the business. Plaintiff's counsel said soon after the works, of which the plaintiff was appointed manager, were established, it became obvious that the defendants had not sufficient capital to work them properly, and further capital was obtained from Mr. F. J. Moon. Owing to the lack of adequate capital, however, the business was not profitable, and the orders could not be executed expeditiously. Plaintiff made complaints, and was ultimately discharged. It was then alleged against him that he had betrayed the secrets of the firm; that he was not at the works at the proper time in the morning; and that he had not devoted his whole time to the service of the defendants, because while he was employed by them he was working at his own inventions. Defendants counterclaimed for £5, made up of £3. 10s. for two standard lamps, which the plaintiff took out of stock, and £1. 10s. the amount of an account which was paid to him by a customer, but which, after leaving the firm's employ, he repaid to the debtor. Before the cross-examination of the plaintiff had been completed a consultation took place between counsel, and as a result it was agreed that there should be judgment for defendants on the claim and counter-claim.

## PARLIAMENTARY INTELLIGENCE.

### CALEDONIAN ELECTRIC POWER BILL.

On Tuesday a Select Committee of the House of Commons, composed of Sir James Woodhouse (chairman), Mr. Fenwick, Mr. Myers, and Mr. Grenfell, with Mr. Bonham Carter (official referee), had under consideration the bill promoted by the Caledonian Electric Power Co. for the powers to supply electricity to a considerable area around Glasgow. The bill was opposed by a considerable number of local authorities and other bodies, among them being the promoters of the Clyde Valley Electrical Power Provisional Order and the Scottish House-to-House Electricity Co.

Mr. BALFOUR BROWNE, K.C., for the promoters, said this was a competing bill with the Clyde Valley Electrical Power Bill. The proposal was to form a company to supply electric energy over the great manufacturing district of Scotland, of which Glasgow was the centre. The promoters were in a position to show that by the combination of these various districts they would be able to generate electricity at such a very cheap rate as would commend itself to manufacturers throughout the area; and he would say at once that the promoters wished to pose as the small manufacturers' friend, although amongst the promoters were some of the very largest manufacturers. These latter could afford to put down plant for the generation of electric power, but the smaller men could not do that unless by a combination of capital, as in this case. Counsel held that the report of Lord Cross's Committee two years ago gave an impetus to electrical enterprise, and last year there were no fewer than five bills introduced into Parliament to supply electricity to large areas in Great Britain. When those bills passed the people in the district round Glasgow saw their way to approach Parliament, and now there were two sets of promoters asking to be endowed with similar powers to those given to the South Wales Company last year. One remarkable difference between the two bills he referred to was that whilst the Caledonian Company did not propose to include the city of Glasgow within their limits, the Clyde Valley Company did. Continuing, counsel said the cost of production on a large scale depended on the load-factor. If the load-factor was very small, say 5 per cent., the machinery would in the 24 hours produce only one-twentieth of what it could produce, and as the cost of the machinery meant half the cost of production, obviously to have large machines standing idle was the greatest want of economy. The promoters, therefore, had thrown their net wide, in order to touch as many different industries as possible, and so to raise the load-factor as high as they could. They calculated on a load-factor of 25 per cent., and hoped to be able to produce at such a rate that the small manufacturer would be put in a somewhat similar position to that of the man who could instal electricity for himself. In order to get a good load-factor a company wanted what they obtained by their large area—a diversity of factor—as many different people employing electricity for different purposes and at different times as possible. The supply of electricity for some chemical processes was absolutely essential, as with the production of carbide of calcium, and it would be shown that such trades had not come to this country, or having been here had departed again, and were now being carried on in countries where water power could be utilised for electrical purposes. Really it was not a question of water power, but of cheapness, for the promoters of this bill believed they would be able to produce electricity at such a price as would encourage those industries which it had been the object of the Highland Water Power Bill and which it was the object of the Shannon Water Power Bill this year to encourage. The area the company proposed to cover was 1,135 square miles, and in it were some very large populations. With regard to the Clyde Valley Bill the Caledonian Company had suggested amalgamation, but the suggestion was not listened to. The Caledonian Company were willing to amalgamate or partition if the committee thought either course wise, but they were also willing to take their order in competition with the Clyde Company. There was, however, a fallacy about competition. The object was to secure cheap production, but if there were two sets of machinery supplying in the same district its supply could not be so cheap as if there were but one. In the proposed area of supply there were already 10 undertakers authorised to supply electrical energy. Nine of these—namely, Ayr, Airdrie, Motherwell, Kilmarnock, Partick, Govan, Greenock, Paisley and Hamilton—were local authorities; Coatbridge was in the hands of the Scottish House-to-House Company. These 10 provisional orders only covered an aggregate of 21 square miles out of the 1,135, and for a total population of 366,000 out of 843,000. Of the 10 orders, two—Hamilton and Kilmarnock—were not yet being worked; and the electrical system in use at Ayr, Paisley, Airdrie and Coatbridge was only the single-phase alternating system of high periodicity, which was not suitable for large power, and was intended only for lighting. Under the bill there would be seven generating stations, and the site of each fulfilled the requirements for economic electrical production. It was proposed to provide for 40,000 B.H.P., which was equal to 30,000kw., and to allow a margin for a further 25 per cent. of spare plant. The total capital authorised in the bill was £1,000,000 share capital, with the usual borrowing powers of £333,000. There was excellent reason for believing that with 25 per cent. load-factor the company would be able to manufacture, ignoring interest on capital, at 0·7d. per unit, which, on the estimated manufacture, would give £153,000. Assuming that they could sell 52,000,000 units yearly at only 1·25d. per unit the income would be £273,000, so that there would remain a net profit of £120,000, which would be sufficient to pay 4 per cent. on the £333,000 borrowed money, and 7 per cent. on the £1,000,000 share capital. At first, of course, the company did not expect to earn those dividends, but knowing that their own promoters would be large consumers they did not despair of being able ultimately to sell that number

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of units at that price and so make a good return. The company were not seeking to obtain a monopoly, but to supply energy in all the burghs that were opposing. The proposal of the bill in this respect was contained in clause 39, which said, "The powers of the company for the supply of energy under this act shall be subject to the following provisions: Energy shall be supplied under this act only (A) in bulk to authorised distributors, (B) for providing power to any person." That would give the company power to go into Kilmarnock, say, and supply to a manufacturer there energy for power purposes only. Even that was guarded by the provision that "The energy supplied to authorised distributors may be used for lighting or other purposes, and the energy supplied to any person for power may be used by such person for lighting on any premises on any part of which the power is utilised, but, save as aforesaid, the company shall not supply energy for lighting purposes." That was only what a manufacturer in Kilmarnock could now do. It was further provided that, "Energy shall not be supplied under this act by the company in any area being at the passing of this act the area of supply of any authorised distributors, except with the consent of those distributors, but that consent shall not be unreasonably withheld." That was where the opposition arose, and that was the whole case between the promoters and the burghs. The burghs asked that they should be allowed to withhold their consent unreasonably. It was proposed that if any question arose as to whether the consent was unreasonably withheld it should be determined by the Board of Trade, and he thought that the Committee would not say that was an improper tribunal. Then it was provided, "The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time." This would prevent a corporation from blocking the introduction of electrical energy into its district and at the same time themselves refuse to supply. Again, if a corporation had an installation and proposed to supply at 3d. while the company was willing to supply—of course only for power—at, say, 1½d., was the manufacturer to pay the higher price? Such a thing would be simply monstrous. The local authorities wanted to have an absolute veto to say the company should not enter their towns even to supply for power. Would the Committee give that veto, which might be greatly against the public interest? The supply of electricity for power purposes was not a proper municipal function. A clause in favour of the county councils was proposed to be added to clause 39 as follows:—"If any county authority not being an authorised distributor within the meaning of this act requires from the company a supply of energy for the purposes of electric lighting or for other purposes which are or may be within the scope of their statutory powers for the time being, the company shall be bound to afford such supply as if such county authority were an authorised distributor within the meaning of this act." Negotiations had taken place with the county councils, and he hoped they would not eventually oppose the bill, in which various clauses for their protection had been inserted.

Mr. A. A. C. SWINTON said he had given much attention to the transmission of electrical energy and electric power for the past eight years, and had had experience in designing and superintending plant for the supply of electricity. He was also electrical adviser to the Elswick works of Messrs. Armstrong, Whitworth & Co., and engineer to the scheme of the present bill. Electricity was the most convenient and adaptable form of energy known, and it was recognised, not only in this country but on the Continent and in America, that it was of the greatest importance to manufacturing districts that a cheap and easily available supply of electrical power should be provided. In America, particularly, many of these power distribution schemes were at work, energy there being transmitted as far as 80 miles at pressures, he believed, as high as 30,000 volts. The bulk of the power generating stations abroad were water-driven stations, but there was no difference in principle between a station which provided its energy by using water, and one which made its energy out of coal. Where electric power is provided cheaper than the manufacturer can make it himself, and with less trouble, by that amount the foreign manufacturer is at an advantage as compared with the British manufacturer. Great economies were effected by concentration in large stations as against the provision of power in a large number of small sub-stations; and he put in tables showing that as the manufacture of electricity increased, the cost, in proportion, decreased. Engineers differed as to the point where the saving began to fall off: he should say the economy would go on materially increasing until the stations were of 20,000 H.P. or 30,000 H.P. and even more. He had no doubt the company would be able to supply at the low rate proposed by the bill, but that was strictly dependent on the character of the district.

By Mr. BAGGALLAY: Do you also propose to supply electric motors on hire?—Yes. The load-factor on which the calculations had been based was 25 per cent., but he should be surprised if a better one were not obtained. It was now demonstrated that electrical power could be transmitted with very slight loss over very considerable distances; and he had generally taken 10 miles as the radius from the generating station for covering the area under this scheme. In the first instance the company would lay mains to supply manufacturers and authorised distributors. The single-phase alternating current system of high periodicity was used by several of the local authorities supplying electricity, which every engineer would agree was not suitable for supplying power on any considerable scale. Electric mains were being improved from day to day, and if one could be obtained which would give greater resistance, electricity could be transmitted to much greater distances. The company estimated that they would require 40,000 H.P., and in arriving at the figure they made inquiries as to the actual horse-power at present in use in the district. They found that approximately there were 9,000 boilers in the district, which at 20 H.P. on average per boiler, would give 180,000 H.P., so that the 40,000 proposed H.P. was not excessive. That 40,000 H.P. included 25 per cent. of spare power, so that there would be 32,000 H.P. available, equal to 24,000kw. The expenses under the bill were estimated thus:—Land, £40,000; buildings and foundations, £60,000; engines, dynamos, boilers, steam and exhaust pipes, condensers, pumps, switchboards, &c., £530,000; mains transformers and sub-stations, £500,000; making a total of £1,130,000, or, plus £113,000, being 10 per cent. for contingencies and preliminary expenses, £1,243,000; leaving £90,000 for working capital. Taking the average load factor to be 25 per cent. and with 24,000kw. maximum demand, the total output would be 52,560,000 units per annum. The cost per unit might be estimated as follows:—Fuel, 0·17d.; oil, water, and stores, 0·05d.; wages, 0·15d.; repairs and maintenance, 0·16d.; management, 0·10d.; rates, 0·07d.; contingencies, 0·08d.; total, 0·78d., which, on the 52,560,000 units, would mean £170,820. Assuming that this number of units produced yearly were sold at an average price of only 1·25d., this would mean an annual income of £273,750. Deducting the estimated cost, £170,820, there would be a net profit of £102,930, which would be sufficient to pay 4 per cent. on the £330,000, 6 per cent. upon the £1,000,000 share capital, and leave £29,730 annually for depreciation, reserve, &c. The Company did not propose to enter into competition with anybody or to supply in any district in which anyone else was authorised to supply; and a clause would be inserted giving local authorities the right to break up the streets if they desired, and do the necessary work, where a main had to be taken through a district, at the cost of the company. The company had adopted the same schedule of rates of charges as was sanctioned in the South Wales Bill—viz., for the first 400 hours of supply a maximum demand per quarter of 3d. per unit, and for further hours of supply 2d. per unit. The same sliding scale as in the South Wales case was adopted. The prices the municipalities charged were such as could only be used where the price did not enter very much into the cost of manufacture. The aggregate amount of electrical power installed and authorised in all these boroughs was only about 4,000 H.P. The promoters had complied with all the regulations in force for the protection of gas and water companies' pipes.

Cross-examined by Mr. Wilson, for the Clyde Valley Electrical Power Bill, WITNESS said the inter-connection of the various generating stations which was contemplated would make applicable to every station the diversity factor of the whole area. He had not calculated the cost of coupling up all the stations.

Cross-examined by Mr. Erskine Pollock, for several burghs in the area, WITNESS said the company had no agreement with any local authority for the supply of electricity.

Mr. MOON, at this stage, said the Ayr, Dumbarton, Lanark, Renfrew, and Stirling County Councils had been settled with, and were now supporters of the bill.

Mr. SWINTON (further examined) said in transforming there was a loss of 7 or 8 per cent. of energy; in the case of large powers it would go down to 3 or 4 per cent.

Cross-examined by Mr. Blennerhassett, for the burghs of Irvine, Port Glasgow, Clydebank and Dumbarton, WITNESS agreed there was no scheme like the present actually working in the country, but there was perfectly trustworthy data to act upon.

Mr. A. WYLIE, M.P. for Dumbartonshire, and a member of the County Council, said he was satisfied the scheme would be of great advantage to the community in his district. The introduction of electricity would facilitate the construction of tramways and light railways, and thus enable workmen to get into the country more easily than at present.

The committee then adjourned till Thursday, when

Mr. A. C. C. SWINTON was further examined, and said: In the Lancashire and South Wales Acts of last year a number of local authorities were excluded from the operations of the company, although the company were given power to supply in the surrounding areas. He did not agree that the principle was recognised that in these electric power bills urban districts ought to be excluded. The clause under which anyone taking electricity for power might use that electricity for lighting purposes as well was copied from the South Wales Act of last year, and the reason he supposed that was put in the South Wales Act was that if a man were supplied with electricity the supplier could not control what he did with it. It was suggested that in case of an appeal to the Board of Trade with regard to the consent of a local authority to allow the company to supply for power in its district being unreasonably withheld, the mandate to the Board of Trade to consider the terms on which the company could give the supply would enable the company to compete with the local authority—to undersell them and so make their position untenable; he held that if the company were able to undersell a local authority it would be to the advantage of the consumer that they should be able to do so.

Do you think it is reasonable that a large company like you, for the purpose of underselling the local authority, should be allowed to reduce your price and cause loss to fall on the rates?—If we can manufacture cheaper than the local authority I think it is in the interests of the consumer that we should supply.

That is to say you would be in direct competition with the local authority?—So far as supplying for power is concerned. But the local authorities in the area practically do not supply for power. They have not laid out their stations for supplying power, and therefore there will be no competition.

Under section 40 there is nothing to prevent you from applying for provisional orders, and so entering into direct competition with the local authorities?—The practice of the Board of Trade is never to grant provisional orders except the local authority has given its consent.

Mr. BLENNERHASSETT said there were numbers of cases in which provisional orders were granted in face of the opposition of the local authority.

The CHAIRMAN: I think the statement would be more accurate if you said "very few."

The WITNESS: I think they are very few, and it has only occurred in

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exceptional circumstances—where local authorities have had powers and have not used them.

Mr. BLENNERHASSET (to witness): I suggest that as long as the local authorities have to fear your competition and the abstraction of their best customers, they will not run the risk of establishing generating stations for themselves?—I can point out a very obvious way in which they can veto that. They can take their supply from us in bulk; and if local authorities who have generating stations can supply cheaper than we can the Board of Trade will not give us the power to go in.

Suppose a local authority has a veto: then they would be perfectly safe and secure in trying to establish a supply for themselves?—Yes, but they have a veto—a reasonable veto.

But if the local authority think it better to get their supply from you, the fact of their veto will not prevent their doing what they consider best?—The difficulty is this: they know nothing about it. They are not experts. They have to employ an engineer, and he makes a report. He hopes to be employed afterwards on a larger scale to build stations, and he naturally makes out, as far as he can, that it would be best for that local authority to erect its own lighting station. As to the 18 per cent. which it had been suggested the company could pay under the sliding scale adopted, that depended on the company being able to sell at 1·25d. per unit, which was not likely to occur for some time. Further, the Board of Trade had power of revision, and that power he was afraid would be exercised long before they reached the 18 per cent.

Mr. Swinton's evidence was then concluded. He was followed by Mr. G. C. Cunningham, Mr. G. T. Beilby, Prof. S. P. Thompson and Mr. D. Urquhart, whose evidence continued untill the adjournment of the Committee till to-day (Friday).

## THE ELECTRIC LIGHTING (LONDON) BILL.

Mr. Campion, one of the examiners of private bills at the House of Commons, on Monday had before him several bills to confirm provisional orders of the Board of Trade granting powers to local authorities to supply electrical energy. The usual proofs of compliance with standing orders having been given, all the bills proceeded to a second reading. The Electric Lighting (London) Bill came up for proofs of compliance with standing orders. This Bill, which has been introduced by the President of the Board of Trade and Mr. Austen Chamberlain, is to provide for the adjustment, in accordance with changes of boundary effected under the London Government Act, 1899, of the areas within which local authorities and companies are authorised to supply electricity. The boundaries of electric lighting areas were not dealt with by the schemes under the London Government Act, as it was considered expedient that they should be dealt with as a whole by a single bill. A memorial was presented by Messrs. G. C. Martin and Edwin S. Piggott alleging non-compliance with standing orders, the grounds of the allegation being that the notice for the bill as published in the *London Gazette* did not, as it should have done, state the provisions to be made as to the transfer of the mains and pipes within the transferred areas as amongst the objects of the intended application.

Mr. H. L. CRIPPS (Messrs. Dyson & Co., parliamentary agents) appeared to support the memorial. He said under the provision of the bill the Board of Trade might transfer from any company to another portions of their authorised area of supply so as to make the boundaries of their area coterminous with the areas of the new boroughs. Clause 5 of the bill, which was the important clause of the whole, was to the effect that, where any area is transferred under the act, the council or company to whom it is transferred shall take over from the council or company from whom it was transferred any mains or other works suitable to and used for the supply of electricity which were within the transferred area, "and shall pay to them such price as may be agreed upon, or as may be determined in default of agreement by a single arbitrator appointed by the Board of Trade as the actual value of the mains or works taken over." This point largely affected some of the companies. An area might be transferred to a council and the mains, which might be trunk mains, would be taken over by that council. The value of the works might be small, but the company would lose its use of the mains when it lost its interest in the lands. There was nothing, he contended, in the notice which dealt with that point. The effect of the bill would be that, under clause 2, part of the area within which the County of London and Brush Provincial Electric Lighting Co. had power to supply would be taken over by a council or company at a price determined by a single arbitrator as the actual value of the mains or works taken over. A similar objection applied to the Chelsea Electricity Supply Co., the London Electric Supply Corporation, the Metropolitan Electric Supply Co., the City of London Electric Lighting Co. and the Blackheath and Greenwich District Electric Lighting Co. The form of agreement between the companies was of less importance; but what was of vital importance was the transfer of the mains and pipes on arbitration terms to councils to whom they do not belong. The mains and system of one company might not fit in with the mains or system in use in the area to which it was transferred. The question was a very serious one, and they asked to have the matter adjourned so as to consider the matter with the Board of Trade.

Mr. HOOKER, of Messrs. Wyatt & Co., parliamentary agents for the bill, said the bill did not deal with the large areas but only with small outlying portions of the boroughs. Clause 5 only provided that where an area was transferred to another council or company, such council or company should take over the mains and pipes in the area. The bill was the machinery for the proper adjustment and winding-up of the interests of the companies in areas outside their own district. The Board of Trade had consulted the companies, and he asked the Examiner to say that the standing order had been complied with.

The EXAMINER said it appeared to him that the provisions with regard to taking over the mains and works were a natural and necessary consequence of the transfer of areas. Whether the scheme was a fair or unfair one was a question of evidence which it was not for him to decide. He considered the notices sufficient, and he would report to the House that the standing orders had been complied with.

## SHANNON WATER AND ELECTRIC POWER BILL.

This measure, which proposes to incorporate a company with powers to utilise, by diversion, the waters of the River Shannon for the generation of electric energy; to erect a generating station at Cloonlara, Co. Clare; and to supply electric current for manufacturing and other purposes, and to local authorities within certain areas of the city of Limerick, and of the counties of Clare and Limerick, was set down on Tuesday for consideration before a House of Commons Committee presided over by Mr. Arthur Elliot.

Mr. GREIG, on behalf of the promoters, said there were three petitions against the bill: one had been settled, another was practically settled, and in the remaining one, if time were given, the parties would probably be able to come to terms. He asked that the bill might stand over till Monday next, and this was agreed to.

## WEST AND SOUTH LONDON JUNCTION RAILWAY BILL.

This measure, which proposes the construction of an electrical underground railway, about 4½ miles in length, extending from a connection with the Great Western Railway at Paddington to a point near Kennington Park, proceeding by way of Victoria and Vauxhall, and joining up the various railway termini en route, came on Tuesday before the Standing Orders Committee of the House of Commons, presided over by Mr. Halsey. The non-compliance reported by the examiners was in respect to proper notice not having been given to certain owners of vaults and cellars. The promoters were now prepared to undertake to insert the usual protective clauses. It was ultimately decided by the Committee to dispense with the Standing Orders, and allow the bill to proceed.

## ELECTRIC POWER SCHEMES.

In the House of Commons, on Monday, Mr. R. REA asked the President of the Board of Trade whether, in view of the multiplication of bills of companies for the distribution of electrical energy, he intended to promote legislation to give effect to the recommendations of the Joint Committee of 1898 to confer additional powers upon the Board of Trade, to enable promoters of such bills to acquire the necessary powers by means of provisional orders instead of by private acts.

Mr. GERALD BALFOUR replied that the recommendations of the Joint Committee had not been lost sight of, but he was unable to make any definite statement at present.

# CORRESPONDENCE.

## A NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some weeks ago you were good enough to refer in your publication to the movement which had been inaugurated with a view to forming a National Electrical Contractors' Association. Of necessity the progress of the provisional committee is slow, as one of the duties laid upon it was to foster the formation of local associations in London and the provinces, with a view to their future affiliation with the proposed National Association. With regard to London, steps are being taken to form four local associations—one each for the eastern, western, northern, and southern districts; and it would greatly facilitate the work of the committee if, through the medium of your columns, you would suggest to London electrical contractors who are in sympathy with the movement the desirability of at once communicating with me on the subject with a view to convening meetings in the several districts as early as possible for the purpose of forming the local associations. Thanking you in anticipation.—Yours, &c.,

THOS. GUTHRIE, Convener of Provisional Committee.

46, Queen Victoria-street, London, E.C., April 17.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

"Etude sur les Paratonnerres." By A. Della Riccia. (Liège: Léon de Thier.)

"Notizie Statistiche sugli Impianti Elettrici Esiotenti in Italia alla fine del 1898. E. Cenni, Sulle Industrie Elettriche in Italia, A. Tutto il 1900." (Rome: G. Bertero.)

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The National Physical Laboratory committee propose shortly to consider the appointment of the following members of the staff, and are prepared to receive applications :—Superintendent of engineering department, one or two assistants in the physics department, and an assistant in the physics department to take charge of chemical investigation. The committee are also prepared to receive applications for a small number of junior assistantships. An advertisement contains some additional information, and further particulars may be obtained from the director (Mr. R. T. Glazebrook), Old Deer Park, Richmond, Surrey. Applications by May 24.

Eastbourne Corporation require an assistant engineer and a dynamo and switchboard attendant. Applications to borough electrical engineer (Mr. J. Kempe Brydges), Electricity Works, Eastbourne, by May 3. See advertisement.

The Jandus Arc Lamp Co., Hartham Works, Hartham-road, Holloway, N., require an engineer to take charge of testing room and technical work. See advertisement.

A science master is required at the Auckland Grammar School, New Zealand. Salary £300 to £350 per annum. Particulars from Agent-General for New Zealand, 13, Victoria-street, London, S.W.

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The governors of the Northern Polytechnic Institute, Holloway, London, N., have appointed Mr. R. T. Smith, B.A., as principal of the institute in succession to Dr. J. T. Dunn, who is leaving to take up practice as an analytical and consulting chemist in the North of England. Mr. Smith was 34th wrangler in his year, and afterwards took a second class in Part II. of the Natural Science Tripos. He organised and equipped the South African College at Capetown, and acted as professor of mathematics and physics in the college for some years. Returning to England, he took up work with Messrs. Vickers, Son and Maxim, and was also appointed lecturer in mathematics and physics in the Goldsmiths' Institute, New Cross. The new principal will undertake the teaching of mathematics at the Northern Polytechnic Institute.

Mr. Alfred Hay, D.Sc., lecturer on electro-technology at Liverpool University College, has been appointed professor of the same subject at the Royal Indian Engineering College, Cooper's Hill.

Mr. W. A. Fraser, borough electric lighting engineer at Lancaster, has been appointed borough electrical engineer by the Nelson Corporation.

Mr. H. D. Norman, assistant engineer at Durban, has been appointed borough electrical engineer at East London, South Africa.

Messrs. A. T. Gordon-Smith and J. E. Pownall have been appointed assistant engineers at the Hammersmith (London) electricity works.

**Personal.**—Mr. William Cotsworth, who has for several years had charge of Messrs. Drake and Gorham's Manchester branch, is resigning, having taken up an appointment as electrician and assistant mechanical engineer with the Calico Printers' Association (Ltd.).

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**Barnsley.**—On Friday an inquiry was held into the application of the Council to borrow £20,000 for electric lighting extensions. The borough electrical engineer (Mr. S. E. Bastow) explained that the electricity works were opened about a year ago, the capital expenditure having been £25,000. Temporary plant, costing £3,500, was added, and the growth of the demand for current was such that it was necessary that the station should be enlarged at an estimated cost of £20,000. There was no opposition.

**Barnstaple.**—The Electric Lighting committee have instructed their consulting engineer (Mr. W. H. Trentham) to prepare a detailed report on electric lighting.

**Batley.**—An inquiry was held on Friday into the application of the Council to borrow £52,451 for electric tramways. The length of the track will be over 7½ miles. There was no opposition.

**Burton-on-Trent.**—An inquiry was held here last week into the application of the Council to borrow £5,000 for electric lighting extensions. The town clerk (Mr. Whitehead) and the engineer and manager of the electricity and gas works (Mr. F. L. Ramsden) supported the application, the latter supplying technical details. It was stated that the electricity works were opened on Feb. 26, 1894. Over 7,000 yards of mains had been laid. In the first year there were 53 consumers, and the loss provided out of the rates was £1,802. 9s. 3d. This had gradually decreased, until in 1900 there were 173 consumers, and the loss was £5. 9s. 6d. An all-round charge of 6d. per unit for lighting was originally made, but in 1898 the maximum demand system was adopted—6d. per unit for the first hour and a-half's maximum demand and 3d. per unit after. By that alteration the average price per unit for lighting had been reduced to a fraction over 5d. There was no opposition.

**Combined Telegraph and Telephone Apparatus for Field Work.**—It is announced that a syndicate has been formed at Stockholm to purchase and work the patents of Lieut. Ljungman for combined telegraph and telephone apparatus for army field work. The capital of the syndicate is to be 500,000kr.

**Cork.**—The Blackrock electric tramway route was opened for traffic last week.

**Dublin.**—The *Freeman's Journal* announces that the Local Government has remitted the surcharges imposed by the auditor at his last audit on certain members of the Electric Lighting committee in connection with the re-wiring of consumers' premises, holding that the auditor was right in law, but that the Corporation acted bonâ fide.

**Electric Railways in Sweden.**—It has been proved that the force of the Lagan waterfall will suffice for the working of the West Coast Railway by electricity, an undertaking now to be carried out. A concession has been granted for the construction of an electric railway from the great shipping port, Sundsvall, in the Baltic, to Bergefors, the cost being estimated at £125,000. The line is to be narrow gauge, and is intended chiefly for the transport of forest produce. The length will be 24,100 metres. The speed is to be 40km. per hour. The cars are to hold 90 persons. There are to be two in each train, with a goods van. Electric current will be supplied from accumulators.

**Exeter.**—The net profit on the electricity department for 1900, after paying interest and sinking fund, was £377. 7s. 8d.

**Exhibition in Russia.**—An important exhibition, exclusively confined to British manufactures and productions is to be held in St. Petersburg from Nov. 14 next to Feb. 14, 1902. The exhibition will be held in the Tauride Palace and grounds, which have been lent for the purpose by the Empress of Russia. The enterprise is under very distinguished patronage, and the British Advisory committee includes a number of leading men in British industrial and political life. In the prospectus attention is called to the importance of this exhibition to industrial Britain, and it is pointed out that British trade with Russia has declined considerably since 1883. The present opportunity, therefore, should be embraced to stem the tide of this reduction in Anglo-Russian trade.

**Failure of a Swedish Electrical Undertaking.**—It is announced that the company formed to work the electric smelting furnace invented by Mr. De Laval has gone into liquidation, £800,000 having been lost in the venture.

**Insurance Risks.**—The Birmingham Mutual Fire and General Insurance Association (Ltd.), which claims to maintain free competition in fire insurance outside the tariff companies, has decided to increase its capital to £300,000. Mr. Herbert Chamberlain, J.P., has been appointed chairman of the association. Many of the directors of the company are associated with large industrial undertakings. Particulars of this company's system of insurance can be obtained from the offices, Peel-buildings, Lower Temple-street, Birmingham.

**Irregular Wiring Connections.**—At Cardiff, on Tuesday last, before Mr. T. W. Lewis, the stipendiary, Mr. E. Nelson, tobacconist, Queen-street and St. Mary-street, appeared to summonses charging him with unlawfully using the electric current of the Corporation of Cardiff on Dec. 21.

The STIPENDIARY, at the commencement of the proceedings, said that in order to substantiate the main charge it must be proved that defendant not only improperly used the light, but did it in such a way that malice or fraud might be inferred.

Mr. HALLORAN, for the Corporation, said defendant was a tobacconist, and for three years his shops had been lighted by electricity. Up to September last he had always paid his electricity accounts regularly. After this there was difficulty in collecting the account, and although defendant's meter was disconnected, it was noticed that the light was again on. A cheque for the amount due was subsequently paid. The inspector saw Mr. Nelson, and told him that he must have broken the Corporation's seal, and he replied that he put the fuse in. The current used had passed through the meter and was registered, and the Corporation had been paid for it.

After evidence had been given, the STIPENDIARY commented on the fact that the prosecution were not in a position to give evidence from which it could be inferred that the accused person did what he had done with a felonious intention, and it was therefore useless to proceed any further with this charge. The summons was consequently dismissed.

A further summons, charging Mr. Nelson with making improper and unlawful use of the Corporation's current was then taken, and, after hearing the particulars, the learned STIPENDIARY said there were no grounds for the graver charge ; but in disconnecting the meter the officials were acting within their legal rights, and he fined the defendant 20s. and costs (6s. 6d.) for having re-connected the supply.

At Hanley Police Court last week, W. A. Martin, an ex-employé of the Corporation, was summoned for taking electric current without the consent of the Corporation, and Sambidge Askey, fish merchant, was summoned for causing the same to be done. The town clerk (Mr. A. Challinor) explained that the summonses were taken out under sec. 18 of the Gasworks Clauses Act, 1847, which was incorporated

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with the Electric Lighting Act, 1882. The Corporation had supplied Askey with electric current, and recently he desired to extend it, and asked Martin to do the work. Martin had no authority to do this kind of work, but he did it by tapping the main outside the meter, so that none of the current consumed was paid for, or could be accounted for in any way. Both prisoners pleaded guilty. In Martin's case the Bench inflicted a fine of 40s. and costs. In the case of Askey a fine of 40s. and costs was also imposed, defendant agreeing to pay for the extra current consumed.

**Kendal.**—On 17th inst. inquiry was held into the application of the Corporation for power to borrow £14,000 for an electric lighting scheme. Mr. A. H. Dykes (Messrs. Handcock and Dykes, Westminster and Newcastle-on-Tyne) engineers to the scheme), explained the proposals. Evidence as to the need for such a supply was given by the chairman of the Electric Lighting committee (Ald. Monkhouse). There was no opposition.

**Leeds.**—An inquiry was held on Thursday last into the application of the Council to borrow £510,500 under the Public Health Act, 1875, and the Electric Lighting Act, 1882. The town clerk (Mr. W. J. Jeeves) gave particulars of the electricity department. Since 1893 the revenue had grown from £4,001 to £43,264 per annum, and the working expenses had increased from £2,706 to £13,770. Last year, owing almost entirely to the greater cost of coal, the expenses had increased more than 25 per cent, but the profits, amounting to £29,894, showed an increase of £3,600 on the previous year. Of the proposed loan about £160,000 was required for new buildings and plant; £141,929 had been already spent upon the existing works, and the remainder was required for new mains, &c.

**Light Railways.**—The Light Railway Commissioners on Friday considered an application by the Lancashire Light Railways Co. for power to construct 9¼ miles of electric tramway to connect up the existing electric tramways of Darwen and Bolton. After hearing evidence the Commissioners intimated that they would recommend the granting of the order. During the application a request was made for the insertion of a new clause in the agreement between the promoters and the National Telephone Co. so as to indemnify the promoting company against accident from the contact of telephone wires and the live trolley wire. This was strongly opposed by the National Company, but the matter is to be considered by the Board of Trade.

An inquiry was held at Bolton last week into the application of the Barton-on-Irwell Council for an order to construct about 1½ miles of light electric railway at Clifton. The cost is put at £11,433, plus £6,466 for electrical equipment. It is proposed to take current from one of the neighbouring local authorities. The application was unopposed. The tramway will secure a through service from Bolton to Salford and Pendlebury.

The Blackburn, Whalley and Padiham, the Kidderminster and Bewdley, and the Durham and District Light Railways orders have been submitted to the Board of Trade for confirmation. Objections by May 17.

**Liverpool.**—On the recommendation of the Electric Power and Lighting committee the Corporation, on Wednesday, decided to increase the salary of the city electrical engineer (Mr. A. Bromley Holmes) from £1,600 to £1,800 per annum. The salary of Mr. C. R. Bellamy, general manager of the tramways, has been increased from £1,000 per annum to £1,200 per annum. Mr. P. M'Cullogh, assistant manager of tramways, at £500 per annum, is to take up the duties of electrical equipment engineer, at £550, increasing by annual increments of £25 to £600 per annum. Mr. C. W. Mallins, tramways traffic superintendent, has also obtained an increase from £300 to £350, advancing by annual increments of £25 to £400 per annum.

**Mansfield.**—The Council decided on Wednesday to purchase a site for electricity works.

**Morley.**—An inquiry has been held here into the application of the Corporation to borrow £7,035 for electric lighting extensions.

**Pontypridd.**—The Council's application for a provisional order has been granted by the Board of Trade, but the British Electric Traction Co. has been unsuccessful in its application for a tramway provisional order for the district.

**Shanklin.**—The question of adopting electric lighting is to be settled by a poll of the ratepayers.

**Stepney (London).**—In 1897 the County of London and Brush Company obtained provisional electric lighting orders for Mile-End Old Town, St. George's-in-the-East, and Limehouse, and in 1900 the local authorities of the three districts applied for and obtained electric lighting powers. The orders were obtained, and provided that, if within six months the company served upon the authorities notice in writing setting forth the amount which they claimed as representing (*a*) the cost of obtaining their electric lighting powers, and (*b*) the cost incurred by them with the object of affording a supply of electricity such claim should be met by the authorities in equal parts. The company have now served upon the Stepney Borough Council (the successors of the three authorities) a claim for £1,248 incurred under heading (*a*) and £20,746 under heading (*b*). The Council propose to apply to the Board of Trade to appoint an arbitrator in the matter.

**Subways for Electrical Wires.**—In the City of Baltimore, U.S.A., an extensive system of city subways is in course of construction and will shortly be completed. It has been ordered that all private owners of overhead lines (excepting tramway trolley lines) are to place their wires and cables in these subways, for which the following rentals are charged:—Up to and including 5,000 duct ft., 7 cents per duct ft. per annum; above 5,000 up to 25,000 duct ft., 6½ cents; 25,000 to 50,000, 6 cents; 50,000 to 100,000, 5½ cents; beyond 100,000, 5 cents.

**Stettin (Pomerania).**—The total capital of the Stettin Electric Tramway Co. now amounts to £147,059, and on the working for 1900 the net profits were £9,835. A dividend of 6 per cent. has been declared. Under the agreement with the municipal authorities £371. 10s. of the net profits belong to the town. The length of lines owned by the company is 46,365 metres. The receipts averaged 3½d. per kilometre. The company owns 82 motor cars, 25 open, and 22 closed cars.

**Stockholm (Sweden).**—The local tramway company has decided to convert its lines from horse to electric traction on the overhead system. Current will be taken from the new electricity works about to be erected in the city. These new works will involve an outlay of 8,000,000kr.

For a new line of railway into this city a tunnel is to be bored by electric power, current for this installation being generated at a waterfall in the district. A large saving is anticipated from this enterprise.

**Swiss Imports and Exports.**—In 1900 the imports of electrical apparatus and scientific instruments into Switzerland were valued at £210,635, an increase of £12,300 over 1899. The exports of Swiss-manufactured electrical apparatus and scientific instruments were valued at £120,459, an increase of £9,300 over 1899. The imports of wholly electrical apparatus were valued in 1900 at £109,000, and in 1899 at £100,000. Exported dynamo-electrical machinery was valued in 1900 at £508,000 against £490,000 in 1899. The value of this machinery imported into the United Kingdom in 1899 was £21,000.

**Telephone Development in Sweden.**—The Swedish Telegraph Administration is considering a project for laying a telephone cable between the mainland and the island of Gothland in the Baltic. Many objections are being raised to the carrying out of this enterprise as the problem of long-distance submarine telephony has not yet been satisfactorily solved. Certain statistics have been prepared which show that the following submarine telephone cables are working:—Buenos Ayres-Monte Video, 45km., laid in 1890; Dover-Calais, double cables, 37km. each, laid 1891-93, a third being in course of construction; Belfast-Glasgow, 38km., laid 1893; Cuxhaven-Heligoland, 75km. (an old telegraph cable). All these work satisfactorily except the Heligoland one. The Gothland cable would vary in length from 100km. to 150km., with a land extension to Stockholm of from 115km. to 325km., according to the landing place. The cost is estimated to range from 819,000kr. to 690,000kr. The cable would consist of two 4·5mm. copper wires, and would cost 5,000kr. per kilometre, insulated with paper and indiarubber.

**The Vibration Committee.**—The Exchange Telegraph Co. announces that it has been definitely decided that the Board of Trade Committee on Vibration, in connection with the Central London Railway, will take no further evidence, but will proceed with the preparation of a report to be published as promptly as possible. This course has been taken in view of the investigation to be carried out by the Joint Parliamentary Committee on the bills promoted this session for the construction of other underground electric lines.

**Underground Electric Railways.**—In the House of Commons on Tuesday, on the motion of Mr. J. W. Lowther, it was agreed that a select committee of five members (Sir W. Arrol, Mr. Ashton, Mr. Cawley, Sir M. Foster, and Sir J. Dickson-Poynder) be appointed to join with a committee of the House of Lords on underground railways. The members of the House of Lords Committee were given in our issue of March 29, p. 874.

**Waterford.**—A provisional order was granted to the Corporation as far back as 1892, and they still desire further time to carry out its provisions. Last week a deputation waited upon the Board of Trade seeking an extension of time in which to raise the necessary capital, £50,000.

**Water-Power Generation in Sweden.**—The City of Falu Electric Light Co. has purchased, for 85,000kr., some waterfalls in this neighbourhood, and a turbine-driven generating station is being erected to supply current for all purposes. When completed, the present steam station is to be closed.

A similar scheme is being carried out on the Motala river, at Norrköping, where a canal is being constructed, with a fall of 6¼ metres, for the driving of an electric generating station. The

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canal is to be an underground watercourse, 11 metres wide and 1½ metres deep. The equipment consists of four 300 H.P. and two 20 H.P. turbines.

The Frej Mining Co., Lapland, has rented some of the Crown falls in the district at 11s. per effective H.P. per annum for the purpose of driving generating plant for the working of the poorer iron ores in its mines.

The Swedish Crown, which owns the Alfkarleby waterfalls, between Stockholm and Gefle, has recently invited tenders for their rental, but it is anticipated that the State may eventually utilise the falls for working electric railways in the district. Official calculations recently made estimate the total power of the larger Lapland waterfalls at 10,000,000 H P, the average height being taken at 370 metres.

**Withington.**—The Council have applied for 12 months' grace to construct the tramways authorised by their 1897 provisional order.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week*]

### TENDERS INVITED.

*Ashton-under-Lyne* Electricity committee invite tenders for two continuous-current generating units, each of 250 H P. to 300 H.P., with double-acting enclosed engines. An advertisement contains further particulars, and specifications may be obtained from the borough electrical engineer, Mr. Neville Appelbee. Tenders to town clerk by noon, April 29.

An advertisement elsewhere notifies that the *Dundee* Town Council require tenders for the supply of copper bonds. Specification, &c., may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope-crescent-road. Tenders to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by May 1.

*Dundee* Gas Commissioners invite tenders for a 700kw. triple expansion steam engine and dynamo. Specifications from the city electrical engineer (Mr. Walter H. Tittensor) and tenders to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by May 11. An advertisement contains further particulars.

*Swansea* Corporation invite tenders for the supply and erection of two-phase motor generators and switch gear. Specifications after 29th inst. from the Guildhall, Swansea, and may be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, London. Tenders to the town clerk (Mr. Jno. Thomas) before noon of May 15. See advertisement.

*Bristol* Electrical committee invite tenders for steam and other piping, low-tension switchboard, and a 210kw. continuous-current dynamo. Specifications can be obtained from the city electrical engineer (Mr. H. Faraday Proctor), and tenders (addressed to the chairman) must be in by noon of May 9. An advertisement contains further particulars.

*Edinburgh* Corporation invite tenders for 12 months' supply of electricity meters. Particulars from the resident electrical engineer (Mr. F. A. Newington), Dewar-place, and tenders to town clerk (Mr. Thos. Hunter, W.S.), by May 6. See advertisement.

*Dublin* Lighting committee invite tenders for main and sub station switchboards, transformers, arc lamps and arc lamp pillars. An advertisement contains further particulars, and specifications may be inspected at the offices of the engineer (Mr. Spencer Harty), City Hall, Dublin, and at the offices of the consulting engineer (Mr. Robert Hammond, 64, Victoria-street, London, S.W.), after 29th inst. Tenders to town clerk (Mr. Henry Campbell), City Hall, Dublin, by 4 p.m. June 3.

*Rochdale* Corporation invite tenders for two 412kw. steam dynamos. An advertisement contains further particulars, and specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh, and Sillar), 78, King-street, Manchester, and 2, Queen Anne's-gate, Westminster, but can be obtained from the latter office only. Tenders to the town clerk (Mr. James Leach) by May 16.

*Stirling* Town Council invite tenders for extensions of steam, drain, and feed pipes and feed heater. Specifications from the town clerk (Mr. Thomas L. Galbraith), and specifications and drawings can be seen at but not obtained from the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to town clerk by May 1. See advertisement.

*Fulham* (London) Borough Council invite tenders for the supply of materials and goods required in connection with their electric lighting and dust destructor station for the period ending March 31, 1902. An advertisement contains additional particulars, and tenders must be delivered at the Town Hall, Fulham, London, S.W., by 5 p.m. May 15.

*Portsmouth* Corporation invite tenders for supplying and laying telephone conduits, and cables, copper wire, iron and steel stay wire, insulated wires, lighting and high-tension guards, arm bolts, nuts and washers, miscellaneous ironwork, insulators, switchboards, batteries, telephone instruments, fixing subscribers' instruments, creosoted poles, oak arms, erecting poles, arms, stays, insulators, wires, &c., and silicum bronze wire. Tenders to town clerk by 30th inst.

The directors of the *Great Eastern Railway Co.* invite tenders for stores, including telegraph materials, galvanised iron, lead, tin, &c., bolts, screws, and rivets, tools, hardware, cast-iron pipes, &c. Forms of tender at the secretary's office, Liverpool-street terminus, London, E.C., on and after 30th inst, and patterns can be seen at the company's stores, Stratford. Tenders to the secretary (Mr. W. H. Peppercorne), by 10 a.m. May 14.

*Tonbridge* District Council invite tenders for boiler and engine-house plant, condensing apparatus and pipe work, travelling crane, switchboard and instruments, accumulators, mains, meters, public arc and public incandescent lighting. Tenders to clerk by 4 p.m. May 30.

*Wells* City Council invite offers for their electric lighting provisional order (1896). Tenders by May 1.

*Alloa* Electric Lighting committee invite tenders for insulated cables, joint boxes, public arc lamps, lamp pillars, &c., and sub-station equipment and sundry connections. Tenders to town clerk by April 30.

The Burgh of *Partick* requires tenders for main switchboard and instruments and batteries of accumulators and accessories. Tenders to Mr. Jas. Donaldson, 97, West Regent-street, Glasgow, by noon of April 29.

*South Lancashire Electric Traction and Power Co. (Ltd.)*, 12, St. John's-lane, Liverpool, require tenders for 6,250 tons of steel girder tramway rails and 190 tons of steel fish-plates, points, crossings and filling-pieces. Tenders by May 13.

*Motherwell* Electric Light committee invite tenders for cast-iron lamp columns, arc lamps, switches, fittings, &c. Tenders to town clerk by May 18.

*Motherwell* Electric Light committee also require steam dynamo and switches, steam, feed, and exhaust pipes, &c. Tenders by April 29.

*Cardiff* Corporation invite tenders for overhead line materials for the electrical tramways department. Specifications from Mr. Arthur Ellis, Old Post Office Building, Cardiff. Tenders by April 30.

*Manchester* Electricity committee require water-tube boilers, steam engines, with condensing and auxiliary plant, three-phase generators and motor transformers. Tenders to chairman by May 7.

*Norwich Mutual Telephone Co.*, who are about to establish a telephone exchange, invite tenders for various telephone cables, instruments, &c. Tenders to secretary (Mr. Campbell Steward) by April 30.

*Battersea* (London) Borough Council invite schemes for wiring consumers' premises. Tenders to Mr. W. Marcus Wilkins, Municipal Buildings, Lavender-hill, S.W., by May 14.

*Battersea* Borough Council also invite tenders for electric pumps, pipe work, &c., for condensing water, and pipes and pits for condensing water supply. Tenders by noon of April 30.

*Middlesbrough* Electric Lighting committee require boiler and engine-house plant and condensing apparatus. Tenders to town clerk by April 30.

*Ludlow* Corporation invite tenders for electricity generating plant. Tenders to town clerk by May 20.

*Kircaldy* Corporation invite tenders for the permanent way construction of tramways, rails, car sheds, &c. Tenders by May 13.

*Norwegian* Telegraph Administration invite tenders until May 9 for copper wire, copper ribbon wire, &c.

### TENDERS RECEIVED AND ACCEPTED.

Ayr Corporation have placed an order with Messrs. D. Bruce Peebles & Co., for the supply of balancers and boosters for their electricity works.

The contract for the electric lighting of the Victoria Infirmary, Glasgow, has been let to Messrs. R D. Cassells & Co. at over £2,000.

The tender of Mr. W. J. Furse has been accepted for wiring and fitting up the Notts. Shire Hall at £297. 5s.

Stirling Town Council have accepted the tender of Messrs. Wm. Arnott & Co. for the supply of two boilers for their electricity works, at £1,280.

La Société Anonyme des Moteurs à Grande Vitesse has obtained the order for a 25kw. alternator recently advertised for by the Bray (Ireland) Council.

Messrs. Geoffroy and Delore have obtained the order for the whole of the underground cable required for the Cheltenham light electric railway now under construction. The cable is of the fibrous insulation type, lead-covered and armoured, and the length about 5½ miles.

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## BUSINESS NOTICES.

The Faradian Club have removed from 8 and 10, Charing Cross-road, W.C., to new and larger premises at the St. Ermin's Hotel, Westminster, London, S.W.

The Berrenberg Electric Lamp Syndicate (Ltd.) have registered the trade mark "Minim," and in future their lamps will be stamped "Minim" instead of "Berrenberg."

## BANKRUPTCIES, LIQUIDATIONS, &c.

Notice is given to creditors of the Hiram S. Maxim Electrical Corporation (Ltd.) (in liquidation) that particulars of debts or claims against the company are required not later than Saturday, May 25. Mr. M. Devinish, Warnford-court, London, E.C., is liquidator.

It has been decided to wind-up voluntarily the Spiral Globe (Ltd.) (with Mr. L. L. Langmead, 81, Cannon-street, E.C., as liquidator) for reconstruction. The new company will be entitled the Spiralette Lighting Co. (Ltd.).

A meeting of the West Kent Electricity Supply Co. (Ltd.) will be held at 3, Lothbury, London, E.C., on May 29 to receive an account of the winding-up. Mr. A. E. Jones is liquidator.

It has been decided to wind-up voluntarily Lyons' Patent Electric Refrigerator Syndicate (Ltd.), 45, West Nile-street, Glasgow.

Separate meetings of the first, second, and third mortgage debenture holders, contributories, and the unsecured creditors of the Coventry Gas Fitting, Electrical and Engineering Co. (Ltd.) will be held at Coventry on May 6 to consider a scheme of reconstruction.

G. J. Lloyd (trading as G. J. Lloyd & Co.), electrical and mechanical engineer, lately of 109, Chesterfield-road, and Castle Mill-street, Bristol, has been adjudicated bankrupt. At an adjourned meeting held on Wednesday, Mr. H. W. Freshwater was appointed trustee with a committee of inspection.

On Friday last the first meeting of creditors was held of George William De Tunzelmann, consulting engineer, 6, Penywern-road, Earl's Court, S.W., and 1, Bush-lane, Cannon-street, E.C., London, The senior official receiver, Mr. E. Leadam Hough, said from debtor's statements it appeared that in June, 1895, he transferred his business to the General Engineering Co. (Ltd.), receiving £400 in cash, £5,000 in fully-paid shares, and £2,100 in debentures, and he was retained as managing director. In September, 1899, he retired from that post, but remained a director until January, 1900. Since September, 1899, he had been engaged in literary work and as a consulting engineer. Insolvency was attributed to loss through the absconding of a company promoter, the engineers' strike, and the opening of endowed technical colleges. No statement of affairs had been filed, but the unsecured liabilities were estimated at £8,000 or £9,000, and the value of the assets was very uncertain. The matter remains in the hands of the official receiver.

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**Electric Road Vehicles.**—The Lombard-Gerin system of electric road vehicles, which take current from overhead conductors, is about to be put into practical operation, a service of 'buses being about to be started between the town and railway station of Eberswalde, Germany. The system was shown at work at the Vincennes annexe of the Paris Exhibition last year.

**Dead-Beat Moving Coil Instruments for Alternating Currents.**—The Electrical Co., 122-124, Charing Cross-road, London, W.C., have now ready a new list of instruments of the dead-beat moving coil type, for alternating current working, and we illustrate in Fig. 1 a voltmeter from this set. The body of the instrument is built up of laminated sheet iron, with an internal and circular space in which is placed the stationary coil, consisting of two windings. Between these windings is the spindle carrying the moving coil, to which current is led by spiral springs, these latter also acting as the controlling force. The spindle also carries the pointer and the aluminium vanes, the outer edges of which move between the poles of the two brake magnets serving in the usual manner to damp the swings of the moving system. In this arrangement the lines of force are completely enclosed within the iron box, and none of them pass through the damping magnets, so securing the permanent magnetism of the latter. The interior of the instruments in which the moving coil swings is, however, entirely free from iron, the lines of force having only an iron path to complete the magnetic circuit. Of the three classes of these moving-coil instruments (voltmeters, wattmeters and ammeters), the voltmeter is claimed to be the simplest. The resistance of the winding (the stationary and moving coils taken together) is about 130 ohms, the dead resistance about 2,000 ohms, total 2,130 ohms. The current is thus not quite 0·06 ampere, and the lost wattage under 7·5, which is claimed to be a very favourable result for alternating-current instruments. The dead resistance consists of a material very nearly independent of temperature, the temperature coefficient (taking that of the copper windings as 0·04) being 0·0024. These instruments have, as a rule, two scales. Fig. 2 shows the ammeter. The stationary coil in this instrument is in the main circuit, in series with a standard resistance, across the terminals of which is a moving shunt coil. This arrangement is that usually adopted in ammeters of the moving coil type, the only difference being that the field is not produced by permanent magnets, but by

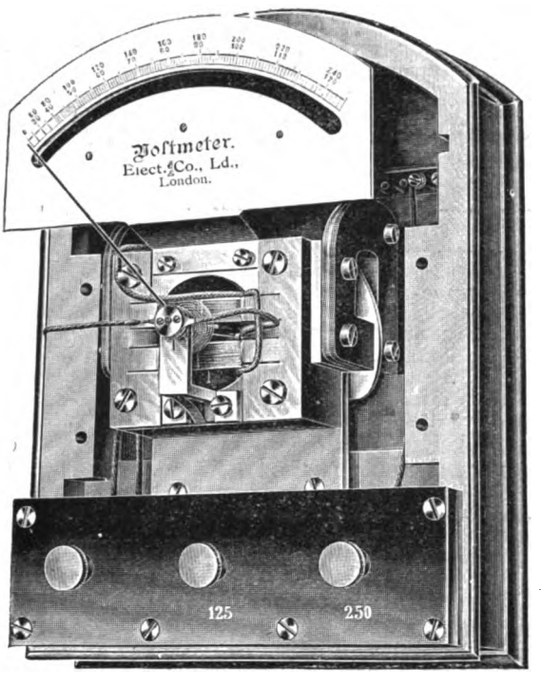


FIG. 1.—E.C. Dead-Beat Moving-Coil Voltmeter.

the main current coil. By a special winding of the resistance, and so proportioning it that its impedance bears the same ratio to its ohmic resistance, and has the same temperature coefficient as the moving coil, the readings of the instrument are independent both of periodicity and temperature, so that it reads equally well with

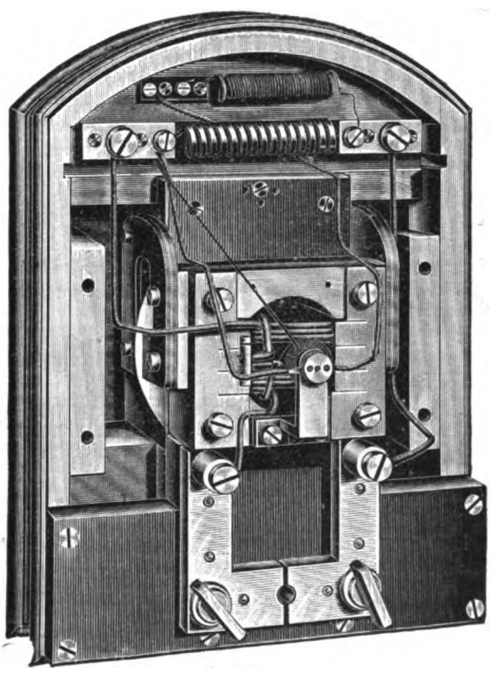

FIG. 2.—E.C. Dead-Beat Moving-Coil Ammeter.

alternating as with direct current. The list also illustrates a recording form of ammeter for alternating currents constructed on the same principle.

**The Jungner Accumulator.**—Progress is being made, it is announced, with the exploitation of the new accumulator invented by Herr Jungner, a Swedish engineer. Trial drivings have been taking place with a motor car equipped on the Jungner system since November last, it is said with success. The Jungner Accumu-

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lator Co. has been formed for working the patents, and has commenced the manufacture of accumulators at Norrköping. These works are at present supplied with current from a central electricity station, but arrangements are being made for the erection of a plant of 2,500 H.P. capacity to be driven by water-power plant from a neighbouring fall. The Junger Company are negotiating for the sale of their accumulator patents outside Scandinavia.

**General Electric Apparatus**—A leaflet issued by the General Electric Co. illustrates a form of electric curling iron heater with automatic switch, which has been supplied in considerable quantities to H.M.S. "Ophir" for the royal tour. There is also shown a patent hydrometer for pocket batteries and for use with ignition cells for motor cars.

**Name Tablets**—We have received from the Endolithic Manfg. Co., of 61½, Fore-street, London, E.C., some sample address tablets in brass, plated brass, white metal, &c. The Endolithic Ivory Co., the predecessors of the Endolithic Manfg. Co., were known for many years for the special make of inexpensive ivory tablets which that firm placed upon the market, and it is now announced that this special system of lettering has been adapted to metals. The examples before us show how effectively and neatly this has been done. The company are, therefore, in a position to supply not only the goods for which they have made a name in the trade, but also a large variety of this new class of labels of excellent quality at low prices. We understand that samples of these goods are at the disposal of trade users.

**Pocket and Portable Accumulators**—A handy list of these goods has been prepared by Messrs. Peto and Radford, 57B, Hatton-garden, London, E.C. The list contains instructions for using portable accumulators and directions for charging, together with some particulars suitable for non-technical readers of the uses and construction of storage batteries. The illustrations include types of portable batteries for various uses.

A list of the "Allan" type of portable accumulators is being sent out by Messrs. Allan and Adamson, of Ashstead.

**"A New Plante Plate."**—In our issue for March 29, page 859, appeared an article with the above title, in which it is stated that the plate described is manufactured at Clichy by Messrs. Geoffroy and Delore, who, it is further stated, have granted a licence for Germany to the Berliner Accumulatoren Gesellschaft. This was an error, the Berliner Company being the owners and Messrs. Geoffroy and Delore the licensees for France. Messrs. Pritchetts and Gold, of Feltham, Middlesex, have recently been granted the sole licence to manufacture these plates and to use the forming process in the United Kingdom, and will shortly place the plates on the market.

**Westinghouse Plant.**—Direct-connected railway generators is the subject of circular No. 1,044 issued by the British Westinghouse Co. Several types of these generators are illustrated.

**Electric Fan Motors.**—We have received a price list of "Peerless" fans from the Improved Electric Glow Lamp Co. Copies of the list can be obtained on application. Several types of fans are illustrated for both alternating and direct-current working.

**Sundries List.**—A new edition (7th) of the illustrated price list of the Universal Electric Supply Co., 47, Crossciffe-street, Moss Side, Manchester, is just published.

**B.T.H. Plant.**—The British Thomson-Houston Co.'s pamphlet No. 93 treats of direct connected continuous-current lighting generators.

**Tramway Tools, Supplies and Sundries**—A new catalogue of tramway tools, supplies and sundries is just issued by Messrs. R. W. Blackwell & Co.

**Exhibition.**—A naval and military exhibition will be held at the Crystal Palace, Sydenham, from May to September, 1901, which will include a section devoted to inventions, patents and designs. Mr. H. C. Braun, C.E., 236 and 238, Pentonville-road, King's Cross, London, is technical adviser and manager of this section of the exhibition.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 17 to 23, with the ports of destination:—

*Africa*—Cape Town, £3,991 (including £3,255 telegraph material); Durban, £742; East London, £306; Port Elizabeth, £98; Suez, £212 (telegraph material). *Argentina*—Buenos Ayres, £227. *Australasia*—Fremantle, £277; Melbourne, £22; Port Chalmers, £23; Sydney, £129; Wellington, £2,091. *Belgium*—Ostend, £866. *Brazil*—Bahia, £51 (telegraph material). *Germany*—Hamburg, £686 (including £200 telegraph material). *Holland*—Amsterdam, £65. *Hong Kong*—231. *India*—Bombay, £695; Calcutta, £295. *Japan*—Kobe, £9,358 (telegraph cable); Yokohama, £782. *Mauritius*—£15. *Russia*—Kure, £2,624 (telegraph cable); St. Petersburg, £75 (telegraph material). *Straits Settlements*—Singapore, £34. *Sweden*—Stockholm, £429 (telegraph wire). Total £24,324, against £191,047 for 12 days last year (April 13 to 24).

# COMPANIES' MEETINGS AND REPORTS.

## Eastern Extension, Australasia, and China Telegraph Co. (Ltd.).

The fifty-fifth half-yearly ordinary general meeting of this Company was held on Wednesday, April 24, 1901, at Winchester House, Old Broad-street, under the presidency of the Most Hon. the MARQUIS OF TWEEDDALE, K.T.

The CHAIRMAN: I have first to express the great regret of our Chairman that he is unable to be present to-day. He was bitten by a collie dog some days ago, and as the wound is rather a deep one, and will take some days before it is healed, his medical adviser insisted on his remaining in his country home.

THE MANAGER and SECRETARY (Mr. F. E. Hesse) having read the notice calling the meeting, the minutes of the fifty-fourth half-yearly ordinary general meeting and of the extraordinary general meetings held on the 7th and 22nd of November, 1900, which were approved and signed by the Chairman, the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, I have now to ask your approval of the report and accounts—the best, I think, that have ever been submitted to the shareholders of this Company. The gross revenue for the past half-year amounted to £360,889, being an increase of £21,439 over that of the corresponding period of 1899. As, however, we have received for the past half-year £11,000 less in Government subsidies than during the same period of 1899, the working for the past six months has shown an even better result than the figures I have quoted indicate. The increased revenue is chiefly derived from China and Japan traffic. The working and other expenses have amounted to £104,640, showing a decrease of £12,295. This is accounted for by the "expenses attending maintenance of cables" having been considerably higher in 1899 than during the past six months. Comparing the figures for the whole year the results are as follows:—The gross revenue amounted to £674,116, being an increase of £10,305, as compared with that for the year 1899, while the expenses amounted to £213,300, being a decrease of £10,901. The usual quarterly interim dividends of 2s. 6d. per share have been distributed during the past year, making, with the final dividend for 1900, proposed to be paid to-morrow, a total dividend of 5 per cent. A bonus of 4s. per share, or 2 per cent., will at the same time be paid for the past year, making a total distribution to the shareholders of 7 per cent. The agreed dividend of 2s. per share and interest, amounting to 2s. 1d. per share, on anticipated payments in respect of the new issue of shares will also be paid to-morrow, and the old and new shares will then rank pari passu. The revenue balance of £141,481 and the premium of £150,000 on the issue of new shares have been carried to the general reserve fund, which now stands at £1,248,395, after having been debited with £125,137 for expenditure to date on the Cape-Australian cable.

The Company, in conjunction with the Great Northern Company, has been enabled to carry out further important work in the North of China during the past half-year, by constructing landlines between Taku, Tientsin and Peking in connection with the international cables laid and opened by them last autumn. These landlines have been opened to the public without any additional charge being levied on telegrams exchanged between Europe and China. The Companies have also arranged to strengthen telegraphic communication between Shanghai and Taku by laying a duplicate cable between Chefoo and Taku. Consequently, with the German Government cables between Shanghai, Kiauchau and Chefoo, this additional line will afford duplicate communication the whole way from Shanghai to Taku. The material for the purpose is now in Chinese waters, and the work is expected to be completed very shortly.

The report will have informed you that the Netherlands Indian Government have decided to establish cable communication between Java and Borneo, and that they had entrusted our Company to supply and lay the same. The manufacture of the cable is now completed, and we expect to have it laid before the end of the current half-year. We understand that the Government intend to construct a landline between Bandjermasin, where the Borneo end of the cable will be landed, and Koetei, the centre of a large oil industry in Borneo; and when this is completed it ought to form an important feeder to our system.

As stated in the report, the "Standard Revenue" fixed by the Cape-Australian cable agreement, for regulating the Australasian tariffs, was maintained during the past year, and, consequently, the tariff was further reduced on Jan. 1 last for telegrams exchanged with South Australia, Western Australia and Tasmania to 3s. 6d. per word, and if the "Standard Revenue" is similarly maintained during the current and next year, the tariff will be further reduced on Jan. 1 next to 3s. and to 2s. 6d. on Jan. 1, 1903. Since the close of the year the Government of New South Wales has formally accepted the Cape-Australian agreement, and, consequently, the reduced rate of 3s. 6d. was applied to telegrams exchanged with that State as from the Feb. 1 last. When the Postmaster-General of New South Wales officially notified the Company of his Government's decision, we were simultaneously advised by the Postmaster-General of Victoria that the Victorian Government had likewise decided to join the Cape arrangement, and was, therefore, prepared to conclude a supplemental agreement with the Company. Subsequently, however, the Victorian Government repudiated their Postmaster-General's action in the matter, and the old tariffs are still maintained for that and the other outstanding States. The States have now, however, ceased to control the telegraphs, owing to their having been taken over on March 1 by the Federal Government. Consequently, any further action in regard to the reduced rates will have to be taken by the Commonwealth. Meanwhile, the merchants of Victoria are intensely disappointed at not participating in the reduced rates enjoyed by their trade rivals in the contracting states; and the Press are pursuing

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an active campaign to bring about uniform tariffs throughout the Commonwealth. We hope that they will be successful before very long.

The s.s. "Britannia," with a portion of the Adelaide-Perth section of the Cape-Australian cable, left the Thames for Australia on the 6th ult., and the "Anglia," with the Durban-Mauritius section, sailed for Natal on the 29th ult. The manufacture of the remaining sections is being rapidly proceeded with, and the communication between the Cape and Australia, which the new cable will establish, is expected to be completed and opened for traffic before the end of the present year. That will be accompanied by a considerable reduction in the tariffs between the Cape and Australia, and no doubt this will stimulate commerce between those two important colonies.

You will have seen it announced in the newspapers that a contract has been entered into by the Governments interested with the Telegraph Construction and Maintenance Co. for the manufacture and laying of the "All-British Pacific Cable" at a cost of nearly £1,800,000. To this has to be added about £200,000 for erecting stations, providing apparatus, instruments, repairing ship, and defraying other preliminary expenses, making the initial expenditure roundly £2,000,000 sterling. We understand that the cable is not expected to be completed before the end of next year; but when it is opened it is not likely that, consisting, as it will, of a single line of cable, with one unbroken stretch of 3,600 nautical miles, it can effectually compete with our vast network of triplicate and quadruplicate cables.

You have, doubtless, seen it announced in the newspapers that an inter-departmental committee was appointed a few months ago, under the presidency of Lord Balfour of Burleigh, to inquire into the present system of telegraph communication between different parts of the Empire, and to consider in what respects it requires to be supplemented; also to investigate the relations between private cable companies and the Imperial and Colonial Governments, the amount of control exercised by these Governments, and the policy which should be pursued by them in future—especially when new concessions are sought. Further, to examine the existing rates, to report how far they are fair and reasonable, and, if not, how any reduction should be effected. The Committee have already held many sittings, and as the inquiry is a very wide one, some little time will probably elapse before the Committee will be in a position to make their report. In view of the persistent attacks made upon the Associated Telegraph Companies by ill-informed agitators, your Directors cordially welcomed the opportunity afforded by this inquiry of explainining matters which have been frequently put before the public in an inaccurate and misleading light; and they, therefore, informed the Committee that they would be happy to furnish them with every information in their power, and to assist them in every possible way. We have already given evidence on a number of points, and expect to again appear before the Committee to give further information.

You will probably remember that when addressing you on former occasions I have referred to Signor Marconi's interesting experiments in connection with wireless telegraphy, and the probable effect of this remarkable system on submarine telegraphy. It is now nearly six years since Signor Marconi first startled the world with his discoveries, and during that period considerable progress has been made in communicating with light ships, exchanging messages between passing ships, and speaking across the Channel, &c., the longest distance now reported to have been attained being nearly 124 nautical miles. For such purposes as those I have indicated wireless telegraphy undoubtedly meets a long-felt want; but the sensational reports appearing in the newspapers from time to time as to wireless telegraphy being used for communicating across the Atlantic, between England and Australia, and even with the planet Mars—(laughter)—must not be taken seriously. If it were possible to use the wireless system for long distance submarine telegraphy, the British and Colonial Governments would hardly have entered into the contract to which I have made reference for bridging the Pacific Ocean at a cost of two million sterling, when their object might have been attained at a trifling expenditure. The fact is, gentlemen, that Marconi's system will no doubt, as I said, I think, some two or three years ago, prove a feeder to this system. With these observations I beg to move—

"*That the report and accounts of the Directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 4s. per share, both free of income-tax, payable on the 25th inst., making with the previous distributions a total payment of 7 per cent. for the year 1900.*"

Mr. F. A. BEVAN seconded the motion.

The CHAIRMAN expressed his readiness to answer questions, but no shareholder rising to address the meeting, he put the motion, which was carried unanimously. Continuing, he proposed the re-election as a Director of Sir Albert J. Leppoc Cappel, K.C.I.E.

Mr. JOHN DENISON-PENDER seconded the resolution, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by the Hon. GEORGE PEEL, Mr. Clement S. Colvin, C.S.I., was also re-elected to his seat at the Board.

The CHAIRMAN stated that the next business on the agenda was the re-election of auditors. The Directors received a letter from Messrs. Welton, Jones & Co. a few days ago, in which they referred to the great increase of business that had taken place with which they had to deal in auditing the accounts, and they suggested that, under those circumstances, it would not be unreasonable to ask for an increased remuneration. The matter was entirely in the hands of the shareholders, but not only did the Directors offer no objection but they confirmed the statement made by the auditors as to the large increase in their work.

Mr. JOHN NEWTON proposed—

"*That Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. Welton, Jones & Co. be and they are hereby elected auditors for the ensuing year at a remuneration of £200 each.*"

He remarked that it was only fair, after the Chairman's statement, that the remuneration of the auditors should be increased.

The motion was seconded by Mr. HOBBS and carried unanimously.

Mr. BLUNDELL then proposed a vote of thanks to the Chairman, Directors, and staff, both at home and abroad.

Mr. G. M. DAVEY seconded the motion, which was carried unanimously.

The CHAIRMAN: I beg to thank you, gentlemen, on behalf of my colleagues and myself and also on behalf of the staff. I need hardly say that whatever our exertions might be, they would be attended with little success unless we were supported by the staff both at home and abroad. We have every reason to be satisfied with every member of the staff of all ranks and in all quarters. I beg to thank you very warmly for referring to our services.

The proceedings then terminated.

## London Electric Supply Corporation (Ltd.).

The ordinary general meeting of this Company was held on Tuesday, under the presidency of the Right Hon. Lord WANTAGE, V.C., K.C.B.

The SECRETARY (Mr. H. C. Carter) having read the notice calling the meeting,

The CHAIRMAN said: When I addressed you last year, you may recollect that, owing to the default of the contractors in delivering the additional plant required for the winter of 1899-1900, and which was ordered about 18 months before it was required, our existing plant was subjected to such a severe overstrain that it caused it, firstly, to become inefficient, and, secondly, to break down. It was only with the most unremitting care on the part of the whole of our staff, which is worthy of the highest praise—and with respect to which I cannot express myself too highly—that we were able to get through that winter. As soon as it was over we instructed our consulting engineer to prepare a report on the condition of the plant and machinery in the station, and as the result of his report, and acting on his advice, we shut down the station for a complete overhaul and to enable us to erect the new plant so long overdue. I must say that that course was to me a matter of great grief. However, the station was shut down early in April last year, and we did not recommence running until October. During that period we received the whole of our supply from three companies whose mains adjoined our area. We were grateful to our friends for this timely assistance, as it enabled us to retain our customers, but the price charged for the energy so purchased left us no margin of profit. The profit which you see in the revenue account, therefore, was made as the result of our own working, and principally during the last quarter of the year. Although it is very disappointing that we have had to pass the preference dividend for the year—and to none is this more so than the directors, who are the largest shareholders—yet the effect of shutting down the station has been so beneficial to your future interests that I hope, after I have informed you what we were able to do during that time, and the good results which have followed, you will agree with me that the policy was a wise one, and justifies us in expressing the hope that the passing of the preference dividend is only temporary. At the last meeting I gave you an account of the additions and improvements we proposed to make at the station during the year. Nearly the whole of these additions and improvements have been in connection with our steam system, and it was from this cause that the troubles which we experienced in the winter of 1899-1900 arose. The one pleasing feature in connection with these troubles was that not one of them was due to electrical causes, but were almost entirely due to the non-delivery of the boilers, which was quite beyond our control, such as might happen in any business, and had nothing to do with our system of supply. The only new work which I mentioned last year which is not yet completed is the new well, from which we hope to obtain the whole of our feed water, which at present costs us nearly £2,000 per annum. This well is being sunk to a depth of 420ft., the depth up to the present time being 360ft. The work is being done by contract, and although it has taken a considerably longer time than was stated in the contract, owing to the hardness of the strata, we shall not have to pay more than the contract price when it is completed. The work we have accomplished during the year could not have been accomplished had the station not been shut down. We recommenced running for part of the supply in October and for the whole of the supply in December, and up to the present time we have had no trouble of any kind from our plant and machinery, the supply being entirely satisfactory. In addition to this, however, the cost per unit, both generated and sold, has been diminished by one-half as compared with the corresponding quarter of 1900, and to an appreciable extent when compared with the corresponding quarter of 1899. This result has been accomplished notwithstanding the fact that the price of coal during the quarter ended March last was 12 per cent. greater than during the quarter ended March, 1900, and 20 per cent. greater than during the quarter ended March, 1899. But, in addition to this extra price of coal, we were condensing and using our economisers to heat our feed-water during the March quarter of 1899, while we were not condensing, and our economisers were not available during the last quarter, although the economisers will be available shortly. These results are, in our opinion, distinctly gratifying, and we have every reason to believe that they will be maintained during the remainder of the year. But while we have been busy putting our house in order at Deptford, we have not been neglecting our business in town. During the year we have laid 9,861 yards of new mains, and we have increased the capacity of some of our distributing stations. As was to have been expected, during the period of our impaired service in the winter of 1899-1900 we lost a number of customers. It is pleasing to be able to report that, as the result of our satisfactory running during the last four months, we have made up the number of lights connected to within 1,000 of the largest number previously connected, and the orders we are at present receiving are very encouraging, and justify us in saying that the

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previous record will soon be passed. The accounts themselves call for no further special comment. There is, however, one other matter I think I ought to mention. When I last addressed you I stated that we had been successful in the Divisional Court in a patent action which had been commenced against us in connection with the use of the transformers, but that the plaintiff had appealed. I am glad to be able to inform you that the appeal was subsequently withdrawn. The judgment of the lower Court, with costs on the higher scale, therefore, remained, and we have nothing further to fear in this direction. As to the future prospects, and without wishing to prophesy, I shall only say that, if the results of the first quarter of the present year are kept up (the profit on which is nearly equal to that shown in the balance sheet for the whole of last year)—and I see no reason why they should not be kept up, and probably they will be increased, considering that our station was never in a more efficient condition than it is now—I anticipate, as the result of this year's working, that we shall resume the payment of our preference dividend. As the holder of nearly two-fifths of the entire capital of this Company, I am glad to be able to state again that I have confidence in its future, as I have in this large investment. I now move the adoption of the report and accounts.

Sir W. H. PREECE, K.C.B., F.R.S., seconded, and said that he was at the Corporation's Deptford station on the previous day, and found everything in the most satisfactory condition. They had now ample surplus plant to meet every emergency. He endorsed completely the Chairman's statement.

The MANAGING DIRECTOR (Mr. R. Stewart Bain, C.A.) having replied to some question relating to the accounts,

The motion was carried unanimously.

The retiring Directors, Sir William Preece and Mr. R. Stewart Bain, were re-elected, as was the auditor, and a hearty vote of thanks to the Chairman and Directors terminated the proceedings.

**BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)**—At the meeting on Friday the chairman (Mr. J. B. Concanon) said the receips of 1900 showed an increase compared with those for 1899 of £11,026, while the expenses showed a decrease of £2,187, the net increased receipts being £13,233. Both the increase in the receipts and the decrease in the expenditure were due to the gradual alteration from horse to electric traction over their whole line. The net result was an available profit, including £1,776 from 1899, of £39.736. They had placed £3,000 to a renewal fund; debenture interest absorbed £19,825, leaving £16,911. An interim dividend of 3 per cent. on the A preference had been paid, and a further distribution, making 6 per cent. for the year, was now recommended, and 2½ per cent. on the B preference, which would leave £1,473 to be carried forward. On Sept. 10 they inaugurated electric traction over the whole line, and they had shown the net result for the three months to Dec. 31. Those results, with receipts of £38,320, and expenditure £21,360, or about 55 per cent. of the receipts, gave some idea of the effect of electric traction. The directors have appointed Mr. Marengo general manager at Buenos Ayres, and had every reason to be pleased with what he had done. Mr. H. Brown added some interesting remarks. He said the company's original concession was to run into the inner section with accumulators or with underground conduits, but by the exertions of their representatives on the spot, Messrs. Boutell and Abellia, they had been able to adopt the overhead trolley system into the centre of the town.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ELECTRICAL SUPPLIES, RUBBER AND EBONITE CO. (LTD.)**—Registered April 20, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical machinery, cables and all accessories required for electric lighting, traction and power, &c.

**GRAVESEND AND NORTHFLEET ELECTRIC TRAMWAYS (LTD.).**—Registered April 18, capital £80,000 in £5 shares, to carry on the business of carriers of passengers and goods, electricians, electrical and general engineers, contractors, manufacturers of and dealers in railway, tramway, electric, and other apparatus, and generally the business of generating, accumulating, transmitting, using and supplying light, heat, sound and power by electricity or other means, and of constructing, owning and managing tramways and railways. The subscribers are G. Stevens, E. Garcke, J. F. Albright, electrical engineer, G. E. Medhurst, C. H. Dade, J. Devonshire, electrical engineer, and W. J. Greer. The first directors are E. Garcke, G. Stevens, J. F. Albright, J. Devonshire, and W. J. Greer.

**INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.**—Registered April 15 with an unlimited number of members, each liable for £1 in the event of winding-up, to bring municipal electrical engineers and chairmen and members of municipal electrical committees together, to hold meetings for the discussion of subjects germane to municipal electrical undertakings, to establish a reading room, library and collection, and generally to promote the interests of municipal electrical undertakings. The word "limited" is omitted from the title by licence of the Board of Trade. The subscribers are H Faraday Proctor, electrical engineer, Bristol; Ald. George Pearson, Bristol; Baillie W. Maclay, Glasgow; W. A. Chamen, electrical engineer, Glasgow; Robert C. Quin, electrical engineer, Blackpool; E. T. Ruthven Murray, electrical engineer, Willesden, London; and John F. C. Snell, electrical engineer, Sunderland. The management is vested in a council. Registered office, St. James' Hall, Piccadilly, London, W.

**MAY-OATWAY FIRE APPLIANCES (LTD.)**—Registered April 15, capital £40,000 in 39,850 ordinary shares of £1 each and 3,000 founders' shares of 1s. each, to adopt an agreement with the May-Oatway Syndicate (Ltd.), C. E. May and G. H. Otway, to acquire certain inventions, to manufacture and deal in fire alarms, telegraphic apparatus, signals, thermostats, wire, and apparatus, and to carry on the business of mechanical and electrical engineers, &c. The subscribers (with 100 shares each) are S. B. Heward, H. F. Jackson (electrical engineer), H. W. Maynard, G. H. Oatway, W. Dymock, A. F. Soward, and J. H. Gartside. The first directors are S. B. Heward, H. W. Maynard, W. Dymock, H. F. Jackson, and G. H. Oatway.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27½d. per oz. (April 25). Consols (2¾ per cent.) 94⅛—94¼ for money, 94⅛—94¼ for account; 2½ per cent. 94¾—95½ (April 25.) Consols Pay Day, May 3; Stocks and Shares Continuation Days, May 13 and 29; Ticket Day, May 14; Pay Days, April 26 and May 15; Mining Share Carry-over Days, May 11 and 28.

**BRITISH INSULATED WIRE CO. (LTD.)**—During the week this company invited applications for an issue of £250,000 4½ per cent. first mortgage debenture stock at par.

**CLAYTON AND SHUTTLEWORTH (LTD.)**—At the statutory meeting of this company held at Lincoln on Wednesday the report of the directors showed that the applications for shares in the company were fully subscribed and that the progress made since the formation had been of a most satisfactory character.

**CUBA SUBMARINE TELEGRAPH CO. (LTD.)**—The directors recommend the payment of a dividend on the ordinary shares for the half-year to Dec. 31 at the rate of 4 per cent. per annum (tax free).

**GENERAL ELECTRIC CO. (U.S.A.)**—The directors have decided to exchange the preferred stock for common stock, share for share.

**MERTHYR ELECTRIC TRACTION AND LIGHTING CO. (LTD.)**—This company is inviting applications for an issue of 6,000 5 per cent. cumulative £5 preference shares at par.

**OSWESTRY ELECTRIC LIGHTING AND POWER CO. (LTD.)**—The report of the directors for 1900 states that the company continues to progress. The net profit of £251. 8s. 11d. enables the payment of a dividend at the rate of 4 per cent.

**ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)**—The quantity of electricity sold by this company for the quarter ended Lady-day is returned at 1,778,340 units, estimated to produce £31,121, against 1,599,768 units, which produced £28,062 for corresponding period of 1900.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed May 2 as a special settling day in the further issue of 40,000 £1 fully-paid shares (Nos. 400,001 to 440,000) of the *Cape Electric Tramways (Ltd.)*, and has ordered the further issue of 10,000 ordinary £5 fully-paid shares (Nos. 80,001 to 90,000) of *Willans and Robinson (Ltd.)* to be quoted in the official list. The committee has also been asked to appoint a special settling day in, and to grant a quotation to, the provisional certificates for £250,000 4 per cent. debenture stock of the *Charing Cross and Strand Electricity Supply Corporation (Ltd.)*, and to allow the further issue of 1,500 ordinary £10 fully-paid shares (Nos. 6,001 to 7,500) and 1,500 cumulative preference £1 fully-paid shares (Nos. 13,501 to 15,000) of the *Bournemouth and Poole Electricity Supply Co. (Ltd.)*, and the further issue of £100,000 4½ per cent. first mortgage debenture stock of the *Castner-Kellner Alkali Co. (Ltd.)* to be quoted in the official list.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Apl. 20 | 632 | - 43 | 46 | 30,491 | + 3,495 |
| *Birmingham Tramways | ,, 20 | 4,255 | - 723 | 15 | 61,732 | + 819 |
| *Blackburn Corporation.. | ,, 19 | 428 | - 186 | 16 | 6,738 | + 621 |
| Blackpool Corporation.. | ,, 18 | 290 | - 622 | 13 | 1,533 | + 259 |
| Blackpool and Fleetwood | ,, 20 | 269 | - 489 | 16 | 3,242 | - 283 |
| Bolton Corporation ..... | ,, 21 | 1,526 | + 236 | 3 | 4,697 | + 1,053 |
| Bradford Corporation.. | ,, 21 | 944 | + 412 | 3 | 3,051 | + 1,603 |
| Brisbane Trams ..... | Mar. 6 | 2,138 | + 361 | 9 | 18,546 | + 2,323 |
| *Bristol Trams & Carriage | Apl. 19 | 4,056 | + 156 | 15 | 59,997 | +16,748 |
| *Buenos Ayres & Belgrano | Mar. 24 | 2,771 | + 555 | 12 | 33,372 | + 5,327 |
| Carlisle Trams. Co. ..... | Apl. 20 | 152 | ... | 16 | 1,990 | ... |
| Central London Railway | ,, 20 | 6,443 | ... | 16 | 97,934 | ... |
| City & South London Ry. | ,, 21 | 1,929 | + 718 | 16 | 32,020 | +12,331 |
| Cork Elec. Trams ..... | ,, 18 | 420 | - 40 | 15 | 5,480 | + 543 |
| Dover Corporation ..... | ,, 20 | 195 | - 41 | 3 | 669 | + 51 |
| Dublin & Lucan Rly. .. | ,, 20 | 103 | - 77 | 16 | 1,279 | + 104 |
| Dublin United ..... | ,, 19 | 3,445 | - 967 | 16 | 40,774 | - 875 |
| Dublin Southern Dist... | ,, 19 | 753 | - 748 | 16 | 11,740 | |
| *Dundee Corporation ... | ,, 17 | 531 | + 167 | ... | ... | ... |
| *Glasgow Corporation .. | ,, 20 | 9,294 | - 431 | 16 | 134,913 | + 1,217 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 20 | 762 | - 91 | 3 | 2,535 | + 488 |
| Hull Corporation..... | ,, 26 | 1,524 | + 204 | 42 | 61,448 | +32,274 |
| *Liverpool Corporation.. | ,, 13 | 9,148 | +1,608 | 15 | 119,488 | +17,461 |
| Liverpool Overhead Rly | ,, 21 | 1,644 | - 21 | 16 | 24,328 | + 1,858 |
| Perth (W.A.) Elec. Trams | ,, 19 | 835 | + 440 | 42 | 27,284 | ... |
| Portsmouth Corporation | ,, 20 | 545 | - 618 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 21 | 3,460 | + 912 | 16 | 46,939 | +16,814 |
| Southampton Corporat'n | ,, 18 | 622 | + 113 | ... | ... | ... |

* Partly electrical. † Mings 3 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | NAME. | Previous Week's Price, Apr. 17. | Price Wednesday, Apr. 24. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Apr. 24 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | | |
| 100,000 | 1 | ... | Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ... | ... | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 75 | 70 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ 12½ | 11½ 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ 8⅛ | 7⅞ 8⅛ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅞ 8⅞ | 8⅞ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6⅞ 7⅛ | 6⅞ 7⅛ | ... | ... | 6⅞ | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 10 0 | February and August | 9⅛ | 9⅛ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 5⅛ | 5 5⅛ | 4 1 10 | ,, ,, | 5⅛ | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5⅜ 6⅛ | 5⅜ 6⅛ | 4 8 0 | March | 6 | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 104 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 110 | 100 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8⅛ 9⅛ | 8⅛ 9⅛ | 4 4 3 | February and August | 9 | 8⅞ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 13 | 12 13 | 4 12 4 | January and July | 12⅝ | 12⅛ |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 121 126 | 122 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 103 | 101 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 9 | 8 9 | 4 8 11 | ... | 9⅛ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 12 | 11 12 | 5 0 0 | March and September | 11⅞ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 106 109 | 106 109 | 4 2 7 | ... | 107½ | 103 |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5 5½ | 5 5½ | 3 12 9 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7 8 | 7 8 | 2 16 3 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10½ 11⅛ | 10½ 11⅛ | 4 11 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅞ 7 | 6⅞ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | ... | Do. 4% Deb. Stock (red.) [Deb Stk. (red.) | 101 104 | 101 104 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'k) 4% | 101 103 | 101 103 | 3 17 8 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ 1⅜ | 1⅛ 1⅜ | ... | ... | 1⅛ | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 3⅞ 4⅛ | 3⅞ 4⅛ | 6 13 4 | ... | 4 | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 101 | 98 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 11½ 12½ | 10½ 11½ | 5 4 4 | April and October | 12 | 10½ |
| 13,769 | 10 | 9d. | Do. (£7 10s. paid) | 9 10 | 8 9 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | 110½ | 110 |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 100 | 98 99 | 3 11 5 | ... | 98½ | ... |
| 6,452 | 10 | 8/0 | Notting Hill Electric Ordinary | 15½ 16½ | 15⅛ 16½ | 4 13 4 | March | 16½ | 15⅞ |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅛ 6⅛ | 5⅛ 6⅛ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/8 | Rand Electric | ⅜ ⅝ | ⅜ ⅝ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 75 | 65 75 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 200 220 | 200 220 | 3 12 9 | April and October | ... | ... |
| £115,500 | 100 | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 102 104 | 102 104 | 4 6 2 | ,, ,, | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 13½ 14½ | 13½ 14½ | 5 0 0 | February and August | 14½ | 14 |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅞ 9⅛ | 8⅞ 9⅛ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 101 | 93 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2⅛ 3⅛ | 2⅛ 3⅛ | ... | ... | 2⅛ | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 11½ 12½ | 11½ 12½ | 4 4 0 | March and September | 12⅛ | 11⅞ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 3⅞ 4⅛ | 4 4⅛ | 4 14 2 | April and October | 4⅜ | 4 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 123 128 | 124 129 | 4 14 6 | ... | 127½ | 125 |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 9½ 10½ | 9½ 10½ | 1 18 1 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,000 | 100 | 5% | Do. 5% Debentures | 96 101 | 96 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 12 15 | 12 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ 3⅜ | 2½ 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ 4⅝ | 4½ 4⅝ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 101 | 99 101 | ... | ... | 99½ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ 23¾ | 23½ 23¾ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ 10⅝ | 10⅜ 10⅝ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 115 | 114 115 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6⅞ 7⅛ | 6⅞ 7⅛ | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 10 10½ | 10 10½ | 4 15 3 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅝ 102⅝ | 98⅝ 100⅝ | 4 19 0 | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 15½ 16 | 15 16 | 5 6 3 | ... | 15⅛ | 15⅛ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 13 | 12 13 | 4 12 4 | February and August | 12⅝ | 12⅜ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 119 122 | 119 122 | 4 2 0 | ... | 120½ | 1.0 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | 1⅞ | 1¼ |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5½ 5⅝ | 5⅛ 5⅝ | 5 4 4 | ... | 5⅝ | ... |
| 27,500 | 5 | ... | Do. "B" | 4⅛ 5⅛ | 5 5⅛ | ... | ... | 5⅛ | 5⅛ |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 107 | 104 107 | 4 13 6 | ... | 105⅛ | 105⅛ |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 1 8 | ... | 98½ | 97⅛ |
| 34,440 | 10 | 2/0 | Calcutta Trams. (Nos. 1 to 400,000) | 10½ 11⅛ | 10⅛ 11⅛ | ... | ... | 10⅛ | 10⅛ |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 103 104 | 102 104 | ... | ... | 102½ | 102½ |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | ... | ... |
| 206,297 | 10 | 2/6 | Central London Ordinary | 9 9⅛ | 9 9⅛ | 2 18 0 | June and December | 9⅛ | 9⅛ |
| £628,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | ... | 113 113 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5⅛ 5⅜ | 5⅛ 5⅛ | 4 6 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 101 104 | 104 104 | 3 16 11 | ... | ... | ... |
| £855,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 43 46 | 40 46 | 2 10 0 | February and August | 47 | ... |
| 37,500 | 10 | 2.0% | Do. Ordinary (Nos. 22,501 to 60,000) | 4 5 | 4 5 | ... | ,, ,, | 4⅜ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 127 | 122 127 | 3 18 9 | ... | ... | ... |
| £244,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 118 | 113 118 | 3 9 0 | May and November | 114½ | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 14 | 13 14 | 4 5 9 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 1½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5½ | 5½ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4¾ 5¼ | 4¾ 5¼ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ 22½ | 22 24 | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ 15 | 15 15⅞ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 114 | 112 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | ... | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7⅞ 8 | 7⅛ 8⅛ | 4 1 5 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 13½ | 13 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 17 2 | January and July | ... | ... |
| $350,000 | $1,000 | 5% | London Street Rly. (Ont.) 1st Mrt. 5% Dbs. (red.) | 100 102 | 100 102 | 4 18 0 | ... | ... | ... |
| £328,744 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts (filypd) | 102 104 | 102 104 | ... | ... | 10 ¾ | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mor. Debs. (1908) | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 2¾ 3⅛ | 2¾ 3⅛ | 3 8 8 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4¾ 5 | 4¾ 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | ... | ... | ... | ,, ,, | ... | ... |
| 13,234 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 12 | 11 13 | 1 13 4 | ... | 11⅜ | ... |
| 20,000 | 10 | 6/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 87/0 | Do. 4½ per Cent. Debenture Stock | 107 109 | 107 109 | 4 3 9 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ... | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 94 97 | 94 97 | 3 9 2 | June and December | 95 | 94 |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 17. | | Price Wednesday, Apr. 24. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Apr. 24. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) ... | 99 | 102 | 99 | 102 | 3 18 5 | January and July..... | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph..... | ... | ... | ... | ... | ... | June and December ... | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures ..... | 55 | 65 | 55 | 65 | ... | ... | ... | ... |
| £332,720 | Stock | 15/0 | Anglo-American..... | 50 | 53 | 50 | 53 | 5 17 11 | Feb., May, Aug., Nov. | 51⅞ | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred ..... | 94 | 96 | 94 | 96 | 6 5 0 | ,, ,, | 95½ | ... |
| £3,088,640 | Stock | 5/0 | Do. Deferred ..... | 8½ | 8¾ | 8½ | 8¾ | 2 17 2 | ,, ,, | 8 7/16 | 8½ |
| 13,333,300 | $100 | $1¼ | Commercial Cable Capital Stock ..... | 160 | 170 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock ..... | 100 | 102 | 100 | 102 | 3 18 5 | ,, ,, | 101½ | 101½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary ..... | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. ..... | 16 | 17 | 16 | 17 | 5 17 8 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary ..... | 3 | 4 | 3 | 4 | 5 0 0 | April and October..... | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference ... | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures ..... | 100⅞ | 104⅞ | 100⅞ | 104⅞ | 4 6 7 | January and July..... | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable ..... | 9½ | 10¼ | 9½ | 10¼ | 6 16 7 | Jan., Apr., July, Oct. | 10 | 9½ |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Deb. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December ... | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary ..... [to 1,200) (red.)... | 140 | 145 | 137 | 142 | 4 18 7 | Jan., Apr., July, Oct. | 141½ | 137 |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock ..... | 91 | 9 | 91 | 94 | 3 14 6 | ,, ,, | 95 | 92 |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) ... | 113 | 117 | 113 | 117 | 3 9 0 | May and November ... | 115½ | 113 |
| 250,000 | 10 | 2/6 | Eastern Extension ..... | 14½ | 14¾ | 14 | 14¾ | 4 16 7 | Jan., Apr., July, Oct. | 14⅜ | 14½ |
| 50,000 | 10 | ... | Do.(Nos.250,001to300,000)£3pd.is'd at £3pm,all pd | 13¾ | 14¼ | 13¾ | 14¼ | ... | ... | 13 13/16 | 13¾ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock..... | 114 | 114 | 114 | 116 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909... .... | 99 | 102 | 99 | 102 | 3 18 3 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.)... | 101⅞ | 104⅞ | 101⅞ | 104⅞ | 3 17 8 | May and November ... | ... | ... |
| 180,227 | 10 | 1/9 | Globe Telegraph and Trust ..... | 9⅞ | 10½ | 9⅞ | 10½ | 5 2 5 | Jan., Apr., July, Oct. | 10½ | 9⅞ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference ..... | 14½ | 15½ | 14½ | 15½ | 3 13 8 | ,, ,, | 15 1/16 | 14 15/16 |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen ..... | 33 | 35 | 34 | 36 | 3 9 5 | January and July ..... | ... | ... |
| £82,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos | 99 | 102 | 99 | 102 | 4 9 1 | June and December ... | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European ..... [1 to 1,200) (red. | 45 | 49 | 44 | 48 | 5 4 2 | May and November ... | 47½ | 46 |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 ... | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) ... .. | 99 | 102 | 99 | 102 | 3 18 5 | June and December ... | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's ..... | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October..... | 8½ | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust..... | 121 | 123 | 120 | 125 | 4 16 0 | ,, ,, | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph ..... | 2 | 3 | 2 | 3 | 4 9 3 | December and July ... | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) ..... ..... | 97 | 100 | 97 | 100 | 5 0 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America ..... | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures ..... ..... | 99 | 102 | 99 | 102 | 3 18 5 | January and July..... | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama ..... | ⅜ | ⅞ | ⅜ | ⅞ | ... | May and November ... | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference ..... | 6 | 7 | 6 | 7 | 8 11 6 | ,, ,, | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference ..... | 5 | 7 | 5 | 7 | 8 11 6 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures ..... | 103 | 106 | 103 | 106 | 4 14 4 | January and July..... | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zill'n Submarine) ..... | 13½ | 14½ | 13¾ | 14½ | 4 18 3 | Mar., June, Oct., Dec. | 13¾ | 13¾ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) ..... | 101 | 104 | 101 | 104 | 4 16 2 | June and December ... | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) ..... ..... | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) ..... ..... | 3 | 3¼ | 3¼ | 3¾ | 5 6 8 | August ..... | 3 7/16 | 3½ |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. ..... ..... | 2/3 | 2/9 | 2/6 | 3/1 | 8 11 6 | April and October ..... | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary ..... ..... ..... | ¾ | ⅞ | ¾ | ⅞ | 5 0 0 | November ..... | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference ..... ..... | ½ | 1 | ½ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2 6 | National..... | 3 | 3½ | 2¼ | 3½ | 8 16 0 | February and August | 3 1/16 | 2 15/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference .. | 11 | 13 | 10 | 12 | 5 0 0 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference ... | 10 | 12 | 10 | 12 | 5 0 0 | ,, ,, | 10½ | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. .. | 4½ | 4¾ | 4 | 4½ | 5 11 1 | ,, ,, | 4⅜ | 4 |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.).... | 89 | 92 | 87 | 90 | 3 18 8 | June and December ... | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.)..... | 95 | 98 | 95 | 98 | 4 2 8 | ... | 97½ | ... |
| 171,504 | 1 | 0/6 | Oriental ..... | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 3 9 | April and October..... | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate ..... | 4½ | 5 | 4½ | 5 | 7 0 0 | July ..... | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref... ... ..... ..... | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December .. | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.)..... | 103 | 103 | 103 | 106 | 4 14 9 | June and December .. | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref..... | 13/32 | 7/16 | 13/32 | 7/16 | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. ..... | 3/8 | 7/16 | 3/8 | 7/16 | 6 17 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary ..... ... ... | 1/64 | 3/64 | 1/64 | 3/64 | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference ..... | 3/64 | 5/64 | 3/64 | 5/64 | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures ..... ..... | 85 | 90 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary ..... ..... | 10 | 11 | 10 | 11 | 6 16 4 | July and February ... | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference..... | 5¾ | 6¼ | 5¾ | 6¼ | 4 16 0 | January and July .. | 6¼ | 6 1/16 |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference ..... ..... | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering ..... | 1⅝ | 1⅞ | 1⅝ | 1⅞ | 3 8 7 | September ..... | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid ..... ..... | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. ..... | 2 | 2½ | 2 | 2½ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid..... | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock ... | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock ... ... | 101 | 103 | 101 | 103 | 4 7 5 | January and July..... | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. ..... ..... | 15 | 16 | 15 | 16 | 4 13 9 | ,, ,, | 15¾ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference .. .... | 5½ | 6 | 5½ | 6 | 4 3 4 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.).... | 109 | 113 | 109 | 113 | 3 19 10 | November and May ... | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) ..... ..... | ⅞ | 1⅛ | ⅞ | 1⅛ | 7 2 3 | ... | 15/16 | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) ... ... ... .. | 95 | 98 | 95 | 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary ..... ..... .. | ¾ | 1 | ¾ | 1 | 6 10 0 | March ..... ..... .. | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference ..... .. | ¾ | 1⅛ | ¾ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) ..... | 3½ | 4 | 3½ | 4 | 5 12 7 | January and July... .. | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) . | 100 | 103 | 100 | 103 | 4 17 6 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref..... | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) .. | 1½ | 2 | 1½ | 2 | 9 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid)..... | 3 | 4 | 3 | 4 | 6 12 3 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb.Stock (red.) . | 87 | 89 | 87 | 89 | 4 9 6 | June and December ... | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. ..... .. | 5 | 5⅛ | 5 | 5⅛ | 7 14 7 | Half-yearly ..... | ... | ... |
| 13,363 | 5 | ... | Do. Cumulative Preference..... | 5⅛ | 6 | 5⅛ | 6 | ... | ... | 6⅛ | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) ... | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric ConstructionCo. (Limited) ..... ..... | 1⅝ | 2⅛ | 1⅝ | 2⅛ | 5 6 8 | January and July..... | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference ..... | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July ..... | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 | 104 | 101 | 104 | 3 16 11 | January and July..... | ... | ... |
| 110,000 | 1 | ... | Giffre Electro Chemical and Power Co. Ord ..... | ... | ½ | ... | ½ | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary ..... .. ..... | 15 | 16 | 15 | 16 | 6 5 0 | February and August | ... | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... ..... | 5¼ | 6 | 5½ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb.Stock(red.) ... | 107 | 111 | 107 | 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works ..... ..... | 21 | 22 | 21 | 22 | 4 10 11 | ,, ,, | 21⅛ | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 | 104 | 101 | 104 | 3 17 9 | March and September | 101 | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. ..... ..... | 33 | 40 | 33 | 40 | 5 4 6 | March and July ..... | 37½ | 36¾ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908 ..... | 101 | 104 | 101 | 104 | 3 17 0 | January and July ..... | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary ..... ..... | 10½ | 11½ | 10½ | 11½ | 5 12 6 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference..... | 5⅛ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary ..... .. ..... | 11 | 12 | 11 | 12 | 5 0 0 | April and October..... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference ..... | 6¾ | 7¼ | 6½ | 7 | 4 15 9 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures .. | 105 | 107 | 105 | 107 | 4 0 0 | May and November ... | 103 | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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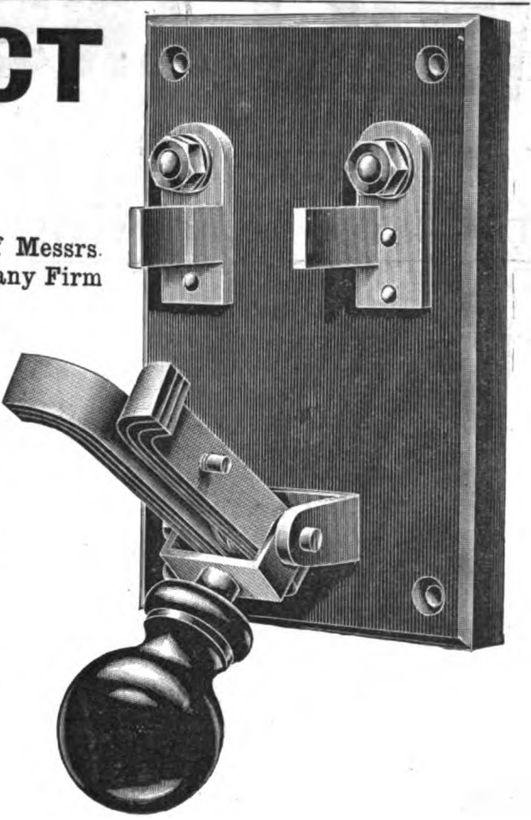
# SPRING CONTACT SWITCHES.



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**Messrs. Stevens & Barker.**
**Messrs. Christian & Phipps.**
**Edison & Swan United Electric Light Co., Ltd.**
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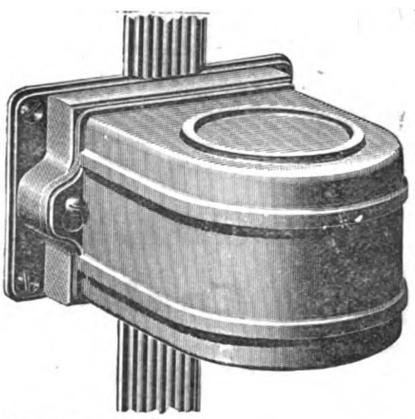

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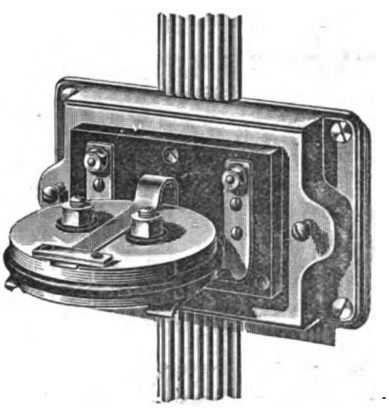

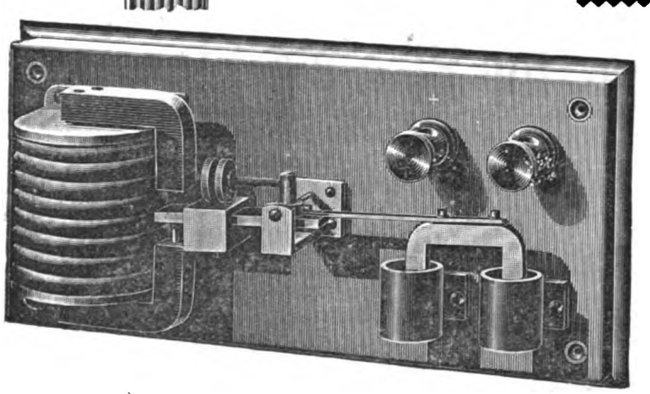

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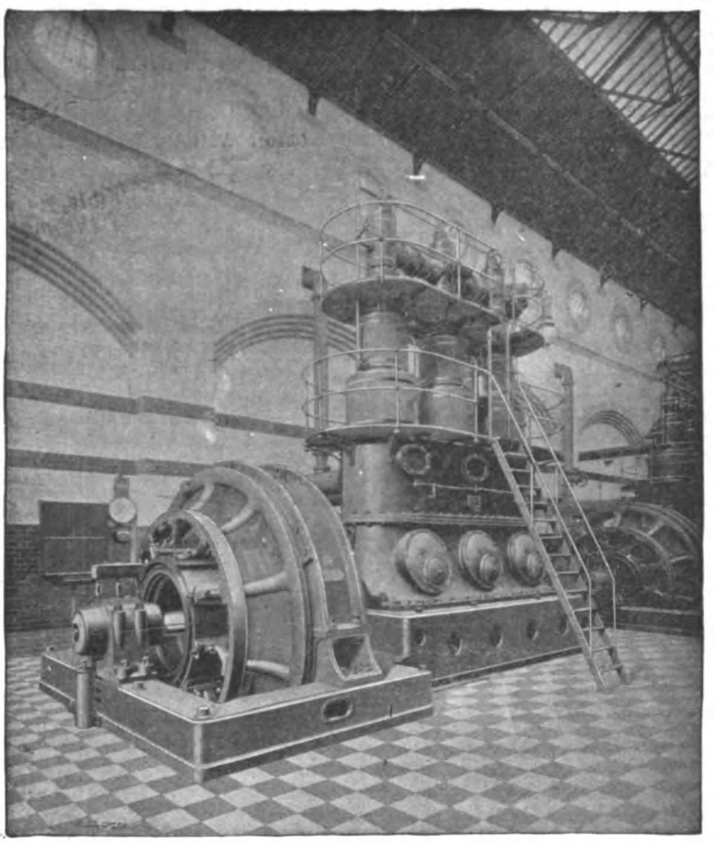

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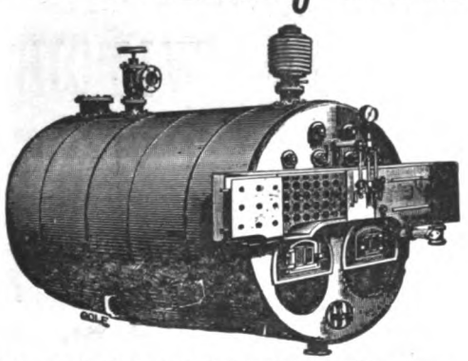

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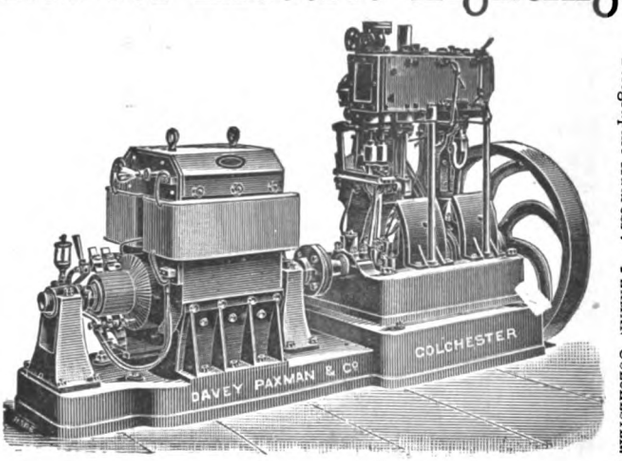


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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,198. [No. 2. Vol. XLVII.] FRIDAY, MAY 3, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30c., or 70pf


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## NOTES.

At the meeting of the Institution of Electrical Engineers last night the list was announced of the president-elect and proposed members of Council for the forthcoming session. We publish this list on page 48. Our readers will observe that the choice of the Council has fallen upon Mr. W. Langdon, who, needs no introduction to our readers; he is well known to electrical engineers in more than one branch of the profession. His claim to the presidential chair of the Institution is based on varied qualifications, of which it may be useful to give a brief summary. His electrical career dates from the early days of the Electric and International Telegraph Co., in which he occupied the post of telegraph superintendent. For many years past Mr. Langdon has been the chief of the electrical department of the Midland Railway. As a prominent telegraph engineer, he may claim to have developed on that railway what is probably the most perfect and complete system of electric signalling in the United Kingdom, if not in the whole world.

In other ways, moreover, he has had control of applications of electricity to railway working. On the Midland Railway there are a large number of electric power stations for the supply of current for lighting and motors at the principal stations and goods depôts. In the erection and control of these, Mr. Langdon has shown high ability, their equipment and working being on the lines of the best modern practice. With regard to this department we may remark that electrical engineers are indebted to Mr. Langdon for his pioneer work in gas-driven electricity stations, the works at Leicester being one of the best equipped and most economical gas engine stations in the country. On several occasions the Institution has listened to Papers contributed by Mr. Langdon. The most important of these include Papers on "Railway Telegraphs, with Special Reference to Recent Improvements," in 1896; on "Electric Current for Lighting and Power on the Midland Railway, and Driving Machinery Direct by Electric Motor without Shafting," in 1898; on "Electric Intercommunication in Railway Trains," in 1899; and on "The Supersession of the Steam by the Electric Locomotive," last November. Mr. Langdon is also the author of a standard treatise on "The Application of Electricity to Railway Working." He has been on the Council of the Institution since 1895.

Our readers, or at all events those among them who are not Wolverhampton ratepayers, will learn with interest that the Corporation of this town are inclined to experiment with the surface contact system of electric traction. A short time ago a deputation of the Wolverhampton Tramways committee visited Paris and inspected the Dolter surface contact system there, and arrived at the conclusion that, in this system, too great a danger existed in the contact knobs remaining charged after the passage of the car. The Diatto system in Paris, it may be mentioned, has also suffered from this defect, having recently killed a horse (a way in which surface contact systems occasionally show their antagonism to horse traction), and the company running the system has been warned by the Municipal Council. At a meeting of the Wolverhampton Council, held on Monday, a communication was read from the Lorain Steel Company, offering to put down in Wolverhampton an experimental track on the Brown surface contact system, and, as seen in our report in another column, several members were in favour of this. Others objected on the score of expense, should the system prove successful and be adopted; and the question of safety was also raised, the discussion on this point, however, being somewhat affected by the erroneous impression, conveyed by the recent Liverpool accident, that the overhead trolley system is really a source of danger even when properly constructed and protected. We await with interest the decision of the Council at its meeting next Monday, when the debate on the Lorain Company's offer will be renewed. A large scale trial of a surface knob system in this country would be welcome.

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Electric traction engineers will not be satisfied until the Tramways Act of 1870 has been doomed. The main complaint against it has been the 21 years' purchase clause, which has done much to prevent the progress of electric traction. Now that inter-urban tramways are becoming more and more questions of the moment, however, another serious obstacle exists in the shape of No. 22 of the Parliamentary Standing Orders, which lays down that the production of the consent of the local authorities through whose domain the tramways pass is an indispensable preliminary to the introduction of a tramways bill. In the case of a purely urban tramway, where the local authority will profit in 21 years' time by its permission for the introduction of the line, this standing order hardly affects the matter; but in the case of an inter-urban line, the power placed in the hands of a municipality lying on an intermediate part of the line is liable to considerable abuse. In our issue of April 19th, we published a manifesto by the Tramways and Light Railway Association on this question, and it is again dealt with at great length in a letter by Mr. J. Clifton Robinson to last Monday's *Times*. Mr. Robinson illustrates his argument with the following example:—

> Twelve miles, say, of tramways are proposed through roads governed by five local authorities, A, B, C, D and E. Of the mileage A has 3 miles, B 1¼, C 2½, D 4¼ and E 1¼. The assents of A and E are readily obtained. Districts B and C hang back a little at first, but, by a little—sometimes a great deal—of negotiation and argumentation, their objections are also removed; perhaps an additional widening of a road is agreed to, or a new façade is put in to the vestry hall. District D now sees its opportunity. The tramway company has got 8 miles of its 12¼ agreed to, but the assents are worthless without the central and connecting portion of the system, and, as the dominant power over one-third of the scheme, the men in authority in D have the matter entirely in their hands. If the company tries negotiation, the demands in the shape of wayleave, of bridge building, of street or road widening, present and to come, are so absurd that it may be bound to cry "enough." To argument on the views of the ratepayers the "dogs in the manger" remain deaf. They know that by simply sitting tight they can wreck the scheme on "standing orders" if their exactions are not yielded to.

This is perhaps a slightly exaggerated case, but it certainly demonstrates clearly the temptation to which local authorities are subjected, and to which, alas! too many yield.

Cable Communications Committee.—This Committee met as usual on Tuesday, when evidence was given by Mr. J. C. Lamb, C.B., C.M.G., second secretary to the General Post Office.

Opening of Exhibitions.—The Glasgow Exhibition was formally opened yesterday by the Duke and Duchess of Fife, and the opening of the Pan-American Exhibition at Buffalo took place on Wednesday.

Lectures on Dynamo Design.—On Thursday, May 30th, Prof. C. A. Carus-Wilson will commence a series of lectures to the senior students of the Electrical Standardising, Testing and Training Institution upon dynamo and motor construction.

Cable Interruptions and Repairs:—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... ..... | Mar. 2, 1900 ... | — |
| Bali—Macassar ..... ..... | April 14, 1901 ... | April 30, 1901 |
| Cayenne—Pinheiros ..... ..... | April 21, 1901 ... | — |

Borough Polytechnic Institute.—At the Borough Polytechnic Institute two special summer courses of lectures with laboratory work will be held by Dr. John Henderson on electrical measurements. Some particulars of the courses are set out in an advertisement.

Liverpool Engineering Society.—The annual meeting of this society was held on April 24th, when Mr. A. Musker was elected president. The total number of members has increased to 520, against 502 at the close of the previous year. The Derby Gold Medal was awarded to Mr. T. L. Miller for a Paper on "Electrical Distribution in Cities."

Long-Distance Power Transmission.—On Saturday last, according to a Laffan telegram, the Yuba River—Oakland (California) power transmission scheme was successfully put into operation. Power is transmitted from the Yuba River to Oakland, a distance of 140 miles, at 40,000 volts pressure, and is employed at Oakland to work a system of electric tramways.

Personal.—In New York telegraph circles Mr. George Gray Ward, vice-president and general manager of the Commercial Cable Co., is well known and much respected, and we join with his numerous friends in the old and new worlds in congratulations on the occasion of the marriage of his only daughter, Miss Flaurence Oliphant Ward, with Lieut. Henry Hughes Hough, of the United States navy.

Telephones on Railway Trains.—In Sweden in future all the principal railway trains will carry a telephone apparatus which may be connected with the telegraph wires, and thus communication be established with the nearest station. The arrangement is, of course, invaluable in case of accident. The apparatus is set in working by the coupling of one telephone wire on to the telegraph line and another to the rails.

Electricity as a Galactagogue.—The *Medical Press* states that "one of the latest suggestions for promoting the secretion of milk in women, who are unable to discharge this important maternal function, is electrisation of the nipples. This method is due to the ingenuity of Dr. Bedart, of Lille, who has found that by electrically stimulating the skin of the nipple by means of a statical machine once a day for 10 minutes, the lacteal function is restored in a large proportion of cases; indeed, he chronicles 11 unequivocal successes out of 13 observations."

The New York Elevated Railway.—The British Thomson-Houston Co. has received information from its allied company, the General Electric Co. of New York, that the latter has secured, after severe competition, the contract for the train equipments of the Manhattan Railway (New York Elevated), including 1,600 large motors of over 100 h.p. each. This, we are informed, is the largest contract for car equipments that has ever been placed. The trains are to be equipped with the train system of control, which is the same as the British Thomson-Houston Co. is supplying to the Central London Railway for an experimental train.

Royal Institution.—At the annual meeting of the Royal Institution on Wednesday the following were unanimously elected as officers for 1901-1902:—

President, the Duke of Northumberland; treasurer, Sir James Crichton-Browne; secretary, Sir William Crookes; managers, Sir Frederick Abel, Sir William de W. Abney, Sir James Blyth, Sir Frederick Bramwell, Dr. Thomas Buzzard, Viscount Gort, Dr. Donald Hood, Lord Kelvin, Sir Francis Laking, Mr. Hugh Leonard, Dr. Frank McClean, Mr. James Mansergh, Mr. George Matthey, Mr. W. H. Spottiswoode, and Lord Justice Stirling; visitors, Sir Andrew Noel Agnew, Dr. C. E. Beevor, Mr. W. H. Bennett, Dr. Francis Elgar, Mr. Joseph G. Gordon, Dr. J. Dundas Grant, Lord Greenock, Mr. Maures Horner, Mr. H. F. Makins, Sir Thomas Sanderson, Mr. W. S. Squire, Mr. Harold Swithinbank, Mr. J. J. Vezey, Mr. Roger W. Wallace, and Mr. James Wimshurst.

Institution of Civil Engineers.—The following officers for 1901-1902 were elected at the annual meeting of the Institution of Civil Engineers on Tuesday last:—

President, Mr. Charles Hawksley; vice-presidents, Sir William H. White, Mr. J. Clarke Hawkshaw, Mr. F. W. Webb, and Sir Guilford L. Molesworth; members of council, Mr. James Barton, Mr. Horace Bell, Sir Alexander Binnie, Mr. B. Hall Blyth, Mr. C. A. Brereton, Mr. T. Forster Brown, Mr. R. Elliott Cooper, Mr. G. F. Deacon, Mr. W. R. Galbraith, Mr. G. H. Hill, Mr. J. C. Inglis, Dr. Alex. B. W. Kennedy, F.R.S., Mr. A. G. Lyster, Mr. J. A. McDonald, Mr. E. P. Martin, Mr. William Matthews, C.M.G., Mr. Alex. Siemens, Mr. Thomas Stewart (Cape Town), Mr. J. I. Thornycroft, F.R.S., Prof. W. C. Unwin, F.R.S., Sir E. Leader Williams, Mr. C. W. Darley (Sydney), Mr. E. P. Hannaford (Montreal), Mr. William Shelford, C.M.G., Mr. John Strain, and Mr. F. R. Upcott, C.S.I. (Calcutta).

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**The Marylebone Provisional Orders.**—The Electric Lighting Provisional Orders (No. 1) Bill, which was down for second reading in the House of Commons on Monday, dealing with the question of provisional orders in Marylebone, referred to on page 982 of our issue for April 19, has been postponed until Thursday next by arrangement. As reported in another column of this issue, the Marylebone Borough Council last night decided to purchase the Marylebone portion of the Metropolitan Company's undertaking at a price to be agreed, or failing agreement, by arbitration under the Lands Clauses Act.

**Association of Technical Institutions.**—The following resolutions were adopted at the annual general meeting of the Association of Technical Institutions, held at the Fishmongers Hall, on April 6:—

1. That this association cordially approves the main provisions of the Secondary Education Bill, 1900, and hopes that His Majesty's Government will take steps to secure its enactment at the earliest possible date.

2. That, in view of the position created by the Cockerton judgment, this association also hopes that the new education bill promised by the Government, or other measure, to be speedily proposed, will prevent unnecessary and wasteful overlapping and competition between the educational work of School Boards and County Councils; at the same time preserving the easiest possible provision for the continued instruction of boys and girls in or leaving the public elementary day schools in subjects preparatory to, and necessary for, the successful development of technical and secondary education.

3. That a copy of this resolution be sent to the Prime Minister, the President of the Board of Education, and to all members of the House of Commons.

**Opening of the Barnes Electricity Works.**—The electricity supply works of the Barnes Urban District Council was formally opened on Wednesday, and the supply of current to both Barnes and Mortlake commenced on the previous Saturday. The station was built by Messrs. Munday & Sons from designs by Mr. Fairley, the consulting engineer to the Council. The plant consists of four Belliss engines coupled to Siemens two-pole undertype dynamos, the aggregate capacity being about 400kw. Superheated steam is used, the steam being raised by three 250 H.P. Babcock and Wilcox boilers. River water is employed for condensing, a Wheeler surface condenser with an area of 1,410ft. being employed and capable of dealing with 1,200lb. of exhaust steam per hour. A Webster feed-water heater of the same capacity is also installed, and there are two Worthington duplex direct-acting feed pumps. The supply is on the three-wire system with 420 volts between the outers. About 14 miles of mains have so far been laid, Callenders lead-sheathed and armoured cables being used and drawn into Sykes stoneware conduits. For day load 274 E.P.S. cells have been fixed having a capacity of 300 ampere-hours at ordinary rates and a maximum discharge of 160 amperes. Schattner meters are used, and the price charged is 6d. per Board of Trade unit, the price of gas in the district being 2s. 11d. per 1,000 cubic feet.

**Institution of Electrical Engineers.**—At the meeting last night, besides the reading of the list of the proposed new Council, given below, several interesting announcements were made. The date of the annual general meeting has been postponed until May 30th. The annual conversazione will take place on Friday, June 14th, at the Natural History Museum, South Kensington. M. Mascart has been elected an Honorary Member. Finally, it was announced that:—

The Council has appointed a committee to determine whether it can recommend the Council to take any action, and, if so, what action, to assist the industry in connection with the matter dealt with in Mr. Madgen's recent Paper. The committee is anxious to inquire impartially into the matter, and to hear the views that may be put forward on all sides of the question. It has, therefore, determined, with the sanction of the Council, to ask for evidence from gentlemen representing different interests or views, and to consider such evidence carefully. A procedure in many respects similar to that of a parliamentary committee will, therefore, be adopted. Proof offered by the witnesses will be circulated among the members of the committee before the meeting, and this proof will then be discussed with the gentlemen presenting it. In order that the mass of evidence which it is hoped may thus be obtained shall not be lost, shorthand notes will be taken of the proceedings at the meetings.

Mr. C. G. Lamb then described briefly the instrument for measuring the permeability of iron and steel designed by himself and Mr. Miles Walker. The discussion on the Paper was equally short, the only members taking part in it being Mr. Sydney Evershed and Mr. W. B. Esson.

**Nominations for the New Council of the Inst. E.E.**—The following is a list of the Council nominations for the election of Council and hon. officers for 1901-2, as announced at the ordinary general meeting yesterday:—

*President.*
Mr. W. LANGDON.

*Vice-Presidents.*

| | |
|---|---|
| *Major P. Cardew, R.E. | *Mr. John Gavey. |
| *Mr. S. Z. de Ferranti. | Mr. R. K. Gray. |

*Members of Council.*

| | | |
|---|---|---|
| Mr. H. H. Cunyngham, C.B. | *Lieut-Col. H. C. L. Holden, R.A., F.R.S. | *Mr. W. H. Patchell. |
| Mr. Henry Edmunds. | Mr. J. E. Kingsbury. | *Mr. J. H. Rider. |
| Mr. Robert Hammond. | Mr. A. J. Lawson. | *Mr. Mark Robinson. |
| *Mr. H. E. Harrison. | *The Hon. C. A. Parsons, F.R.S. | Mr. R. Percy Sellon. |
| Mr. Hugo Hirst. | | Mr. C. P. Sparks. |
| | | *Mr. J. Swinburne. |

*Associate Members of Council.*
Mr. W. R. Cooper, M.A., B.Sc. | *Mr. W. Duddell.
Mr. R. W. Wallace, K.C.

*Hon. Auditors.*
Mr. F. C. Danvers. | Mr. E. Garcke.

*Hon. Treasurer.*
Prof. W. E. Ayrton, F.R.S.

*Hon. Solicitors.*
Messrs. Wilson, Bristows, and Carpmael.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the Council in accordance with article 45 of the articles of association. All the honorary officers, being eligible, are nominated for re-election.

**Wireless Telegraphy.**—With reference to the note in our last issue, stating that the Marconi International Marine Communication Co. were putting up a wireless signalling station on the mainland close to the Fastnet rock, according to the instructions of the Board of Trade, it appears that the Liverpool Steamship Owners' Association is not satisfied with this measure. What it really wanted was an installation of wireless telegraphy on the Fastnet rock itself, from whence communication could be made with the mainland. By this means, vessels not fitted with Marconi apparatus would be able to signal to the Fastnet with flags, and the information so obtained could be communicated to the mainland by wireless telegraphy.—— On Saturday Mr. Henniker Heaton introduced to the Postmaster-General a deputation from Marconi's Wireless Telegraph Co., suggesting the establishment of a wireless telegraphic system at sea similar to that existing on land. It was agreed that it would be a great convenience to business men at sea and add largely to the Post Office revenue. Major Flood-Page, on behalf of the Marconi Company, also asked for a licence from the Post Office both for the transmission of wireless telegraph messages within territorial waters and for an ordinary licence under the Telegraphs Act of 1869, "so that arrangements convenient for the public may be made for dealing with telegrams to and from foreign places and for land purposes." Lord Londonderry said he would consider the matter carefully, but that the Admiralty would also have to be consulted, and he would place himself in communication with Lord Selborne.

**The Thermite Welding Process.**—An interesting demonstration of Dr. Hans Goldschmidt's method of welding was made in Westminster on Wednesday, when several pipes were welded with great ease, as also were two lengths of steel tramway rails. The process was first introduced to this country in a Paper read before the Institution of Mining Engineers on June 15, 1900. The ends to be welded are filed, the separate pieces are clamped firmly together, and the joint is then surrounded by a sheet-iron casing, jacketed externally with moist sand, which again is kept in place by a box surrounding it. The thermite, consisting of aluminium and oxide of iron in about the proportions of one to three, is then prepared in a crucible lined with magnesia or alumina, and a small quantity of superoxide of barium is sprinkled over the mixture, after which the whole is ignited with an ordinary match. The chemical reactions are very vigorous, the whole becoming molten in a very short time, when the mass, which has separated into two layers, may be poured into the mould. The top layer consists of an oxide of aluminium, which immediately forms a

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thin coat round the pieces, thus effectually preventing the iron which follows being welded to them. When the welding temperature is reached, the clamps are slightly tightened, and, after cooling, the whole mass can be easily removed. By a simple modification, the iron from the thermite mixture can be also welded on to the joint; this consists in having a small opening at the bottom of the crucible covered by a piece of sheet iron. The crucible is in this case placed over the mould, and when the reaction takes place the sheet iron is melted, and the iron at the bottom of the crucible touches the joint before the slag, and is welded to it. We are informed that a 3in. pipe 0·16in. thick can be welded with 5lb. of thermite. The distance of the sheet-iron mould from the pipe is 0·72in. and the length of the mould 8·2in. The welding temperature is reached 1½ minutes after the thermite is poured in. The makers claim that the cost of welding two 2in. tubes is from 2s. to 4s. according as the thickness ranges from 0·10 to 0·24in., the prices including crucible, mould, and labour. It will be interesting to follow this process and see the results of breaking and extension tests made by competent authorities. It is also claimed that the thermite can be used for the manufacture of special classes of steel, repairing steel castings, softening armour plates. For electrical engineers the method may be useful for welding rails and possibly for steam pipe ranges. The owners of the patents are the Allgemeine Thermit Gesellschaft of Essen, and it is proposed forthwith to form a company for working the patents in the United Kingdom.

Polyphase Working.—In delivering the first of a series of four Howard lectures on this subject at the Society of Arts last Friday, Mr. A. C. Eborall opened his discourse with the statement that single-phase working had nothing to recommend it either from the commercial or technical point of view, and that foreign manufacturers had fully realised this and had already arrived at a standardisation of polyphase plant, so that there was a resemblance in the practice of the best firms. Passing by alternators with copper disc armatures with a few remarks as to their unsuitability for polyphase working, owing to the difficulties in securing phase symmetry, in construction, and in synchronising, the lecturer examined, at some length, the features of inductor machines and the reasons for their gradual abandonment by Continental makers. Not only was half of the armature-copper wasted in these machines, as compared with the now ordinary type of rotating field magnets with alternate polarity, but the leakage flux, which was great, induced a back E.M.F. in the idle part of the windings. In a revolving field alternator the magnetic leakage could be made up for by adding more windings; it was mere leakage and did not produce back E.M.F. Then there was more trouble with the inductor type of machine if the revolving part became slightly eccentric. In fact, practically the only advantages of the inductor alternator were the absence of slip rings and the employment of less field-magnet winding. For use with steam turbines, however, Mr. Eborall thought these machines might yet be retained, as they were pre-eminently suitable for high speeds. He then described Mr. C. E. L. Brown's machine, in which the necessity of having two armatures was got over by the employment of staggered poles—one set on either side of a single armature. After briefly comparing revolving field and revolving armature machines, the lecturer proceeded to a consideration of the mechanical features of armature design, and then the relative advantages of star and mesh winding. He preferred star winding, whatever the output of the machine, on account of the cross currents which may be obtained in mesh-wound armatures under unfavourable conditions. Next the reasons for many and few slots per pole per phase were given, one or two for high-pressure machines and three or four for low-pressure machines being finally recommended. Mr. Eborall prefers to laminate merely the pole-tips of the field magnet rather than the whole pole-pieces, and considers that all well-designed alternators should have oval poles with laminated shoes cast into the pole core. The oval shape takes up less room, although it takes more wire for the same magnetic force, but, as the magnetic leakage is less with the oval shape, there can, he says, be no doubt that it is the best. The question of magnetic leakage he considers to be the most important factor in polyphase alternator design. He prefers to wind the magnets with copper strip set on edge, and previously compressed hydraulically, and to excite the magnets with separately-driven dynamos, as these are better than direct-driven exciters in view of pressure regulation and good parallel running. After explaining the different methods of getting at the armature for examination, the lecturer gave a number of useful data, which he recommended in addition to those already mentioned:—Peripheral speed of field-magnets, 5,600ft. to 6,000ft. per minute. Flux densities (lines per square inch): In cast-iron, 40,000; in cast steel, 90,000; in pole cores, 90,000; in pole shoes, 105,000; in air-gap, 60,000; in armature teeth, 120,000; in armature iron, 40,000. Current densities: 800 to 1,000 amperes per square inch in field, and 1,500 to 2,000 in armature. The lecture was well illustrated with lantern slides, and was greatly appreciated by a crowded audience.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), May 3rd.**

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture II. on "Polyphase Electric Working," by A. C. Eborall.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel, when the Northcott Prize Paper, by W. Powrie, entitled, "How May the Best Efforts of Employers and Employed be Exerted for their Mutual Advantage and for the National Benefit?" will be read and discussed.

**SATURDAY, May 4th.**

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

*2 p.m.* Visit to the Davies-street Works of the Westminster Electric Supply Corporation.

**MONDAY, May 6th.**

SOCIETY OF ENGINEERS.

*7:30 p.m.* Ordinary Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "The Treatment of Low Grade Iron Ores for the Smelting Furnace," by T. B. Grierson.

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture III., on "Alloys," by Sir W. C. Roberts-Austen, F.R.S. This lecture will be delivered by Dr. T. Kirke Rose.

**TUESDAY, May 7th.**

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

*7:30 p.m.* Meeting at the Finsbury Technical College, Leonard-street, E.C. Paper to be read: "Recent Work on Hertz Wave Phenomena and their Application to Wireless Telegraphy," by F. T. Hiss, jun.

**WEDNESDAY, May 8th.**

IRON AND STEEL INSTITUTE.

*10:30 a.m.* Annual Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W.

**THURSDAY, May 9th.**

IRON AND STEEL INSTITUTE.

*10:30 a.m.* Continuation of Annual Meeting at the Institution of Civil Engineers.

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting at the Society of Arts, John-street, Adelphi. Paper to be read: "Storage Batteries in Electric Power Stations Controlled by Reversible Boosters," by J. S. Highfield.

**FRIDAY, May 10th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Papers to be read: (1) "Applications of Elastic Solids to Metrology," by Dr. C. Chree. (2) "The Thermal Properties of Isopentane compared with those of Normal Pentane," by Prof. S. Young and J. Rose-Innes.

SOCIETY OF ARTS.

*8 p.m.* "Howard" Lecture III., on "Polyphase Electric Working," by A. C. Eborall.

ROYAL INSTITUTION.

*9 p.m.* Evening Discussion by Prof. J. C. Bose. Subject: "The Response of Inorganic Matter to Mechanical and Electrical Stimulus."

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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Magnetic Theory of the Solar Corona.*—From a theory based upon Ebert's and Pupin's experiments on the behaviour of a conducting body placed in a vacuum and subjected to magnetic force, F. H. Bigelow is led to conclude that the photosphere of the sun is the seat of powerful electric discharges which ionise portions of its material, or at least set free minute particles of matter charged with electricity. These are repelled outwards in a coronoidal radiation, and give the forms seen in the disorganised streamers. This nucleus of the sun must be the seat of a powerful magnetic field whose axis is near that of the sun's axis of rotation, and whose action upon the ions repels them from the polar zones in accordance with Ebert's experiments. The equatorial regions of the sun usually show that there is a tendency to form a trumpet-shaped extension along the ecliptic, widening in proportion to the distance from the sun. This is another evidence of the fact of mutual electrical repulsion between the charged ions of like sign, since the spreading is similar to that of the cathode bundle in a vacuum tube.

[F. H. Bigelow, *Am. Jour. of Science*, April, 1901.]

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*Esperanto.*—The proposed international language called "Esperanto" has received recognition by the French Academy of Sciences to the extent of being made the subject of a Paper by one of its members, H. Sebert, who writes "On the Scientific Utility of an Auxiliary International Language." The author publishes a letter by C. Meray, pointing out the many advantages possessed by Esperanto over previous systems, and mentioning that Esperanto is used by some 40,000 or 50,000 people already. The system, devised by Dr. Zamenhof, of Warsaw, is based upon the Latin languages, which have the closest relation to the scientific nomenclature of the present day, words and roots being adopted in proportion to the frequency of their international usage. The author presses the claim of the question to be considered by the International Association of Academies, and calls upon the French Academy to take the initiative. The adoption of an international "auxiliary" medium for scientific purposes would no doubt save an immensity of time and trouble. English speakers are fond of pressing the claims of their own language; but those claims are commercial rather than scientific. Italian has the strongest scientific claims, but as no nation is likely to give way to the other, the adoption of an artificial system, as in the case of algebra, seems the most rational solution.

[H. Sebert, *Comptes Rendus*, April 9, 1901.]

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*Exciters for Wireless Telegraphy.*—In attempting to obtain the purest and least-damped waves, F. Braun (see also *The Electrician*, Vol. XLVI., p. 778) hit upon two possibilities of compensating the damping of the oscillations by their own electromagnetic radiation. One of these consists in attaching the open exciter to a closed condenser circuit. Not only does the capacity of the latter reduce the damping by the spark, but it restores the energy radiated to the exciter. In the second device the exciter is quite detached, and represents an interrupted wire. Its lower end is twisted into a coil, and in this coil the oscillations of the primary condenser circuit are reproduced by induction. The exciter is then quite sparkless, but, all the same, amplitudes of potential variation may be produced in it of such magnitude as would be valueless if the exciter, with its small capacity, contained a spark-gap. Resonance between the primary and secondary circuits is very essential. Both methods give (1) nearly pure sine oscillations, (2) favourable radiation conditions, and yet (3) only a very slight damping. For long-distance work, the author believes these methods to be the best yet devised.

[F. Braun, *Phys. Zeitschr.*, March 23, 1901.]

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*Action of Radium Rays upon Selenium.*—In 1899 Perreau discovered that the Röntgen rays produce upon selenium an effect comparable with that of light. E. Bloch has taken the further step of testing whether radium rays have a similar effect. One selenium cell tested was constructed in the manner of the old Siemens pattern, with a spiral trough between two metallic wires, and had an initial resistance of 30,100 ohms. It rapidly diminished by 800 or 1,000 ohms under the action of a feeble diffused light. Placed at a distance of 50cm. from an incandescent lamp with ground-glass bulb it fell rapidly to 15,000 ohms, subsequently recovering very slowly in the dark. When a preparation of radio-active barium carbonate was brought within 1mm. of it, with black paper intervening to cut off the light emitted by the preparation, the resistance slowly fell, attaining a value of about 29,000 in 10 minutes. On removing the radium preparation the resistance gradually increased again, reaching its initial value after about two hours. The radium preparation had an activity 1,000 times that of uranium, which is not much as modern attainments go. Another selenium cell had a resistance of 654,000 ohms, and this fell to 640,000 in 10 minutes, an effect which is about the same as that due to very feeble diffused light.

[E. Bloch, *Comptes Rendus*, April 15, 1901.]

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*Coherers for Wireless Telegraphy.*—A satisfactory coherer must be uniform in its action. Its sensitiveness must be great, and must vary but little from time to time. The final resistance of the coherer must fall below some predetermined value after each signal, but it need not be low, as the relay can be adjusted for any value desired. C. Kinsley, in specifying the requirements of a good coherer for wireless telegraphy, points out that however much uncertainty attends the use of the wireless telegraph it need not be due to the coherers. He emphasises most strongly the fact that the sensitiveness does not depend on the metal or metals employed. Coherers of any degree of sensitiveness desired may be made of any metal. It is only necessary to treat each metal in accordance with its peculiar nature. The limit of sensitiveness is defined by the difference of potential which must always be present between the coherer terminals whenever a relay is used. This should always be kept as low as possible to preserve a safe working margin, and thus to prevent any local disturbance from producing a false signal. The best difference of potential seems to be 0·4 volt; as the current must also be kept small —say less than 0·002 ampere—a very sensitive relay should be used, operated, say, by a current of 0·001 ampere.

[C. Kinsley, *Phys. Review*, March, 1901].

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*Photographophone.*—Among the various methods of registering sound vibrations those based upon photography are the most sensitive and accurate; but, though good photographic records have been obtained both from the ordinary phonograph cylinder and from sensitive flames, no method of reproducing the sounds from the photographic record has hitherto been devised. E. Ruhmer has now, however, hit upon a method of reproducing them which is distinctly ingenious and novel, and opens up a new vista of possibilities. He photographs a "speaking arc" or other sensitive flame on a moving film, and reproduces the sound by projecting light through the film on to a selenium cell in circuit with a battery and telephone. Every variation of the light impinging upon the selenium cell produces a sound in the telephone, and the reproduction is superior in sensitiveness and clearness to the Poulsen telegraphone. Moreover, the film can be made of very considerable length without losing its lightness and portability, which cannot be said of either the wax cylinder or the telegraphone wire. Another great advantage is that any number of prints of equal value can be taken off the same negative. A print kindly sent by the author shows 13 clear maxima of luminosity. Cylindrical lenses are used for concentrating the light upon the film. The author is at work improving the speaking flame.

[E. Ruhmer, *Der Mechaniker*, No. 7, 1901.]

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## THE BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

After consideration of the representations made at the recent inquiry, held at the Westminster Town Hall (see *The Electrician*, Vol. XLVI., pp. 748, 790, 832, and 871), with respect to the regulations made by the Board of Trade under the Electric Lighting Acts for ensuring a proper and sufficient supply of electrical energy, the Board has decided to amend the regulations B5 and B6 to read as below. The words printed in italics in the two cases are the conditions which are now added:—

5. FIXING OF STANDARD PRESSURE.—The standard pressure shall be fixed by the undertakers and notice of the amount of such standard pressure shall be given to the *local authority before the undertakers commence to supply energy to consumers, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month in such manner as the local authority may require of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

*Provided that so long as effect is given to the next following regulation the undertakers shall not be bound, under this regualtion or any regulation corresponding thereto, previously made, to comply with any condition which has been or may be imposed thereunder, the effect of which is to prohibit any change in the pressure of the supply to any premises except with the consent of the consumer.*

6. DECLARED PRESSURE AT CONSUMER'S TERMINALS.—Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

Provided that no change shall be made in the pressure of the supply to any premises which at the date† of these regulations are supplied with energy by the undertakers except with the consent of the consumer.

*But where the consumer withholds his consent after the undertakers have offered to comply with the general terms and conditions imposed by the *Local Authority, and, if not required to do so under those terms and conditions, also to pay the reasonable cost of or incidental to the change (including compensation for any loss or damage incurred in consequence of the change), the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, give their consent to the change on such terms and conditions as they impose, and the consent of the Board so given shall for the purpose of this regulation have the same effect as the consent of the consumer.*

*The Board of Trade may, if they think it necessary in any case, refer to a single arbitrator appointed by them to determine what terms and conditions it would be proper to impose under this provision in case the consent of the Board is given.*

*Any such arbitration shall be subject to the like provisions as an arbitration in pursuance of a special act under Part I. of the Board of Trade Arbitrations, &c., Act, 1874, and shall also be subject to the provisions of the Arbitration Act, 1889, as if the arbitration were pursuant to a submission, except that the powers under the last-mentioned act with respect to the costs of the reference and award shall be exercised by the Board of Trade instead of by the arbitrator.*

## WIRELESS TELEPHONY.

BY PROF. E. WILSON AND C. J. EVANS.

It is well known that "wireless" telephony can be accomplished over short distances, between two circuits mutually inductive, when one includes a telephone transmitter and the other a receiver. In May, 1899, a considerable number of experiments were made in the Siemens Laboratory, King's College, London, with a view to producing the effect over an increased distance. Two fundamental experiments with a direct-current arc may be of interest.

I. In Fig. 1 M is an electromagnet with laminated core energised by currents from a small battery *b* in circuit with a telephone transmitter T. In some cases an extraneous and constant magnetising force was applied to M to bring the arc to a central position between the poles. The magnet and transmitter were placed in different rooms and connected by twin wire. The current in the arc A was supplied by a battery B, and passed through a coil P 4ft. in diameter, consisting of 40 turns of 18 S.W.G. cotton-covered copper wire. A similar coil placed opposite P served as a secondary, and included a telephone receiver in its circuit. With a silent arc the voice at T could be heard in the telephone in this secondary circuit. This experiment was tried with both open and enclosed arcs, but the former was found the more convenient.

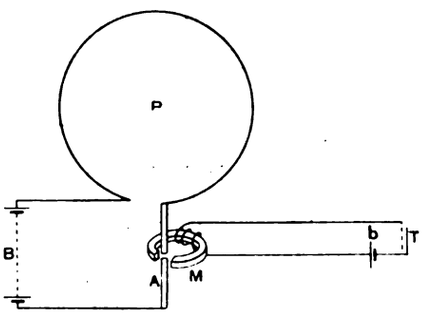


FIG. 1.

II. In Fig. 2 a loud-speaking receiver, *t*, was connected by an india-rubber tube to the lower end of a carbon A, from which the core had been extracted. As before, the transmitter T was in a different room to the arc A, and the voice could be heard in the telephone in the secondary circuit placed opposite the primary P. This arrangement was also tried, substituting a speaking tube mouthpiece for the telephone receiver *t*; as before, the voice could be heard. With both

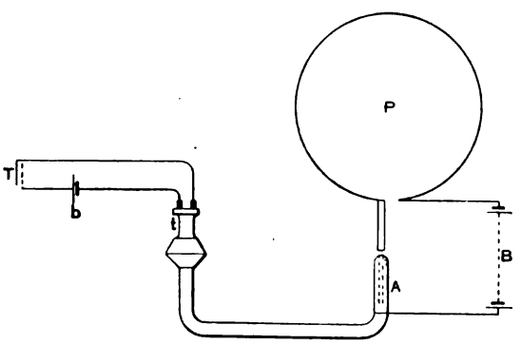


FIG. 2.

these arrangements the best condition appeared to be that the arc should play all round the periphery of A so that it sustained the full effect of the vibrations.

A variety of modifications were tried, but the maximum distance traversed was not great.

## THE PARIS EXHIBITION.—XVII.*

(BY OUR SPECIAL CORRESPONDENT.)

Meters figured very conspicuously in the parts of the electrical palace devoted to the exhibit of articles of smaller size, and it was noticeable that to a large extent they were separate from other "instruments of precision." It is surprising how few eminent English makers of laboratory, workshop, and switchboard instruments should have taken up seriously the manufacture of meters for the measurement of electrical energy, and the same seems to apply to some extent to the practice in foreign countries as well. Except in the case of

* In the London company form substitute "County Council" for "Local Authority" throughout this regulation. In the London Local Authority form read "public notice" for "notice to the Local Authority," and substitute "County Council" for "Local Authority" where occurring subsequently. According to the provincial Local Authority form, notice must be published and the terms and conditions are imposed by the Board of Trade.

† This date is fixed by the date of the letter of the Board of Trade sending the regulations to the undertakers in question.

* Previous articles appeared in *The Electrician* of July 20 and 27; Aug. 3, 24 and 31; Sept. 14 and 28; Oct. 5, 12 and 26; Nov. 2, 16 and 30, 1900; Jan. 18, Feb. 1, and April 12, 1901.

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those large firms who manufacture everything electrical, meter manufacture is largely a specialised industry.

An interesting meter of which one may expect to see more in this country is the O'Keenan, or "O'K.," meter. It was exhibited by the Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz, and in England is supplied by the British Thomson-Houston Co. The makers informed me that it had become very popular in France, 12,000 having been sold during the first year of its manufacture there. It is based on the idea that in a perfect motor at maximum efficiency with no load (*i.e.*, with the back

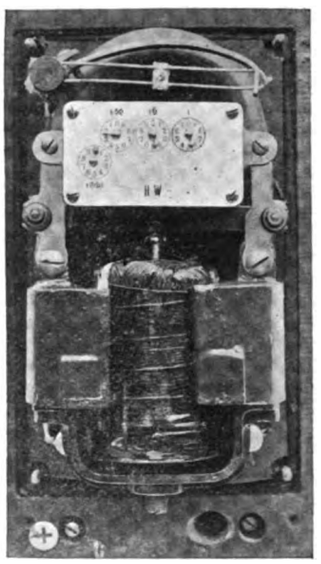

FIG. 110.—THE O'KEENAN METER.

E.M.F. equal to the impressed E.M.F.) the speed is proportional to the difference of potential between its terminals. The makers endeavour to attain this condition by reducing the friction as much as possible and running the meter as an ampere-hour meter at extremely low voltage, shunted to a German silver resistance in the main circuit, using, of course, no brake. A general view of the instrument with the case removed is shown in Fig. 110. The magnet is a permanent

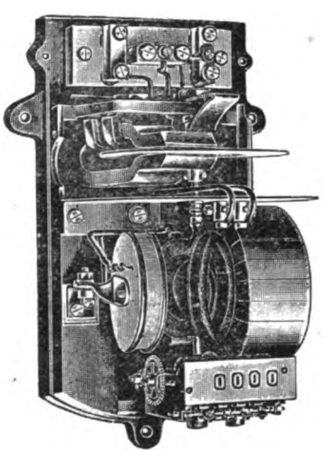

FIG. 111.—THE LUX METER.

one, with large pole-pieces between which the armature revolves, resembling somewhat the magnets of a d'Arsonval galvanometer. The armature is built up of coils in the form of semi-cylindrical shells, connected in drum-fashion to the commutator below, the spindle of the motor being vertical. Concentric with the armature and inside it is a cylinder of soft iron, such as is employed in a d'Arsonval galvanometer to concentrate the magnetic field, this being held on a non-magnetic support to receive which the lower part of the armature is bell-shaped. The iron cylinder remains fixed and does not revolve with the meter, so that there is no hysteresis loss. The spindle is, of course, mounted in jewelled bearings, and carries a worm which gears into the registering train in the usual manner. To facilitate cleaning the com-

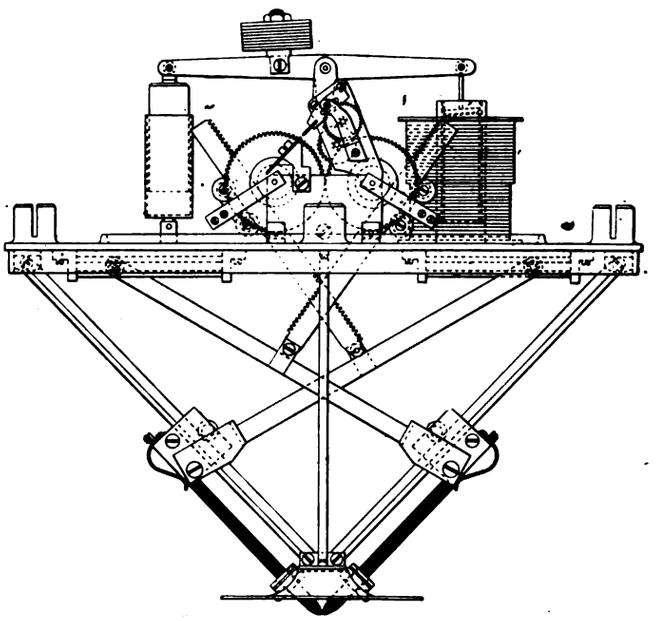

FIG. 112.—THE HACKL ARC LAMP.

mutator and examining the jewel of the lower bearing, this end of the spindle is covered in by a separate box, which can be opened without opening the meter case.

It seems reasonable to expect that the meter is not accurate over a very wide range, but undoubtedly its starting current

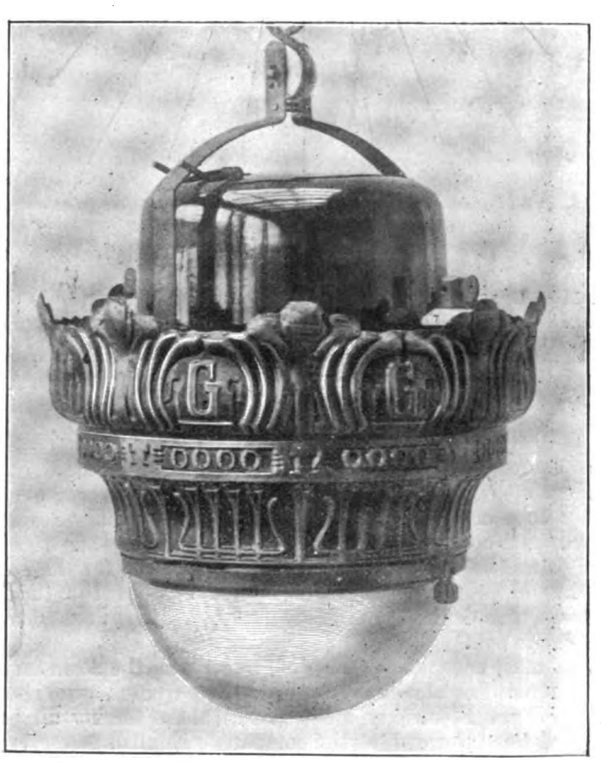

FIG. 113.—GENERAL VIEW OF HACKL LAMP, WITH COVER AND GLOBE IN POSITION.

must be very small as well as its energy consumption, so that as a cheap meter for small consumers it has certain advantages. We understand that the British Thomson-Houston Co. recommend it for circuits up to 3 amperes only.

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The Compagnie pour la Fabrication des Compteurs also exhibited a number of Thomson meters of various sizes and for various purposes. One of these was designed for a maximum current of 10,000 amperes. Its field was formed by flat copper bars, and two armatures arranged astatically on the same spindle were employed so that they should not be affected by the large current through the wires near the instrument.

In a Ferraris alternating current meter exhibited by Messrs. Siemens and Halske, a device was added to diminish the static friction of the bearings without, as in the Thomson meter, introducing the danger of the armature starting and running on the shunt if the static friction of the bearings were lessened by an occasional vibration. This device kept up continuously a state of vibration by a small piece of metal made to vibrate in synchronism with the frequency.

Among other varieties of meters was one fitted with a registering arrangement similar to that of a speed counter instead of the usual dials. This one, the Lux meter (Fig. 111), is a motor meter with a Foucault brake, but differs chiefly from the ordinary instruments of this type by the winding of the armature, which was on the open coil arrangement as

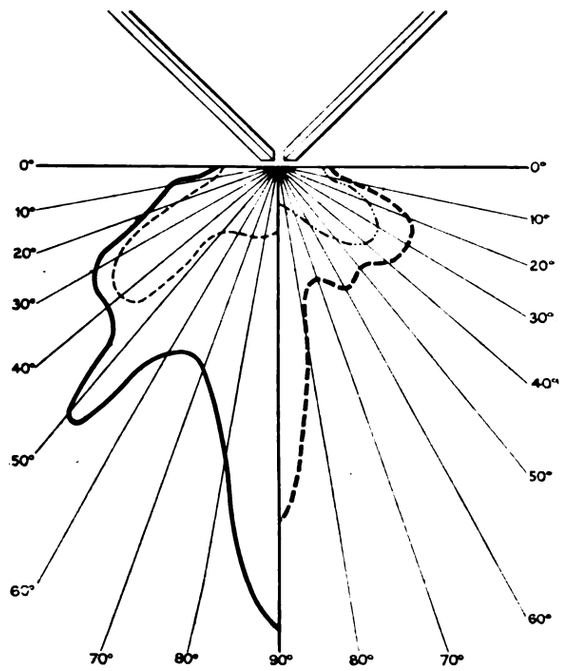


Fig. 114.—Curves Showing Relative Illumination and Light Distribution given by Hackl and Ordinary Alternate Current Lamps.

Ordinary Lamp without Globe.
Ordinary Lamp with Globe.
Hackl Lamp without Globe.
Hackl Lamp with Globe.

in a Thomson arc-lighter. The armature has three coils, 120deg. apart, one terminal of each of the coils being connected to a common point, and the other terminal of each to a three-part commutator. It is calculated that this winding diminishes the weight of the armature, or that, for the same weights of copper on the armature, 1·7 times the turning moment of a drum armature is obtained. The field consists of a single coil.

The most conspicuous English meter was the Aron meter, various patterns of which, for different purposes, were shown by the Aron Electricity Meter (Ltd.), these having all been made, I was informed, at the company's English factory.

Among the multiplicity of arc lamps at the exhibition, the Hackl alternating current lamp, made by Messrs. Ganz & Co., was interesting. Its characteristic feature is that its carbons are inclined at an angle instead of being placed vertically. Fig. 112 is a scale drawing of a 10 ampere lamp, taking from 28 to 30 volts, Fig. 113 is a general view of the lamp, and Fig. 114 is a comparison of the illumination and light distribution given by this and an ordinary alternate-current lamp. As is seen in Fig. 112, the mechanism is simple, consisting of a rack with its system of gear-wheels for each carbon, so arranged that the carbons feed at equal rates. The mechanism is driven by the weight of the carbon-holders and braked by means of a solenoid. Usually the lamps are made with one series solenoid only for use with a "divider"—a choking coil connected across the low pressure mains and divided into three parts, to each of which a lamp is connected. For combined light and power circuits, however, a differential system is preferred.

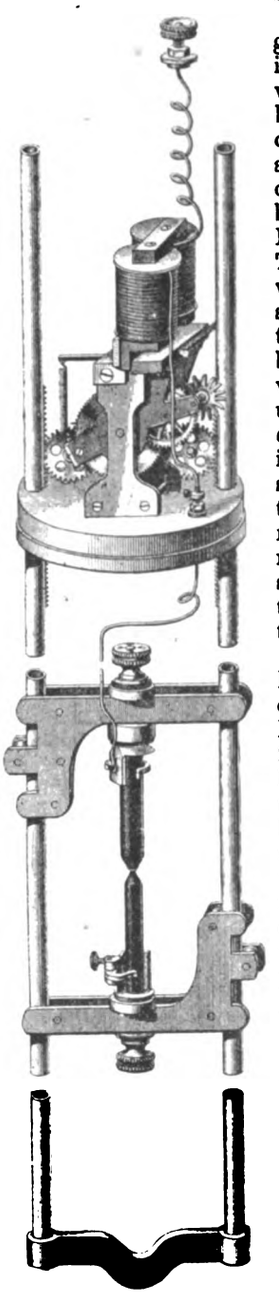

Fig. 115.—The Mougin Arc Lamp.

A curious sight in one of the galleries was several arc lamps fixed in lines radiating from a centre, the whole star rotating, while the lamps burnt comfortably without their oblique position occasioning them any apparent inconvenience. The details of this lamp, which is made by the Société les Fils d'Adolphe Mougin, are shown in Fig. 115. Two racks connect the mechanism with the carbon-holders. These slide up and down in two brass tubes, the lower ends of the racks being in mechanical connection with the carbon-holders, and their upper ends being controlled by a clockwork escapement. The latter is driven by a spring and released step by step by a shunt magnet as the arc becomes too long. A series magnet effects a movement of the racks in the opposite direction by a slight movement of the whole wheel train about its main axis in order to strike the arc.

An enormous Schuckert search-light was in daily use on the tower of the German navigation section. Its parabolic glass mirror was 2 metres in diameter, with a focal length of 869mm. The weight of the apparatus being 5 tons, ball bearings were used to facilitate its rotation. At the focus of the mirror was a 200 ampere continuous-current arc, with 49mm. and 35mm. carbons. An arrangement was provided, constructed on the same principle as the iris shutter used in photographic apparatus, by means of which the light could be completely shut off. This was operated by a motor, so that it could be controlled from a distance if required, and a hand-wheel was also provided so that it could be worked by hand. I was informed that this search-light is the largest in the world, and that the mirror is so accurately polished that the rays of a beam of light falling on the mirror in a direction parallel to its axis are united at the focus in a spherical space not quite 2mm. in diameter.

Before leaving the subject of search-lights, I should add that the French firm of Sautter, Harlé & Cie. exhibited a fine collection of these, and also examples of other applications of electricity on warships.

The Nernst pavilion, an artistically arranged pavilion in an oriental style of architecture, erected on the main gallery of the electricity palace, demonstrated that the Nernst lamp had certainly reached its manufacturing stage, for its interior was lighted with over 800 of these lamps. Enquirers as to price and other details were asked to have patience. As seen in

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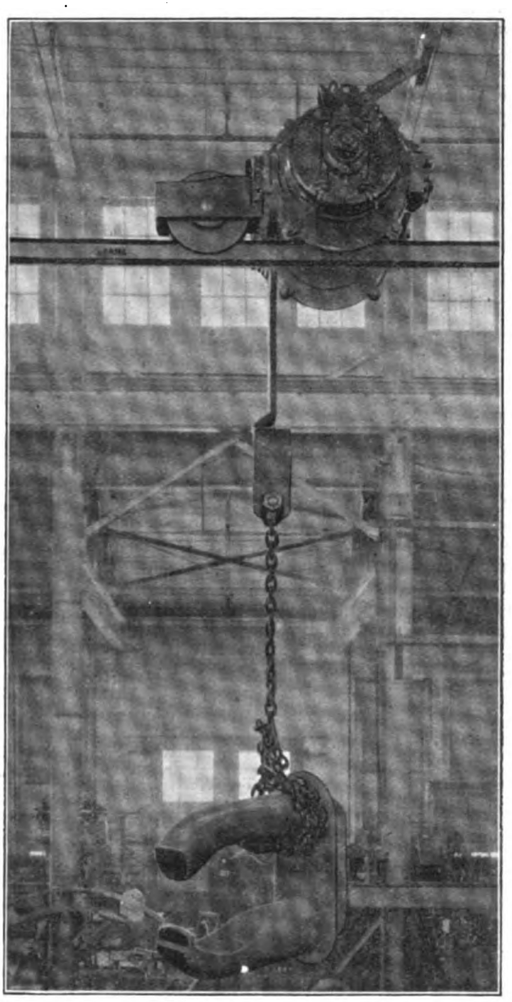
article in last week's *Electrician*, the lamp will soon be the obtainable in quantities.

In contrast to this lamp, constructed on a scientific principle, a lamp called "La Saymar" was shown not far off by a French company, in which the old fallacy was revived that by winding the filament in a double spiral around a rod of fluorescent glass an increase in light is obtained.

The Société Centrale d'Electricité, another maker of incandescent lamps, were actually manufacturing lamps at their exhibit, utilising the Malignani thermo-chemical process of obtaining the vacuum. A partial vacuum is created by an air-pump, and the vacuum is completed by chemical action. For this, red phosphorus or some similar product, in the form of a fairly liquid paste, is rubbed on the interior of the neck of the lamp up to a certain height by means of a piece of cotton wool fixed to a wire. The vacuum is reduced by the air-pump down to at least 1mm. of mercury, a hydrocarbon gas is let into the bulb, which is again partially exhausted by the pump, and then the remaining gases are absorbed by the above-mentioned product under certain conditions of temperature.

## AN IMPROVED SYSTEM OF TELPHERAGE.

It will be remembered that telpherage was first introduced by Prof. Fleeming Jenkin in 1883, but at that time there was neither a satisfactory motor on the market nor were there the perfected systems



TELPHER LINE IN AN ENGINEERING WORKSHOP.

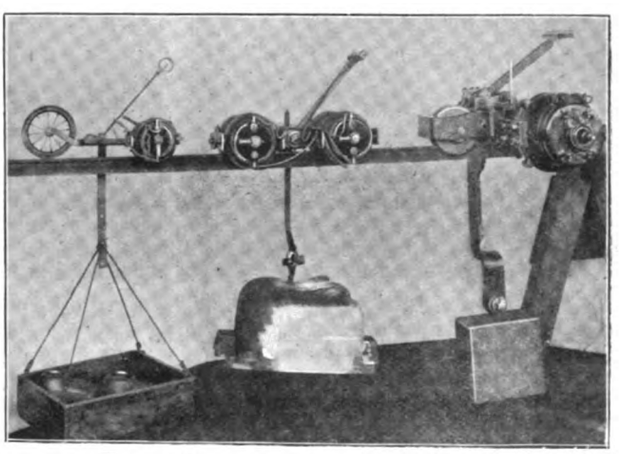
of insulators and clamps that have since been developed for electric traction. This method of transit has, however, lately been re-introduced by the Consolidated Telpherage Co., of New York, who have already installed it in a number of factories in the United States. The standard train consists of single telphers with or without trailers, but the hanging and slinging arrangements attached to the telphers and trailers are of great variety and adapted to the transportation of all kinds of material, such as barrels, ore, fruit, sugar, &c., whilst a combination of telpher and trailer is suitable for carrying rails, logs of wood, &c.

The telphers are single and double unit, the former having two and the latter four motors. The single-unit telphers are made in sizes from ½ H.P., to 6 H.P. weighing from 351b. to 3751b., with carrying capacities of from 251b. to 6001b. The smallest double-unit telphers are 1½ H P., and the largest 8 H.P., weighing from 1251b. to 7251b., with carrying capacities from 1251b. to 1,2001b. The telphers are fitted with ball bearings, and there is no gearing. Hoists can be fitted to the hangers, and all the insulators, clamps, &c., are much the same as are used in standard overhead trolley construction.

TELPHER LINE CARRYING CASTINGS.

Arrangements can be made so that the telphers automatically slow down at curves and at terminals before stopping; and, as originally worked out by Profs. Ayrton and Perry, there is no chance of telphers overtaking one another.

In a circular issued by the company, an account is given of the working of a 125lb. line, for the period of one month, at Messrs. J. A. Goldsmith's brass foundry, Roseville, N.J. The total weight carried was 27,156lb., the average load 1391b, the number of trips 195, the maximum load 204½lb., the maximum weight, including telpher



VARIOUS TYPES OF TELPHERS AND HANGERS

hoist, car, and foundry case and castings, 402lb. The total distance travelled was about 59 miles, the length of line being about 800ft. The average speed was about 12 miles an hour, and the power required rather less than ½ H.P. On curves ½ H.P., and on starting ⅔ H.P., was required, whilst on a 4 per cent. gradient ¾ H.P. was absorbed. The maximum strain on the system was on a Saturday, when 2,748lb. were carried in the half-day. The total cost of repairs for three months was 10 cents. No record was taken of the total cost of working, as the electric plant had already been installed for lighting and power. At present the only system adopted has been overhead, the telpher either running on a steel wire cable, or

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where the distance is short and the loads large on rails; but the company are also developing a system of tubular dispatch, in which the telphers run on double rails, the system being adapted for pipes from 27in. diameter to 36in.

Our illustrations show several varieties of telphers and the two systems of overhead telpherage.

## CONVERSAZIONE OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The annual conversazione of the American Institute of Electrical Engineers was held at Columbia University on April 12. The exhibit which attracted the most attention, according to our New York contemporaries, was that of Mr. P. C. Hewitt, consisting of mercury vapour tubes. The simplest form consists of a plain cylinder having a bulb at one end containing mercury, and a positive electrode of iron at the other end. Before sealing, the tube is partly exhausted. The amount of exhaustion was not stated, but it was said that no tube was exhausted below a pressure corresponding to 1mm. of mercury when running. Fig. 2 shows a lamp in which the tube is coiled. In starting up, a momentary wave of higher

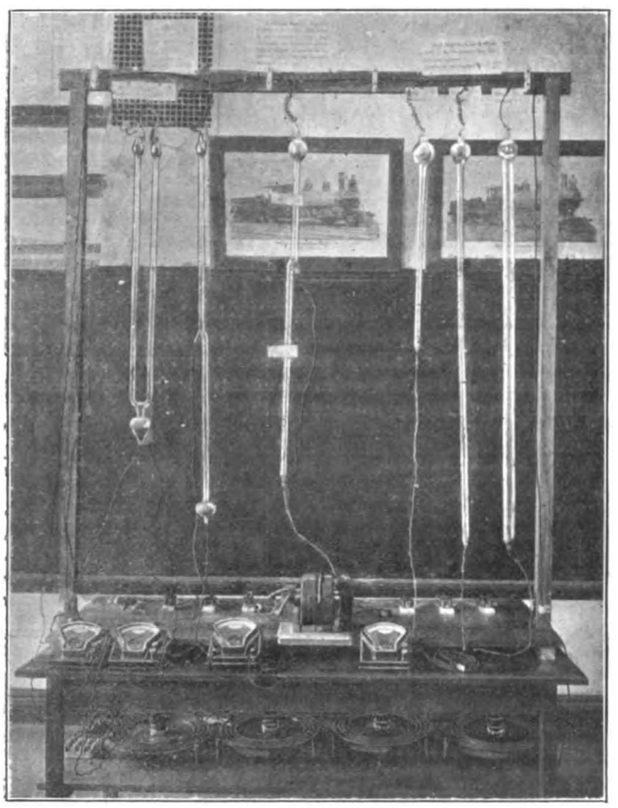

FIG. 1.—EXHIBIT OF MERCURY VAPOUR TUBES.

voltage than normal was used to start the discharge through the tube, but it was stated that tubes could be put in operation without having recourse to a high starting voltage.

A number of sheets of curves were exhibited, showing the variations of efficiency under different conditions and with currents of different value. A tube 54½in. long with an inside diameter of 1in. at 74 volts and 3 amperes gave a candle-power of 700, which corresponds to 0·32 watt per candle. The photometric value was determined by measurement at right angles to the axis of the tube, and, therefore, does not correspond to the basis upon which candle-power of incandescent and arc lamps is determined. For each vapour, Mr. Hewitt states, there is a density corresponding to maximum conductivity, but for each one there also holds good the extraordinary law that when they are confined in cylindrical tubes the conductivity varies as the *diameter* of the tube and not as its area. There is also a curious effect noticed in that each vapour, at a given density, seems to possess a kind of critical breakdown point of voltage, so that in effect wide differences in current flow may be produced with exceedingly small changes in impressed electromotive force. Virtually this makes the vapour tube act like a conductor whose resistance varies inversely as the current flows through it. An interesting feature was the introduction of red into the spectrum of the light obtained by the use of red reflecting screens. The vapour spectrum of mercury consists of a number of lines in the yellow, greenish and blue parts of the spectrum, but there is no radiation in the red part. In consequence, the light emitted, though extremely brilliant, is of a disagreeable bluish-green colour, but this effect may readily be corrected, as was demonstrated, by the introduction of reflecting screens of a deep red colour, these adding the necessary element to produce a fairly normal distribution of colour.

Mr. W. S. Andrews exhibited a small-bore revolving glass tube, connected to an alternating current circuit of 118 volts and 58 cycles for analysing the high-frequency spark. The results obtained showed clearly that each half-wave might be the source of a number of high-frequency oscillations. Mr. C. L. Clarke exhibited a new form of synchroniser, which consisted of two 12-pole synchronous motors, with shafts axially in line rotating blackened aluminium discs in opposite directions. Six narrow slots, extending radially inward, are cut in the circumference of each disc at equal distances apart. A brilliantly-lighted white screen is located behind the discs. The stroboscopic effect of viewing the screen through the slots in the discs as they rotate appears in the form of an image, consisting of a series of bright, narrow radial lines arranged circumferentially upon a black background. At the circumference of, and in the same plane as, the front disc is located a scale which reads to 180deg. on each side of a zero line, and embraces ½th of the circumference of the disc. Directly behind this scale, and in the plane of the rear disc, is located another similar scale. The two scales together constitute a single scale for avoiding error due to parallax. The scales are fixed together, and, as a whole, are capable of a certain amount of motion about the discs for adjustment. When the discs rotate at or near the same speed and, therefore, the motors are at or near synchronism, the characteristic image appears, in which case 12 lines at equal distances apart are seen. These lines will be stationary if the motors are in synchronism, or slowly rotate if the motors are nearly in synchronism, the direction of motion depending upon which motor is going the faster. To adjust the scale both motors are connected with the same source of E.M.F., with the necessary result that they run in synchronism, and, therefore, the characteristic image appears, and its lines are stationary and assume the position for zero difference of phase. The scale is then adjusted to bring its zero line opposite a line of the image. Besides its use for the connecting-in of generators, as before described, this indicator is also applicable for showing the phase relations of a current and an E.M.F., or two currents of the same frequency.

FIG. 2.

Prof. Elihu Thomson exhibited amongst other novelties an improved dynamo-static machine. This machine contains a small direct-current motor, the windings of which are tapped and connected to two rings, giving a primary alternating current for the operation of a step-up transformer, which gives a secondary current that can be regulated through a range up to about 20,000 volts. The tops of alternating-current waves of high potential obtained from this secondary transformer are used to charge a number of glass plate condensers in parallel. The rotating frame synchronously driven with the motor makes connection to the condensers periodically and in synchronism with the alternating current. The connection by the rotating frame is alternately in parallel and in series; the condenser plates may thus be charged to 15,000 volts with 10 plates in parallel, giving 150,000 volts when connected in series. The machine thus furnished, from low tension direct-current, high-potential discharges of definite polarity at the machine terminals.

## ELECTRICAL MINERS' SAFETY LAMPS.*

BY SYDNEY F. WALKER.

In nearly every coal mine of any size the whole of the surface arrangements, together with the shaft bottoms, the main roads for a certain distance from the shaft bottoms, and the underground engine houses and other important points, have long been illuminated with incandescent lamps; but up to the present very little has been done in the way of the adoption of the incandescent lamp at the face of the coal. Mr. Swan was very early in the field with a proposal to use lamps at the face of the coal, taking their supply of current from the regular lighting service, and some attempt was made to introduce it in that form; but mining engineers felt that the possibility of a spark passing between the broken ends of a severed cable was too serious to be entertained, and no attempt has since been made to introduce that method, except that in some cases, where electric pumps are working at or near the face, incandescent lamps are in use, taking their current from the power supply service. And so the solution of the problem resolved itself into the provision of a

* Abstract of a Paper read before the Institution of Electrical Engineers, March 28.

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portable lamp. A great many inventors, headed again by Mr. Swan, have made repeated attempts to solve this problem, but up to the present only one lamp is in practical use in the collieries of the United Kingdom—the invention of a Belgian named Sussmann—and only a very limited number of these are actually in operation in this country, and their use is confined to two or three collieries in the county of Durham. On the Continent of Europe a good deal more has been done in the matter, but the writer believes that even there it is only the Sussmann lamp that is in use.

The present miner's lamp consists of a short brass cylinder, about 3in. in diameter, forming the oil well, with its wick, and a wire pricker to stir it up when it is dull, surmounted by a stout glass cylinder and by an arrangement of three wire gauzes, fitting one inside the other, the whole of the gauzes being protected from injury by an iron bonnet. The gauzes and glass are carried by a brass framework into which the cylindrical oil well screws, and the whole lamp is carried by an iron hook attached to the top of the bonnet, the hook being large enough to hitch into the collier's belt when he is walking, attending to trams, &c. The lamp, made in brass, weighs from 2½lb. to 3½lb.; made in aluminium it weighs from 1¾lb. to 2½lb. It furnishes a light, when first lighted, of from ¼ c.p. to ⅔ c.p., each for 12 hours if required. It costs, in brass, from 5s. 4d. to 15s.—the 15s. is a special pattern. It costs to maintain from 2d. to 3d. per lamp per week, including oil, wick, glasses, cleaning, and repairs of all kinds.

In the first place the weight forms one of the most difficult parts of the problem. So impressed are mining engineers with the absolute necessity of not giving the colliers any additional weight to carry that when Mr. Swan presented his first portable lamp to the North of England Institute one of the leading members, who was very favourably impressed with the lamp, proposed that the lamps should be taken to the face on coal trams Mr. Swan's first lamp weighed 8lb., his second weighed 5½lb. Mr. Pitkin's, which had a good trial in a large number of mines, weighed 8lb. The Sussmann, in use at South Hetton colliery, in the county of Durham, at the present time, weighs 4lb.; the writer's weighed, when charged, 3½lb.

The first cost and the working cost of the electric miner's lamp would be prohibitive if competition with oil lamps is to be only on those lines. But these are not the only difficulties. The source of light, whether it be a candle or a safety lamp, performs a double office for the collier. It furnishes light and also indicates the presence of gas. Both the ordinary safety lamp and the naked candle denote the presence of carburetted hydrogen gas by an elongation of the flame on the lamp and of carbonic acid gas by the extinction of the flame. Carbonic oxide gas and sulphuretted hydrogen gas are not indicated by the miner's lamp at present in use. Mr. Rosenthal, the inventor of the gas testing apparatus which the Sussmann Company are adding to their lamp, states that his apparatus will denote the presence of any kind of gas; but the writer believes that he has not succeeded in distinguishing between the different gases which may be present with his apparatus.

On the other hand, the advantage which an electric portable miner's lamp possesses, supposing it to be a reliable apparatus, are:—

1. Complete freedom from the risk of an explosion from any carelessness or wilfulness of the working collier.

2. A lessening of the accidents from falls of roof and from accidents due to the machinery that is used for haulage and other purposes. The ordinary miner's lamp not only gives a poor light compared with that given by the portable electric lamps which have been tried in collieries, but it is also extremely sensitive. It must not be held much out of the vertical, and it must not be jerked suddenly, or it will be extinguished. Certain officials of the colliery go round periodically to examine the roof, &c., and to see that all is safe. With a light not good at its best, and one which it is necessary to hold in a vertical position, the examination is never so effective as it would be if a lamp was in use, such as the portable electric lamp, which could be held in any position and placed as close as required to the object, and which furnished a better and a clearer light in addition. This applies also to the operation of fixing timber in the mine and replacing it as required. The operation of fixing timber is one requiring considerable skill.

The problem, therefore, resolves itself into the provision of an incandescent lamp, giving more light than the existing lamp does, attached to a source of electric energy capable of furnishing it with current for 12 hours, eight of which should be such that the light given by the lamp is the best that it is capable of giving, and of doing this at a cost as to manufacture and as to maintenance that shall not be too large a multiple of those of the existing apparatus, and with the reasonable hope that with increased use and increased knowledge the cost may be brought down to and below that of the existing lamp.

*Difficulties Common to both Primary and Secondary Battery Lamps.*—1. The incandescent lamp itself presents a very considerable portion of the whole difficulty. Lamp makers are unable to construct lamps of 1 c.p. or 2 c.p. at voltages below 3½ volts, and lamps at this voltage have only recently been made, and are not always as satisfactory as one could wish. The filament generating heat and light is necessarily extremely short, and it has connected to its ends two platinum wires, which are in turn connected to two copper wires; hence it follows that a large proportion of the heat generated in the filament is carried off as heat by the terminal wires, and is not available for furnishing light. The writer's first idea was to have had a single cell of only 1 volt pressure, but that he found quite out of the question, as no lamp manufacturer would even consider the possibility of making lamps of the necessary size.

2. The case which is used to hold the battery, whether primary or secondary, has always been a serious stumbling-block to inventors.

3. The arrangement of the connections between the cells and between them and the lamp and the switch, when there is one, is also a difficult matter. It is not so serious in the secondary battery as in the primary battery, because with the former it is not necessary to break the connections each time the lamp is used, as it with the primary battery. On the other hand, with the secondary battery the connections are apt to be overlooked, not being necessarily attended to at each charge; and with both forms there is always the trouble that the liquid, which always contains acids of some kind, will creep to the connecting wires and eat them in two, assisted by the current of the battery itself. With the primary battery also there is considerable difficulty in arranging that the connections shall be quickly and surely made. It must be remembered that in some of the large collieries as many as 1,000 lamps may be in use at the same time, and have to be got ready for the workmen in a certain time, so that any arrangement which involves the occupation of a long time in making connections to each individual lamp will put the lamp out of the running from that cause alone.

4. The prevention of the escape of the liquids used in the battery, whether primary or secondary, is also a matter of considerable difficulty. One of the great beauties of the electric lamp is to be the possibility of using it in any position. And this is not all, unfortunately. In the working of both forms of battery, as is well known, gases are given off, which also tend to drive the liquids out of the vessels by any opening which presents itself, and severely strains any arrangement made for keeping them in.

*Difficulties Peculiar to the Secondary Battery Form of Lamp.*—1. The first difficulty, the uncertainty of the life of the battery itself, is well known to electrical engineers who have had anything to do with secondary batteries. When you are confined as to space, so that any chippings from the active material fall between the plates, and may cause short circuits, and when in addition you subject the battery to motion so that the active material tends to work loose under the operation of the motion and the pressure of the gases formed, the battery has a somewhat short life; and these are the conditions under which the battery has to work in the miner's lamp. It is only fair to say, however, that secondary batteries are being improved in this respect.

2. The fact that the battery requires 10 hours to re-charge is, of course, not so much against it when a large number of lamps are in use together, and when the whole thing is established on a proper system, but it is rather a drawback in the early stages of its introduction.

3. The uncertainty as to whether a lamp is actually charged, and will run its full shift when it is sent down the pit, is a very serious matter indeed, and it follows from the same cause as that mentioned in 1—viz., that the active material has a constant tendency to chip off during the use of the lamp, and to drop between the plates and short-circuit one of the cells, with the result that the lamp is extinguished.

*Difficulties Peculiar to the Primary Form of Battery Lamp.*—1. If you can have plenty of liquid for the secondary salts to be dissolved in, which means plenty of space and weight, and if you can separate the liquids which surround the positive and negative elements, and if you can arrange for the gases which are formed in the working of the battery to come away freely into the surrounding atmosphere, you have a chance of getting a primary battery to give you a fairly constant current; but you have none of these conditions present with the battery which is to work the miner's lamp. A porous cell would be absolutely prohibitive, as it would so complicate the arrangements for making the connections, renewing the zincs, and closing the vessels containing the cells; and it is doubtful if the porous cell would behave as an efficient separator when subject to the swinging motion that the lamp receives under ordinary circumstances.

In the working of every primary battery the salt of zinc which is formed upon its surface must be dissolved off, or polarisation is set up. Further, apart from the fact that the hydrogen gas liberated, as well as any metallic salts, require the presence of a certain quantity of material that will deliver up its oxygen, the secondary salts which are formed require also a certain quantity of liquid that will dissolve them. It is a most difficult thing to put all these, in one liquid, within the space and weight that are permissible, and to provide as well for the solution of the gases which are formed in the working of the battery.

2. The provision of the necessary energy to furnish the required candle-power at a price which will compare with the present cost of



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doing the same work is, perhaps, the hardest problem of all. In order to obtain the necessary quantity of energy within the space and weight allowable, it is absolutely necessary to employ the strongest acids on the market; and, again, one of the most powerful—nitric acid—cannot be used on account of the fumes which are formed by its decomposition in working of the battery. Practically, the problem resolves itself into the employment of one of the salts of chromium, which are unfortunately very expensive as at present made. The zinc used in the battery is not a serious item, and all ends of zincs unused can be worked up again. Several inventors have proposed the recovery of the used-up liquor and the working up of the materials, but one great difficulty has always stood in the way—viz., that of collection of the used-up material. Nevertheless, in the writer's opinion, it is in this direction that primary battery inventors of electric miner's lamps must work, and he believes that, with proper organisation, any difficulties met with would be overcome.

3. Where there are, say, 1,000 lamps to be supplied with liquid every day, and each lamp takes one pint, or thereabouts, the quantity of liquid to be stored at the colliery, or to be prepared each day, is a serious matter, as is also the provision of arrangements for quickly filling the cells each time they come for charge, and quickly emptying them, together with some necessary provision for dealing with the old material, and the testing and cleaning of the different parts in addition. Again, the whole of this is a matter for organisation.

### Secondary Battery Lamps.

Secondary battery lamps are represented by those of Mr. Swan, Mr. Pitkin, the lamp known as the Bristol, and the Susaman, the Headland, as well as those of Mr. Niblett and other experimenters. Mr. Swan's first lamp, which was brought before the North of England Mining Institute in December, 1885, contained seven separate vulcanite cells, fixed inside a vulcanite cylinder with a vulcanite cover. The outer vulcanite cylinder measured 4½in. in diameter by 7½in. high. Each vulcanite cell contained a grooved lead cylinder, the grooves being packed with spongy lead, and a lead wire in the centre coated with peroxide of lead and wrapped with a cloth; dilute sulphuric acid, as usual, was the electrolyte between the elements. The lamp was fixed on the side of the outer cylinder, protected with a glass bull's-eye, and backed by a piece of white cartridge paper. The lamp gave a light of 2½ c.p., gradually falling to 2 c.p.; it weighed 8lb. So far as the writer is aware, this lamp never came into practical use.

Mr. Swan's lamp of 1886 was made in two sizes, with two and four cells respectively. The body of the lamp consisted of a block of hard wood, with two or four ebonite cylinders embedded in cylindrical holes provided for them in the block. The terminals were at the bottom of the lamp, and a gas tester was attached to it. It weighed 5¾lb.

Mr. Swan's lamp of 1887, the writer believes, the last which Mr. Swan brought out, consisted of four cylindrical cells, formed of one casting of gutta-percha, the whole embedded in a block of hard wood, and the outer case fitted with a strong iron cover, with a handle attached, and a lock. It furnished a current of 0·5 ampere at a pressure of 8 volts, and weighed 8lb. It was also fitted with a detachable gas-testing apparatus, consisting of a platinum wire within a combustion chamber, to which the atmosphere to be tested was admitted for a short interval, and the current then turned on from the battery; a dial registered the amount by which the volume of the gases present was diminished, when the fire-damp had been consumed by the heated platinum wire, this being the measure, properly proportioned in the dial, of the fire-damp present. Some 3,000 of these lamps were ordered for a colliery in South Wales, and 600 were actually supplied and put to work, but their use was abandoned on account of the fact that the gutta-percha softened owing to the heat developed by the action of the sulphuric acid on the wood.

Mr. Pitkin's lamp consisted of four rectangular vulcanite cells, each with a pair of lead plates, properly formed, the four being fixed in a polished wood box. The box had a wooden cover, which either slid into a groove or was screwed on. The incandescent lamp was carried on one end of the wooden box, in the focus of a reflector, and protected by a strong glass. It also had a switch and an adjustable resistance, a very pretty arrangement, but one the writer feared at the time would be found too delicate for colliery work. It consisted of a rheostat formed by coiling a resistance wire round another wire, and forming the two into a circle, over which a contact piece, fitted with a thumb piece, moved. The lamp was supported by a leather handle, which was nailed to each end of the wooden box. The lamp weighed about 8lb., and gave a light in one direction of about 4 c.p.

It was tried at a number of collieries: in one case that the writer knows of, the manager going so far as to give two colliers, working at the face, a lamp between them, so that the question of weight should not be prohibitive. As far as the writer is aware, no lamps of this kind are in use at present in collieries in the United Kingdom, and he believes that they succumbed to the three causes which he has named—viz.: the inherent trouble attendant upon the secondary battery when the plates are confined, and when they are subject to constant motion; the destruction of the wooden cases owing to their being attacked by the acids which were spilled; and the fact that constant trouble was experienced with the connections getting eaten in two by the acid.

The Bristol lamp is very much on the same lines as the Pitkin, but smaller. The writer believes that no serious attempt has been made to introduce it for mining work, though the writer knows of one lamp in which the outer wood case has been replaced by a metal case, which is stated to have given very good results. It is used by a managing director who does not often go down the pit.

Mr. Niblett made also a determined attempt to produce a practical secondary battery miner's lamp, using a solid plate of peroxide for the positive plate. He also made several attempts to protect the connections between the cells, and between the cells and the lamp and switch, by gold-plating the connecting pieces, and by other methods; but the writer believes that at present none of the lamps made on the plan introduced by Mr. Niblett's company are now in use in mines.

The Headland is another attempt of more recent date, and it is in many respects a very promising one, though the writer believes that it has not yet come into practical use. Mr. Headland's idea seems to have been to imitate the old form of lamp exactly, in outward appearance, and he has succeeded in doing so remarkably well. In appearance it is a bonneted Mueseler lamp, or one of a similar type, the difference being, on inspection, that in place of the oil-well there is a plain brass disc forming the base of the lamp, and that light is given by an inverted incandescent electric lamp, held inside the space usually occupied by the lamp-wick and the vapour that is burning. There is the same stout glass cylinder outside the incandescent lamp that protects the oil-lamp flame, and the glass is protected as in the oil lamp by vertical brass bars surrounding the glass, at intervals. The secondary battery of the Headland lamp is carried inside the iron bonnet above the incandescent lamp, and connection is made between the cells and the incandescent lamp by means of wires led to an ingenious form of switch. The switch consists of the top and bottom of the lamp, or rather of springs similar to, but larger than, the ordinary push springs used in house-bell work. Switching on and off between the battery and the lamp is accomplished by turning the bottom portion of the lamp through an arc of 90deg., the springs attached to the top and bottom allowing this to be arranged. So far as the writer is aware, the only special feature about the battery is, that it is made on Mr. Headland's special form, with the object of securing a larger quantity of active material. The battery is contained in the usual vulcanite case, and consists of two cells. The writer has seen and used this lamp underground, and it appeared to him to be a remarkably convenient form. It gives a light of 1 c.p. for the usual shift of 10 hours.

The Sussmann lamp consists of two vulcanite cells, each containing two lead plates of the usual secondary battery type, one supporting a coating of peroxide of lead, the other finely divided lead. The cells are held inside a tin case, which is lined with either paper or varnish. The cells are closed, as are all those of the secondary lamps, with pitch run in on top of the plates, leaving vent holes and spaces for the tops of the plates. The lamp is mounted on a small platform consisting of a block of vulcanite, which also carries the switch, and which is attached to the tin case forming the base by means of screws. Connection is made between the vulcanite top, with the lamp and switch, and the cells, by means of flexible cords similar to those used for pendant incandescent lamps, and which are fitted with small brass plugs which again fit into holes in the lead plates arranged for them. This arrangement is very convenient, as it enables the top to be easily and quickly removed for charging, and to be made interchangeable. In the Sussmann lamp also a couple of porcelain reflectors are carried, one above and one below the lamp, each being of a conical form; and with the lamps intended for colliery officials there is also a reflector behind the lamp. The reflector behind the lamp is of great service in the lamp used by the colliery officials, as when two or more are walking along a road underground they do not want the light of the man in front in their eyes. But the great feature of the Sussmann lamp, and that which has made it successful, as far as it has been so, is undoubtedly the material which is placed between the secondary plates.

The writer understands that in the early lamps trouble was experienced from three causes, all of which have been faily got over—viz.: (1) The two vulcanite cells for each lamp were made in one casting, and the division-wall was constantly failing: they are now made in separate cells, two for each lamp. (2) The active material of the plates chipped off, and made short circuits at the bottom of the cell in the well-known manner: this has been got over by placing two indiarubber bands, fairly thick, vertically round each plate, so as to lift it off the bottom of the cell, as in stationary batteries, and keep the plates apart. (3). The early form of the substance which was placed between the plates was of a gelatinous nature, through which the active material sometimes worked, again forming short circuits: this has been got over by forming the sub-

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stance of a vegetable material, which, it is stated, successfully resists the passage of the active material through it.

The adoption of these improvements has apparently made the Sussmann lamp a success, according to the accounts of the colliery managers who have used it in the county of Durham. But the Sussmann Company have also gone a step further, and have added to the lamp a gas-indicating apparatus, consisting of a smaller lamp, coloured red, as are all similar indications in a mine. The apparatus consists of a perforated metal cylinder containing a substance which is stated to expand in the presence of an atmosphere containing a certain percentage of any gas, presumably any of the gases which the miner has to fear. The expansion of the material in the cylinder is made to mechanically work a small lever which makes contact between the battery and connections leading to the small red lamp, which then immediately lights up, and warns the miner that he must retire. The writer saw the Sussmann lamp with this addition tested at the company's offices, the gas employed being ordinary town illuminating gas, and it appeared to work well.

Secondary battery lamps are usually charged from the ordinary electric light service, the lamps being connected in series parallel. The Sussmann lamps, which require about 6 volts to charge, are arranged in strings of 16, with a resistance and a small incandescent lamp in series. In the writer's opinion it would be much better to charge each lamp, or rather each battery, direct from the circuit, transforming the current, if necessary, for the purpose, down to the voltage necessary for each individual lamp.

The lead plate of a secondary battery only performs the office which the carbon plate performs in the primary battery, with the addition that it acts as the support for the active material. If another metal could be arranged to act as the electrode and as the support for the active material, such as aluminium, the grids being formed of that metal, the result should be a very much lighter cell for the same work and a very much stronger one. The writer understands that something of the kind has been done, but that it was not followed up, a secondary battery plate being formed of an aluminium grid, with the active material, postive and negative, pressed into it. From America also comes an account of a grid formed of some special vegetable material, which is stated to form with the active material, under the influence of the current, a solid mass that will take a charge in the usual way and deliver it.

*(To be concluded.)*

## NOTES ON SOME SYSTEMS OF LAYING UNDERGROUND CABLES.

**The following is an abstract of the discussion which took place on Mr. A. Devey's Paper on this subject before the Glasgow Section of the Institution of Electrical Engineers. An abstract of the Paper appeared in our last issue:—**

Mr. HENRY MAVOR, in a communication referring to Mr. Devey's preference for armoured cable laid solid in wood troughs with bitumen, said that this was a fairly satisfactory method where there was not a very substantial road-bed, but where the access to such a cable involved lifting well-laid granite sets on a layer of concrete the disturbance to the streets was a very serious disadvantage. Mr. Devey, he said, did not advocate the only really satisfactory way of dealing with the question in cities—viz., the provision of thoroughly adequate conduits to which access can be obtained from end to end. The extra cost of these conduits, as compared with the present methods, was not such as to prohibit their use, and most city engineers were agreed that they ought to be provided, not only for electric light and power, telephone and telegraph cables, but also for gas, water, hydraulic power, pneumatic tubes, and the underground conductors for electric street railways. Such conduits could be proceeded with at once, leaving the present arrangements intact until their work could be done by the new arrangements. Although this would involve an enormous expense it did the work once for all, and would probably be the cheapest in the long run.

Mr. W. W. LACKIE, in a communication, said that he did not see that it meant keeping a larger stock of cable in hand with a draw-in system than with a solid system, neither was it necessary to make two joints with a draw-in system. In a solid system the trouble was, of course, to find the place to open, which often necessitated digging up 10yd. or 12yd. of the street, whereas in a draw-in system the two nearest joint boxes could be opened and the cable drawn out of the pipes. No hard-and-fast rule could be laid down; in outlying and country districts lead-covered and armoured cables laid direct in the ground with a tarred board over them appeared to answer the purpose perfectly, but in a city where there were likely to be tramways and stray currents it was necessary to adopt a solid system of some kind with the cable run in partially insulating troughs. He thought, however, that there were places where a draw-in system would pay, as the cost of opening the street to remove or repair a fault came to be very heavy where the streets were laid with concrete and wooden blocks.

Mr. W. B. SAYERS, in opening the discussion, said that Mr. Devey had spoken of getting rid of the gas mains from the streets. He (Mr. Sayers) did not think there was any prospect of this. The increase in the revenue of the London gas companies from 1896 to 1898 amounted to over £3,000,000, and their profits for one year to £1,611,000. The latter sum was just about equal to the total revenue of the electricity supply companies of this country. Another point was that there could be very little doubt that the gas companies would start a heating supply, and he was afraid that what they would have to look forward to was not the removal of the gas mains but the duplication of them. He concluded by asking Mr. Devey to give them examples of damage which were actually due to electrolysis.

Mr. WM. McWHIRTER asked when the cables Mr. Devey referred to were laid at Bray. He maintained that cables depending entirely upon the lead covering for their duration, although in wood conduits and entirely surrounded by bitumen, were yet far from being permanent. He remembered years ago laying a long length of gutta percha covered telegraph wire and also a considerable quantity of vulcanised indiarubber cable in creosoted wood troughs, and in less than a year these cables had all to be removed and replaced by others with gutta percha insulation laid in similar wood troughs but impregnated with boiling Stockholm tar. These cables, so long as they were under his care remained in perfect order. The troughs were made of a V shape, 1in. thick, a board being laid on the top, not, however, nailed, as suggested by Mr. Devey, as experience had shown that nails were sure to find their way through the wood and damage the cables. At distances apart of 2ft. the covers were secured by means of a short length of galvanised iron wire simply passed round the troughs, the ends being twisted securely. He agreed with Mr. Mavor that a proper built conduit, to contain all the pipes and cables, was advisable. He asked what was the accurate system of fault localisation the author proposes using, but endorsed his advice about manholes, congratulating Mr. Chamen on the splendid work he was doing in introducing his cast-iron manholes. Brooks' semi-solid system would be an almost ideal one if it were possible to keep the pipes thoroughly filled with oil and to prevent any leakage. The new fibre pipes now being introduced, he was afraid, were not of a nature to give confidence to anyone who had had experience in the various bitumenised paper conduits which had been in use for the last few years. He had never found moisture fail to destroy these conduits very rapidly, and anyone who had had occasion to use fibre to any extent must be aware how readily it was affected by damp.

Mr. E. GEORGE TIDD agreed with a remark made by Mr. Maxwell that in the Brooks' system it was often very much more difficult to get the oil into the pipes than to get it out. He had experienced this in a system of mains for the lighting of the Glasgow harbour tunnels, although, on the whole, the installation had been very successful. It seemed to him that there was not the slightest use in a draw-in system for distributors at any rate, because it would be quite impossible to draw out a length without opening the ground at every connection and cutting the joints, and he would scarcely think that the advocates of draw-in systems would go as far as to propose a manhole and joint box for each consumer. Mr. Devey had mentioned that pump-log ducts were very cheap where timber was cheap but he would think that the labour in boring out a 3in. hole through a log of timber would be a very expensive matter. Mr. Devey had stated that in the solid system not more than one cable should be laid in the same trough, but it was a very common practice to put three single cables in the same trough. The speaker also objected to Mr. Devey's suggestion to use nails on the lids of the troughs.

Mr. J. C. A. WARD said that if, as Mr. Devey wished, the armouring of the cable were taken into the glands of the joint-boxes, moisture would follow. If the steel sheathing was trimmed off outside the joint-box it would be necessary to bond it thoroughly to the lead, as his experience had been that in many cases arcs very often took place between the lead of the cable and the steel sheathing at points where the steel sheathing terminated. The draw-in system was not suitable for distributing mains for the reason that the numerous T joints in such mains did away with the advantage of being able to draw the cable. Another disadvantage was the number of draw-in boxes required, and also the risk of gas. He had had experience of air circulation, and did not consider it a workable scheme. He did not think the cost of the Glasgow Corporation electric lighting department's cast-iron chambers would work out very much higher than brick or concrete pits of the same dimensions. Cast-iron chambers could very quickly be erected, took up far less space than brick pits, and, moreover, were gas and water tight. They also formed excellent earth plates. In calculating the cost of brick pits to be used in a similar manner the cost of an earth plate should be added, as also the cost of a special lining of asphalt at the bottom and also between different sections of the brickwork, this being the only means by which the box could be kept free from gas and water. He considered that there was a great opening for designs and arrangements in the street disconnecting points which would facilitate the manipulation of sections of the mains in a very short space of time. Anything designed with a view to doing away with spanners and tools of every description when breakdowns occurred would be of great advantage. If covers were not locked, in the event of a gas explosion in the chamber the cover alone is lifted, and this was preferable to the cover taking a portion of the street with it. It did not seem desirable to go to the expense of lead-caulked joints in cast-iron pipes containing rubber, vulcanized bitumen, or sheathed cables, as, however carefully the joints were made, water always accumulated in some portion of the pipes. Unless the cast-iron pipes required bonding for purposes of preventing electrolysis or protecting lead-covered cables, it seemed to be an unnecessary expense. The question of electrolysis was one for discussion, but he felt sure that those engineers who had adopted the method of not keeping the lead covering of cables metallically connected throughout, but had broken the lead at every 150yd. or so, were making a serious mistake. Doulton ware was a more excellent conduit, but it required a certain amount of skilled labour and considerable skill in working the mandrils under circumstances where bends or sets out of the straight were required. Pump-log ducts were very durable—in fact, the most durable form of duct that could probably be obtained—but great difficulty would be experienced in using them for a system which required a considerable amount of jointing.

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Brooks' semi-solid system was an excellent one if the joints could be kept tight, but if the water happened to get at any of the joints, and a fault occurred on the mains, it was rather troublesome to rectify. The speaker did not consider that lead-covered cables should be braided if laid on the solid system, for the reason that if the braided cables were stored in the open for any length of time the braiding would become saturated with moisture, which, being dispelled when the hot bitumen was poured into the troughs, would cause the bitumen to become porous.

The CHAIRMAN (Mr. Chamen) said that in draw-in systems it seemed to him that ¼in. clear in the bore of the pipe above the outside diameter of the cable was not always a sufficient clearance, but that the rule should be some percentage of the diameter of the cable, as very large cables were stiff and unwieldly and would probably require more clearance than small ones. He also thought that another objection to jute braiding the outside of lead-covered cables, when being laid on the solid system, was that it prevented defects or injuries in the lead from being observed at the time of laying. Referring to the question of electrolysis, he pointed out that the use of concentric cables, as in Glasgow, should reduce this trouble to a minimum. The cables were all triple concentric, having the neutral conductor outermost and next to the lead. The neutral conductor being maintained at earth potential by means of an earth connection at the generating station, it was clear that any injury to the cable should result in first making contact between the lead and this neutral or earthed conductor, which would be harmless. In this respect the system worked perfectly, but experience had proved that in spite of all it was possible for the lead to be made alive from the positive or negative conductors by troubles arising at the end connections. End connections were a completely separate study in themselves and were capable of giving an immense amount of trouble, whether the cables were concentric or single ones. He was quite in agreement with Mr. McWhirter in his view that the gas mains would not disappear from the subsoil, and was convinced that, in the future, gas engines would take the place of steam engines; but the difficulty at the present time was to get sufficiently good gas engines in large enough sizes for the purpose of generating electricity in large quantities. He had heard that Mr. Westinghouse was engaged in elaborating a scheme by which gas would be made at convenient spots and forced, under pressure, to sub-stations, where the pressure would be reduced and the gas consumed in gas engines driving dynamos. He thought there was a great future for a system of this kind, and sincerely hoped that Mr. Westinghouse would succeed in producing a satisfactory gas engine, which he certainly could not say was to be found upon the open market to-day. It was a notable fact that the Glasgow Corporation, along with others, were seeking powers to reduce the illuminating power of gas. This, of course, was a step in the direction of cheapening gas supply for cooking and for driving gas engines, while doubtless it would have some bearing upon the question of incandescent gas mantle illumination which was being boomed so much at present. In view, therefore, of all these considerations it did not seem likely that gas pipes would disappear from beneath our streets and leave any more room for electric mains than was found at present. The bare copper strip system of mains had not been mentioned by any of the speakers. It was an extremely good system and much easier and cheaper to maintain when properly laid than any other. There was a large quantity of bare copper strip in use in the city of Glasgow, and for some two years past he had had a section of mains of this kind carrying a supply at 500 volts pressure, and it had never given one moment's trouble under these conditions. The Glasgow conduit was a cast-iron one of a rather too shallow form, and the conductors—particularly when there were three or four strips piled one on top of another—were in too close proximity to the cast-iron roof. The conductors were not stretched, but were supported on insulators some 6ft. apart, and while precautions had been taken to prevent the strips sagging downwards and touching the bottom of the culvert, the fact had apparently been overlooked that they might buckle upwards and touch the roof. This unfortunately was what they did when expanded to a slight extent through a small rise in temperature which occurred owing to the amount of current passing through them at times of full load. This difficulty, however, would not occur when in use on a 500 volt supply as the current density could be kept so very much lower and there would be practically no warming effect at all to cause trouble. A most interesting point in the Glasgow system was, that what was known as the "sodium" trouble—namely, the accumulation, like a growth of fungus, of sodium upon the insulators round the negative conductor—appeared to be entirely absent. This was no doubt caused by the fact that as the conduits were formed of cast iron, there was no cement or other material from which sodium could be extracted. Altogether, the results of the two years' trial of the bare copper strip had been so satisfactory that he had decided to convert more of the old mains in the same way. In Edinburgh, where the culverts were made of concrete, the sodium trouble was considerable, particularly after the increase of pressure; but the arrangement of mains had been altered by the utilisation of the Crompton system, in which the conductors were tightly strained up in a thoroughly mechanical and substantial manner, doing away altogether with the greater portion of the insulators which were used with the other system and allowing the use of special insulators of a kind particularly adapted for preventing leakage. The results since the alteration had been entirely satisfactory, and he had often wished to use this system in Glasgow, but, owing to the impossibility of constructing long runs of culvert beneath the footway, he had been compelled to give up the idea, as the construction of culverts beneath roadways was very expensive and undesirable. The question of constructing large underground tunnels was a very fascinating idea. The engineers of the various departments held very varying views about it.

Mr. DEVEY, in reply, said that he regretted he could not agree with Mr. Mavor as regards subways. He thought Mr. Chamen's view was the right one—viz., that subways as usually understood were quite impracticable from an engineering point of view, the question of their cost being put on one side altogether. A subway in the centre of a street would be exceedingly troublesome as regards the distribution question, and, as pointed out by Mr. Chamen, would be exceedingly dangerous to have large gas and water mains in. Distributors should be kept quite separate from the feeders and as close as possible to the place supplied. Their natural place was, therefore, under the footways, and if a sort of concrete duct were built extending from the house-line to the kerb, all distributors should be placed in it. This duct need not be more than 12in. or 15in. deep, and should be covered by ordinary flags; every flag should be capable of being lifted by suitable keys, and the flags could be carried by ordinary **I**-irons. The duct would necessarily be connected to the sewer, to drain off rain-water, &c. The feeders, if properly laid, should never require the least attention; they could, therefore, be buried under the roadway, thus doing away with the necessity of an immensely costly and dangerous subway. Anybody with a little care should be able to locate a fault on a solid system with practically absolute accuracy; but a fault should never occur on a properly laid solid system. Mr. Ward had seemed to have some doubt as to the feasibility of taking the armour of armoured cables inside the glands of boxes, but he (Mr. Devey) could assure him that no trouble as regards water arose from doing so. Mr. Ward also mentioned the possibility of arcing arising in the case of lead-covered cables laid in iron troughs. This was a very real danger, and it was absolutely essential that the troughs should be thoroughly well bonded together.

## ELECTRICITY WORKS ACCOUNTS.

### Bournemouth and Poole Electricity Supply Co. (Ltd.).

The costs of the Bournemouth undertaking for 1900, while they indicate but little improvement as regards economy of working, are very satisfactory for a town so situated. A natural and excusable increase is noticeable in the fuel, and also in the collective generating costs.

Owing to a materially diminished expenditure on repairs and wages at the station, the rise in the fuel charge was to a great extent neutralised. The 1899 management costs included two years' directors' fees, but making due allowance for this, there is a slight improvement noticeable in the management charges. At 9·85 per cent. the load factor of last year was considerably better than that of 1899, while the output was higher by nearly 28 per cent. The lamp connections show an advance of 21 per cent.

In our summary of the accounts we have endeavoured to keep the Bournemouth figures distinct from the general accounts of the company, which include an interest in the Richmond undertaking. The capital of the company at Dec. 31 last included £150,000, raised in equal amounts by £10 preference and £10 ordinary shares, and £70,000 by 4½ per cent. debenture stock. The loans against security stand at £16,950, and bills payable and sundry creditors at £20,162. The proportion appropriated for the Bournemouth undertaking was £169,572, and investments in the Richmond Company £84,686.

In addition to the preference dividend, one of 6 per cent. on the ordinary shares was declared, and was contributed to thus:—£4,447 as the net profit of the Bournemouth concern, £1,290 balance from last account, and £2,317 from the Richmond Company, leaving a balance carried forward of £661.

### Pontypool Electric Light and Power Co. (Ltd).

Very creditable indeed are the results of the working at this station during 1900. A glance at our table will show how heavily the high coal rates of last year affected this concern, but also that by economies in other expenses the aggregate costs were reduced in comparison with those of 1899. Even considering that this undertaking is situated on the fringe of the South Wales coalfield, and therefore favourably so for fuel, the results are excellent, obtained as they are on such a modest output, and on a load factor of only 7 per cent. The item of oil, waste and stores remains still almost double what we should have expected, but the total management and property charges have fallen, and stand at the low figure of 0·55d. per unit.

It is unfortunate that the undertaking grows so slowly. The additional lamp connections last year raised the total only 5·9 per cent. above that at the end of 1899, while the year's output was only 17·5 per cent. higher.

Owing to the cost of opposing the South Wales Electric Power Bill, it was decided not to declare a dividend, although the net profit amounted to £600, representing 5·32 per cent. on the mean capital as compared with £275 or 2·55 per cent. on the capital in 1899.

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| | BOURNEMOUTH. | PONTYPOOL. |
|---|---|---|
| *Undertaking Worked by* | Bournemouth and Poole Electricity Supply [Co. (Ltd.) | Pontypool Electric Light and Power Co. |
| *Date of Commencement of Supply* | 1891. | August, 1893. |
| *System of Supply* | Alternate-current transformers sub-stations. | Low-pressure con.-curr. 2-wire system with [batteries. |
| *Chief Engineer* | E. Ll. Ingram. | G. A. Maquay. |

| YEAR ENDED | DEC. 31, 1899. | DEC. 31, 1900. | DEC. 31, 1899. | DEC. 31, 1900. |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 836,914 | 996,045 | 65,850 | 79,796 |
| „ **SOLD (TOTAL)** | **528,039** | **675,242** | **58,201** | **68,391** |
| „ sold to consumers | 528,039 | 675,242 | 57,809 | 63,837 |
| „ sold for public lighting, &c. | nil | nil | 392 | 4,554 |
| „ used on works | 64,697 | 97,295 | 2,878 | 2,905 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | **16·9** | **16·2** | **12·3** | **13·8** |
| Maximum supply demanded | 710 kilowatts | 824 kilowatts | 99 kilowatts | 111 kilowatts |
| Number of public lamps | nil | nil | 2 arc | 6 arc |
| Number of consumers | 616 | 755 | — | 101 |
| Connections to mains in 8-c.p. lamps | 44,096 | 53,379 | 5,618 | 5,949 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | **31,250** | **41,600** | **4,720** | **4,970** |
| **CAPACITY OF PLANT IN KILOWATTS** | **1,000** | **1,330** | **151** | **159** |

| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| **AUTHORISED (TOTAL)** | — | — | — | — | — | — | — | — |
| Share | £150,000 | £150 | £150,000 | £113 | — | — | — | — |
| Loan (including Debenture charges) | — | — | — | — | — | — | — | — |
| **RECEIVED (TOTAL)** | **143,230*** | **143** | **169,572*** | **128** | **£10,241** | **£67·8** | **£10,241** | **£64·4** |
| Share | — | — | — | — | 5,241 | 34·7 | 5,241 | 33·0 |
| Loan (including Debenture charges) | — | — | — | — | 5,000 | 33·2 | 5,000 | 31·4 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | — | — | — | — | — | — | — | — |
| Share (unissued) | 6,770 | 6·77 | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | — | — | — | — |
| **REPAID (TOTAL)** | — | — | — | — | — | — | — | — |
| **RESERVE OR SINKING FUND** | 2,226[k] | 2·23 | 1,982[k] | 1·49 | 454[a] | 3·01 | 654[g] | 4·11 |
| **DEPRECIATION FUND** | 2,205 | 2·21 | 3,705 | 2·79 | 432 | 2·86 | 445 | 2·80 |
| **EXPENDED (TOTAL)** | **143,230** | **143** | **169,572** | **128** | **11,205** | **74·2** | **11,344** | **71·3** |
| Lands and buildings | 19,145[a] | 19·1 | 22,089[g] | 16·6 | 1,385 | 9·17 | 1,385 | 8·71 |
| Plant | 56,799 | 56·8 | 72,649 | 54·6 | 6,506 | 43·1 | 6,639 | 41·8 |
| Mains | 42,992 | 43·0 | 50,833 | 38·2 | 1,407 | 9·32 | 1,407 | 8·85 |
| Miscellaneous | 24,291[b] | 42·3 | 24,002 | 18·0 | 1,906 | 12·6 | 1,914 | 12·0 |
| **BALANCE OF CAPITAL ACCOUNT** | nil | — | — | — | −9[h] | −6·39 | −1,103[b] | −6·93 |

| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold |
|---|---|---|---|---|---|---|---|---|
| **TOTAL** | **£14,457** | **6·575d.** | **£17,416** | **6·198d.** | **£1,492** | **6·156d.** | **£1,722** | **6·045d.** |
| Revenue from supply | 13,289 | 6·042d. | 16,424 | 5·845d. | 1,445 | 5·960d. | 1,594 | 5·595d. |
| „ meters, &c. | 803 | 0·365d. | 722 | 0·257d. | 35 | 0·144d. | 45 | 0·158d. |
| „ public lighting | — | — | — | — | 4 | 0·017d. | 81 | 0·284d. |
| „ sale of lamps, &c. | — | — | 199 | 0·071d. | — | — | — | — |
| „ miscellaneous sources | 365 | 0·166d. | 71 | 0·025d. | 9 | 0·037d. | 2 | 0·007d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| **TOTAL COSTS** | **£6,807** | **3·094d.** | **£8,447** | **3·003d.** | **£716** | **2·953d.** | **£836** | **2·933d.** |
| **WORKS COSTS** | 4,318 | 1·964d. | 5,997 | 2·133d. | 549 | 2·264d. | 679 | 2·383d. |
| *Generation of electricity* | *3,945*[c] | *1·793d.* | *5,355* | *1·904d.* | *477* | *1·968d.* | *644* | *2·260d.* |
| Fuel (including cartage, &c.) | 1,939 | 0·882d. | 3,197 | 1·138d. | 104 | 0·429d. | 261 | 0·916d. |
| Oil, waste, water, stores | 346 | 0·157d. | 471 | 0·168d. | 66 | 0·274d. | 78 | 0·274d. |
| Wages at station | 1,256 | 0·571d. | 1,337 | 0·476d. | 277 | 1·143d. | 276 | 0·969d. |
| Repairs and maintenance at station | 326 | 0·148d. | 227 | 0·081d. | 30 | 0·124d. | 29 | 0·102d. |
| *Distribution of electricity* | *373* | *0·170d.* | *642* | *0·228d.* | *72* | *0·297d.* | *30* | *0·105d.* |
| Wages, &c. | 266 | 0·121d. | 335 | 0·119d. | 55 | 0·227d. | 30 | 0·105d. |
| Repairs, renewals of mains, &c. | 107 | 0·049d. | 307 | 0·109d. | 17 | 0·070d. | — | — |
| *Public lighting* | — | — | — | — | — | — | *5* | *0·018d.* |
| Attendance | — | — | — | — | — | — | 5 | 0·018d. |
| Renewals | — | — | — | — | — | — | | |
| **MANAGEMENT AND PROPERTY CHARGES** | **2,489** | **1·132d.** | **2,450** | **0·872d** | **167** | **0·689d.** | **157** | **0·551d.** |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *750* | *0·341d.* | *1,044* | *0·371d.* | *80* | *0·330d.* | *79* | *0·277d.* |
| *Management* | *1,739* | *0·791d.* | *1,406* | *0·500d.* | *87* | *0·359d.* | *78* | *0·274d.* |
| Salaries | 1,100[d] | 0·500d. | 859[h] | 0·306d. | 40[c] | 0·165d. | 40[c] | 0·140d. |
| Stationery, &c. | 472 | 0·215d. | 415 | 0·148d. | 7 | 0·029d. | 8 | 0·028d. |
| Establishment charges | | | | | 8 | 0·033d. | 6 | 0·021d. |
| Law charges, &c. | 167[e] | 0·076d. | 132[i] | 0·047d. | 32[d] | 0·132d. | 24[h] | 0·084d. |

| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
|---|---|---|---|---|---|---|---|---|
| **WORKING PROFIT FOR YEAR** | **£7,650**[i] | **6·19%** | **£8,969** | **5·73%** | **£776** | **7·18%** | **£887** | **7·87%** |
| Sum carried to Depreciation Fund | 1,528 | 1·24% | 1,510 | 0·965% | 100 | 0·925% | 100 | 0·887% |
| Sum carried to Reserve or Sinking Fund | 362 | 0·293% | 376 | 0·240% | 200[e] | 1·85% | nil | — |
| Net interest on loans (incl. Debenture charges) | 319 | 0·258% | 2,636 | 1·68% | 214 | 1·98% | 200 | 1·77% |
| **BALANCE FROM LAST ACCOUNT** | **1,276** | **1·03%** | **1,290** | **0·824%** | **13** | **0·12%** | **13** | **0·115%** |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 6,716[j] | 5·43% | 5,737[j] | 3·67% | 275 | 2·55% | 600[i] | 5·32% |
| *Deficit* | — | — | — | — | — | — | — | — |
| **ORDINARY DIVIDEND PAID** | 5% | — | 6% | — | 5% | — | nil | — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 47·1% | | 48·5% | | 48% | | 48·5% | |
| Expenditure per kilowatt capacity | £6. 16s. 2d. | | £6. 7s. 0d. | | £4. 14s. 10d. | | £5. 5s. 1d. | |
| **REVENUE PER KILOWATT CAPACITY** | **£14. 9s. 2d.** | | **£13. 2s. 0d.** | | **£9. 17s. 7d.** | | **£10. 16s. 7d.** | |
| Expenditure per 8-c.p. lamp capacity | 4s. 4¼d. | | 4s. 0¾d. | | 3s. 0½d. | | 3s. 4¼d. | |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | **9s. 3d.** | | **8s. 4¼d.** | | **6s. 4d.** | | **6s. 11d.** | |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | **6s. 6¼d.** | | **6s. 6¼d.** | | **5s. 3¾d.** | | **5s. 9½d.** | |
| Price charged for lighting, per unit | 7d. (1hr.) to 3½d.[f] | | 7d. (1½hr.) to 3½d. | | 6d. | | 6d. | |
| Price charged for power, per unit | 4d. | | 4d., 3d. to 2½d. | | 3d. | | 3d. | |
| Price charged for public lighting | — | | — | | 3d. per unit.[f] | | £ 5 per lamp per ann. | |

**BOURNEMOUTH.**—REMARKS—* Appropriated to Bournemouth order and exclusive of £79,700 invested in the Richmond Electric Light and Power Co., at Dec., 1899, or £84,636 at Dec., 1900. *a* Inclusive of £3,885 on transformer sub-stations. *b* Includes "special items" (expended during 1899) £22,691. *c* Includes £78 stores and works expenses. *d* Inclusive of £800, directors' remuneration for two years. *e* £47 to auditing and £101 to insurance. *f* On maximum demand system. *g* Inclusive of £4,419 on transformer sub-stations. *h* Inclusive of £500 directors' fees. *i* Insurance £92, auditing £37. *j* Exclusive of £84 in 1899, and £2,317 in 1900 received in interest and dividends from the Richmond Electric Light and Power Co. *k* From premiums on stock and shares less expenses of issue.

**PONTYPOOL.**—REMARKS—*a* Includes £304 at credit of reserve fund and £150 at credit of debenture redemption account. *b* Over-expended. *c* Secretary's salary. *d* Includes £8 to auditing and £24 to insurance. *e* £50 being carried to reserve, and £150 to debenture redemption account. *f* Plus an extra charge for hire of posts and lamps and for trimming making a total of £15 per lamp per annum. *g* £354 at credit of reserve account and £300 at credit of debenture redemption account. *h* Insurance £16, auditing £8. *i* This is disposed of in £88 written off preliminary expenses and remainder in payment of outstanding charges, including costs of opposing the South Wales Electric Power Bill, which were £315.

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## THE ALTERED BOARD OF TRADE REGULATIONS.

The decision of the Board of Trade with regard to the amendments of its regulations under the electric lighting acts is given in full in another column. According to the original regulations of 1896 the "undertaker," or supplier of electrical energy, if he wished to change the pressure of supply had a course to pursue somewhat as follows:—He had first to give notice to the local authority (in London to the County Council) that he wished to make this change. Then public notice had to be given for one month in a form considered suitable by the local authority, and, finally, the alteration in pressure could only be made subject to terms and conditions imposed by the local authority. This is set forth in the Board of Trade Regulation B5. But this was not the sum total of the restrictions imposed. Under Regulation B6, the consumer himself had to be conciliated if his premises had already been supplied with electrical energy at the date the Board of Trade Regulations of 1896 were sent out to the undertaker, and his consent had to be obtained to the increase in pressure. It is only right that certain restrictions should be imposed to prevent changes of "declared" pressure being made without sufficient cause and with too great frequency; but these regulations would certainly deliver the undertaker too much into the hands of the local authority were it not for the provision that he might appeal to the Board of Trade against the restrictions the local authority wished to impose in this respect. An example of such an appeal occurred last year. The City of London Electric Lighting Co. gave notice that it wished to change the "declared" voltage in its Southwark area from 100 to 200 volts. In graciously sanctioning this, the London County Council intimated that their sanction was subject to 12 conditions, under which the company was to change the consumers' wiring free of cost and to allow him a reduction of 15 per cent. in the price charged for electrical energy, no extra charge was to be made to consumers objecting to be

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changed over, and, finally, the new wiring was to be guaranteed for a year. An appeal was made to the Board of Trade, and this body sanctioned the change-over if merely the first of these 12 conditions were complied with—namely, that relating to free re-wiring so far as necessary.

But if the supply company has had this remedy of appeal against the action of the local authority, it has hitherto not been in the same position with regard to a consumer withholding his consent to a change of pressure under Regulation B6; and a number of supply undertakings, both company and municipal, petitioned the Board of Trade to specify in its regulations for an appeal to the Board against the consumer's conditions or veto. Local authorities supplying electrical energy are interested in this matter as well. Under B5, in the regulations applying to municipally-owned works, public notice is substituted for notice to the local authority, and the Board of Trade may impose conditions itself to regulate the arrangements for a change-over of pressure; but under B6 an unreasonable consumer could cause as much trouble to a municipally-owned works wanting to double its supply pressure as to a company. Thus, in the recent Board of Trade inquiry into the advisability of altering these two regulations, we had the strange result of local authorities on both sides, some supporting and others opposing any alteration in the regulations—depending on whether they owned electricity works themselves, or, as in the case of the London County Council and the Corporation of the City of London, they desired through the medium of their ratepayers to exert as much control as possible over companies supplying electricity within their areas.

A full report of the inquiry has been published in our columns, and we do not propose in this place to repeat the evidence given on the two sides. We may emphasise, however, that of all the Westminster Electric Supply Corporation's subscribers, only eight had objected to the change-over, one of these being Prof. George Forbes, who had consumed only 17 units during the year 1900, and another, a firm of consulting engineers, whose consumption during the same period had been but 70 units, and one of whose partners, we believe, had been retained by some of the other six objectors. Thus in this typical case the hardship involved by a a change-over to higher pressure was practically nil in comparison with the advantages which will eventually accrue to the consumers by enabling the company to employ more economical distribution; and evidence of greater hardship in other supply districts was not forthcoming. It is, therefore, no matter for surprise that the Board of Trade has decided to amend its regulations to permit of an appeal to the Board in the case of such refractory consumers. When the undertaker has offered to comply with the local authority's conditions (or, in the case of a municipal supply, with the Board of Trade's conditions), and when, in addition, it has offered to pay the reasonable cost of the change, including compensation for any loss or damage in consequence of the change, and the consumer still refuses his consent, then the undertaker may, under the amended regulation, appeal to the Board of Trade to exercise compulsion. In view of the facts of the case, the consumer would not have been badly treated, even if the Board of Trade had given the undertaker powers, after due notice, to cut off the consumer's supply if he refused the offer of supply at higher pressure, with a free overhauling of his house-wiring, and under the favourable conditions just cited (constituting as they do almost a guarantee), and had left to the consumer instead of to the supply works the onus of applying to the Board of Trade for assistance if circumstances justified it.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

### Lecture III.—The Electromagnetic Medium.

The fact that electric oscillations produced in one circuit can set up secondary oscillations in another circuit at a distance, forces upon our consideration, in the next place, the problem of the nature of the machinery by which this effect is brought about. It is not necessary to occupy time in quoting the words of notable investigators of natural phenomena, from Newton to Maxwell, who have expressly stated their convictions that distance actions of this character compel us to make the hypothesis of an intermediate agency of some kind unless we are to take refuge in the bald assumption, repugnant alike to common sense as well as philosophic thought that matter can act in a place where it is not. Descartes, Huyghens, Ampère, Fresnel, Henry, Faraday, Maxwell, and Hertz, successively laid the courses of a great edifice of evidence that physical changes produced by one body in another at a distance can only be due to actions taking place successively at contiguous points in an intermediate medium. Their teaching has compelled us to accept, as one of the cardinal tenets in the creed of science, some assumption of this kind as an indispensable basis for any intelligible explanation of the phenomena of electromagnetism or optics. Between subtle speculation or ingenious hypothesis, and that sober collection of evidence which science demands, a great gulf lies fixed, and it needed something more than the guesses of genius to place the supposition of a special electromagnetic medium and its identity with an optical æther on a sufficient basis. That work began, however, when Clerk Maxwell took up the study of Faraday's experimental researches, and endeavoured to discern whether the ideas of Faraday, which were then not in accord with current views, were capable of being translated into mathematical language and made the foundation of a new method of regarding electrical facts.

The publication in 1865 of Maxwell's Paper, "A Dynamical Theory of the Electromagnetic Field," marks a great epoch in the history of scientific thought.† In that Paper, Maxwell appropriated to electromagnetism a generalisation which the French mathematician, Joseph Louis Lagrange, had established in dynamics, connecting the kinetic and potential energies, the velocities and forces of the various parts of any system of connected moving bodies. Maxwell saw that in electric and magnetic actions we have energy involved, and that this energy takes two forms, electrostatic and electrokinetic, which have a close similarity to energy of strain and motion. Moreover, the interconvertibility of all forms of energy and the fact that we can evaluate them all in their equivalent of motional energy, indicates that all energy is probably in the ultimate issue of the same nature.

The systematic examination that has been made of the relations of the electric and magnetic quantities shows us that we can co-ordinate these in a scheme of related magnitudes, each of them corresponding to some well-known dynamical equivalent. Thus, corresponding to the fundamental dynamical quantities mass, velocity, acceleration, momentum, force, energy, and activity or power, we can place in contiguity such electrical quantities as inductance, current, rate of current change, total magnetic flux, electromotive force of self-induction, current energy, and rate of dissipation of current energy. Also in parallel with mechanical quantities such as stress, strain, elastic yielding, strain energy, we can place electric and magnetic quantities such as electric and magnetic forces, displacement or magnetic flux, dielectric constant or magnetic permeability and electric or magnetic energy. We may, as Oliver Heaviside and other writers have shown, draw up many consistent schemes of analogy between mechanical and electromagnetic quantities, but we must beware of falling victims to any one particular set of mechanical similarities. Analogies of this kind are often like mountain paths which begin in well-beaten routes, but sooner or later, if followed up too far, terminate in a barren region. There remains, however, the fact that corresponding to two well recognised forms of mechanical energy—namely, motional energy measured by half the product of momentum and velocity, and configurational energy measured by half the product of stress and strain—we have a duplex system of electric and magnetic quantities, which are for the most part circuital or manifested in circuits. Thus we have *two circuits*, the electric and magnetic; *two physical effects* produced in these, *electric strain* or *displacement* (D) and *magnetic flux* (F); *two agencies* producing these effects, electric and magnetic force; *two specific physical qualities* of the circuits corresponding thereto—namely, *dielectric constant* and *magnetic permeability*, or, as Mr. Oliver Heaviside calls them, *permittivity* and *inductivity*; also *two line integrals* of electric and magnetic force called *voltage* (V) and *gaussage* (G); *two forms of*

*Cantor lecture delivered before the Society of Arts, December 10, 1900.

†Maxwell sent in this Paper to the Royal Society on October 12, 1864; it was read December 8, 1864, and printed in the Volume of the *Philosophical Transactions* of the Royal Society for 1865, p. 419.

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**Table I.**—*Table of Observed Values of* v *in Centimetres per Second.*

| Year. | Name. | Reference. | Electric quantity measured. | v in centimetres per second. |
|---|---|---|---|---|
| 1856 | Weber and Kohlrausch | Electrodynamische Maasbestimmungen and *Pogg. Ann.*, XCIX, Aug. 1C, 1856 | Quantity | $3{\cdot}107\times10^{10}$ |
| 1867 } 1868 } | Lord Kelvin and W. F. King | Report of British Assoc., 1869, p. 434; and Report on Electrical Standards, F. Jenkin, p. 186 | Potential | $2{\cdot}81\times10^{10}$ |
| 1868 | Clerk Maxwell | *Phil. Trans.* Royal Soc., 1868, p. 643 | Ditto | $2{\cdot}84\times10^{10}$ |
| 1872 | Lord Kelvin and Dugald McKichan | *Phil. Trans.* Royal Soc., 1873, p. 409 | Ditto | $2{\cdot}89\times10^{10}$ |
| 1878 | Ayrton and Perry | *Journal* of the Society of Telegraph Engineers, Vol. VIII., p. 126 | Capacity | $2{\cdot}94\times10^{10}$ |
| 1880 | Lord Kelvin and Shida | *Phil. Mag.*, Vol. X., p. 431, 1880 | Potential | $2{\cdot}955\times10^{10}$ |
| 1881 | Stoletow | Soc. Franc. de Phys, 1881 | Capacity | $2{\cdot}99\times10^{10}$ |
| 1882 | F. Exner | *Wien. Ber.*, 1882 | Potential | $2{\cdot}92\times10^{10}$ |
| 1883 | J. J. Thomson | *Phil. Trans.*, Roy. Soc., 1883, p. 707 | Capacity | $2{\cdot}963\times10^{10}$ |
| 1884 | Klemencic | *Proceedings* of the Society of Telegraph Engineers, 1877, p. 162 | Ditto | $3{\cdot}019\times10^{10}$ |
| 1888 | Himstedt | *The Electrician*, March 23, 1888, Vol. XX., p. 530 | Ditto | $3{\cdot}007\times10^{10}$ |
| 1888 | Lord Kelvin, Ayrton and Perry | British Association, Bath; and *The Electrician*, Sept. 28, 1888 | Potential | $2{\cdot}92\times10^{10}$ |
| 1888 | Fison | *The Electrician*, Vol. XXI., p. 215; and *Proc.* Phys. Soc. Lond., June 9, 1888 | Capacity | $2{\cdot}965\times10^{10}$ |
| 1889 | Lord Kelvin | Royal Institution Lecture, Feb. 8, 1889 | Potential | $3{\cdot}004\times10^{10}$ |
| 1889 | Rowland | *Phil. Mag.*, 1889 | Quantity | $2{\cdot}981\times10^{10}$ |
| 1889 | E. B. Rosa | *Phil. Mag.*, 1889 | Capacity | $3{\cdot}000\times10^{10}$ |
| 1890 | J. J. Thomson and Searle | *Phil. Trans.*, 1880 | Ditto | $2{\cdot}995\times10^{10}$ |
| 1897 | M. E. Maltby | *Wied. Ann.*, 1897 | Alternating currents | $3{\cdot}015\times10^{10}$ |

*energy*, electric and magnetic; and *two* corresponding *forms of activity* or rate of change. Moreover, we have a curious inter-linking of these quantities when circuital, best expressed by *two circuital laws* which symbolically and in rational units are stated as follows:

$$-\dot{F}=V \text{ and } \dot{D}=G.$$

The first of these equations is merely the symbolical expression o Faraday's law, that the electromotive force or line integral of electric force round any circuit is numerically equal to the time rate of decrease of the magnetic flux through it; and the second is the simplest expression of Maxwell's principle that the time rate of change of electrical displacement through any circuit is measured by the gaussage or line integral of magnetic force round the circuit.

In cases when the circuits are formed of certain kinds of matter we have also to introduce two other conceptions, namely, *electric current* and *magnetisation* which are produced when the two circuits possess *conductivity* or *susceptibility*, and when these qualities are present the fundamental equations take a more general form as expressed by Mr. Oliver Heaviside in rational units, viz., $-(\dot{F}+\dot{M})=V$ and $\dot{Q}+\dot{D}=G$,* where M stands for magnetisation, and Q for a quantity of electricity moved non-elastically past any section of the circuit, and the *dot* over the symbol stands for its time rate of change. Out of this double-stranded system of interlinked quantities and their fundamental relations, it follows that in considering the measurement of any one electric or magnetic quantity we can arrive at the same point by two paths, starting either from an electric or magnetic definition. Thus we may consider an electric current to be due to a series of successive discharges of electric strain by a conductor, or we may consider it to arise from the movement of a magnet to or from a closed conducting circuit. In the one case our measure of current involves the quantity K or the dielectric constant of the medium in which the electric strain takes place. In the other case it involves $\mu$, namely, the magnetic permeability of the medium which encloses the magnet and the circuit. In every case in which this double measurement of the same quantity can be carried out the numerical ratio of the two measurements when conducted in absolute or dynamical units gives us a number which it can be shown represents either the geometric mean of K and $\mu$, viz, $\sqrt{K\mu}$ or its reciprocal $1/\sqrt{K\mu}$ or their squares $K\mu$ and $1/K\mu$ In other words, it gives us a numerical value for the product of these two quantities, but it does not tell us their individual values for any medium. An immense number of investigations of the last 20 years have shown that the product of $K\mu$ for air or good vacuum closely approximates to a value $\frac{1}{9\times10^{20}}$ and the square root of the reciprocal of this number is denoted always by the symbol *v*. A list of the principal determinations of this unitary ratio called *v* is given in Table I. A glance at this table shows that the numerical value *v* or of $1/\sqrt{K\mu}$ for air or vacuum is identical with that of the velocity of light through empty space when measured in centimetres per second.

The question then arises: What is the physical meaning of this identity? It would be necessary to enter into a discussion involving mathematical analysis of a rather complicated character, and little suited for a general audience, if we were to follow in detail Maxwell's full investigations on this matter. Without, however, dealing with any very intricate symbolism, it will, I think, be possible to put you in possession of the outlines of Maxwell's arguments. Maxwell invented for the purpose of handling this subject a mathematical quantity he called the *vector potential*. To obtain an insight into the physical meaning of Maxwell's conception of the vector potential, let us take a very simple and limited instance. Consider a straight conductor through which an electric current flows, the return conductor being at a considerable distance (Fig. 1). It is well known that the lines of magnetic flux round such a circuit are circles embracing the wire with their centres on the axis and their planes perpendicular to the wire. Take two points on the wire a unit of length apart, and through these points draw two parallel lines at right angles to the wire and continue them to infinity. Let a plane pass through these lines. Then it is easy to see that the coaxial lines of flux will intersect this plane in a series of points. Let the dots in Fig. 1 represent these points at any place, draw two other lines *ab*, *cd*, parallel to the wire and very near together, separated by a small distance. If we consider the current

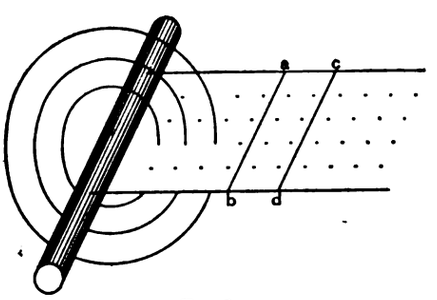


FIG. 1.

in this conductor as started suddenly into existence, we may either suppose that the lines of magnetic flux embracing it appear instantly in their places everywhere throughout space, or we may consider them to grow outwards from the wire like circular ripples when a stone is dropped on the surface of still water. Let us assume the latter to be the case and follow out the consequences. Imagine two observers to stand at the bounding lines *ab*, *cd* and endowed with a kind of vision which enables them to see these points where the lines of flux intersect the plane. Then when the current is suddenly started they will see the circular lines of flux expand outwards, and moving like a procession down a street cut across the two parallel lines *ab*, *cd*. If the observers both took note up to any instant of the total number of lines which had crossed each boundary, the difference between the two numbers must represent the accumulations of lines of flux in the area *abcd*.

Maxwell's vector potential in reality represents the total number of lines of flux N reckoned from the starting of the current, which would have crossed any boundary, say *ab*. Hence it is clear that the difference between the values of N observed at the two stations (call it *d*N) is equal to the total flux at any instant included in the area *abcd*, or since *ab* is equal to unity, and *bd* is equal, say, to $\delta x$, we must have the relation between N and B expressed by the equation $P\delta x=-dN$.

The minus sign is prefixed to *d*N because the number of lines of flux crossing *cd* is less than that crossing *ab*—that is, there is a decrement in N as distance reckoned from the wire increases. But the total flux in the area *abcd* is also changing with the time, and its time rate

*The systematic formulation of these circuital laws as well as a fuller appreciation and elucidation of Maxwell's views have been assisted of late years in a remarkable degree by the writings of Mr. Oliver Heaviside.

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of change is the measure of the electromotive force acting round the circuit *abcd*—that is, it is equal to the line integral of electric force round this boundary. If we suppose the lines *ab* and *cd* to be metallic wires, then it is perfectly clear that as the lines of force cut across them they will give rise to electromotive forces in these conductors just as is the case when the inductors of a dynamo armature are moved through a magnetic field and made to cut the lines. If we imagine the whole circuit *abcd* to be a closed metallic circuit it can be shown that there will be a relation between the elecctromotive forces set up in the sides *ab* and *cd*, and the total magnetic flux at any instant linked with or passing through the area *abcd*.

As a preliminary problem let us first imagine the lines of flux of the straight current to be fixed in space and stationary in the position in which they would be when the current is steady in the circuit. We know that under this condition the magnetic force, and, therefore, the magnetic flux density, is greater at points nearer the wire than at a distance. In fact, it varies very nearly inversely as the distance of the point from the conducting wire if the wire is straight and very long. Suppose, then, that the circuit *abcd* consists of a wire rectangle, which is moved in its own plane towards the current-carrying wire, and that the sides, *ab* or *cd*, are moved so as to remain parallel to the wire. Let V be the velocity with which the rectangle moves, let B be the flux density along the side *ab*. This flux is perpendicular to *ab*, and to the direction of motion, *ab*. We may conveniently take the length of *ab* to be 1cm. Then the E.M.F. set up in *ab* by its motion across the lines of flux of the field is equal numerically to the product BV, and since $ab=1$ this is also the value of the electric force acting between *a* and *b*. Let us denote this electric force by the letter E; then we have

$$E=BV.$$

Let the distance of *ab* at that moment from the wire be called $x$, and let the width of the rectangle *bd* be $\delta x$, and let it be so moved that it passes over its own width $\delta x$ in a small time $\delta t$. Then $V=\delta x/\delta t$. Since the flux density B varies with $x$, the E.M.F.

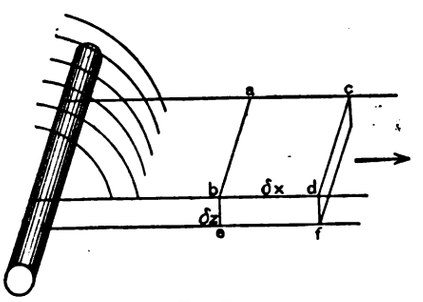


FIG. 2.

created in *ab*, and hence also the electric force E will vary with $x$. But if the velocity of the rectangle is constant then the rate at which the electric force varies with $x$ will be equal to the rate at which the flux density varies with $x$, or

$$\frac{dE}{dx}=V\frac{dB}{dx},$$

Again, since $V=dx/dt$ or $dx=Vdt$, we may write the above equation

$$\frac{dE}{dt}\frac{1}{V}=V\frac{dB}{dx},$$

or

$$\frac{dE}{dt}=V^2\frac{dB}{dx}.$$

Hence the rate at which the electric force varies with time is equal to $V^2$ times the rate at which the flux density varies with space. The velocity with which the rectangular circuit moves may therefore be measured by the square root of the ratio of the time rate of change of the electric force along one side, to the space rate of change of the flux density or magnetic force in a direction at right angles.

In the next place, suppose that instead of moving a wire rectangle we move in the same manner across the field a plane sheet of any dielectric having a length equal to unity parallel to the straight conductor, and a width $\delta x$ (see Fig. 2). Let this dielectric have a dielectric constant, K, and a magnetic permeability, $\mu$. Let us consider a part of this sheet of dielectric having a depth $\delta z$. When this prism is moved across the field of flux there is, according to Maxwell's views, the same creation of electric force in it as in the case of the conducting wire moved parallel to itself across the lines of flux of the field. In the case, however, of the dielectric the electric force E expends itself in making what Maxwell called an *electric displacement* (D) in the same direction as the force E. The relation between D and E is expressed in rational units by the equation $D=KE$, or the displacement (through unit of area) is proportional to the electric force and to the dielectric constant.

Hence it follows that the time rate of change of the displacement is proportional to the time rate of change of the electric force or

$$\frac{dD}{dt}=K\frac{dE}{dt}.$$

It is convenient to denote the time rate of change of a quantity in Newtonian fashion by a *dot* placed over it, hence $dE/dt=\dot{E}$.

Therefore

$$\frac{dE}{dt}=\frac{1}{K}\dot{D}.$$

Again, if we look at the block of dielectric end on as it passes across the field, we shall see that if B is the flux density parallel to the side, *be*/*b*, then the flux density parallel to the side *df* must be represented by $\frac{dB}{dx}\delta x$, because $bd=\delta x$.

By fundamental definitions the flux density is equal to the product of the magnetic force and the permeability or $B=\mu H$, that is $B/\mu=H$.

By Maxwell's principle a change in the electric displacement is in magnetic effect an electric current, and is accompanied by the production of magnetic force. In other words, time rate of change of displacement is to be reckoned as an electric current. Hence, by Maxwell's circuital law, the line integral of the magnetic force round the block in the direction *befd* must be equal (in rational units) to the total electric displacement parallel to *ab* or *cd*.

It is easy to show that the line integral of magnetic force round *befd* is expressed by the quantity

$$\frac{1}{\mu}\frac{dB}{dx}\delta x\delta z,$$

and that the total displacement through the same area is expressed by $D'\delta x\delta z$, if D' is the displacement through unit of area.

Hence, we have

$$\frac{dD'}{dt}=\frac{1}{\mu}\frac{dB}{dx},$$

or

$$\frac{dB}{dx}=\mu\dot{D}'.$$

Substituting the values thus obtained for $dE/dt$ and $dB/dx$ in the equation

$$\frac{dE}{dt}=V^2\frac{dB}{dx},$$

we arrive at the equality

$$\frac{1}{K}\dot{D}=V^2\mu\dot{D}',$$

or

$$\frac{\dot{D}}{\dot{D}'}=V^2\mu K.$$

What then must be the relation between the actual velocity V of the prism of dielectric moved parallel to itself so that the time rate of change of the displacement due to the electric force E created in it parallel to one side of the block or prism of dielectric is such as to be equal to the line integral of the actual external magnetic force perpendicular to the side? In other words, what must be the value of V in order that D in the above equation may be equal to D'? The answer is obviously that V must be equal to $1/\sqrt{K\mu}$. We have seen, however, that this last quantity is equal to the velocity of light in the dielectric, and, accordingly, if the sheet of dielectric is moved parallel to itself and at right angles to the direction of the flux with that velocity, the distribution of magnetic flux will be consistent with the distribution of electric displacement. But now suppose the block or sheet of dielectric stands still, and that the lines of flux move across it parallel to themselves with the constant velocity.

A consideration of the circumstances then shows that the velocity must be such as to reconcile the two requirements—viz., that the time rate of change of the displacement produced by the "cutting" of the lines of flux shall be equal to $KV^2$ times the space rate of change of the magnetic flux, and so fulfil two circuital laws. In order that this may be the case the velocity of the flux perpendicular to itself must be equal to $1/\sqrt{K\mu}$cm. per second, or to the velocity of light in the dielectric. Even before the experimental evidence, which we shall review in the next lecture, was obtained, that magnetic flux moves with a finite velocity, the above relation constituted a powerful argument in favour of the belief that whatever might be the machinery concerned in the propagation of light through space or transparent media, it was also intimately connected or identical with that involved in the transmission of electromagnetic impulses from place to place with an equal finite velocity.

It is needless to say that the above sketch is a mere outline of the form of Maxwell's reasoning, but in its complete shape it formed the basis for a scientific conception and justifiable theory that light itself is an electromagnetic phenomenon. Optical facts afford abundant proof that along the path of a ray of light at contiguous points something having direction and magnitude is reversed from 400 to 700 billion times a second, and that at places, separated by distances

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from $\frac{1}{40000}$th to $\frac{1}{20000}$th part of an inch, the same operations are being repeated at the same time. The fact that we can produce what we may call non-luminous electrically generated light, or electric radiation, by processes to be considered in the next lecture, and find experimentally an exact equality between the finite velocity of transmission of the electrical invisible and ordinary visible radiation is a sufficient warrant for the hypothesis that both are identical affections of a medium which is one and the same. Accordingly, if we consider a current in a wire and the embracing magnetic flux have reached a steady state, and if we then imagine the current instantly reversed in direction, the field at a distance of 186,000 miles or 30,000 million centimetres from the wire, would not be reversed until one second afterwards. Let us clearly notice that in this simple case we have two directed quantities with which we are concerned, *the electric force* (E) revealed by its creation of electric displacement parallel to the wire or to *ab*, and *the magnetic force* (H) producing magnetic flux perpendicular to the wire or to the line *ab*, and that the time rate of variation of E at any point is by fundamental principles in a constant ratio to the space rate of variation of H in a direction at right angles to that of E or along the direction of movement of the flux lines, that is of N. Hence E, H, and this last direction are all at right angles to each other, and the magnitude of E and H are derived from the time and space variation of another quantity called the vector potential. Moreover, the mathematical relation between these two variations leads us to a differential equation involving N, which is of exactly the same type as that at which we arrive when investigating the propagation of a sound wave or disturbance through the air down an infinitely long pipe. Hence it appears that this vector potential may be regarded as being propagated from place to place with a velocity equal to that of light.

Maxwell came, therefore, to the conclusion that if magnetic flux is created in any place in a dielectric, it spreads outwards or extends itself through that dielectric with a finite velocity, being, so to speak, handed on from point to point, and does not appear instantly everywhere. It was not until more than 20 years after the first promulgation of these new ideas that they received, as we shall see in the next lecture, experimental confirmation. Briefly speaking, the principal new conceptions involved were as follows:—At any point in a dielectric we must consider that there are two possible operations of an electromagnetic nature. First, we may have created at that point a physical state called electric displacement due to electric force. The production of this displacement involves an energy expenditure, and the energy per unit volume expended in making a displacement D by an electric force E is measured by $\frac{1}{2}$ED or by $\frac{1}{2}$KE$^2$, where K is the dielectric constant. If an electric displacement is changing with time, then its time rate of change, represented by D, or $dD/dt$, is equivalent to an electric current and is accompanied by the production of circuital magnetic flux round the displacement or at right angles to its direction, and the line integral of the magnetic force is equal (in rational units) to the rate of change of the displacement. The energy expended per unit of volume in making a magnetic flux B due to a magnetic force H is measured by $\frac{1}{2}$BH or by $\frac{1}{2}\mu$H$^2$, where $\mu$ is the permeability of the medium.

Let us consider, then, the movement of a line of flux or sheet of magnetic flux parallel to itself through a dielectric, and consider what happens as it sweeps across a line drawn in the dielectric parallel to the sheet of flux and at right angles to its motion. The electrice force per unit of length set up in this line is E, and as we have seen if V is the velocity of the flux sheet or line

$$E = VB = V\mu H,$$

where H represents the magnetic force along the sheet of flux, and the permeability of the dielectric. The electric force produced by the flux cutting across the line expends itself in producing displacement which vanishes as the electric force disappears. Hence the forward movement of the sheets of flux is accompanied by an equal movement of a sheet of electric displacement, the displacement being in a direction at right angles to the direction of the magnetic force and to the motion of the sheet of flux.

An examination of the process of wave propagation leads to the conclusion that at any instant the energy per unit of volume is half magnetic and half electric, or that in this case we have

$$\frac{1}{2}KE^2 = \frac{1}{2}\mu H^2.$$

Combining the equation with the former one, viz:

$$E = V\mu H,$$

and we arrive by another path at the conclusion that,

$$V^2\mu K = 1,$$

or

$$V = 1/\sqrt{K\mu}.$$

Hence the process by which magnetic flux is transferred from place to place is said to be a wave motion, and has an exact analogy to the process by which a sudden compression produced in the air or motion given to it is conveyed from one point to another. The air at any one point is alternately in a state of compression and motion corresponding to the electric displacement and magnetic flux. This close connection existing between the velocity of light in a dielectric and its two electric and magnetic constants cannot be a matter of accident. It argues a very close connection between the phenomena.

Maxwell's next step was to make a fresh deduction from this interconnection. We know that light moves more slowly through any transparent body, say, water, than through empty space, as shown by actual experiments, and the ratio of the velocity in space to the velocity in water is called the refractive index of the water. Hence, if the velocity of the light in space is measured by $1/\sqrt{K\mu}$ where K and $\mu$ are respectively the dielectric constant and permeability of empty space, it is not an unjustifiable assumption that the velocity of water will be represented by $1/\sqrt{K'\mu'}$, where K' is the dielectric constant of water and $\mu'$ the magnetic permeability of water. Accordingly, the refractive index of water will be numerically measured by the ratio of

$$\sqrt{K'\mu'} \text{ to } \sqrt{K\mu}.$$

Experiment shows that the permeability $\mu'$ in the space occupied by water is not sensibly different from the permeability $\mu$ of empty space. Hence, if we take the dielectric constant of space arbitrarily to have a value unity, we should have a relation between the dielectric constant of water and its refractive index ($i$) as follows: $i = \sqrt{K'}/\sqrt{K}$, or if K is taken as unity, then the dielectric constant of water should be equal to the square of its refractive index or $i^2 = K'$ (see Fig. 3). The same argument applies to all other transparent and defractive dielectrics, and it therefore becomes a test of Maxwell's theory to examine how far the above law (called Maxwell's law) holds good. At the time when Maxwell published his theory there were very few data by which to test it, but in the last 20 years an immense number of methods of measuring dielectric constants have been invented, and a great number of numerical measurements made for different substances.

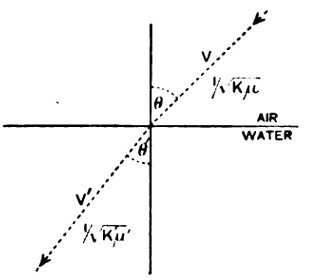


FIG. 3.

As soon, however, as Maxwell's law began to be compared extensively with the results of experiment it became manifest that the exceptions were far more numerous than the agreements. The dielectric constant has generally been measured by comparing the ratio of a steady or slow period alternating electric force E, with the corresponding displacement D so as to obtain K from the equation

$$D = KE \text{ or } K = D/E.$$

If this experiment is tried for example with water, for steady or even very rapidly reversed displacements, we get a value for K not far from 80, and for most varieties of glass we obtain values of K varying from 6 to 10. The optical refractive index of water, however, is 1·3, and that of most kinds of glass from 1·5 to 1·6. Hence it is clear that for these substances there is an enormous discrepancy between the square root of K (namely 9 and 2·5 or 3·1) and the refractive indices (namely 1·8 and 1·3). More extensive research has shown that there are many cases of agreement, and that we may divide all dieletrics broadly into two great divisions, namely those for which Maxwell's law is approximately obeyed, and those cases in which there are great discrepancies between the value of the dielectric constant and the square of its refractive index.

*(To be continued.)*

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**Low-class Fuels for Electric Power Plants.**—Mr. W. H. Maw, in his presidential address before the Institution of Mechanical Engineers, mentions that one of the effects of establishing electric power plants, or power-gas distributing plants, at collieries would very probably be to enable colliery proprietors to obtain remunerative prices for low-class fuels, which are at present not worth extracting; and in this way there may be effected a material extension of our national fuel supply. This is a result which, on the one hand, would render it unsafe to base the cost of working power plants at collieries on the present costs of low-class fuel; and, on the other hand, would probably tend to reduce the price of the higher classes of fuel, the demand for which would be lessened.

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# CORRESPONDENCE.

## THE LIGHT RAILWAYS ACT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the present juncture it may interest you to know what action the Tramways and Light Railways Association has taken with regard to obtaining modifications in the Light Railways Act which is now before Parliament for renewal.

On Feb. 28 last a deputation was received by the President of the Board of Trade from this Association, represented by our Law and Parliamentary Committee and one or two other of our members. This deputation laid before Mr. Gerald Balfour the following suggestions to be embodied in the new Light Railways Act, at the same time detailing their opinions on the various points :—

1. Applications under the Light Railways Act should not be refused a hearing on the ground that the proposed light railway lies wholly in a single urban district.
2. Make the Board of Commissioners a permanent paid body, and increase their numbers.
3. The act should not be regarded as incorporating any of the provisions of the Tramways Act, 1870, or as making any of the provisions of that act applicable to any order promoted thereunder.
4. The Commissioners to have power to amend the provisions of the existing local acts and orders relating to any tramway undertaking to be worked in connection with the light railway, including power to postpone the date of purchase.
5. Commissioners to have power to allow land to be taken compulsorily for the purposes of constructing a road over which the light railway is to run.
6. Sec. 9, sub-sec. (3). Add at end of sub-section, "But shall, if so required by the promoters, submit the same to Parliament as a provisional order."
7. The Commissioners to have power in suitable cases to grant compulsory running powers subject to sec. 23 of the act.
8. Sec. 13 sub-sec. (1). Omit the words "and contiguous."
9. Insert provisions enabling the Commissioners to authorise statutory companies to raise additional capital and subscribe to light railway companies and to be represented therein, and *vice versâ*.
10. Sec. 7 sub-sec. (3). Omit the words "whether made formally or informally," and insert "made in the prescribed manner."
11. Questions of speed not to be dealt with in the order, but left to the Board of Trade inspector hereafter.
12. Commissioners to have power to vary sec. 92 of the Lands Clauses Act, "Part of a House," and to insert "Underpinning Clause." (See Model Bill.)
13. No local inquiry to be essential to an amending order, and inquiries into unopposed orders may be held in London.

It is hardly necessary to say that the views put forward by the different speakers of the deputation had been most carefully considered beforehand, and it was felt that the amendments suggested were only fair and reasonable. It was understood that the views of the deputation should receive every attention, but it is much to be regretted that the President of the Board of Trade has not seen his way to include more of the suggestions of this Association in the new bill.

The idea seems prevalent in some quarters that as yet sufficient experience has not been obtained to enable a permanent measure to be satisfactorily drafted, and it is, therefore, proposed to do little more than prolong the act for another five years in its present form. We cannot believe, however, that the majority of those competent to judge on the question will agree with this; and, before the new bill is passed, we trust that all those who are in any way interested in tramway and light railway matters will do their utmost to bring before Parliament the necessity of inserting further modifications in the new Light Railways Act than appear in the bill as at present drafted.—Yours, &c.,

The Tramways and Light Railways Association,
London, April 26. NORMAN A. THOMPSON, Secretary.

## ALTERNATE CURRENT WATTMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Within the last few days I have been able to avail myself of Mr. Addenbrooke's invitation, expressed through your columns, to inspect his electrostatic instruments, and have been much interested in them.

In my recent article on the Alternate Current Wattmeter I expressed a doubt as to the value of electrostatic wattmeters, based on my experience of ordinary electrometers when used for the purpose. The difficulties which I have generally found with these instruments have been:—

(*a*) In the attractions due to the induction between the needle and the quadrants producing an instability of the zero with high needle potentials.

(*b*) In contact or Volta forces due to differences in the composition of the needle and quadrants.

(*c*) Liability to change of constant with small alterations in the level, &c., of the instrument, when working with small distances between the needle and quadrants.

(*d*) Want of proportionality in the deflections, and

(*e*) Sluggishness in their action with low potentials.

I find that Mr. Addenbrooke has experienced a considerable amount of trouble in these directions except with inductive effects, which he appears to have been free from owing to his using a small fraction only of the total P.D. on the needle. By dint of very great patience and ingenuity he has, however, succeeded in reducing the other difficulties to such an extent that they are now of little importance.

As far as the relative merits of the electrostatic and dynamometer wattmeters are concerned, the electrostatic instrument has the advantage in being deflectional and of easily being made direct reading by suitably varying the distance between the quadrants and setting the distance of the reading scale. In other respects, however, I am of opinion that the dynamometer form is preferable, as it is stronger and more portable, requires no delicate setting or adjustment, has a strictly proportional scale, and can be read to a greater percentage accuracy than the reflecting instrument. It also has the advantage of requiring no projection arrangement, and is very much cheaper in cost. Either the electrostatic or the dynamometer form of instrument can be used either as ammeter, voltmeter, or wattmeter with equal ease, though the electrostatic instrument has the advantage of being available for obtaining wave forms by contact makers. There is no doubt, however, that either the dynamometer or the electrostatic wattmeter can now be made to give perfectly accurate readings on circuits of any power-factor without any appreciable correction, and it is to be hoped that the prejudice against wattmeters will now disappear, as well as the other elaborate methods of attempting to measure alternate current power which have been in vogue.

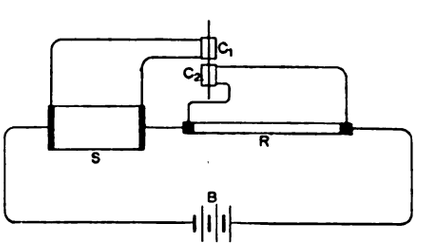
In conclusion, I may still be allowed to express a hope that Mr. Addenbrooke will favour us at some date with an account of the methods he has employed to eliminate the faults of electrostatic instruments. Much has been done and written on this subject, but Mr. Addenbrooke has certainly attained a greater degree of perfection in his instruments than anyone else.—Yours, &c., CHARLES V. DRYSDALE.

London, April 29.

## A LOW RESISTANCE MEASURER FOR WORKSHOP USE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with Mr. C. W. S. Crawley's recent Paper on the differential galvanometer, I think the following




particulars of what might, perhaps, be called a direct reading differential instrument, may possibly be of some interest. The instrument was designed some months ago for the rapid comparison of low resistances on a commercial scale; that is to say, low resistances were to be measured in much the same way as amperes or volts can be read off on the ordinary switchboard instrument.

The accompanying figure shows the connections in diagrammatic form. B is a source of direct current (which, it may be mentioned, need not be steady), S is the standard

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with which the unknown resistance R is to be compared. From the terminals of S and R wires are run to two coils C1 and C2, rigidly fixed to the same axis, which is so pivotted as to allow the coils to rotate in a strong permanent magnetic field, as in the ordinary moving coil instrument. The two coils are connected in such a way that they tend to turn in opposite directions, and the pole pieces of the magnet are so cut away that, as it moves round, one coil gets into a stronger and stronger field, while the other gets into a weaker and weaker field. The result is, that for any given ratio between the voltage drop in R and S, the moving system takes up a definite position, which is quite independent of the current flowing, and which is indicated by a pointer carried by the coils and moving over a graduated scale.

A number of standards (S) are provided, any one of which can be inserted in the circuit by means of a plug. Thus, resistances of, say, 1, $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$ ohm, &c., can be put in series with the unknown resistance, and the value of the latter obtained directly by dividing the dial reading by 1, 10, 100, or 1,000.

The normal drop required on the standard resistance is about 0·1 of a volt, so that for the measurement of $\frac{1}{100}$th of an ohm about 10 amperes would be used. The reading is, however, independent of the value of the current, except that if the drop be reduced below a certain limit, the flexible leading-in connections introduce a slight uncertainty.

Besides being perfectly dead-beat and direct-reading, the instrument has the advantage of enabling a resistance to be measured at its normal working current, and without removal from the circuit in which it may be connected. Thus, for example, the resistance of the coils between neighbouring commutator bars can be readily compared without disconnection from the lugs, and a fault immediately localised. While of course not capable of the same accuracy as can be obtained by the potentiometer method, it has the great advantage that any available source of current can be employed, whereas by the former method an absolutely constant current is necessary. The two coils being in the same case, temperature errors are eliminated.—Yours, &c., KENELM EDGCUMBE.

London, April 24.

# PARLIAMENTARY INTELLIGENCE.

## CLEVELAND AND DURHAM COUNTY ELECTRIC POWER BILL.

This bill, promoted to incorporate and confer powers upon the Cleveland and Durham County Electric Power Co. to establish electricity supply for certain specified areas, came on for hearing before Sir William Houldsworth and a committee of the House of Commons on Wednesday last week.

Mr. BALFOUR BROWNE, K.C., for the promoters, stated that the opposition of the local authorities whose areas were affected arose mainly from the fear of competition. The company would be able to supply power at 1½d. per unit, while the average price charged by the Middlesbrough Corporation was 4½d.

Mr. HUGH BELL, managing director of Bell Bros. (Ltd.), whose capital is £1,500,000, gave evidence as to the advantage of electric power for driving in ironworks, collieries, &c.

Mr. S. Z. DE FERRANTI said many small manufacturers would now take a supply of electric current for power if they could get it from some one whose business it was to produce it, but it did not pay them to put down their own plant. The production of this power was a business in itself, and to produce it economically required a special knowledge. A consumer having his own separate power plant incurred a lot of waste compared with what was the case if power was supplied from a central station. A very large manufacturer could, in certain cases, put down his own plant economically. They did not propose to compete for the custom of small manufacturers—those who used, say 10 H.P., and who could be and were well supplied by the municipal authorities, although the price to them was not so advantageous as to larger consumers. It would not pay this company to take what the local authorities received. With regard to putting the cables over Stockton-on-Tees bridge, he saw no engineering difficulty, and the opposition of the Stockton Bridge Board was absurd. He presumed the objection was only one asking to have their rights recognised, with, perhaps, some nominal payment. Although they did not propose to compete for the custom of all the small shopkeepers who got their supply from the corporations, they would have to supply small people under certain conditions. The promoters' idea was to do that which would give the best results to everybody concerned, and he did not think local authorities should be allowed to handicap manufacturers in the towns and stop them from getting their supply from outside. He did not think it would be unfair to ensure that, in the case of large consumers, the corporations should have the right to supply them first provided they did not handicap the business, and that, in his opinion, would be a fair restriction to put in the bill. There was no advantage in having the middleman. It was far better to get at the customer direct than to leave it to someone who was not particularly interested. The promoters of the bill represented more than one-half of the horse power in the area which the company proposed to serve.

Mr. E. LLOYD PEASE, a director of Messrs. Pease & Co., coal-owners, Durham, said he was one of the promoters of the bill. He did not anticipate any difficulty in financing the scheme, and the funds would very largely be found by those interested. Most of the promoters, if they did not combine with a scheme of this sort would have to spend money to put down plants for themselves. For that reason alone a considerable amount of capital would be available. He knew that the South Wales Bill contained a clause which prevented the promoters from going into local authorities' districts without their consent. This company did not wish to oppose local authorities in any way, but they wished consumers to have absolute freedom as to where they obtained their electrical power. He contended that if the corporations could not show they could supply the power at a low price and in a reasonable time, then the Board of Trade would grant the desire of the promoters of this bill.

Mr. STORR, secretary to Messrs. Bolckow, Vaughan & Co., Middlesbrough, said his firm owned 38 large furnaces round Middlesbrough, and was the largest iron, coal, and steel company in Great Britain. They were now erecting their own electricity generating station, but had it been known that this company was to be formed they would have saved that outlay. Even now, however, a large part of their works would be without a supply of power, and his company, therefore, although they had previously opposed the bill, now welcomed its proposals. The Cleveland Salt Co., who manufactured 30,000 tons of salt per annum, were favourable to the scheme.

Mr. WALTER JOHNSON, a director of Bell Brothers (Ltd.), supported the bill.

Sir THOMAS WRIGHTSON, M.P., director of Head, Wrightson & Co. (Ltd.), one of the promoters of the bill, said that at his firm's Thornaby engineering works they had about 1,000 H.P. There was no public installation at Thornaby, and in witness's opinion the trade of the neighbourhood had suffered in consequence. He agreed that local authorities should provide current for electric lighting, but not for power also. They had been very successful with the former, but in the latter had not been so successful.

Mr. BAGLEY, managing director of the South Durham Steel and Iron Co., owning works in Scotland, Stockton, and West Hartlepool, and employing 5,000 hands, said the supply of electrical energy as proposed by this scheme would be a great boon to the industrial undertakings of the neighbourhood. Some years ago his firm applied to Stockton Corporation for electric energy for lighting, but they delayed so long that the firm had to put down its own installation. Two years ago they applied to the Corporation for energy for power, but the conditions upon which it was offered were not such as his firm could agree to. One condition was that the firm was to provide and lay their own cable underground from the generating station to the works, and this they had no power to do. Another condition was that the company was to provide the meter, but the supply was to be measured at the Corporation works, so that all leakage would be paid for by the company. A further condition was that the supply was not to exceed what was necessary for 200 H.P., whereas his company required it for 800 H.P. to 1,000 H.P. The Corporation's price per unit was to be 1½d., and the company was to make a minimum payment of £150 per quarter; his company was compelled to decline the offer.

Mr. W. NORMAN, manager to Robt. Stevenson & Co., Darlington, said 12 months ago Darlington Corporation approached his company and suggested they should take electrical power from the Corporation mains, but the terms were too high, and the company put down its own installation.

Mr. CECIL LUGARD, electrical engineer, Stockton, said last October his firm made application to the Stockton Corporation to supply them with electric current for 50 H.P. continuously day and night from Monday morning until Saturday afternoon, but the Corporation did not care to run the cable. In consequence, they put down their own plant.

Mr. T. G. GREENYER, colliery manager for Messrs. Pease & Co., Durham, said his firm employed over 5,000 hands, raised 1½ million tons of coal per year, and had 7,887 H.P. If there was a cheap supply of electricity available in the neighbourhood it would replace steam to a very large extent.

Mr. HENRY PALMER, mining engineer to the Consett Mining Co., Durham, said his firm employed 6,600 hands, raised 1½ million tons of coal per annum, and used 30,000 H.P. A cheap supply of electricity would replace a considerable portion of steam power now used in the works.

Mr. GEORGE T. HYDEN, chairman of the Consett District Council, said Consett had a population of about 10,000. He was sure it would not be profitable for the Council to generate its own electric current.

Mr. HENRY GRAHAM HARRIS (Westminster) said he had reported on schemes such as that of this bill in most of the countries of Europe and America and in the mining districts of Africa and Australia. He was engineer to the South Wales Act, which was almost exactly similar to this bill. There were in the area of this scheme 369 factories and collieries. The collieries numbered 160, salt works 8, iron works 8, saw mills, and other shops. The local authorities could not possibly supply current for power to any great extent unless they put down fresh plant. The promoters of this scheme would use very common coal, costing from 5s. to 8s. 4d. a ton, and it was very possible that at some of their stations they would use refuse which they would get at something considerably less than the price of coal. That should enable them to produce current at below ¾d. per unit. The corporations could not use this refuse because it was too poor to bear the cost of carriage.

Mr. BAGGALLAY, K.C. (for Middlesbrough): What is the smallest plant that could be established to economically work for power?—So much

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would depend on the purpose for which the current was used. It is impossible to give a correct answer to that question. I should think, however, that 4,000 H.P. could be worked very economically.

Mr. BAGGALLAY: And if you made it larger, say 15,000 or 20,000, you would not gain much, if anything, in economy?—I do not think you would gain very much.

By Mr. DAVIES WILLIAMS (for West Hartlepool): A considerable portion of the area included in the bill contained important places common to the Durham scheme, and was therefore a mutual district within the meaning of the present bill, but he could not give details as to the number of consumers of more than 100 H.P., of between 50 H.P. and 100 H.P., and of less than 50 H.P. It was impossible for him to draw a dividing line between what consumers corporations ought to supply and what consumers this company ought to supply. He, of course, admitted that if local authorities were supplied with current in bulk they would still require to build distributing stations and to provide working staffs.

Under the bill for power purposes you propose to supply high-pressure current at 6,000 volts. Do you suggest that the Board of Trade would allow you to take a current of 6,000 volts direct on to the premises of consumers?—I hope the Board of Trade will allow us to take a current of 10,000 volts on to the premises of consumers.

In addition to the relaxation in reference to high pressure in the mains?—Which has already been granted in other cases. Of course you must not take premises in the sense of small shops. I am speaking of premises where from 1,000 H.P. to 2,000 H.P. would be used. Even if the Board of Trade did not grant this concession it would make very little difference to consumers. If they do allow it it will come a little cheaper.

If the Board of Trade do not allow you to depart from the existing regulations?—Then we shall transform our current, which will cost us about £3 or £4 per H.P.

Assuming a local authority comes to you and drops your load factor, it would not be an advantageous thing for you. Having certain maximum charges you would, I presume, save yourself by putting on the highest charge for lighting, and in that way stave off your customers for light who would bring down your load-factor?—We could not do anything of the sort. We could not give anything in the nature of undue preference.

Mr. GERALD LODER (a member of the Committee): How was this load-factor brought into the bill at all?—Because in the area there are a large number of our promoters—notably the Consett Ironworks—which could not be supplied by the Durham Company at all.

Mr. A. H. SILL, solicitor, Middlesbrough, clerk to the Ormesby and Redcar District Councils, said his Councils obtained provisional orders about ten months ago, but had not taken any steps to give effect to them. They had asked Middlesbrough for their terms of supply, and Middlesbrough replied that they had no powers to supply. The Ormesby Council had found that it would cost £8,000 to put down their own plant. They thought that under this bill they would get a cheaper supply.

This concluded the case for the promoters.

Mr. BAGGALLAY, for the Stockton and Middlesbrough Corporations, who opposed, said he did not intend to hinder the promoters of the bill in any way except so far as was necessary for the fair and due protection of Stockton and Middlesbrough, both of whom were authorised distributors.

The CHAIRMAN: Then by the bill you are protected—that is to say, the company shall not supply energy in any case in which they are distributors without consent.

In support of his case counsel called

Mr. ROBERT HAMMOND, consulting engineer for the boroughs of Stockton and Middlesbrough, who said he looked upon those two towns as ideal places for the generation and distribution of electrical energy, and they possessed all the conditions necessary to economical production. Supposing this company were authorised, Stockton and Middlesbrough would still have to carry on their undertakings. Witness was confident that Middlesbrough could cope with all the demands made upon it for both electric light and power, and there was no need for this company to come into the town at all. His view was that in cases where authorised distributors had obtained powers under the electric lighting acts the company should not be allowed to come in and interfere with them. As to laying electric cables over Stockton Bridge, he did not see why they could not be laid under the river.

Mr. HYND, chairman of the Stockton Corporation Gas and Electricity committee, said his Corporation had spent over £29,000 on their electrical works, and were prepared, if necessary, to extend their plant in order to supply further demands. They could deal with all the probable demands for electricity in Stockton for many years to come.

Yesterday the Chairman announced that the Committee would decide this bill separately from the other electric bills in the group. The Committee had pretty well made up their minds. As far as they could see they would decide the bill on its merits.

Mr. FORBES LANKESTER called evidence for the Stockton Bridge Commissioners, the contention being that nothing ought to be done to that bridge to save the promoters' money without the consent of the Board.

Mr. C. JOHNSON, engineer to the Commissioners, said the bridge cost £88,000. There was no room for a water pipe or for electric mains on the bridge. There would be no practical difficulty in carrying wires across the bridge, but it could not be done in a way that would be approved by the Board. They could carry 10 mains across the bridge by altering the structure.

The CHAIRMAN intimated that the Committee thought the promoters and the Board might come to some arrangement which would take the form of a clause.

Mr. DAVIES WILLIAMS said it was common ground and obvious that it was unnecessary to argue the general question of the desirability of the supply of electrical power, but it was necessary for the Committee to consider how vested interests were likely to be affected by the scheme under consideration. The borough of West Hartlepool comprised 2,665 acres, with a population of 60,000. There was no centre of population outside West Hartlepool at all. There were at present a dozen large works using a considerable amount of power from their own installations within the area. After the Corporation got out of the Durham Bill last year they started their own installation, and now had a station that would admit of all the extension likely to be required for some years to come, so that there was no prospect whatever of the supply not keeping up with the demand. They therefore wished to be excluded from the area, and they wanted it made clear that no mains were to be laid within their district without their consent.

Mr. A. C. CRUMMACK, borough engineer for Hartlepool, stated that about 18 months ago the Corporation obtained a provisional order which contained all the necessary powers of supply for any purpose whatever in Hartlepool. The borough contained an area of 972 acres, and the population was between 26,000 and 27,000. Work on the generating station had not been commenced, but the scheme was being prepared. They were going to provide about 300 H.P. at first. There were half-a-dozen works in the neighbourhood which they would be quite prepared to supply with power.

By Mr. RUSSELL, K.C.: Is not yours a scheme for electric lighting only?—My Corporation has instructed me to prepare for supplying power as well as lighting. They are going to spend £15,000 on the works.

Mr. LINDEN MACASKIE (for Thornaby) only objected to the company supplying anybody in Thornaby without the consent of the Corporation. They could run their mains through Thornaby to supply consumers outside.

On behalf of Darlington, Prof. KENNEDY said he had been employed by the Corporation to design their electricity station, and to attend to their system of distribution. Arrangements had been made for the purchase of the tramways by the Corporation, and then they would require an extension of their plant in order to deal with 1,600 H.P. or 2,000 H.P. He had also designed an electricity station for West Hartlepool much on the same lines as that at Darlington.

The Committee then adjourned till to-day (Friday).

## CALEDONIAN ELECTRIC POWER BILL.

On Thursday, last week, after the evidence of Mr. A. A. C. Swinton,

Mr. J. C. CUNNINGHAME, examined by Mr. Baggallay, K.C., said he was chairman and principal shareholder of the firm of Merry and Cunninghame, iron and coal masters, chairman of the Glengarnock Iron and Steel Co., and largely interested in various other local trading enterprises in the area proposed to be served by this bill. The introduction of electricity for power purposes on a large scale would be of great advantage, and stimulate industry of all kinds. It would assist in the development of the tramway system, which was very desirable. At present electricity was not used to any great extent in coal pits, but all the authorities held that underground haulage would be done by electricity in future.

The CHAIRMAN: I think you may assume the Committee are quite alive to the utilitarian advantages of electricity.

WITNESS: Another principal use for electricity in mines was pumping, which was rendered safer by the use of electricity. At present if coal-masters wished to use electricity they had to manufacture it themselves, but no doubt large stations would be able to produce it more cheaply. A petition in favour of the proposals of the company had been signed by 300 representatives of large firms in the district.

Mr. G. T. BEILBY said for the past 30 years he had been engaged in the application of chemical and physical science to chemical manufacture. In particular his attention had been directed to the application of electricity in chemical works both as a convenient means of distributing power and in electro-chemical and electro-metallurgical processes. In the production of bleaching powders and caustic sodas by means of electricity there had been great development in this country. He saw no reason why there should not be a very extensive development of chemical manufactures on the Clyde by the modern methods; and the supply of cheap electricity throughout the district would tend to the rapid development of such industries. Of the electro-chemical processes, a very large number required the current to be used continuously during the 24 hours, and thus the load-factor would often be 100 per cent. The future production of electricity would be by means of changing coal into cheap gas, and progress in this direction in the last few years had been most remarkable, and he thought it would be still more rapid in future. He thought these processes, which would reduce the cost of manufacture, could only be carried out in units of very considerable size.

Prof. S. P. THOMPSON, said the district was admirably suited for the work of an electrical power company. Central generating stations were of the greatest importance. The establishment of a number of small stations, as would be the case if all the burghs went for independent installations, would be bad economy. There must be a large and a varied demand for power to make it economical, and he did not see how this great district could be better supplied than by the Caledonian scheme.

By the CHAIRMAN: There was a distance beyond which it was not advantageous to convey electricity. That was when the distance caused the interest on the additional capital involved in carrying the electricity to outweigh the advantage of working from a large centre. The longest distance contemplated in the Lancashire Bill last year was 25 miles.

Mr. DAVID URQUHART, one of the promoters of the scheme, said he was largely interested in the coal trade of the district. Electricity facilitated the work of a colliery, and cheapened the cost of production of coal. By means of electrical machinery one company in Scotland was able to work thin seams which could not be reached by miners. There was a great field for the use of electricity in the area proposed to be served if it could be provided at a moderate cost.

Lord KELVIN, examined by Mr. Baggallay, said the feasibility of the transmission of electric power over great distances had been clearly demonstrated. The distance of 16 miles over which the electric power was transmitted from Niagara to Buffalo was by no means a great distance now. In many places in America and on the Continent electric power was



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nsmitted up to a distance of 80 miles at 30,000 volts with success on the multiphase system, which system was probably the best. Electric power was now used largely in coal pits and mines, and the liability of accident from electric works with modern apparatus was probably less than from any other kind of engineering works. In the very early days of electricity he had demonstrated that the danger of very high voltages of electricity was not as great as with a circular saw. He was acquainted with the general scheme of the bill, and the particular circumstances of the district to be supplied, having himself resided there for the greater part of his life, and he believed the carrying out of the proposals of the bill would be of great practical value to the industries of the district. He considered the sites for the generating stations well chosen. The stations were so arranged that 10 miles was the general distance and 15 miles the maximum over which the energy would have to be distributed. The loss in transmission would be reduced to a very low point. Taking a distance of 5 miles, it would be possible to transmit 2,000 H.P. by means of a cable, at 10,000 volts, with a loss of 1·65 per cent. Over a distance of 15 miles the loss would be three times as great, 4·90 per cent., or, say, 5 per cent., which was a small loss proportionately. As the scale of manufacture of electricity increased the working expenses became proportionately less.

Local witnesses having given evidence in favour of the scheme,

Mr. JAMES SWINBURNE said he was in no way connected with the promoters, but was only acting as consulting engineer. The importance of getting a good load was becoming understood more and more, and its economical advantages. It was, therefore, essential to embrace a large area and get as large a consumption as possible. At a lighting station at 7 p.m., when most people were using the light, the demand would be about 10 times the average, so that with a station of 5,000 H.P. there would only be an average load of about 500 H.P. But the machinery to produce the maximum load would have to be there during the whole time, and the cost of interest and sinking fund on the capital would be very large. A local authority might prefer to do its own work and have its own mains, but it would be generally better for them to take power in bulk. They would be saved more than the capital expenditure of generating electricity for themselves—the tiding over the first two or three years of an undertaking. It would be a great boon to a local authority to put the risk on to a concern like the Caledonian Company. The chief opening, however, for this company would be for power distribution—it would not pay them to do much in lighting. Electro-chemistry was getting behind in this country owing to the lack of water power, many of the works having been taken to Norway. But if cheap electric power could be obtained here it would pay better to keep the works at home. With the exception of iron, most of the other metals, he thought, might in the future be produced electrically. It was essential to have some such company as this to supply power in this district, and the scheme of the bill was well designed, and the sites for the stations well selected for generation and supply.

The CHAIRMAN here intimated that the Committee would hear, after the promoters, the Clyde Valley Company against the bill, and then the local authorities.

Evidence was then heard in support of the Clyde Valley Company's bill, and

Sir DAVID RICHMOND said his firm were unable to obtain a sufficient supply of electricity at present, and the price charged was too high. He was one of the promoters of the Clyde Valley scheme. The area was well selected, and nowhere in Scotland was there greater need for such a scheme. He had pledged his own money for the scheme because he desired to see it carried out in the public interest. The Clyde Valley Company was a local one; there was no construction company behind it. It was promoted by local gentlemen who represented all the great interests on the Clyde. Three hundred owners of works had petitioned in favour of the Clyde Company's scheme, and the company's stations were admirably situated.

A number of local witnesses having given evidence in support of the Clyde Company's scheme,

Mr. ROBERT ROBERTSON, civil and electrical engineer (Messrs. Strain and Robertson, Glasgow), engineer to the scheme, said the Clyde Company's scheme was practically modelled on the South Wales Bill, and it and the Caledonian scheme were very much alike. The area included in the Clyde scheme was 732 square miles, including the city of Glasgow. At present a supply of electricity was only being given in 13 square miles out of 710, excluding Glasgow. Large iron and steel works were included in the area, and a great many coal pits, and there were some 1,200 works of importance altogether. In regard to the system of supply, all the calculations had been based on the adoption of the multiphase alternating-current system. That was, in his opinion, the right system, and one which was largely used in America and on the Continent, where experience was such as to convince anyone that that was the system to be adopted for distribution of power on a large scale. In the event of a local authority taking a supply in bulk for lighting and also for power, he thought it would be found possible to give a supply for power by an alternating current and for lighting a separate supply transformed into continuous current. The stations were to be placed so as to be coupled up for the purpose of an interchange of factors, and also so that they might supplement each other and be mutually supporting in the case of any failure of the plant. He had, in conjunction with Sir Wm. Preece and Major P. Cardew, prepared estimates of the expenditure. The capital of the company would be £900,000, with £300,000 borrowing powers, or £1,200,000. Provision had been made in the estimates for two stations of 10,000kw. and one of 5,000kw., with a voltage of 10,000. The cables would cost £75,000 for connecting the stations, and the cost of the transformers would be £105,000, the total initial cost of distribution, plant, &c., being £400,000. He had considered the question of the danger from motor generators in fiery coal mines, and he certainly quite agreed that there was a risk from sparks in such mines, especially where there must, at any time, be a lack of ventilation or an outburst of gas. Such a risk would make it quite impossible, in his opinion, or certainly very objectionable, to put in anything in the way of an electric continuous-current motor. A certain amount of protection might be got by putting in an enclosed continuous-current motor, but such a protection was not, he thought, quite sufficient. Under the system of distribution proposed by the Clyde Company the motors were on the alternating current system, and had no brushes, and practically no liability to spark, and so far as these motors were concerned there was little or no danger. That did not, however, get over the possibility of a rupture taking place in the cable. But in addition to that there were a great many other purposes in mines, near the shafts and in connection with ventilation, for which electrical energy could be utilised advantageously.

By Mr. BALFOUR BROWNE (for the Caledonian Company): He had not personally carried out any authorised undertaking. As to his estimates of cost, they were formed on information obtained as to the working of similar stations in America, where alone there were stations as large as those which it was proposed to construct under the Clyde Valley scheme.

Major P. CARDEW (Messrs. Preece & Cardew) said he, along with Sir Wm. Preece, had been consulted by Mr. Robertson, engineer to the Clyde scheme, and had gone over the ground with him, and assisted him in the preparation of the estimates. They had been based on tenders actually received, and information of an indirect character, and he regarded them as moderate estimates within which the work could be satisfactorily carried out. The scheme was a well-contained one to serve an industrial district, and promised to be a success, both for the consumer and the company.

Local evidence in support of the Clyde Company's bill was then given, and the Committee adjourned till to-day (Friday).

## SHANNON WATER AND ELECTRIC POWER BILL.

The Select Committee of the House of Commons, presided over by Mr. Arthur Elliot, on Monday considered this bill.

Mr. BUSHE, K.C., for the bill, said of the petitioners against the scheme one only now appeared by counsel, Major O'Connor, who was the leaseholder of an island, 12 acres in extent, at the entrance of Lough Allen. The bill was one of that group of electric power bills of which so many had lately been before committees, and which should show how the tide was setting on the question of the application of electrical energy to industrial enterprise. Under this bill the proposition was that the electrical energy should be generated by water power. The utilisation of water power had not been so frequent in the United Kingdom as in America and on the Continent—notably on the Rhone and in Switzerland. In the West of Ireland where there was no coal supply, all coal had to be brought from England, but there was in that district the greatest river in the United Kingdom—the Shannon—and it was from this that the company proposed to derive electric power. The bill sought to incorporate a body of gentlemen, with a capital of some £360,000, for the purpose of utilising the great water resources which have been so long running to waste. It was proposed to construct a canal, with an intake from the Shannon at a point a few miles from Limerick, 2½ miles in length, to Cloonlara, where a power-house would be erected. There was at this point a fall of 40ft. The station would be equipped at first to produce 5,000 H.P., which eventually would be extended to 8,000 H.P. The water would, after passing the power-house, have to be re-conveyed to the Shannon, and for that purpose a tail-race, 2 miles in length, would be constructed; 4 miles of the river only would be interfered with under the scheme. On the few occasions when they could not take water from the river, an auxiliary steam apparatus would be set up to enable the company to continue to fulfil their obligations to their customers. The area proposed to be supplied extended 30 miles from the power-house.

Mr. FRASER, C.E., engineer to the scheme, said the price to be charged for electric power was based on the schedules attached to the great power schemes of last year, varying from a maximum of 5d. to a minimum of 2d. The Corporation of Limerick would be supplied at 2d. The proposed capital of the company was £360,000, with borrowing powers of £180,000. The works would cost £265,000 and the working plant £75,000, a total £240,000.

Sir COURTENAY BOYLE was asked by the Committee to explain certain objections of the Board of Trade to the bill. He said the electrical clauses required careful consideration by the Committee, since, if passed as they were, they would vary the general law of electric lighting. The bill gave wide powers of breaking up streets, and imposed no corresponding obligations on the companies for the protection of the public. The area proposed was much larger than those over which electrical powers were usually given. The company also proposed to take powers to supply electricity not only for motive purposes but also for general lighting. This was contrary to adopted policy. Lighting powers should be taken only for special districts and not wholesale. The South Wales company last year asked for general powers, and were refused, and told that they must get provisional orders in each case. The promoters then asked to be put in a position to grant powers to other persons. That clause was *ultra vires*. There was in the bill no obligation to supply on reasonable demand as in the bills of last year, and there was no sliding scale proposed. If the water power was abandoned, there was nothing in the bill to show that the other powers of the promoters ceased.

Mr. BUSHE said the promoters had not before heard of these objections, and were prepared to satisfy the demands of the Board of Trade as far as they could.

Mr. STEVENSON, of the Board of Works (Ireland), said the Treasury contended that payment should be made for the water abstracted from the Shannon.

After further evidence, the Committee decided that the preamble of the bill was proved, but that clauses might be brought up to satisfy the wishes of the Board of Trade. In regard to the contention of the Treasury, the Committee was not in favour of it.

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## MOND GAS BILL.

On Friday last this bill came before a Select Committee of the House of Commons, presided over by Col. Welby.

Mr. BALFOUR BROWNE, K.C., said the bill was one to incorporate and confer powers on the South Staffordshire Mond Gas Power and Heating Company with regard to the supply of a producer gas invented by Dr. Ludwig Mond. The gas was a power and heating gas, and practically could not be used for illuminating, its flame being similar to that obtained from spirits of wine. The gas could be produced from cheap slack, and as the sulphate of ammonia was recovered in the process as a by-product, the cost of the coal, and consequently of the gas, was reduced to a very small figure. Practically the only object the company had in applying to Parliament was to obtain power to open streets in order to lay mains for distribution purposes, as in the case of an ordinary gas, water, or electric light or power company. One of the great advantages of establishing the company would be that they would supply power and heat to the small manufacturer at a marvellously low rate—more cheaply than electricity for these purposes could be supplied. Mond gas at 2d. per 1,000 cubic ft., used in a gas engine, would give a fuel cost of £4. 7s. 7d. per I.H.P. for one year, working continuously day and night; whereas if a manufacturer bought electricity at 1d. per unit—(a very low price indeed)—the equivalent cost would be £27. 4s. If that were anything like approximately accurate, surely it would be of enormous advantage to the manufacturers in the Black Country, where there were an enormous number of trades, which would consequently allow a considerable diversity factor to be obtained. A considerable number of local authorities opposed the measure, chiefly because they objected to the interference with their streets which the operations of the company would entail, and in some cases because they supplied coal gas, with which it was feared the new gas would or might compete. Counsel however, pointed out that it would only compete where gas was supplied for power or heat, and then only in the larger supplies, because it would not pay to undertake to supply the very small consumers for these purposes. Among the opponents was the Midland Electric Corporation for Power Distribution, who had power to supply electrical energy in a certain portion of the area. The answer to their petition was that an electrical company could supply energy for power, but not for heat. The cost of electricity would not allow it to be used in any way for heating purposes, so that for many objects, such as brick-kilns, puddling, &c., electricity was not available. The result was that this opposition only extended to the supply of gas for power purposes, and really he thought the object of the company was to obtain protection with regard to their mains.

Sir F. BRAMWELL, in giving evidence in support of the bill, pointed out at length the enormous advantage of gas engines over steam engines, and said Mond gas was quite suitable for use in gas engines. He also gave a list of industries in connection with which this gas would be especially valuable. The power of the gas was about one-fourth that of coal gas. It involved the use of very large pipes. From each of the five manufacturing stations proposed under the bill there would be a 2ft. 6in. arterial main in each direction, which would deliver 120,000,000 cubic ft. daily. The pressure in those pipes would be about 32 times the pressure in coal gas pipes. The Mond gas, if provided, would compete with the electric power supply of the Handsworth District Council, who had lately obtained authority to supply electricity for power. As to light, there would be no competition with the local authority.

By Mr. HUGO YOUNG, K.C.: This Mond gas may be used may it not for working tramways?

WITNESS: I do not know a way to do it. I wish I could invent one.

By Mr. LLOYD MORGAN (a member of the Committee): Is there any instance of this Mond gas having been used for illuminating purposes?—None that I know of.

Lord KELVIN was then called and gave evidence as the practicability of the scheme. Mond gas seemed to him to be invaluable for manufacturing purposes.

By Mr. PRITCHARD (representing the Midland Electric Corporation for Power Distribution): You were comparing the gas engine with the steam engine, and you stated that in your opinion the gas engine would be a great deal cleaner and more convenient than the steam engine?—Yes; than the steam engine with its fires and boilers.

Is it not also the fact that electric motors would be still cleaner and still more convenient than gas engines?—Yes.

Can you suggest any advantage that a gas engine worked by Mond gas possesses over an electric motor other than that of price?—The electric motor wants a steam engine or a gas engine.

In the same way that a gas engine requires a producer to produce the gas in the first instance. I am putting myself in the position of a manufacturer in this district. I have to take into consideration whether I shall use Mond gas for power purposes or electricity, either of which I can obtain on tap. I ask you whether you can suggest any other advantage that I should get from the use of Mond gas than that of price?—If you can get the electric power on tap at any moment you want it at a lower rate or even the same rate as the Mond gas, you are quite entitled to choose the one over the other.

Would not electricity be the more convenient for most manufacturing purposes?—Yes, if the power can be supplied at the same price the electric power for many manufacturers would be more convenient. Mond gas used in a gas engine would be the most suitable possible means of producing electric power in this district. In fact, one of the chief applications of Mond gas was to drive dynamos to produce electricity. It could not be said that electricity for heat could be produced at anything like the price at which Mond gas could be supplied for the purpose.

Mr. HERBERT HUMPHREY, engineer to Messrs. Brunner, Mond & Co., at whose works the Mond gas was produced, said he was responsible for the engineering features of the present scheme. The use of Mond gas would lead to a saving in fuel, in labour, in time, in cost of repairs and valuable space, and would give better results with less waste of material than ordinary fuel. The estimated expenditure of the company was £789,686, of which £40,000 was for land, railway sidings, &c., at the five stations, and £387,000 for works at the stations, making £427,000, which left the very big figure of over £360,000 for distribution plant.

Prof. DEWAR gave evidence regarding the chemical constituents of the gas, and Mr. HARRY JONES, engineer and general manager to the Commercial Gas Co. of London, spoke as to the adequacy of the estimates for the distributing works. A number of witnesses were called from the district, who spoke strongly in favour of Mond gas, and as to its suitability for use in particular trades.

Yesterday Sir A. HICKMAN, M.P., who is largely interested in steel works, blast furnaces, collieries, and brick works in South Staffordshire, said in the near future producer gas would be used for driving engines generally, and also for steel furnaces. He had had producer gas in his works for some time past, and the effect had been to reduce the cost of fuel for heating and steam engines to one-fourth of what it was previously. He believed Mond gas would benefit every industry in the district, and thus benefit even the coal gas companies.

Mr. SCLATER, consulting engineer, and engineer to the Northwich Electrical Supply Co., said the fuel used for the supply of electricity at Northwich was Mond gas, which was supplied from the Winnington works of Messrs. Brunner, Mond & Co, about three-quarters of a mile away. Their dynamos had been running smoothly, and the gas had been uniform in its distribution. They had been running for three years and five months, and had never yet found it necessary to take out a piston, The deposit on the valves was extremely small. He had had experience of other electrical works, and having regard to that experience should advise producers of electricity generally to use Mond gas to produce electricity. In saying the engines had been running for three years and five months he meant without breakdown or stoppage for repairs. Of course, the company had shut down their engines from time to time. The Mond gas consumed was measured by a meter at Winnington to which the Northwich company had access. They paid 2d. per 1,000ft. for the gas, and the consumption last year was somewhat over 20,000,000ft.

Mr. SOARES (a member of the Committee): Were your engines new?—Yes, put down for this purpose.

By Mr. PRITCHARD (for the Midland Electric Corporation for Power Distribution): He had not tried to use gas engines when the supply was alternating current. As to the relative cost of an electric motor and a gas engine using Mond gas, he said the cost per B.H.P. of Mond gas at 2d. per thousand feet was approximately £4. 10s. per year running continuously, that was on the basis of a consumption of 75 cubic ft. per B.H.P. per hour, while electric current at 1d. per unit cost nearly £28 per year per B.H.P.

There are other things you have to compare. First, there is the price of your gas engine or motor?—Yes. We have recently had occasion to put down in our works either a gas driven piece of apparatus or an electric-driven piece of apparatus. The electric apparatus would have been coupled direct to the machine, and thus saved foundations and all connecting gear. We got estimates from good firms, and found it to our advantage to put down gas-driven plant, although in an electric lighting station.

The actual price of the plant is cheaper?—Yes, for gas. The power of the motor is 20 H.P. We find also that the repairs of the gas-driven part of our machinery is a small fraction of the repairs of our electric machinery.

And with reference to oil, waste and so on?—Oil and waste are undoubtedly in favour of the electric motor, but the whole amount is so small that even if it is 50 per cent. less it is trifling.

Labour and attendance would be a great deal higher with the gas engine than with the electric motor?—As a matter of fact, it has made no difference whatever in our case.

By Mr. PEMBROKE STEPHENS, K.C. (for Willenhall Gas Co.): The extent of the business of the Northwich Company was about 10,000 lights spread over 16½ miles of mains. They had 320 H.P. in the works. All the Mond gas they used was supplied from Messrs. Brunner, Mond & Co.'s works and it was utilised for every purpose.

Other evidence having been given, the case for the promoters closed.

Mr. FREEMAN, K.C., having opened the case for the Birmingham Corporation,

The Committee adjourned.

## POSTAL AND TELEGRAPH EMPLOYÉS.

In the House of Commons on Thursday last week Mr. A. CHAMBERLAIN, in replying to Mr. T. Bayley, said that it was only five years since the conditions of employment of Post Office servants were exhaustively investigated by a Committee, of which Lord Tweedmouth was chairman. All the recommendations of that Committee were accepted by the Government, and had been carried out at a heavy cost to the taxpayer, amounting in the present year to upwards of £500,000. No new circumstances had arisen which were not before that Committee, and the Postmaster-General was not prepared to recommend another similar inquiry.

## POST OFFICE LONDON TELEPHONE SERVICE.

Mr. A. CHAMBERLAIN stated in the House of Commons on Thursday last week, in reply to a question by Mr. Bartley, that it was hoped that some of the principal Post Office telephone exchanges in London would be opened within the next five or six months.

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## SOUTH WESTERN AND ISLE OF WIGHT JUNCTION RAILWAY BILL.

This bill came, on Monday, before a Select Committee of the House of Lords, presided over by the Earl of Dartrey.

Mr. ERSKINE POLLOCK, K.C. (for the bill) said the proposed railway was to join the mainland with the Isle of Wight by means of a tunnel beneath the Solent. It commenced at a point on the Lymington branch line of the London and South Western Railway, passed towards Keyhaven and then under the Solent, ultimately forming a junction with the Freshwater, Yarmouth and Newport line, not far from Freshwater, the line being 7½ miles in extent. The railway would have a public and local advantage, both as to passenger and goods traffic; and the War Office viewed with satisfaction the tunnel, which would give them access to the important forts of the island without being dependent on the sea transit. Powers were taken to work the line by steam, but it was actually proposed to work the line by means of electricity. By this means they could convey trains through the tunnel. They had secured 20 acres of land at Keyhaven for a generating station. The tunnel would cost £345,000. The total estimate was about £535,500. The proposed capital of the company was £600,000, with borrowing powers of £200,000.

Mr. E. GRANVILLE WARD, J.P., and Mr. T. B. H. COCHRANE, Deputy-Governor of the Isle of Wight, said the railway would to a very great boon to the island.

Mr. T. S. MEIK, C.E., described the route of the proposed railway and said the only special feature was a tunnel, 2¼ miles long, beneath the Solent, with a gradient of 1 in 40 on each side. The object of the steep gradient was to make the tunnel as short as possible.

Col. PERCY LAKE, of the War Office, said in the view of the military authorities the railway in time of peace would be a considerable convenience, and in time of war would be of great value to the defending force.

The opposition of Lord Heytesbury having been withdrawn, the CHAIRMAN said the Committee found the preamble proved, and the clauses having been adjusted the bill was ordered to be reported for third reading.

## THE LONDON UNDERGROUND RAILWAYS COMMITTEE.

The Joint Committee appointed to consider various underground railway bills sat for the first time at the House of Lords yesterday. Lord Windsor presided, and the other members of the Committee present were Lord Knutsford, Lord Lauderdale, and Lord Herries, of the Upper House, and Sir J. Dickson-Poynder, Sir Michael Foster, Sir William Arrol, Mr. Ashton, and Mr. Cawley.

The CHAIRMAN said that the Committee would meet on Tuesdays and Fridays, and would apply for leave to hear counsel. It was not their intention to enter upon the question of vibration until the report of Lord Rayleigh's Committee had been received. At present, therefore, evidence would be confined to whether the lines of route for underground railways in and near London proposed in the bills which had been or might be introduced during the present session, were best calculated to afford facilities for present and probable future traffic, and if any modifications in those routes were desirable. It was not proposed either to discuss questions of compensation or damage until the receipt of the report of the Vibrations Committee. The Chairman further said that the Committee would like the views of those representing the various bills as to what order they should be taken.

Sir PRYOR GOLDING (City Remembrancer) suggested that the railways which ran through the City should be considered together.

Mr. LITTLER, K.C., thought the Parliamentary agents should meet and endeavour to agree upon a scheme of procedure. If they were unable to do this he suggested that the bills should be taken in alphabetical order.

Mr. WALLACE, K.C. (for the London electric lighting companies), said he thought the best time for him to be heard would be when the points as to the working and construction of the lines came to be considered.

The Committee decided that counsel and agents should meet, and if no definite arrangement could be come to by Tuesday the bills were to be taken alphabetically, except those competing with each other. Under this arrangement the Brompton and Piccadilly-circus bill would be taken first.

The Committee then adjourned.

## DUBLIN (ST. JAMES'S GATE BREWERY) TRAMWAYS.

This bill, to enable Messrs. Guinness, Son & Co. (Ltd.) to construct and work tramways in the City of Dublin, came yesterday as an unopposed measure before the Committee and the Chairman of Ways and Means at the House of Commons. The preamble having been proved, the bill was ordered to be reported for third reading. The Dublin Corporation and the Alliance and Dublin Consumers Gas Co. had petitioned against the bill, but withdrew their opposition.

**Swedish Telephone Enterprise in Russia.**—As recently reported in our columns, a Swedish syndicate has obtained several telephone concessions in Russia, including the working of the system in Moscow, and the company has now acquired an old castle on a commanding hill near the town, where the first station and works are to be erected. A Swedish engineer, Herr K. W. Petersson, will conduct the company's operations in Russia.

# LEGAL INTELLIGENCE.

## Hawkes v. the Leyton Urban District Council.

The hearing of this case (reported in our last issue) was concluded, before Mr. Justice Buckley, on Tuesday. Plaintiff asked for an injunction to restrain defendants from carrying on their works in connection with electric lighting in such a way as to cause a nuisance by noise and vibration, in violation of an injunction previously ordered by the Court.

His LORDSHIP, after hearing a mass of evidence, in giving judgment, said he did not intend to proceed on the breaches of the Council's undertakings, although he had power to do so, but should only deal with the breaches of the injunction. It was his duty to see that the orders of the Court were obeyed, and when persons had the assurance to tell the Court that, after giving an undertaking, they deliberately proceeded to break it, he had no alternative but to visit them with the consequences. The only point upon which he had any doubt as to the conflict of evidence, was the question whether or not some of the witnesses were correct in saying they had heard vibrations and explosions at midnight and in the early hours of the morning. If he had felt it necessary to come to a distinct conclusion on this matter he should not have found that the log-sheets showed that the engines did not run after midnight. These log-sheets were untruthful in some respects, and all the back-fire was not recorded in them. The nuisance caused by explosion and vibration which he found to exist at the trial still continued. He therefore came to the conclusion that the defendants had not obeyed, had not tried to obey, and had never intended to obey the orders which were made. In dealing with a public body of that sort, if it were proved that owing to some sudden accident or pressure they had committed what was in point of fact a breach of the order, he should take that into consideration. In this case he did not find anything of the kind. The defendants deliberately disobeyed the orders of the Court, and did not seek to apply to be relieved from any strain in which they might have been placed by the injunction. Accordingly, he granted the motion of plaintiff that a writ of sequestration should be issued, and the defendants must pay the plaintiff's costs of the action as between solicitor and client.

The case of Hawkes *v.* Leyton Urban District Council was again mentioned yesterday in the Court of Appeal before Lords Justices Collins and Stirling, on a motion for an order staying the issue of the writ of sequestration which Mr. Justice Buckley ordered to be issued against defendants on Tuesday, as above reported.

Mr. H. TERRELL, K.C., in supporting the present motion, now asked that the writ might be stayed until the appeal was heard. Counsel stated that if the motion were not granted the whole district would be thrown into darkness.

Mr. ASTBURY, K.C., for plaintiff, said defendants had committed a grave contempt of court, but he should not object to their lordships expediting the hearing of the appeal.

It was arranged that the appeal should be heard on Monday next, plaintiff meantime undertaking not to issue the writ until after that date.

## National Telephone Co. (Ltd.) v. Corporation of Tunbridge Wells.

This case came before the Court of Appeal, composed of the Master of the Rolls and Lords Justices Vaughan Williams and Romer, yesterday, on the appeal of the plaintiffs from the judgment of a Divisional Court, composed of Justices Grantham and Channell, on June 18, 1900.

Mr. CRIPPS, K.C., M.P., for appellants, said another case in the list (National Telephone Co. (Ltd.) *v.* Corporation of Huddersfield) practically raised the same point as the present action, but as the Divisional Court had heard the Tunbridge Wells case and delivered judgment on it, it was decided to take the appeal first. The National Telephone Company were claiming to put down certain lines in connection with the supply of telephonic communication in Tunbridge Wells. The Council, however, objected, and said "You cannot do this without our consent." Under the terms of an agreement, which refers to certain Acts of Parliament, the Council have not got a right of absolute veto, but it is provided that, if there was a difference of opinion, the parties must go to arbitration. Plaintiffs went to his Honour Judge Emden as the arbitrator, and he decided that he had jurisdiction to entertain the matter of arbitration, and that the Council had not the right of absolute veto. The matter then came before the Divisional Court on a prohibition to prevent the County Court judge proceeding with the application before him, on the ground that there was no matter for arbitration, and that the defendants had the right of absolute veto. The Divisional Court decided that the County Court judge was not the proper tribunal to determine any difference which had arisen between the parties. That was the whole point of the dispute. Counsel then referred to the deeds of 1884 and 1896, made between the Postmaster-General and the National Telephone Co., by which the company were authorised to work and use certain forms of telegraph for the purpose of transmitting telegrams within the borough of Tunbridge Wells. By a deed dated 1896, and made between the Corporation of Tunbridge Wells and the Telephone Company, the Corporation consented to the company exercising within the borough such powers as might from time to time be delegated by the Postmaster-General to the company in pursuance of sec. 8 of the Telegraph Act, 1892. This deed went on to say, "It is expressly agreed that the consent contained in the preceding clause is given upon the following conditions:—(1) Except as regards the work mentioned in the schedule the company shall not exercise any of the powers conferred on the Postmaster-General by the Telegraph Acts, 1863 and 1878, in respect of which the consent of the Corporation is required under the said acts, without obtaining the further consent in writing of

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the Corporation, to be from time to time given to the specific works for the time being proposed to be carried out under such powers, it being intended that the general consent contained in the preceding clause is not to operate to relieve the company from the obligations of obtaining the particular consent of the Corporation to such specific work as required by and provided for in the said acts." Clause 10 of this agreement contained a reference of all disputes to two arbitrators and an umpire. The company wished to open a new street and lay telephone wires not mentioned in the schedule to the last-mentioned deed, and applied for the consent of the Corporation. The Corporation refused, and the company contended that under sec. 4 of the Telegraph Act, 1878, they had the right to refer the difference to the County Court judge.

Their lordships, without calling upon counsel for respondents affirmed the decision of the Divisional Court and dismissed the appeal with costs.

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The decision in the above appeal governed the case of the National Telephone Co. (Ltd.) *v.* Corporation of Huddersfield, which raised practically the same point. The plaintiffs' appeal in this case also was dismissed with costs.

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## Atkins and Applegarth v. Castner Kellner Alkali Co. (Ltd.).

This case came on for trial yesterday, before Mr. Justice Buckley, in the Chancery Division. Plaintiffs' claim was (1) for an injunction to restrain defendants from infringing plaintiffs' Letters Patent 20,768 of 1890; (2) for damages for the infringement of the said letters patent, or alternatively ifor an account of all the products made by defendants under any process n infringement of plaintiffs' patents, and declaration of profits; (3) delivery to plaintiffs on oath, or destruction of all machines, apparatus or appliances in the possession of defendants made in infringement of plaintiffs' patent; (4) costs. The statement of claim set forth that defendants had infringed plaintiffs' patent for an invention for improved means and apparatus for separating alkaline and earthy metals and other products from the salts of such metals, or from other substances contained therein. The patent is still valid and subsisting. Such means consist in subjecting a solution of such salts to electrolysis in electrolytic apparatus the cathode pole of which is composed more or less of a flowing or moving surface or body of mercury, whereby the metal or hydrate of the metal can, in the manner described in the specification, be continuously removed, and the counter electromotive force set up at the cathode by the metal and the hydrogen is substantially reduced. Particulars of breaches of the plaintiffs' patents are given. The Castner-Kellner process of defendants is a process whereby caustic soda and other products are produced by electrical decomposition of alkaline salts, which defendants claim to be protected under certain letters patent taken out by Hamilton Young Castner, No. 16 046 of 1892 and No. 10,584 of 1893, and by Chas. Kellner, No. 17,169 of 1892, but which plaintiffs aver have been anticipated by their invention. The plaintiffs are unable to state by which of the said patents or by what combination of the said patents or any of them the process called by defendants the Castner-Kellner process is claimed to be covered or what the process as used exactly is, but in any case they say that the Castner-Kellner process is anticipated by their own patents. In such process plaintiffs say defendants have been using machinery, apparatus and appliances covered by their (plaintiffs') patent. On the other hand defendants, besides denying that they have infringed the patent in question, relied in support of their defence on the following objections to the validity of the patent:—(1) That the alleged invention was not new or the proper subject-matter of letters patent having regard to the state of public knowledge at the date of the patent. (2) That the alleged invention was not of any public utility. (3) That the specification did not sufficiently distinguish which of the matters therein described plaintiffs claimed to have invented and which they admitted to be old. (4) The specification was insufficient and misleading, inasmuch that it did not describe the process and apparatus whereby alkaline and earthy metals may be separated from the salts of such metals or from other substances containing them. (5) That the alleged invention as to so much of it as consists of a moving or flowing mercury cathode was previously to the date of the patent published within this realm in and by a publication in the following manner:—By the provisional specification of Andre Leopold Nolf for apparatus for producing chlorine gas and metallic sodium from chloride of sodium, dated Sept. 12, 1882, and numbered 4,349. By a United States patent specification for a process of and apparatus for obtaining chlorine and sodium granted to Andre Leopold Nolf, dated Oct. 15, 1882, and numbered 271,906, and duly placed upon the shelves of the Patent Office library on or about Aug. 15, 1834. By the provisional and complete specifications for a process for the production of ferricyanides of potassium, sodium and ammonium by electrolysis, upon which British letters patent were granted to Camille Petri, dated June 2, 1886, numbered 7,426. By the provisional and complete specifications for improvements in the amalgamation of gold and other ores and in apparatus employed therein, upon which British letters patent were granted to Arthur Edward Donkin, dated June 6, 1883, and numbered 8,303. The whole of these specifications defendants relied upon.

Mr. T. Terrell, K.C., Mr. Astbury, K.C., Mr. MacCouter and Mr. J. H. Gray appeared for plaintiffs; and Mr. Moulton, K.C., Mr. Bousfield, K.C., Mr. J. C Graham and Mr. A. J. Walter appeared for respondents.

Mr. Terrell's opening speech for plaintiffs was only partly given yesterday.

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## Crow v. Board of Works for Whitechapel (London).

In the King's Bench, before Justices Grantham, Kennedy, and Darling, the hearing of this action was resumed on Saturday. The case was previously argued before Justices Kennedy and Darling last December, but their lordships then disagreed, and the case now came on for a re-hearing before an additional judge. It was defendants' appeal from a decision of Mr. Dickinson, the magistrate of the Thames Police Court, in June last. A summons was taken out by Mr. Crow, district surveyor, against the defendants for not having given him notice under sec. 145 of the London Building Act, 1894, before commencing the construction of a number of inspection chambers under the streets in the district for the reception of the Board's electric cables. Defendants, the local authority for the district, in 1892 were granted an electric lighting provisional order, which came into force on June 27, 1892. By secs. 11 and 12 of this order the undertakers were authorised to construct any such boxes as might be necessary for purposes in connection with the supply of electric energy, including apparatus for the proper ventilation of the boxes. The sections further provided that every such box shall be for the exclusive use of the undertakers and under their sole control, except so far as the Board of Trade may otherwise order, and shall be used by the undertakers only for the purpose of leading off service lines and other distributing conductors, or for examining, testing, regulating, measuring, directing, or controlling the supply of energy, or for examining or testing the condition of the mains or other portions of the works, or for other like purposes connected with the undertaking; and the undertakers may place therein meter switches and other suitable and proper apparatus for any of the above purposes. Every such box, including the upper surface or covering thereof, shall be constructed of such materials, and shall be constructed and maintained by the undertakers in such manner as not to be a source of danger, whether by reason of inequality of surface or otherwise. Sec. 12 further provided that the undertakers should, one month before the commencement of such works, serve a notice upon the Postmaster-General describing the proposed works, together with a plan, and, in addition, a like notice and plan upon the London County Council. Defendants did not, however, before commencing the construction of the boxes, serve Mr. Crow with notice of the intended work under sec. 145 of the London Building Act, 1894. Mr. Crow's contention was that the boxes came within the definition of "building, structure, or work" in that section, and that the defendants were bound, before commencing the work, to serve upon him as district surveyor a "building notice," as prescribed. Defendants contended that the 1894 Act did not apply at all to the boxes constructed in the streets under the provisional order, inasmuch as the order contained a complete code regulating the materials, situation, and mode of construction of such boxes, and provided complete machinery for enforcing such regulations, and with which special code and machinery the London Building Act of 1894 was inconsistent. The magistrate before whom the case was first argued found that the boxes were "buildings, structures, or work" within the meaning of the section, and imposed on defendants the nominal penalty of 1s. and £10. 10s. costs. Hence the present appeal of the defendants.

At the conclusion of the arguments of counsel their lordships reserved judgment.

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## London Electric Supply Corporation (Ltd.) v. Saunders.

In the Westminster (London) County Court on Monday Judge Lumley Smith, K.C., heard an action to recover £17. 9s. 7d. for electric current supplied to defendant, a surveyor. Defendant counterclaimed 50 guineas damages for breach of agreement to supply him with sufficient light.

Mr. A. HARRISON, for plaintiff, said he believed there was no answer to the claim, and he contended the counterclaim must fail, defendant's remedy, if he had any ground for complaint, being in the police court. Plaintiffs agreed to supply him with electric current, and he alleged they had failed to do so. If such was the case he must take the case to the police court, where plaintiffs might be fined up to 40s.

The JUDGE: I suppose if you supplied no electricity you could not recover?

Mr. HARRISON: Defendant counterclaims 50 guineas damages and charges us £3. 15s. for lamps, oil and candles. He has always paid us before on being sued.

Mr. EDWARD FLOOD, plaintiffs' inspector, said the meter at defendant's residence registered 777 units. That would be £16. 3s. 9d., and £1. 5s. 10d. meter rent made up the amount sued for.

DEFENDANT: I resist this claim because the light has been no good. It has gone out from minutes to as long as a day and a night, and I had to resort to other illuminants to carry on my business. Have you your books here showing the voltage?

WITNESS: The pressure is recorded in our books every day.

Mr. HARRISON (to defendant): Do you admit signing the contract?—Yes.

Mr. HARRISON: Then I put that in as evidence, and submit defendant's remedy is at the police court.

The JUDGE said, without giving a decision on the point, that he would hear what defendant had to say.

DEFENDANT complained of inferiority of the light and of its going out. He also complained of the quality of the light. Often he could not read by it. He had cause of complaint up to last September, when the supply was cut off. He had been supplied by plaintiffs for about six years. He provided his own lamps, and they were of the best description. He was connected with the Charing Cross and Strand Company now, and the light had not gone out once. He submitted plaintiffs had broken their contract to supply him with electric current.

The JUDGE: The provisional order says, "The undertakers shall give, and continue to give, a supply." The reason of having a 40s. penalty was to meet a case where the damages could not be put into money.

Mr. E. ROWE, inspector in plaintiffs' employ, said the meter would not go on registering when the light went out. If there was a bad light the meter would work very slowly. The light had never gone out to his knowledge for two nights and a day, and he had been with plaintiffs for 10 years. He knew of no other complaints. The offices of the National Lifeboat Institution were in the same building, and no complaint was received from them. They still had the light. He produced the chief engineer's report book and stated that any failure would be there entered.

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The JUDGE examined the book for the date suggested by defendant, and said the voltage was 106.

DEFENDANT: That is too high; 100 is right.

The JUDGE: Consumers living near the station sometimes get too much pressure, do they not? And those living further away too little?

WITNESS: That might be so.

The JUDGE: It seems to me the 40s. penalty provided by the provisional order is for cases where a consumer asks for a supply and does not get it. I therefore allow defendant 40s.

DEFENDANT: Plaintiffs have offered me £4.

The JUDGE: You should have taken it.

Judgment was then entered for plaintiffs for £15s. 9s. 7d. and costs.

### Callender's Cable and Construction Co. v. Killarney Electric Lighting Co.

Last week in the Chancery Division, Dublin, an application was made on behalf of the defendants for an order that Mr. T. C. Goodman, subsheriff of co. Kerry, who was appointed receiver, should be authorised to collect all sums due to defendants, and to pay the wages and other necessary outgoings under the direction of the directors. Defendants wanted to do what they could to preserve the property.

Mr. P. O'C. WHITE, for plaintiffs, asked that the motion should be either refused or allowed to stand till the hearing of the action, when the whole question as to the appointment of manager could be discussed. Plaintiffs were creditors for £1,300 or £1,400, and alleged that defendants' business had been mismanaged by the directors, and that the books did not show the true financial state of the company. Twenty writs had been issued during the year by creditors against defendants, and five executions had been issued. Defendants owed nearly £2,000, and £80 for wages. The debentures were altogether about £7,000.

The Master of the Rolls granted the order.

### The Electric and General Contract Corporation (Ltd.).

Mr. Justice Wright made an order on Wednesday to restore this company to the register of joint stock companies.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The National Physical Laboratory committee propose shortly to consider the appointment of the following members of the staff, and are prepared to receive applications:—Superintendent of engineering department, one or two assistants in the physics department, and an assistant in the physics department to take charge of chemical investigation. The committee are also prepared to receive applications for a small number of junior assistantships. An advertisement contains some additional information, and further particulars may be obtained from the director (Mr. R T. Glazebrook), Old Deer Park, Richmond, Surrey. Applications by May 24.

South Shields Corporation invite applications for the position of electrical engineer to their electricity undertaking. Further particulars are set out in an advertisement, and applications must be sent to the town clerk (Mr. J. Moore Hayton) by 10 a.m. May 22.

The Jandus Arc Lamp Co., Hartham Works, Hartham-road, Holloway, N., require an engineer to take charge of testing room and technical work. See advertisement.

A shift engineer is required for the Sculcoates-lane generating station, Hull. Applications to city electrical engineer (Mr. A. S. Barnard). See advertisement.

Bradford Corporation require two good jointers for their electricity department. Applications to city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. See advertisement.

A shift engineer is required by the Bexhill Urban District Council. Applications to Mr. W. T. Le Feuvre, resident electrical engineer, by May 9. See advertisement.

An assistant engineer is required for the Wandsworth electric light station of the County of London Company. Applications by May 8. See advertisement.

Lancaster Corporation require a principal for the Storey Institute. Applications by May 13.

Mr. B. Branford, M.A., lecturer in pure and applied mathematics at Yorkshire College, Leeds, has been appointed principal of the Sunderland Technical College.

Mr. F. R. Davies has been appointed resident engineer of the County of Sussex Electrical Power Distribution Co's works at Lewes.

There were 47 applicants for the position of principal of the Crawford Municipal Technical Institute, Cork, and these have now been reduced to the following six:—G. E. Armstrong, M.Sc. (Brighton); Arnold Philip, B Sc. (London); E. A. O'Keeffe, B.E. (Blackrock, Cork); J. R. Cotter, M.A. (Dublin); J. Porter, B.E. (Bandon); and James Comerton, B.A. (Cork). The final selection will be made on the recommendation of the Department of Agriculture and Technical Instruction, Dublin.

**Personal.**—Mr. W. J. Furse, electrical engineer, Nottingham, has been unanimously elected chairman of the Basford Board of Guardians and appointed, together with the vice-chairman, representative on the Poor Law Association of England and Wales.

**Alleged Lead Poisoning.**—There has appeared in several of the London papers a number of misleading statements regarding the death of a paster named Walsh, lately in the employ of the Electrical Power Storage Co. at Millwall. An inquiry into the cause of death was held by Mr. Wynne Baxter at Poplar last Thursday, when the coroner stated that the deceased man expired on the previous Thursday, and it had been suggested that death was due to lead poisoning. Consequently, the funeral proceedings had been stopped, and a post-mortem examination made. A fellow workman with deceased named Dempsey stated that the mixing shed was badly ventilated, the gloves old and worn, that there were only two baths for 150 employés, and that while the mixing process was proceeding others than those engaged on this work were allowed to pass through the mixing room Medical evidence was given, and Dr. Wilson certified that death was due not to lead poisoning, which was out of the question, but to a malignant growth, and he had given a certificate to this effect. This evidence was corroborated by Dr. Moffatt, his assistant. Notwithstanding this medical evidence the finding of the jury was "that deceased died from lead poisoning, and that such death was due to misadventure." In reference to the statements made by the witness Dempsey the Electrical Power Storage Co. made the following comments:—

1. The practice of supplying the workmen with baths, aprons, and pasting gloves, was originated by this company before there were any rules made by the Home Office on the subject. The existing rules, to a large extent, were framed on the practice which had been voluntarily initiated by this company.

2. The company has always been most careful as to the quality and suitability of the gloves, and experience has shown that with reasonable care the gloves supplied should last at least a month. The gloves supplied are not old and worn, as was represented, but are the very best obtainable, and are made specially for the work.

3. The public account of the inquest states that we have only two baths for 150 workmen. The number of our workmen is far in excess of 150, but the company is only required to provide baths for the men—18 or 20 men in all—who are engaged in handling lead oxides, and for these the two baths provided are more than sufficient. The baths are carefully examined at short and regular intervals, and it is quite untrue that one of them has been out of order for months. As a matter of grace we have been in the habit of allowing the use of the baths to other workmen, at such times as they were not being used by the men already referred to.

4. With regard to the statement that the men were allowed to go through the mixing shop when the mixing was going on, it is only right to state that such a practice was not only unnecessary, but was strictly forbidden, and any men who did go through went in distinct contravention of the manager's instructions.

5. The company has for years voluntarily employed and paid a medical man to make fortnightly examinations of the workmen, purely in the interests of the men themselves, and whenever the doctor recommended a change work was found in other departments, as far as possible. The post-mortem examination on the deceased was not made in the interests of the company, as suggested; and, as a matter of fact, the company did not know this was contemplated until after it had been made. The verdict of the coroner's jury was in distinct opposition to the certificate of the cause of death (pyloric obstruction, with malignant growth of uncertain duration) and to the evidence given on oath by the two medical men who attended the deceased and who performed the post-mortem examination.

6. No representative of the company other than the solicitor was allowed to be present at the inquest, and he was necessarily unacquainted with many of the questions arising as to the company's practice.

**Amsterdam.**—The tramways in this city have now been taken over by the municipality and are to be worked in future by electricity. The erection of a power-house has just been decided upon, and the overhead system of working has been selected after satisfactory trials.

**Automobile Exhibition.**—The annual show of motor cars opens at the Agricultural Hall, London, to-morrow (Saturday), and will be the largest display of these vehicles ever given. The number of electrical vehicles shows an increase, exhibitors including the Paris Singer (Ltd.), the British and Foreign Electrical Vehicle Co., Mr. Carl Oppermann, Messrs. Shippey Bros. and the National Motor Car Co. Accumulators and other electrical accessories will also make a fair show.

**Automobiles for China.**—Shanghai is an absolutely flat city, and the *North China Herald* advises the establishment of a company for building, repairing and letting out on hire motor vehicles of all kinds, for which there is a splendid opening. The same journal points to the excellent opportunity which this city presents for the establishment of electric trolley tramways and omnibuses.

**Birmingham.**—The Board of Trade inspection of the Bristol-road electric tramway route will take place on 10th inst.

**Bury St. Edmunds.**—An inquiry was held here on Tuesday into the application of the Corporation for sanction to borrow £12,000 for electric lighting extensions. There was no opposition.

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**Christiania (Norway).**—A deputation recently waited on King Oscar to lay before him plans for the construction of several short underground railways to be worked electrically, connecting Christiania with some of the favourite seaside and mountain resorts of the country. One of the lines would run under the Royal Palace gardens. It is reported that the King's consent was provisionally given. The estimated cost of the works is £350,000.

**City of London.**—At the last meeting of the Court of Common Council a resolution was carried "That it be referred to the City Lands committee to obtain from the City of London Electric Lighting Co. the same reduction in price of electric current used by the Corporation as is allowed to other large consumers."

**Colchester.**—The net profit on the electricity supply undertaking during the past year amounted to £360. The equivalent of 10,540 8 c.p. lamps is now connected to the mains.

**Darlaston.**—An inquiry has been held here into the application of the Council to borrow £200 for the electric lighting of the town hall and public buildings.

**Dundee.**—The Blackness electric tramway route was officially inspected on Tuesday. The electricity rental for March was £740, compared with £460 for the corresponding month last year. The total for the eleven months, ending March, was £8,647, an increase of £2,153.

**Dunkirk (France).**—The Dunkirk Tramways Co. is applying for official consent to the conversion of the horse lines into electric tramways.

**Electric Traction on the District Railway.**—The Metropolitan District Railway Co. gives notice of intention to apply to Parliament by petition for leave to introduce into the District Railway Bill clauses to confirm an agreement for equipping electrically the District Railway Company's lines and the City lines and extensions of the District and Metropolitan companies, the Whitechapel and Bow railway, and certain portions of the London and South-Western Co.'s lines. With the consent of the South-Western Company, they will ask to be empowered to lay and maintain between Studland-road junction and the Ealing Extension Railway cables, conducting rails, &c., and to execute all works necessary for adapting such railways to being worked by electrical power. Authority will also be asked to constitute the generating station at Lot's-road into a separate undertaking, and to empower the District Company to take a lease of same.

**Electricity in Mining.**—In the course of an interesting statement to the shareholders of the Consolidated Kent Collieries Corporation last week Mr. F. O'Driscoll, deputy chairman, dealt somewhat fully with the question of the use of electric coal cutters in their relation to the economical and efficient working of coal mines. The question of the presence or otherwise of coal at Dover is one round which a great deal of criticism has centred; and it would appear that those responsible for this Kentish enterprise rather anticipate the presence of what is known as thin seams. With regard to the working of these seams Mr. O'Driscoll expressed the view that the future success of the collieries in Kent depended upon their having a very complete mechanical installation at the pits, and in furnishing for the working of the mines the newest class of machinery for coal cutting and handling. It would appear from Mr. O'Driscoll's statistics that some of the Yorkshire mines with 2ft. seams can be worked as cheaply with mechanical coal cutters as an ordinary 6ft. seam by hand. At the well-known Normanton collieries, where coal cutting by electrical machinery has been in operation for some years, there is a seam 3ft. 3in. thick costing 2s. 4d. per ton for hand working, but in which the coal is won at 11d. per ton by electrical coal cutters. In the first case the men earn poor wages, in the latter a satisfactory return for their labour. The saving of even 1d. per ton in the cost of coal cutting represents £1,000 net profit to the Kent coal venture. At Carlinghow, a Yorkshire colliery, a 17in. seam only is workable, and cut by hand labour costs 7s. 6d. per ton with an average output of 18 cwt. of coal per man per day. Electric coal cutters were put in which reduced the cost to 2s. 3d. per ton, and increased the output per man to 5 tons per day.

At the meeting of the Utah Consolidated Gold Mines (Ltd.) Mr. John E. Dudley Ryder said a great deal of their work was done by electric power, and the remainder by compressed air and hydraulic. The electric installation was upon a very large scale, capable of working not only all the mechanical contrivances, but also lighting their entire area. Perhaps the most important application of electricity was the large overhead crane, which ran the whole length of the smelter building, some 500ft. The lifting capacity of the crane was 25 tons.

**Engineering Amalgamation in U.S.A.**—A combination of manufacturers of steam engines has been effected by the formation of the Allis-Chalmers Engine Building Co., comprising the E. P. Allis Co., the Fraser and Chalmers Co., the Gates Iron Co., and the Dickson Mfg. Co., with a capital of $32,500,000.

**Gateshead.**—The new electric tramway routes were officially inspected on Wednesday.

**Kazan (Russia).**—The horse tramways in this town have now been converted to electric overhead trolley lines for a distance of 18 kilometres.

**Lancaster.**—The electricity supply mains are to be extended to the Skerton district at a cost of £773.

**Leamington.**—An inquiry was held on Wednesday into the application of the Council to borrow £7,000 for a refuse destructor.

**Lewes.**—The electricity works of the County of Sussex Electrical Power Distribution Co. are approaching completion, and it is anticipated that a supply of electric current will be available in about a fortnight.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Spen Valley Light Railway Order, 1901, and the Spen Valley Light Railway (Extensions) Order, 1901.

Colne Council resolved on Wednesday to draw the attention of the promoters of the Colne and Trawden Light Railway to the delay in obtaining the confirmation of the order, and a copy of the resolution has been forwarded to the Board of Trade. The inquiry by the Light Railway Commissioners was held in March, 1899.

Middlesex County Council intend to apply for powers to construct electric tramways from Tottenham, through Wood Green and Friern Barnet, to near Colney Hatch Asylum, and from Highgate Archway, along Archway Road and Great North Road, to the Hertfordshire boundary near Whetstone. The total cost is estimated at over £500,000, and the Council has entered into a contract with the North Metropolitan Tramways Co. to work the lines. A connecting line from Highgate railway station to the Muswell Hill entrance of Alexandra Palace and Park is also contemplated. Finchley Council propose to construct a tramway to join the proposed Finchley and Hendon lines.

**Limerick.**—The Council have received formal sanction to a loan of £22,000 for their electric lighting scheme. The loan will be issued in four instalments, and is repayable in 25 years at 3¼ per cent.

**Liverpool.**—At Wednesday's meeting of the City Council the report or Mr. A. P. Trotter, electrical adviser to the Board of Trade, on the recent fatal accident from overhead wire breakages was referred to. Mr. Austin Taylor asked that the report might be made public, especially as it was of a reassuring character so far as their tramway system was concerned. It would appear that in Mr. Trotter's report eight separate causes are given as having contributed to the accident—the fall of snow, the failure of the wood guard, the excessive number of telephone wires, the length of span of these wires, the salted slush of the streets, the darkness and consequent invisibility of the wires, the failure of the telephone service, and the delay in cutting off the electric current. Mr. Trotter points out that the absence of any one of these eight causes might have minimised the serious nature of the catastrophe. It was stated during the discussion that the National Company are placing their wires underground. We learn that the question of making the report public is under the consideration of the Board of Trade, but that so far no decision has been come to on the subject.

**London County Council.**—At Tuesday's meeting it was resolved to loan Battersea £10,600 for additional electric lighting mains. It was reported that St. Pancras had withdrawn their application for a loan of £830 for lighting of public buildings by electricity.

*Automatic Fire Alarms.*—The Fire Brigade committee reported that the Treasury had asked the Council's views on the proposal by the Postmaster-General to grant to the May-Otway Fire Appliances (Ltd.) a licence on similar terms to that given to the Pearson Fire Alarm Syndicate (Ltd.) to provide electrical communication between fire stations and premises fitted with May's automatic fire annunciator apparatus. The Pearson application was granted, notwithstanding the dissent of the Council, and the committee now recommended that the Council re-affirm its dissent to any such application being granted.

*Electricity in Bulk.*—A lengthy report was submitted by the Highways committee on this subject. In June, 1893, a conference of local authorities was held, and resolutions agreed to, affirming that "it is essential to the interests of London as a whole that the present purchase clause of the electric lighting acts, which applies to defined areas, should also be made to apply to such companies as propose to supply electrical energy in bulk to the whole of London without regard to area; and that, while preserving intact the rights of local authorities with regard to electric lighting and energy, it is desirable that the London County Council should be in a position to undertake, if it so determine and if so requested by the local authority, the supply of electrical energy in bulk for the convenience of any districts desiring to be so supplied, provided that the Council does not become competitive with the local authority." Since that time (continues the report) in four cases the establishment of bulk supply undertakings had been allowed, and the committee urge that such arrangements did very seriously reduce the power of purchase given to local authorities, as this rendered it difficult if not impossible for the authority to purchase the whole undertaking within its district as a going concern. The Council had endeavoured, without success, to get the insertion of clauses giving effect to the resolutions above set out. The committee now recommended that a conference of local authorities should be called for Thursday, May 16, to consider the matter, and this was agreed to.

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*Bexley Tramways Bill.*—The Parliamentary committee reported that the bill promoted by the Bexley District Council proposed to authorise the construction of lines of tramways, several of which were situated in the County of London, and these would be in continuation of the lines proposed by the Bexley Council outside the county, and would extend to a point near the terminus of the existing trams in the Plumstead-road, at present owned and worked by the Woolwich and South-Eastern Tramways Co. This the committee considered undesirable, and they thought an arrangement might be made with the Bexley Council upon the basis of omitting from the bill the parts relating to the county on the assurance that the London County Council would itself promote a bill next session for the construction of the lines proposed in the bill. It was agreed that this should be undertaken.

*Electric Light Contract.*—It was agreed that the offer of the metropolitan borough of Poplar to supply electricity to the Greenwich tunnel at 1·8d. per unit, upon an estimated minimum quantity of 100,000 units per annum, be accepted.

**Londonderry.**—The Corporation have at last decided to carry out the recommendations of their consulting engineer (Sir William Preece) to give a supply of electric current for private lighting. In January the Lighting committee advised the Corporation to adopt Sir William Preece's proposals and to apply for a loan, and, after various adjournments, the matter was finally disposed of last week.

**Long-Distance Telephone Extension.**—Telephone lines are being established between Christiania, Gothenburg, Malmö, and Copenhagen, and between Stockholm and Malmö. Telephonic communication has recently been established between Hildersborg and Landskorna (Sweden) and Wedbäk on the Danish coast.

**Manchester.**—An inquiry will be held on Tuesday into the application of the Corporation to borrow £810,000 for electrical supply.

At the Corporation meeting on Wednesday the chairman of the Electricity committee (Dr. Bishop) made a statement as to the progress of the Stuart-street generating station. Messrs. C. S. Allott & Son were preparing specifications for the buildings. A large proportion of the plant was expected to be ready by May next year. At a meeting of the sub-committee on Thursday last a resolution was come to, on the advice of Dr. A. B. W. Kennedy, that a deputation should visit various manufacturers of electrical machinery. Three-phase plant had not been adopted in this country, but when their station was completed it would be the best three-phase station in the world. There were only three or four firms in Europe who would be in a position to tender for the electrical portion of the work. The whole question was one of speedy delivery and erection, and it was considered desirable that a deputation should be sent who would report to the Council as to which firm, in their opinion, would be most likely to turn out the work to time. The deputation would consist of four members. Tenders had been invited and had to be in by May 14. Contrary to expectation it would be the end of the month, and possibly a few days later, before the committee would be in a position to run any cars. They could run the cars to-morrow if the Board of Trade had made their inspection, and they could run them as soon as the Tramways committee were in a position to allow them to do so. The deputation is to consist of the chairman and vice-chairman (Mr. Phythian) of the Electricity committee, Mr. Johnston and Mr. Bowes.

**Marylebone (London).**—At last night's meeting of the Borough Council the Lighting committee reported the receipt of a proposal from the Metropolitan Electric Supply Co. that the Council should purchase the Metropolitan Company's undertaking in St. Marylebone by arbitration under the Lands Clauses Act. The Chairman of the Council (Mr. E. Boulnois, M.P.) had agreed that the second reading of the Council's bill in Parliament should be postponed until Thursday, May 9, in order that the Council might have the opportunity of deciding whether they would be willing to purchase on these conditions. Councillor DEBENHAM proposed and Mr. BROOKE HITCHING seconded a resolution pledging the Council to purchase the Metropolitan Company's St. Marylebone undertaking on terms to be agreed, or, failing agreement, to be determined by arbitration, and empowering the Lighting Committee to enter into an agreement for this purpose with the Metropolitan Company. After some discussion this resolution was agreed to.

**Medan (Sumatra).**—An alternating-current electricity station has been erected at Medan by the Electriciteit Maatschapij Medan, under the supervision of the company's engineer-in-chief, Dr. E. Fullner, has been working a year, and on March 1, 1901, had an equivalent connection of 3,000 16 c.p. lamps supplied by overhead conductors. The station is turbine-driven, with an aggregate of 350 H.P. The price of current is 0·50fr. per kilowatt-hour. The total plant capacity of the station is 220kw.

**Middleton.**—An inquiry was held here last week into the application of the Council to borrow £12,442 for electric lighting. There was no opposition.

**Monte Video.**—An interesting gathering of members of Congress, accompanied by the Minister for Foreign Affairs, met recently at the offices of the Western Telegraph Co. and were shown all the latest improvements and developments in telegraphic working established by the company, which owns 7,000 nautical miles of cable and has large interests in South America. The visitors were conducted by Mr. John Oldham, the company's representative at Monte Video, who introduced Mr. H. G. Cheesman, the company's electrical expert, who has recently been engaged in visiting the telegraph stations in this part of the world on technical duty.

**Municipal Telephony.**—Liverpool Corporation was on Wednesday invited to pass a resolution in favour of establishing a municipal telephone service, but the motion was "talked out."

Halifax Finance committee has instructed the borough engineer (Mr. Lord) to prepare an estimate of the cost of establishing a municipal telephone exchange.

**Paisley.**—Messrs. J. and J. B. Atherton have submitted to the Corporation revised terms for the construction of electric tramways in the district, and, provided the terms are accepted, a bill will be promoted next session.

**Poole.**—The Council have applied to the Board of Trade to revoke the Poole and Branksome provisional order (1897), as the promoters have taken no steps to lay mains within the district.

**Rotherham.**—It was announced at the Council meeting on Wednesday that the electric works would be opened in about three weeks.

**St. Helens.**—The salary of the borough electrical engineer (Mr. J. S. Highfield) has been increased from £400 to £500 per annum, and he has been granted a bonus of £100 for extra services when the new lighting station and its accessories are completed. The salary of the assistant (Mr. E. M. Hollingsworth) has been increased from £150 to £180 per annum, and the salaries of Messrs. Carter and Eccles, shift engineers, from £125 to £150. The new 600 H.P. unit was officially started on Friday last.

**Salford.**—All obstacles to the transfer of the undertaking of the Manchester Carriage and Tramways Co. have been overcome, and the formal transfer will take place immediately. The Corporation agree to pay £42,500 for the company's tramcars, horses, and other plant.

**South Shields.**—In our issue for April 19, page 989, we referred to the appointment of Mr. J. A. Jeckell, of South Shields, to the head of the Coventry Corporation electrical department. The present plant capacity at South Shields station should have been stated at eight times, and not four times, that which was first put down by Mr. Jeckell.

**Swansea.**—A difficulty has arisen in connection with the proposed Corporation electric tramways. An arrangement had been arrived at between the Corporation and the tramways company by which the line would be leased to the latter, but the terms of the proposed lease have been omitted from the order. The company now claim a longer lease than 21 years, which the Corporation seems not disposed to grant.

**Telegraphic and Telephonic Communication with the Continent.**—A communication has been addressed by the Postmaster General to the Associated Chambers of Commerce, stating that he has carefully considered their memorial on telegraphic and telephonic communication with the Continent, and direct wires from London to Magdeburg, Lyons, Zurich, Budapest and Genoa have been recently established, in addition to those already existing to Berlin, Hamburg, Bremen, Cologne, Frankfort, Paris, Bordeaux, Marseilles, Lille, Havre, Amsterdam, Rotterdam, Brussels, Antwerp, Vienna and Rome, and the Postmaster-General is in negotiation with the Italian telegraph administration respecting a direct wire to Milan. The new cable to the Netherlands is in operation, the cable to Germany will probably be laid by the end of May, and negotiations are proceeding for an additional cable to Belgium. Lord Londonderry points out that direct wires between Havre and the cotton manufacturing towns in the north and east of France would be of little benefit to traffic from this country for that district of France. It is hoped that before long the provincial towns of England and France will be brought into telephonic communication. The Postmaster-General is unable to arrange for the establishment of any additional direct wires from provincial centres to the Continent, with the possible exception of one between Liverpool and Paris. Respecting the provision of underground lines (continues the Postmaster-General), the great costliness of gutta percha-covered wire and its electrical defects had until recently stood in the way of its being used except in limited extent. The introduction of paper-insulated cable, both cheaper and better from an electrical point of view, had, however, enabled the department to construct the important experimental underground line between London and Birmingham, which had proved of great advantage during last year's storms. This would be extended further northward. He was not without hope that still further extensions might be made.

**Telephone Wayleaves in Sweden.**—A combination of house-owners at Heslingborg recently petitioned the Telephone Administration for a fee of 25kr. per annum for the fixing of telephone wires on their houses. The proposal was rejected, on the ground that an additional charge would have to be made to subscribers, and that this practice is not observed in any other part of Sweden.

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**The Telephone at Glasgow Exhibition.**—The use of the telephone by exhibitors and others at the Glasgow Exhibition is to be a distinctive feature. The National Telephone Co. has secured orders for about 100 wires to connect exhibitors' stands with an exchange which the company is opening in the exhibition. This exchange will be equipped with the most up-to-date apparatus, and ample call office accommodation has been provided for the general public. By payment of 1d. per call communication can be secured with any subscriber in the company's Glasgow exchange area, and for the usual payment trunk communication between the exhibition and all parts of the kingdom can be obtained. Exhibitors who have established the telephone at their stands at the exhibition will have all the usual subscriber's privileges, both for local and trunk communication. The National Company have also, we learn, carried out the wiring for the fire alarm system of the exhibition, which is more than usually complete.

**Turin (Italy).**—The steam tramway lines of the Turin-Gassino section of the local tramways are being converted into electric lines.

**Twentieth Century Electrical Exhibition.**—As previously announced, an electrical exhibition will be held at the Royal Aquarium, Westminster, London, S.W., from Dec. 16, 1901, to Jan. 26, 1902, inclusive. A synopsis of the intended features of this show can now be obtained from the organiser, Mr. M. J. G. Ritchie, who is anxious to get together all the latest inventions relating to electric lighting, power, locomotion, telegraphy, heating, &c., which will be exhibited in the large main hall of the Aquarium, where exhibitions of various kinds are held from time to time. The hall is to be specially fitted for machinery in motion and for the generation of current for the stands in the main hall. The Aquarium buildings are connected to the Westminster Electric Supply Corporation's system. The Aquarium is centrally situated, and the enterprise of the management is well known. A special feature is to be made of electric lighting plant, material, and accessories. The Westminster Aquarium is one of the few prominently situated buildings in London proper where such an exhibition can be held with any reasonable probability of success.

**Ventnor.**—The Council have appointed a special committee to report as to the terms upon which the Ventnor Electric Light and Power Co. will dispose of their undertaking.

**Water-Power Utilisation.**—Prof. S. Arrhenius was engaged last autumn by the Swedish Government to visit the Continent of Europe with a view of studying the various water-power schemes which are working there. In a report just presented, he points to the fact that population is densest where coal is found, as in England, Belgium, France and Germany. Sweden is wholly dependent upon outside supplies for coal, and in 1900 imported coal to the value of 64,000,000kr. Prof. Arrhenius estimates the total waterfall power available in France, Italy and Switzerland at between 3,000,000 H.P. and 5,000,000 H.P., and in Finland at 2,500,000 H.P., exclusive of falls of under 3 metres. Similar force in Sweden is estimated at about 4,000,000 H.P. Geneva and Switzerland, with a population of 100,000, is reported to utilise 15,000 H.P. of its water power. Prof. Arrhenius regards the commercial value of the Swedish falls as having been greatly exaggerated, owing to their distance from the sea and from the present location of industrial undertakings. The water-power installation worked at the lowest cost of any visited by Prof. Arrhenius was that at Savoy, in the French Alps, where the cost is put at 100fr. per H.P. at the source of power. At some of the stations this cost rises to from 1,000fr. to 1,200fr. per H.P.

**West Bromwich.**—The Electric Lighting committee have received the sanction of the Local Government Board to borrow £9,750 for providing materials, &c., for wiring houses on the easy payment system, and supplying motors on hire. The period of the loan is for 10 years. The Board, however, decline to sanction an item of £250 for lamps, which they thought should be paid out of revenue.

**Westhoughton (Lancs.).**—The Council have resolved to apply for an electric lighting order.

**Wigan.**—The Council on Wednesday approved the proposal of the Electric Light and Tramways committee to abandon the maximum demand system of charging, and to substitute therefor a uniform charge of 3d. per unit for long-hour, 4d. for medium, and 5d. for short-hour consumers, with 1d. per unit for power.

**Wolverhampton.**—A meeting of the Town Council was held on Monday to consider a proposal by the Tramways committee to construct an experimental line of tramway on the Brown underground surface-contact system. Ald. C. T. Mander, chairman of the committee, explained the system, and contended there was less danger than attended the using of the overhead trolley system. The Lorain Steel Co., owners of the patents, offered to lay an experimental line from Tettenhall to the borough boundary on the Bilston-road in about eight to 10 months, and they would deliver three motor-car equipments within about three months of receiving the consent of the Council, provided the Council gave the cars a thorough test under actual working conditions for at least 60 days. If the test should prove successful, then the Corporation should enter into a contract with the company for laying 10 miles of single track. If the experiment did not prove a success at the end of a year the company would take up and reinstate the track without expense to the Corporation. The company had also agreed to put down a mile of the track on the Bilston-road and have it in working order in three months if the Corporation wished it. Ald. Mander thought the offer of the company ought not to be refused. There was no question that the overhead system was doomed at an early date, if not within a year or two. Ald. Price Lewis was opposed to putting down an untried surface-contact system. He thought there was more danger in the Lorain system than in the Dolter system, which had been inspected in Paris. He also objected to the expense of the scheme. Ald. Craddock said the overhead system was unsightly, and the Lorain system was up-to-date, but the question was whether the town was prepared to pay £2,000 extra per annum for having the streets clear of unsightly poles. The members of the committee were divided as to the advisability of adopting the system. The meeting was adjourned until Monday next.

**Wrexham.**—The borough electrical engineer (Mr. Sillery) has reported to the Council that the equivalent of 1,323 8 c.p. lamps are connected to the mains.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2, and 3, Salisbury-court, Fleet-street, London :—*

### READY.

Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. United States, 15s.)

**"The Electrician" Electrical Trades' Directory and Handbook for 1901** (corrected to February 4, 1901).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. The latest developments of State and Municipal Telephone enterprise are set out from official sources, as well as the progress of the National Telephone Co.'s service. In the division of "Electric Light, Power and Traction," the valuable Digest of the Law on these subjects by Mr. A. C. Curtis-Hayward, B.A., solicitor, has been much extended; the full text of the Electric Lighting Acts and the Board of Trade Accounts Forms have been added; and Sketch Maps and particulars of the Electric "Bulk" areas are also given, together with a coloured sketch map of the Electric Railways and Tramways of the United Kingdom. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to Feb. 11. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 4, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

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"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By R. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

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# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Extension of Time.—Stirling* Town Council have fixed MAY 10, instead of May 1, as the day for receiving tenders for extensions of steam, drain, feed-pipes and feed-heater. See advertisement.

*Bermondsey* (London) Borough Council invite tenders for wiring and fitting the electricity station and stables, Neckinger. Specifications may be obtained from the Town Hall, Spa-road, Bermondsey, and can also be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George street, Westminster. An advertisement contains further particulars. Tenders to the town clerk (Mr. F. Ryall) by noon May 21.

*Hendon* Urban District Council invite tenders for the wiring of the new Council offices. The installation will comprise 213 lamps, various fittings, fans, and accessories. Specifications, &c., can be obtained from Mr. Robert Hammond, consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W., on and after May 8, and tenders have to be sent to Mr. Henry Humphris, clerk to the Council, Public Offices, the Burroughs, Hendon, Middlesex, before 4 p.m. June 5. An advertisement contains some further particulars.

*Bristol* Electrical committee invite tenders for alternating-current transformers. Tenders to city electrical engineer (Mr. H. Faraday Proctor) by noon May 12. See advertisement.

*Bristol* Electrical committee also require steam and other piping, low-tension switchboard, and a 210kw. continuous-current dynamo. Tenders to chairman by noon, May 9.

*Manchester* Corporation Tramways committee require tenders for steel girder tramway rails, fish plates, tie bars, bolts and nuts, and 5,000 steel tramway poles. Specification, &c., from Mr. J. M. McElroy, general manager, Tramways Department, and tenders to Chairman of Tramways committee, 55, Piccadilly, Manchester, by 1 p.m., May 18. An advertisement gives further particulars.

*Manchester* Tramways committee require cast-iron curbs for tramway centre poles. Specifications from the general manager (Mr. J. M. McElroy). Tenders to chairman, 55, Piccadilly, Manchester, by 9 a.m, May 7. An advertisement contains further particulars.

*Manchester* Electricity committee also require water-tube boilers, steam engines, with condensing and auxiliary plant, three-phase generators and motor transformers. Tenders to chairman by May 7.

*Long Eaton* District Council invite tenders for two steel Lancashire boilers, engines, dynamos, switchboard, and accessories. Specifications, &c., of the district engineer (Mr. F. Worrall), Council offices, Long Eaton, and tenders must be in by noon May 20. An advertisement contains further particulars.

*Dublin* Lighting committee invite tenders for main and sub-station switchboards, transformers, arc lamps and arc lamp pillars. An advertisement contains further particulars, and specifications may be inspected at the offices of the engineer (Mr. Spencer Harty), City Hall, Dublin, and at the offices of the consulting engineer (Mr. Robert Hammond, 64, Victoria-street, London, S.W.) Tenders to town clerk (Mr. Henry Campbell), City Hall, Dublin, by 4 p.m. June 3.

*Dundee* Gas Commissioners invite tenders for a 700kw. triple expansion steam engine and dynamo. Specifications from the city electrical engineer (Mr. Walter H. Tittensor) and tenders to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by May 11. An advertisement contains further particulars.

*Ashton-under-Lyne* Council invite tenders for about 445 tons of steel girder rails, 21 tons of fishplates, 21 tons of sole plates, 31 sets of points and crossings, 220 cwt. of tie bars, and 220 cwt. of nuts, bolts, and washers. Tenders by noon, May 9.

*Plymouth* Corporation invite tenders for overhead line construction. Tenders by 18th inst.

*Fulham* (London) Borough Council invite tenders for materials and goods required in connection with their electric lighting and dust destructor station for the period ending March 31, 1902. Tenders to Town Hall, Fulham, London, S.W., by 5 p.m. May 15.

The directors of the *Great Eastern Railway Co.* invite tenders for stores, including telegraph materials, galvanised iron, lead, tin, &c., bolts, screws, and rivets, tools, hardware, cast-iron pipes, &c. Tenders to the secretary (Mr. W. H. Peppercorne), by 10 a.m. May 14.

*Tonbridge* District Council invite tenders for boiler and engine-house plant, condensing apparatus and pipe work, travelling crane, switchboard and instruments, accumulators, mains, meters, public arc and public incandescent lighting. Tenders to clerk by 4 p.m. May 30.

*Swansea* Corporation invite tenders for the supply and erection of two-phase motor generators and switch gear. Tenders before noon, May 15.

*Battersea* (London) Borough Council invite schemes for wiring consumers' premises. Tenders to Mr. W. Marcus Wilkins, Municipal Buildings, Lavender-hill, S.W., by May 14.

*Newport* (Mon.) Guardians invite tenders for an electric lighting installation at their Stow Hill workhouse. Tenders by May 8.

*Rochdale* Corporation require two 412kw. steam dynamos. Tenders to town clerk by May 16.

*Motherwell* Electric Light committee require cast-iron lamp columns, arc lamps, switches, fittings, &c. Tenders to town clerk by May 18.

*Ludlow* Corporation invite tenders for electricity generating plant. Tenders to town clerk by May 20.

*Kirkcaldy* Corporation invite tenders for the permanent way construction of tramways, rails, car sheds, &c. Tenders by May 13.

*Edinburgh* Corporation invite tenders for 12 months' supply of electricity meters. Tenders to town clerk by May 6.

*Caledonian Railway Co.*, Glasgow, require tenders for larch telegraph poles. Tenders by 13th inst.

*Glasgow* Corporation require a motor dust van. Tenders to Mr. J. Lindsay by May 13.

## TENDERS RECEIVED AND ACCEPTED.

Newport (Mon.) Corporation have accepted the following tenders in connection with their electric tramway scheme :—

| | | | |
|---|---|---|---|
| Hemingways (Ltd.) (structural steel works) | £11,955 | 0 | 0 |
| Markham & Co. (steam engines) | 11,590 | 0 | 0 |
| A. S. Morgan & Co. (foundations) | 9,349 | 10 | 4 |
| Babcock and Wilcox (boilers) | 5,893 | 0 | 0 |
| Witting Bros. (Kolben dynamos) | 5,170 | 0 | 0 |
| Worthington Pumping Engine Co. (condensing plant) | 5,056 | 0 | 0 |
| New Conveyor Co. (coal and ash conveyor) | 1,987 | 0 | 0 |
| Underfeed Stoker Co. (mechanical stokers) | 1,198 | 0 | 0 |
| J. Hitchin & Son (overhead traveller) | 955 | 0 | 0 |
| J. Lysaght & Co. (steel flue) | 712 | 0 | 0 |
| A. Lowcock (Ltd.) (fuel economiser) | 575 | 0 | 0 |
| Westwood and Wright (water storage tanks) | 324 | 0 | 0 |
| J. P. Hall & Sons (feed-water pumps) | 292 | 0 | 0 |

The total of the accepted tenders is £55,006. 10s. 4d.

The West Ham Borough Council have accepted the following tenders for electric lighting plant supplies, &c. :—House wire and wiring accessories, Hands Limited, Veritys Limited, and Geipel and Lange; double-pole house cutout boxes, Reason Manufacturing Co.; meters, British Thomson-Houston Co.; cables, &c., British Insulated Wire Co.; transformers, S. Z. de Ferranti (Ltd.); engine-room stores, Middleton Bros.

Bolton Corporation have accepted the tender of John Musgrave & Sons for new engines at the electricity works.

Burnley Corporation have accepted the tender of the British Thomson-Houston Co. for 24 electric tramcars complete at £765. 3s. each.

Newcastle-on-Tyne Corporation have accepted the tender of Messrs. Higginbottom and Mannock for a 3-ton electric crane for their tramway power station.

Manchester Corporation have accepted the tender of the Edison and Swan Company for the supply of switchboard and accessories for their Bloom-street electricity works.

Southwark (London) Borough Council have accepted the tender of Veritys (Ltd.) for incandescent lamp brackets and fittings at £880. 12s.

## BUSINESS NOTICES.

We have received the following from the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.) :—

"The Hiram S. Maxim Electrical Corporation (in liquidation).

"With reference to the recent advertisements concerning the liquidation of this company there appears to be some misunderstanding as to the reason therefor, and I am instructed to inform you that the business of this company has been sold on favourable terms to the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.). The liquidation proceedings were purely voluntary, and were instituted only for the purpose of carrying out this sale. The whole of the old company's creditors are being paid in full, and the shareholders will receive for their present holding shares in the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.).

W. J. WHEATLEY, Secretary and General Manager.

"65-67, Gracechurch-street, London, E.C."

Messrs. De Grelle, Houdret & Co., 130, London-wall, London, E.C., have been appointed sole representatives in Great Britain for the Braunschweigische Maschinenbau-Anstalt, for the sale of that firm's dynamos, motors, and other electrical manufactures, of which a stock of open and enclosed type machines will be kept in London for immediate delivery. Fully illustrated lists of these machines of the direct-current type are now ready, and can be obtained on application.

The Samuel Barnes Electric Co. have opened offices at Bush-lane House, Cannon-street, London, E.C., where an extensive range of American electrical specialities will be stocked. The company are

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sole agents for a large number of United States manufacturing houses. Mr. Samuel Barnes is general manager of the company.

Julius Sax & Co. (Ltd.) have removed to 51, Rupert-street, London, W.

### PETITIONS, BANKRUPTCIES, LIQUIDATIONS, &c.

Hy. Geo. Massingham, 15, Southernhay West, Exeter (lately electrical engineer, 23, Victoria-parade, Torquay), has been adjudicated bankrupt. The first meeting of creditors and public examination will take place at the Castle, Exeter, on May 16.

Meetings of shareholders, contributories, unsecured creditors, &c., of the Coventry Gas Fitting, Electrical and Engineering Co. (Ltd.) have been called in order to discuss the reconstruction scheme, under which it is proposed that creditors shall receive a cash dividend of 2s. 6d. in the £ within two months from the confirmation of the scheme by the Court, and the remaining 17s. 6d. by half-yearly instalments, the unpaid instalments being secured by a debenture issue. It is proposed that a new company be formed with a capital of £15,000 in £1 shares.

A deed of arrangement has been executed in favour of the creditors of Messrs. Reame, Wokes & Co., electrical engineers, 8, George-street, Hull, the total liabilities being about £2,500, with assets returned at about £650.

At Leeds, on Tuesday, Thomas Arthur Flather, electrical engineer, 406, Meanwood-road, lately carrying on business at the Park Electrical Works, Speedwell-street, Leeds, submitted himself for public examination. The accounts showed a deficiency of £325. 9s. 9d. The examination was adjourned.

A petition for the winding-up of the British Electric Works Co. (Ltd.) will be heard in the High Court on 8th inst.

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**Carbons for all Electrical Purposes.**—Mr. V. Dasnières, 10, St. Mary Axe, London, E.C., has now ready a set of circulars relating to the carbons and carbon-making machinery manufactured by M. J. A. Berne, of Paris, for whom Mr. Dasnières is sole agent. The circulars also illustrate special types of carbon brushes for tramway working. Mr. Dasnières is also sole agent for Messrs. E. Mors & Co., of Courbevoie, France, manufacturers of a new high intensity cell of special type, regarding which full printed particulars are available.

**Westinghouse Plant.**—Circular No. 1,045 of the British Westinghouse Co. deals with the subject of lightning protection. Several types of arresters are illustrated.

**Mather and Platt Plant.**—A well-illustrated catalogue of special types of electric generating plant manufactured by Messrs. Mather and Platt, of Manchester, is just issued for the use of those engaged in the laying down of new or extension of old plant for the generation of electric current for traction, lighting, electrolytic, and other purposes, or for mill driving, pumping, mining and crushing machinery, and general power transmission.

**Glasgow Exhibition.**—Messrs. Alley and MacLellan, Sentinel Works, Polmadie, Glasgow, and 28, Victoria street, London, S.W., are issuing an excellent index map of Glasgow and district which, in addition, gives information which will be found useful by visitors. The same firm are publishing a very neat handbook descriptive of the exhibits at their stand.

**Conradty Carbons.**—These carbons have been selected for use by the Brockie-Pell Arc Lamp (Ltd.) for the installation of their lamps at the Glasgow Exhibition, and we are asked to state that the carbons are made in various qualities for open or enclosed arc lamps, and that stocks are held by Messrs. Crompton & Co., by Messrs. Johnson and Phillips, and by the manufacturers' agents, the Sloan Electrical Co., 15, Fore-street-avenue, London, E.C.

**Complete Electric Lighting Plant Catalogue.**—From Messrs. Drake and Gorham, 66, Victoria-street, London, S.W., we have to acknowledge the receipt of a very complete catalogue of electric lighting plant and accessories. At the start some useful notes are provided on the subject of initial outlay involved in the installation of the electric light in country houses, and the working costs. Messrs. Drake and Gorham's long experience in this special class of work gives additional value to their views on these matters. These notes are followed by tables and text relating to various types of generating plant suitable for large and small installations, accompanied by some good views of lighting and power plants driven by steam, gas, oil, and water. To those contemplating putting down electric plants, this catalogue will prove of particular service, as much of the information is of a special character. The printing industry will find the list of service, as several of the illustrations and textual details refer to motor-driven printing machines. The list, of course, deals especially with the large variety of apparatus of which Messrs. Drake and Gorham are manufacturers or sole agents, and these will be found to cover much of the plant and a large proportion of the accessories required in electric lighting work. The list is notable for an excellent selection of fittings for private and public lighting, and especially for the care with which the indices to the various sections of the book have been prepared. There is instructive matter on the whole of the 200 quarto pages of which the catalogue consists.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 24 to 30, with the ports of destination :—

*Africa*—Cape Town, £515 ; Durban, £4,038 (including £3,650 telegraph material) ; East London, £1,338 (including £1,300 telegraph material) ; Port Elizabeth, £103 ; Zanzibar, £32. *Argentina*—Buenos Ayres, £192 (including £150 telegraph material) ; La Plata, £29 (telegraph material) ; Rosario, £77 (telegraph material). *Australasia*—Adelaide, £25 ; Fremantle, £72 ; Perth, £210 ; Sydney, £1,259. *Belgium*—Antwerp, £14 ; Ghent, £120. *Brazil*—Rio Janeiro, £1,187 (telegraph material). *Burma*—Rangoon, £87. *Canada*—St. John (N.B.), £34 (telegraph material). *Ceylon*—Colombo, £284. *Chili*—Valparaiso, £149. *China*—Shanghai, £284. *Colombia*—Santos, £168. *France*—Calais, £30 ; Gijon, £622. *Germany*—Hamburg, £300. *Gibraltar*—£261 (telegraph material). *Holland*—Rotterdam, £21. *India*—Bombay, £64 (telegraph material) ; Calcutta, £1,543. *Malta*—£25. *Mexico*—Coatzacoalcos, £1,522. *Straits Settlements*—Singapore, £206. *Sweden*—Stockholm, £170 (telegraph wire). *Uruguay*—Monte Video, £21 (telegraph material). Total £15,002, against £18,765 in the corresponding week last year (April 25 to May 1).

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## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 11, 1901.

724. B. J. Brander. Birmingham. Improvements in or relating to telephone instruments with magneto generators.
740. H. Oppenheimer. London. Improvements in and connected with call lines in telephone exchanges. (Actiengesellschaft Mix & Genest, Germany.)
759. E. Sander. London. Improvements relating to filaments for incandescent electric lamps.
776. C. Meissner. London. Improvements in or relating to electrically operated ploughs.*

January 12, 1901.

802. W. Rennison. Manchester. The application of an electrical apparatus for working the speed counter, or speed recorder, or steam, gas, oil or other engine, or any machine having moving parts.
831. W. B. Isworth. London. Improvements in laying street underground electric conductors.
833. F. Taylor. London. Improvements in current collectors for electric railways.
840. Siemens Bros. & Co. (Ltd.). London. Improvements in electric safety fuses. (Siemens and Halske Aktiengesellschaft, Germany.)*

January 14, 1901.

856. J. Dewar. Glasgow. Improvements in and relating to winches for raising and lowering arc lamps.
916. E. R. Hill. London. Improved means for supplying electric energy to railway vehicles.
923. O. Imray. London. Improvements in switches for electric point and signal apparatus. (Société Anonyme de Force et Lumière Electriques, France.)
924. O. Imray. London. Multiple electric contact making and breaking apparatus for railway signals. (Société Anonyme de Force et Lumière Electriques, France.)

January 15, 1901.

946. G. Stevenson and W. H. Farnsworth. Nottingham. Horizontal sliding tension clip for use with flexible electric light fittings.
947. A. de Pont and S. de Pont. Liverpool. Improvements in the materials for electric cables.
969. C. O. Bastian. London. Improvements in or relating to electrolytic electricity meters.
972. W. Denison and H. Denison. Bradford. Cover and circular motion for arm for electrical car top.
973. Major A. Roswell. London. An electrically illuminated portable travelling case.
988. J. Skopec and F. Ondra. London. An improved support for aerial electric conductors and the like.
998. T. C. Newell. London. Improvements in electric brakes.
1,011. P. D. D. Nero and J. Camino. London. Apparatus for testing electric meters.*
1,016. The British Thomson-Houston Co. (Ltd.). London. Improvements in dynamo-electric machines. (E. Thomson, United States.)*

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1,017. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric transformers. (W. S. Moody and W. Le R. Emmet. United States.)*

January 16, 1901.

1,023. A. L. Reinmann. Liverpool. Improvements in or connected with incandescent electric lamps.
1,024. A. L. Reinmann. Liverpool. Improvements in or connected with incandescent electric lamps.
1,025. A. L. Reinmann. Liverpool. Improvements in or connected with incandescent electric lamps.
1,049. The British Thomson-Houston Co. (Ltd.) and Hans S. Meyer. London. Improvements in induction electric motors and method of operating the same.*
1,087. L. B. Atkinson. London. Improvements in electric meters.

January 17, 1901.

1,103. F. W. Francis. London. Improvements in telephonic and other switchboards apparatus.
1,122. C. O. Janney. Missouri. An automatic corrector for step-by-step mechanism driven or controlled by electrical impulses.*
1,134. D. von Olegar. London. Electric-vibrating retouching apparatus.
1,156. J. J. Nef and J. E. Auger. Liverpool. Improvements in or in connection with car trucks applicable for electric tramway cars and other purposes.
1,167. W. A. R. Mathiesen. London. Improvements in electric meters.*

January 18, 1901.

1,181. A. Spark. Aberdeen. Improvements in electric switches.
1,189. T. W. Stansfield. Cheshire. Improvements in carbon brush holders for dynamos and motors.
1,193. R. Haensel. Berlin. Coin-freed delivery apparatus for electric current.*
1,219. H. L. Todd and J. Dunham-Massey. London. Self-contained electric motor.
1,224. B. B. Schaefer. London. Improvements in receiving apparatus for electro-dynamic so-called Hertzian waves.*
1,225. J. Ch. Schäfer & Co. and E. Marx. London. The procedure and apparatus for indicating and registering electric or magnetic signals.*
1,232. H. T. Harrison. London. Improvements in electrical measuring instruments.
1,237. W. H. Wheatley. London. Improvements in trolleys for collecting current from overhead wires. (H. Dufray & Co., France).

January 19, 1901.

1,267. E. Schattner. London. Improvements in prepayment electricity meters.
1,280. M. J. P. O'Gorman. London. Improvements in electric cables.

January 21, 1901.

1,309. W. Smithson. Stockton-on-Tees. Improvements in brakes to be used in connection with railway cars and waggons, tramcars, electric cars, or other vehicles running on rails.
1,330. C. A. Allison. London. Improvements in electric trolleys. (The Pemberthy Injector Co., United States.)*
1,340. A. W. Brown. London. Improved apparatus for registering maximum electric currents.
1,347. J. E. Kingsbury. London. Improvements in telephone exchange systems. (The Western Electric Co., United States.)
1,372. J. W. Wedderburn. London. Improvements in or connected with gas, electric, or other meters.
1,394. The British Thomson-Houston Co. (Ltd.) London. Improvements in acceleration, limiting and recording devices. (A. G. Davis, United States.)*
1,396. A. J. Boult. London. Improvements in or relating to wireless telegraphy. (M. R. Garcia, France.)

January 22, 1901.

1,400. H. Nunns. Halifax. Improvements in electrical switches.
1,401. J. S. Stevens, C. G. Major, E. C. Stevens and P. H. Stevens. London. Improvements in controlling arrangements for electric lifts.
1,403. S. Cowper-Coles. London. An improved apparatus for the electrolytic production of copper tubes and sheets.
1,439. B. J. B. Mills. London. Method of and apparatus for duplicating phonographic records. (National Phonograph Co., United States.)*
1,440. B. J. B. Mills. London. Composition for phonographic records and phonographic blanks. (National Phonograph Co., United States.)*
1,461. E. Ducretet. London. Improvements in telegraphic relays.*
1,468. W. B. Hodgetts. Manchester. Improvements in electro-motors.
1,470. H. W. C. Cox. London. Improvements in or relating to X-rays focus tubes.
1,471. L. F. Bogia, jun. London. Improvements in electric arc lamps.*
1,474. A. L. Adams. London. Improved electric lamp for photographic purposes.
1,484. S. O. Cowper-Coles. London. Improvements in means to be employed in the electro-deposition of metals.
1,485. H. P. Ball. London. Improvements in electrical measuring instruments.*
1,488. H. Brooker and W. J. Russell. London. Improvements in electric measuring instruments.

January 23, 1901.

1,504. A. W. Gattie. London. Improvements in apparatus for governing electric currents.
1,505. E. Barnard and H. Stedman. Hants. An improved electrical fire alarm.
1,506. W. Routledge. Newcastle-on-Tyne. Improvements in or relating to arc lamps.
1,527. W. Clapham, A. Clapham, and A. Clapham. Leeds. Improved automatic electrical attachment for clocks for ringing bells and other purposes.
1,553. J. Slack. London. Improvements in poles for supporting electric trolley wires upon electric tramways.
1,568. M. J. P. O'Gorman. London. Improvements in electric cables.
1,578. F. T. Stewart. Liverpool. Improvements in or in connection with electric lighting devices for tramcars.
1,600. K. Hora, J. Rydl and F. Vsetečka. London. A system of electric circuits with sectional conductors for tramways and the like.*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

21,966. Fanta. Manufacture and repair of incandescent electric lamps.

1900.

138. Loubery. Method of telegraphing indicating time or actuating mechanism electrically.
184. Field. Method of determining the voltage obtaining at a near or distant part of an electric circuit, or the average voltage obtaining at several parts thereof and apparatus therefor.
1,573. Heyl-Dia. Rubber insulated electric cables.
2,473. de Marçay. Electric arc lamps.
2,662. Lancashire Dynamo and Motor Co. (Ltd.), Wood and McLeod. Brush holders for dynamo-electric machinery.
2,880. Cooley. System of and means for regulating electric motors and the like.
3,524. Thompson (Becker). Features of the anodes in electrolytic apparatus.
3,534. Evershed and Vignoles (Ltd.) and Evershed. Electric supply meters.
4,358. Swindell. Electric bell pushes.
5,183. Newton (Carleton). Electric locks.
13,198. Cruvellier. Electric traction with surface contacts.
13,968. British Thomson-Houston Co. (Ltd.) (Davis). Systems of electric motor control.
13,975. British Thomson-Houston Co. (Ltd.) (Barry). Systems for controlling electric motors.
14,506. Brookes (Cotton). Dynamo electric machinery.
14,743. Clayton. Electric cutouts and the like.
15,163. British Thomson-Houston Co. (Ltd.) (Dempster). Commutators for electric machines.
15,378. British Thomson-Houston Co. (Ltd.) (Lunt). Means for generating or converting alternating electric currents.
15,379. British Thomson-Houston Co. (Ltd.) (Steinmetz). Regulating dynamo-electric machines.
15,382. British Thomson-Houston Co. (Ltd.) (Green and Callan). Systems of electrical distribution.
15,921. British Thomson-Houston Co. (Ltd.) (Emmet). Electric cutouts.
16,049. British Thomson-Houston Co. (Ltd.) (Emmet). Electric commutators.
16,128. British Thomson-Houston Co. (Ltd.) (Rice). Regulating electric alternators.
16,051. British Thomson-Houston Co. (Ltd.) (Steinmetz). Means for starting alternating-current motors.
17,049. Kraemer and Weber. Coin-operated electric meters.
19,754. Lucas, Marsh, and Vandam. Key sockets for incandescent electric lamps.
20,362. Howard. Renewing the filaments of electric incandescent lamps.
20,471. Rymer-Jones. Connectors for electric wires and the like.

# COMPANIES' MEETINGS AND REPORTS.

## Indo-European Telegraph Co. (Ltd.).

The thirty-fourth ordinary general meeting of the members of this Company was held on Tuesday, under the presidency of Mr. J. Herbert Tritton.

The SECRETARY (Mr. L. Pagenkopf) having read the notice calling the meeting,

The CHAIRMAN, in moving the adoption of the report and accounts, and the approval of the dividends and bonus therein recommended for payment, said: You are aware there has been a strong agitation, both in this country and in India, for a reduction in the rate to India. I informed the shareholders at the last meeting that this Company would not stand in the way of a reduction, and I have now to inform you that we have actively advocated a reduction, recognising the anomaly of lower rates to Australia than to India, the Australian rate being now 3s. 6d. a word while the Indian rate remains at 4s. A measure of this nature cannot, however, be introduced without other interested telegraph administrations being in accord. Nearly all administrations are adherents to the International Telegraph Convention, formed for the convenience of the administrations for assimilating tariffs, rules and regulations, and introducing direct means of communication for the benefit of the general public, and it is needless to say these arrangements do not always work as we would have them. Hence the

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delay. If the International Telegraph Conference, which was to have been held in May of this year, had not been postponed to next year, this question, like many others of a similar pressing nature, might have been settled with less delay and less trouble and labour to all concerned. This Company is still in negotiation with the German Government for the extension of the German concession. We are glad the public will shortly be supplied through the report of the Committee with full and accurate information concerning telegraph companies which have done so much for he commercial welfare of the Empire, and which have been persistently attacked both in the Press and elsewhere by gentlemen, who do not appear, to say the least of it, always to have been in possession of the facts. As the shareholders are aware, we always endeavour to keep abreast of the times, and with the increased amount of traffic passing over our lines, it is necessary to get the messages through at the greatest speed possible compatible with accuracy. We are now trying a new apparatus for punching automatically the messages for transmission by the Wheatstone apparatus. The principle of the instrument is almost identical with the typewriter, and an entire letter is punched with one depression of the key instead of several depressions, as is the case with the hand-puncher. The rate of punching obtained by this apparatus is more than twice that of the older instrument, and we hope that the speed over the line will be further materially increased by the use of this instrument. Experiments have been made over the section Emden-Teheran with the Wheatstone transmitter, and signals have been sent direct to Teheran—that is, without re-transmission at Odessa—at a speed of from 80 to 100 words per minute. When you bear in mind the distance traversed —viz., 3,430 miles—it shows the very satisfactory condition of the line. Although this speed may not be fully maintained in practical working, as the working will to a large extent depend upon the state of the line, this is nevertheless a first-rate result, showing as it does, that the lines of the Company are maintained in a thoroughly efficient manner, and that their electrical condition is satisfactory. Turning to the financial results of our business, we find there has been a larger balance of profit than for the preceding year, amounting to £9,300. This is accounted for in part by the increased receipts derived from Indian, trans-Indian and South Russian messages. This Company is allowed to accept messages for South Russia, and such messages are now transmitted direct to Odessa over the Company's wires. You will observe that the profit and loss account is credited with a sum of about £17,000 under the head of "Persian Government Repayments." It was a somewhat unexpected windfall during the year and was utilised, as you see, by the directors in providing to the extent of £15,000 for depreciation in the Company's investments. For the first time in the history of the Company the investments show in the aggregate a slight loss, fully covered by this £15,000. The expenditure is somewhat higher owing to additional staff and extra remuneration paid to the staff on account of the increased traffic that has passed over the lines. I now move the resolution.

Mr. C. HOLLAND seconded the motion.

Mr. JAMES MACANDREW asked if the entire cost of the reductions per word to India and Australia fell solely on the Company, or whether any part fell on the lines of the different Governments.

The CHAIRMAN: They all fall *pro rata*, but the exact terms are not settled. We shall not bear the whole of it.

The resolution was carried unanimously.

The retiring directors, Mr. J. Herbert Tritton and Mr. L. Delbrück, were re-elected, as were the retiring auditors, and a cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

## Oriental Telephone and Electric Co. (Ltd.).

The seventh ordinary general meeting of this company was held on Friday last, Sir AUCKLAND COLVIN, K.C.S.I., presiding.

The ACTING SECRETARY (Mr. J. Macleod) read the notice calling the meeting, and the report of the auditors, and

The CHAIRMAN said: At last year's meeting we held out anticipations of an increased dividend should circumstances go well with us, and I am glad to say that those anticipations have been fulfilled, as we have been enabled to add another 1 per cent. to the dividend. One or two points in the report I may notice. The surplus remaining at the end of this year is rather more than that at the end of the previous year. Instead, however, of again placing £3,000 to the new reserve fund, we propose that only £2,000 be so invested, and that a larger sum be carried forward—namely, about £2,700, as against £1,500 previously. The reason for this is that the capital requirements of the Company, both for the electrical branch and for the extension of telephone construction at the different centres, necessitate the employment of all available funds. This was referred to at our meeting last year, and it explains the item in the present accounts of "£3,890 temporary advance on £4,000 Consols." These Consols belong to the capital reserve fund—not to the new general reserve fund—and should have been sold when the funds were required; but the great fall which in the meantime took place in Consols, and our desire not to sacrifice such a security when a considerable recovery is likely to occur within a reasonable time, decided us to raise a temporary loan instead, repayable at the Board's discretion. In Egypt the work of placing all telephone wires underground is about to be commenced and every effort will be made to complete it in time for the opening of the next business season in October. In Hong Kong the future is also very promising. An opportunity occurred last year for the China and Japan Telephone Co. to acquire their own freehold premises both in Hong Kong and in Kowloon at an outlay of about £2,500. This investment is certain to increase in value as time goes on, whilst it affords for the company's business in the future permanent accommodation far more suited to its increased importance than the old hired premises are. I may add that one of our directors, Mr. Grewing, jun., is making a tour of the important subordinate companies and branches in the Eastern Seas, India, the Straits and Burmah, and is personally acquainting himself with the requirements of the different centres, and also with the staffs and the various objects and matters which come before our Board from time to time, so that we shall have the benefit of his own first-hand experience, as well as that we already get from the reports of our local agents. I think, gentlemen, that I need make no further remarks. You can gather from what I have said that our affairs are prosperous, and, with ordinary care, we should do as well this year as in the past year. I now move the adoption of the report and accounts.

Mr. C. E. LYNE enquired what was the full dividend on the Telephone Co. of Egypt. He noticed that 7½ per cent. had been paid on them. Were they entitled to 10 per cent., or what?

Mr. HENRY GREWING, in reply, said that the maximum dividend on those shares was 7½ per cent. Up to now only 6 per cent. had been paid on them, but things had prospered in Egypt as in other parts of the world where they carried on business, and for the past year the Telephone Co. of Egypt had been enabled to pay 7½ per cent. on the preferred shares, which was the maximum. Besides these shares there were £20,000 deferred shares. When 7½ per. cent. had been paid on the preferred shares any surplus there might be was divisible between the preferred and deferred shares. The latter were also held by this Company, so that in the event of any increase in the dividend-earning capacity of the Telephone Co. of Egypt they would have the benefit of it. With the exception of a few shares, the Telephone Co. of Egypt belonged entirely to this company.

Mr. W. TIRRELL said with regard to the electric lighting branch, although it had now been established six years, it did not seem to show any profit. Was it worth while, therefore, to continue to carry it on and take the risk involved?

The CHAIRMAN: With regard to the electric branch, I think if the shareholders are prudent they will leave that in the hands of the Directors. In that branch there is considerable competition, and it is not desirable that we should show in our accounts, or make more public than is necessary, the amount of our profit or loss in respect of it.

Mr. MOUNTCASTLE asked if the Company lighted any town with electricity.

The CHAIRMAN: No. Our business is largely with factories and other buildings. We light these places, but not whole towns.

The resolution was then unanimously carried as were resolutions re-electing the retiring directors—Sir Auckland Colvin and Mr. H. Johnstone Grewing—and the retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co. A vote of thanks to the Chairman terminated the proceedings.

## Western Telegraph Co. (Ltd.).

The report of the directors of this company for the half-year to Dec. 31 last states that the revenue for the period amounted to £264,717. 8s. 8d. and the working expenses to £84,139. 10s. 1d. After providing £10,291. 10s. 10d. for debenture interest and sinking fund, and £6,361. 3s. 4d. for income tax, there remains £163,925. 4s. 5d., added to £8,571. 0s. 8d. brought forward, making £172,495. 5s. 1d. Interim dividends amounting to £62,379 have been paid, and after transferring £100,000 to general reserve and £2,000 to a reserve for maintenance ships there remains £7,689. 0s. 1d., which is carried forward.

The directors refer with much regret to the death of their valued manager, Mr. W. H. Axworthy, who had been connected with the company from its inception, and had continued over many years to render very valuable services. The directors will bring forward a proposition for a grant to his widow.

## West Coast of America Telegraph Co. (Ltd.).

The directors' report for the year ended Dec. 31 gives the gross income at £30,888. 1s. 6d., against £28,347. 9s. 8d. in 1899, and the working expenses £23,046. 8s. 4d., against £21,065. 0s. 4d. After providing interest on the 4 per cent. debentures (£6,000) and interest on the 4 per cent. income bonds (£800), the net balance profit was £1,041. 13s. 2d., and adding £255. 5s. 5d. brought forward, there remains £1,297. 18s. 7d., out of which £709. 14s. 9d. is appropriated for balance of expenses of reconstruction, leaving £588. 3s. 10d. to be carried forward.

The improvement in trade on the West Coast of America was maintained during the year, and the rate of exchange at Valparaiso on London shows a further rise. The company's cables, landlines, and the repairing steamer have been kept in a state of efficiency.

## Calcutta Electric Supply Corporation (Ltd.).

The report of the directors for the year to Dec. 31 states that the capital expenditure, which at the end of the year amounted to £118,266, included £4,330 for purchase of a site for new generating station in Alipore district, for which district a licence has been secured by the company. The number of units of electrical energy sold during the year were 199,829 for lighting and 213,121 for power, and the gross revenue from all sources amounted to £11,147. 15s. 8d., working costs to £5,752. 17s. 4d., resulting in a net profit of £5,394. 18s. 4d. £651. 15s. 9d. was brought forward, and £306. 4s. 4d. has been earned in interest, making £6,352. 18s. 5d., less an interim dividend absorbing £1,436. 9s. 10d., leaving £4,916. 18s. 7d. available for distribution. £2,500 is placed to depreciation, and a final dividend at the rate of 4 per cent. per annum (making 3½ per cent. for the year) is proposed, and £327. 7s. 9d. carried forward. During the year 10,000 additional shares have been issued at £5. 10s. per share, the premium (£5,000) being placed to reserve. The total number of connections at Dec. 31 was 409, the equivalent of 8 c.p. lamps being 28,748, an increase of 294 connections and 19,285 lamps during the year. The popularity of electric ceiling fans continues, and it is anticipated that a

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very large number will be in operation in Calcutta before the close of the present year. Mr. James George Henry Glass, C.I.E., late chief engineer and secretary Public Works Department in Calcutta, has been elected a member of the board, to fill the vacancy caused by the death of Mr. Harrison Hayter.

## Cuba Submarine Telegraph Co. (Ltd.).

The report of the directors for the half-year to Dec. 31 states that the total receipts (including £5,204. 15s. 4d. brought forward) amount to £16,175. 6s. 2d., and the gross expenditure to £5,502. 17s., leaving £10,672. 9s. 2d. The preference dividend absorbs £3,000, and the directors recommend a dividend at the rate of 4 per cent. per annum on the ordinary shares, tax free, the balance, £4,472. 9s. 2d., being carried forward.

The company's cables have continued in good working order throughout the half-year.

The negotiations between the Foreign Office and the Government of the United States, regarding the payment of the subsidy of £2,000 per annum in arrear since January, 1899, and the claim for damage done to the cables during the Spanish-American war still continue.

**CALCUTTA TRAMWAYS CO. (LTD.).**—At the meeting last week the chairman (Mr. E. C. Morgan) said the company's power-house was almost completed for the reception of plant, and some of it was actually in position. Work is also proceeding with the new car sheds, the erection of the poles and the laying of underground feeders. They had to thank the Government Telegraph Department and the Telephone Company for the friendly manner in which they had met them on all matters where there had been a question of telegraphic or telephonic disturbance. The arrangements they had made would tend to mitigate any friction arising between the various parties in the future, and help in the solution of such technical matters as might require consideration. Their available funds were nearly exhausted, and they should, in consequence, offer for subscription almost immediately debenture stock for £100,000, the balance of the stock created when the arrangements for electrical conversion were completed.

**ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.).**—At the meeting on Monday the chairman (Mr. John MacFarlan) said the German company had settled down to what he might call steady-going business, and the final result was considerably better than in 1899. The trading profit of the Metal Company was 448,522 marks, compared with 364,190 marks in the previous year. In 1899 they suffered considerably by the extraordinary rise in copper. Last year, when copper was fairly steady, they anticipated a good result, and but for the increase in the price of coal and in the cost of labour, the result would have been more satisfactory. The Metal Company was now recognised as being one of the most important tube producers in Germany. It was necessary that the company should have ample funds for the purchase of raw copper and stores and the directors suggested the conversion of the present £75,000 8 per cent. into £100,000 6 per cent. debenture stock, redeemable in 20 years. They proposed making a public issue, in order to get a Stock Exchange official quotation. The company was doing good business at good prices. They felt proud that that company should be the first of all the Elmore companies to pay a dividend from profits earned by the working of the process to its original shareholders. A resolution increasing the borrowing powers of the company was passed.

**OSWESTRY ELECTRIC LIGHTING AND POWER CO. (LTD.).**—At the meeting last week the chairman (Mr. A. Wynne Corrie) stated that but for the increase in the price of coal they would have earned nearly sufficient to pay 2 per cent. beyond the 4 per cent. now declared. The sale of current had now reached four figures, £1,069. Mr. E. Bremner Smith (the engineer) said the receipts for current alone were over £200 more than in the previous year. They had put down nearly £2,000 worth of additional plant, and were in a position to supply whatever current might be required for years to come.

**SALISBURY ELECTRIC LIGHT CO. (LTD.).**—At the annual meeting last week the directors' report stated that the company had made satisfactory progress during the year. The number of consumers had increased from 148 with the equivalent of 6,223 lamps connected, to 210 with 9,795 lamps connected, whilst the receipts had increased from £1,165 to £2,320. The profit on the year's working amounted to £1,568. 10s. 4d., and after writing off the debit balance from last year (£206. 7s. 9d.) and payment of £1,230. 19s. 6d. interest on debentures and loans, there remained £131. 3s. 1d. available for ordinary dividend. The directors recommended a dividend at the rate of 3 per cent. per annum, carrying forward £21. 10s. 1d. The chairman (Mr. Wm. Hammick) moved the adoption of the report, and said it was a universal experience that provincial electric light companies had found difficulty in raising the capital necessary to float them, and their experience had been similar. Edmundson's Electricity Corporation were, however, willing to risk their capital, and the result had been the same there as it had been elsewhere. They had generated during the year 125,322 units of current, compared with 19,216 two years ago, and the maximum supply demanded had increased from 37kw. to 138kw. Mr. F. E. Gripper said they had reached a stage when they were earning 5 per cent. on their capital, a stage which any electric light company would be glad to reach in so short a time—practically in their case the second complete year of working. They had spent about £35,000, but supposing that at the present time they wished to sell their business—supposing, for instance, the Corporation wished to acquire it—he would guarantee to find a customer who would pay them £50,000.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27⅜d. per oz. (May 2). Consols (2¾ per cent.) 94⅛—94⅜ for money, 94⅜—94⅞ for account; 2½ per cent. 94⅞—95⅛ (May 2.) Consols Pay Day, May 3; Stocks and Shares Continuation Days, May 13 and 29; Ticket Days, May 14 and 30; Pay Days, May 15 and 31; Mining Share Carry-over Days, May 11 and 28.

**BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.).**—Subscriptions have been invited this week for a balance of 6,400 non-cumulative 5 per cent. preference shares of £10 each in this company.

**CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.).**—The accounts for 1900 show that there is a credit balance of £70,547, with £8,222 brought forward, making £78,768, from which the directors write off for depreciation £7,246, and to machinery renewal £3,000. After paying interest on debentures and preference dividend, there is £56,972 available for distribution. It is proposed to place £23,616 to reserve (making this £100,000), to pay the usual dividend on the ordinary shares of 10 per cent., and a bonus of 5 per cent. (making 15 per cent. for the year), leaving to be carried forward £10,856.

**COMPAGNIE FRANCAISE DES TRAMWAYS ELECTRIQUES ET OMNIBUS DE BORDEAUX.**—This company has declared a dividend of 7.50fr. for 1900, at the rate per share of 7·20fr. on registered shares by endorsement on certificate, 7.55fr. on bearer shares numbered 1 to 50,500, and 6.56fr. on bearer shares numbered 50,501 to 100,000.

**IMPERIAL TRAMWAYS CO. (LTD.).**—This company is raising further capital for paying up its investments in the London United Tramways (Ltd.), and holders of debenture stock, preference, and ordinary shares have been offered the opportunity of making application for 10,000 6 per cent. cumulative preference shares of £10. each at £12. 10s. per share.

**LONDON PLATINO-BRAZILIAN TELEGRAPH CO. (LTD.).**—The twenty-third ordinary general meeting will be held at Winchester House, Old Broad-street, London, E.C., on 7th inst.

**NORTH STAFFORDSHIRE TRAMWAYS CO. (LTD.).**—At the meeting last week, on the motion of the chairman (Mr. Emile Garcke), the report and accounts, an abstract of which appeared in our issue of April 19, were adopted.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed May 8 as a special settling day in 450,000 ordinary £1 fully paid shares (Nos. 70,001 to 520,000), 70,000 5 per cent. cumulative preference £5 fully paid shares (Nos. 1 to 70,000) and £250,000 4 per cent. first mortgage debenture stock of *Clayton and Shuttleworth (Ltd.)*, and has ordered the two first named securities to be quoted in the official list.

**SUBMARINE CABLES TRUST.**—The report of the trustees for the year to April 15, 1901, shows the revenue, including £74. 19s. 11d. brought forward, to have been £24,976. 6s. 5d. Expenses were £1,383. 5s., and payment of coupons £20,061, leaving £3,532. 1s. 5d., out of which £3,487. 12s. has been transferred to redemption fund, leaving £44. 9s. 5d. to be carried forward.

The numbers are given on another page of a drawing of 30 certificates of £120 each in this trust, payable by Messrs. Glyn, Mills & Co., 37, Lombard-street, London, E.C.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Apl. 27 | 632 | + 64 | 47 | 31,123 | + 2,559 |
| *Birmingham Tramways. | ,, 27 | 4,473 | + 253 | 16 | 65,205 | + 1,072 |
| *Blackburn Corporation.. | ,, 26 | 552 | + 95 | 17 | 7,291 | + 709 |
| Blackpool Corporation... | ,, 25 | 330 | + 27 | 13 | 1,913 | + 287 |
| Blackpool and Fleetwood | ,, 27 | 347 | − 47 | 17 | 3,590 | − 329 |
| Bolton Corporation ..... | ,, 28 | 1,414 | + 379 | 4 | 6,111 | + 1,432 |
| Bradford Corporation... | ,, 28 | 883 | + 486 | 4 | 3,945 | + 2,089 |
| Brisbane Trams ..... | Mar. 13 | 1,795 | − 148 | 10 | 20,341 | + 2,175 |
| *Bristol Trams & Carriage | Apl. 26 | 4,648 | + 1,627 | 16 | 64,645 | + 18,375 |
| *Buenos Ayres & Belgrano | Mar. 31 | 2,669 | + 1,532 | 13 | 35,241 | + 6,909 |
| Carlisle Trams. Co. ..... | Apl. 27 | 190 | ... | 17 | 2,181 | ... |
| Central London Railway | ,, 27 | 6,611 | ... | 17 | 104,595 | ... |
| City & South London Ry. | ,, 28 | 1,841 | + 567 | 17 | 33,861 | + 12,898 |
| Cork Elec. Trams ..... | ,, 25 | 511 | + 81 | 16 | 5,991 | + 625 |
| Dover Corporation ..... | ,, 27 | 203 | + 36 | 4 | 873 | + 88 |
| Dublin & Lucan Rly. ... | ,, 27 | 97 | − 3 | 17 | 1,376 | + 102 |
| Dublin United ..... | ,, 26 | 3,613 | − 525 | 17 | 44,387† | − 2,006 |
| Dublin Southern Dist.... | ,, 26 | 857 | − 319 | 17 | 12,597† | |
| *Dundee Corporation ... | ,, 24 | 603 | + 217 | ... | ... | ... |
| *Glasgow Corporation ... | ,, 27 | 10,113 | + 1,152 | 17 | 145,026 | + 2,369 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 27 | 782 | + 201 | 4 | 3,318 | + 600 |
| Hull Corporation ..... | ,, 27 | 1,572 | + 661 | 43 | 63,020 | + 32,935 |
| *Liverpool Corporation... | ,, 20 | 3,566 | + 131 | 16 | 123.054 | + 17,591 |
| Liverpool Overhead Rly. | ,, 28 | 1,591 | + 153 | 17 | 25,919 | + 2,016 |
| Perth (W.A.) Elec. Trams | ,, 27 | 892 | + 492 | 43 | 28,176 | ... |
| Portsmouth Corporation | ,, 27 | 594 | − 267 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 28 | 3,516 | + 1,411 | 17 | 50,455 | + 18,225 |
| Southampton Corporat'n | ,, 25 | 695 | + 282 | ... | ... | ... |

* Partly electrical. † Minus 3 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 24. | Price Tuesday, Apr. 30. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Six Days Ending April 30. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅝ ⅞ | ⅝ ⅞ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 75 | 70 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12 0 | Bournemouth and Poole Elec. Supply Ord. | 11½ 12½ | 11½ 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7¾ 8¼ | 7¾ 8¼ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9 | 8½ 9 | 3 17 9 | March and September | ... | .. |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¾ 7¼ | 7 7⅛ | ... | ... | 7⅛ | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 5½ | 5 5½ | 4 1 10 | ,, ,, | 5⅜ | 5⅛ |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5¾ 6¼ | 5¾ 6¼ | 4 8 0 | March | 6¼ | 6 1/16 |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 110 | 100 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ 9½ | 8½ 9½ | 4 4 3 | February and August | 9¼ | 9 |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 13 | 12 13 | 4 12 4 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 122 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 103 | 101 103 | ... | ... | 102¾ | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 9 | 8 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 12 | 11 12 | 5 0 0 | March and September | 11¼ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 106 109 | 106 109 | 4 2 7 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5 5¼ | 5 5¼ | 3 12 9 | ... | ... | ... |
| 11,000 | 5 | 4/3 | Hove Electric Lighting Ordinary | 7 8 | 7½ 8¼ | 2 15 5 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10½ 11½ | 11 12 | 4 7 6 | ... | 11 1/16 | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6¾ 7 | 6¾ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 104 | 101 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 101 103 | 102 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1¼ 1⅜ | 1¼ 1⅜ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 3⅜ 4¼ | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 93 101 | 98 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 10½ 11¼ | 11½ 12½ | 5 4 4 | April and October | 12¼ | 10½ |
| 13,769 | 10 | 9d. | Do. (£7 10s. paid) | 8 9 | 8½ 9¼ | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | 110½ | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 99 | 96 99 | 3 11 5 | ... | ... | ... |
| 6,452 | 10 | 8/0 | Notting Hill Electric Ordinary | 15½ 16¼ | 15½ 16¼ | 4 13 4 | March | 16 | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5¾ 6¼ | 5¾ 6¼ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅜ ½ | ⅜ ½ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 75 | 65 75 | ... | January and July | 65½ | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 200 220 | 200 220 | 3 12 9 | April and October | ... | ... |
| £115,500 | 100 | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 102 104 | 102 104 | 4 6 2 | ... | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 13½ 14½ | 14 15 | 4 13 8 | ,, ,, | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | February and August | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 93 101 | 98 101 | 3 9 4 | ,, ,, | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2¼ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 103,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 11½ 12½ | 12 13 | 4 0 9 | March and September | 12⅝ | 12 |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 230,007) xd | 4 4¼ | 3⅞ 4⅛ | 4 17 0 | April and October | 4 1/16 | 4 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 129 | 124 129 | 4 14 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 9½ 10½ | 9 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 96 101 | 96 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4¼ 4¾ | 4¼ 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 101 | 99 101 | ... | ... | 100 | 99½ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ 23¾ | 23½ 23¾ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ 10¾ | 10⅜ 10¾ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 118 | 114 116 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6¾ 7¼ | 6¾ 7¼ | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 10 10½ | 10 10½ | 4 15 3 | May and November | 10 | .. |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 98⅝ 100⅝ | 93¾ 100⅝ | 4 10 0 | ... | 99½ | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 15 16 | 15 16 | 5 6 3 | ... | 15⅝ | 15½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 13 | 12 13 | 4 12 4 | February and August | 12⅝ | 12½ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 119 122 | 119 122 | 4 2 0 | ... | 121½ | 120 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | 1 1/16 | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. xd | 5¼ 5⅝ | 5¼ 5⅝ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" xd | 5 5¼ | 5 5¼ | ... | ... | 5⅛ | 5 1/16 |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 107 | 104 107 | 4 13 6 | ... | 103 | 103½ |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 1 8 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) xd | 10½ 11½ | 10½ 11½ | 2 14 2 | ... | 11½ | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 102 104 | 103 104 | ... | ... | 102 | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | 1 1/16 | ... |
| 206,297 | 10 | 2/6 | Central London Ordinary | 9 9⅛ | 9⅛ 9¼ | 2 16 5 | June and December | 9⅜ | 9⅛ |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 118 | 113 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ 5⅜ | 5¼ 5⅜ | 4 6 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 101 104 | 101 101 | 3 16 11 | ... | ... | ... |
| £855,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 46 50 | 50 53 | 2 7 4 | February and August | ... | .. |
| 37,500 | 10 | 2 0/16 | Do. Ordinary (Nos. 22,501 to 60,000) | 4 5 | 5 5½ | 2 5 5 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 127 | 122 127 | 3 18 9 | ... | ... | ... |
| £244,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 118 | 113 113 | 3 9 0 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 14 | 13 14 | 4 5 9 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 1½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5¼ | 5¼ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4¼ 5¼ | 4¾ 5¼ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 22½ | 22 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 15 15¾ | 14½ 15¾ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 114 | 112 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | ... | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7 1/16 8 1/16 | 7 1/16 8 1/16 | 4 1 5 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 13¼ | 13 13¼ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 17 2 | January and July | ... | ... |
| $350,000 | $1,000 | 5% | London Street Rly. (Ont.) 1st Mrt. 5% Dbs. (red.) | 100 102 | 100 102 | 4 18 0 | ... | ... | ... |
| £328,744 | Stock | 3/4 | Lond. Utd. Trams. 4½% 1st Mt. Db. Stk. Prv. Crts (fllypd) | 102 104 | 102 104 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1903) | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 2¾ 3¼ | 3 3½ | 3 8 8 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ 5 | 4¾ 5¼ | 5 14 3 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 13 | 11 12 | 1 13 4 | ... | ... | ... |
| 20,000 | 10 | 0/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 37/0 | Do. 4½ per Cent. Debenture Stock | 107 109 | 107 109 | 4 3 9 | ... | 108 | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ... | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 94 97 | 94 97 | 3 2 2 | June and December | ... | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr 24. | Price Tuesday, Apr. 30. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Six Days Ending Apr. 30. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £36,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 5 | January and July | 99 | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... ... | ... ... | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 65 65 | 65 65 | ... | ... | ... | ... |
| £823,720 | Stock | 15/0 | Anglo-American | 50 53 | 53 56 | 5 11 7 | Feb., May, Aug., Nov. | 55 | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 94 96 | 97 99 | 6 1 6 | ,, ,, | 98½ | 94½ |
| £3,088,640 | Stock | 5/0 | Do. Deferred | 8½ 8¾ | 10¾ 1 ¼ | 2 4 6 | ,, ,, | 11⅞ | 8⅜ |
| 13,333,300 | £100 | £1¾ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 5 | ,, ,, | 101¾ | 101½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ 8½ | 7½ 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 17 | 16 17 | 5 17 8 | ,, ,, | 16½ | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ 104⅞ | 100⅞ 104⅞ | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 9¾ 10¼ | 9¾ 10¼ | 6 16 7 | Jan., Apr., July, Oct. | 1⅛ | 9¾ |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 103 | 99 103 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 137 142 | 135 140 | 5 0 0 | Jan., Apr., July, Oct. | 135 | 135 |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 94 | 91 94 | 3 14 6 | ,, ,, | ... | ... |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) x i | 113 117 | 111 115 | 3 9 7 | May and November | ... | ... |
| 1250,000 | 10 | 6/6 | Eastern Extension xd & bonus | 14 14½ | 13½ 14 | 5 0 0 | Jan., Apr., July, Oct. | 13¾ | ... |
| 50,000 | 10 | 2/0 | Do.(Nos.250,001to300,000)£3pd.is'd at £3pm,all pd x i | 13¾ 14¼ | 13½ 14 | ... | ... | ... | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 116 | 111 116 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 102 | 99 102 | 3 18 3 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101⅞ 104⅞ | 101⅞ 104⅞ | 3 17 8 | May and November | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust xd | 9¾ 10¼ | 9¼ 10½ | 5 2 5 | Jan., Apr., July, Oct. | 9⅛ | ... |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference x i | 14¾ 15¼ | 14½ 15½ | 3 13 8 | ,, ,, | 15 | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 34 35 | 34 35 | 3 9 5 | January and July | ... | ... |
| £82,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb (wthnNos | 99 103 | 99 102 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [to 1,200) (red. | 44 48 | 44 48 | 5 4 2 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 103 | 99 102 | 3 18 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7½ 8½ | 7½ 8½ | 4 14 1 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 120 125 | 120 125 | 4 16 0 | ,, ,, | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2 3 | 2 3 | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 100 | 97 100 | 5 0 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ ¾ | ¼ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 102 | 99 102 | 3 18 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅜ ⅝ | ⅜ ⅝ | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 6 7 | 8 11 6 | ,, ,, | 6½ | 6⅜ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 14 4 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zill'n Submarine) | 13¾ 14½ | 13¾ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | 13¾ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3½ 3¾ | 3½ 3¾ | 5 6 8 | August | ... | ... |
| 324,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 3/0 | 3/6 4/6 | 6 13 4 | April and October | ... | ... |
| 72,680 | 1 | 2¼% | Monte Video Telephone Ordinary | ¾ ⅞ | ¾ ⅞ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | 1 1¼ | 1 1¼ | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2 6 | National | 2¼ 3½ | 2¼ 3½ | 8 9 2 | February and August | 3 | 2⅜ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 10 12 | 10 12 | 5 0 0 | ,, ,, | 10½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 12 | 10 12 | 5 0 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4 4½ | 3¾ 4¼ | 5 17 8 | ,, ,, | 4⅛ | 3¾ |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 87 90 | 87 90 | 3 18 8 | June and December | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 8 | ... | ... | ... |
| 171,504 | 1 | 0/6 | Oriental | ¾ 1⅛ | ¾ 1⅛ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ 5 | 4½ 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ 5¼ | 4¾ 5¼ | 4 15 3 | June and December | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 106 | 103 103 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 5 14 3 | ... | ... | ... |
| 145,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | ¾ ⅞ | 1⅛ 1⅜ | 7 7 8 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | 1/16 1/8 | 1/16 1/8 | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | 1/16 1/8 | 1/16 1/8 | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 90 | 85 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 11 | 10 11 | 6 15 4 | July and February | 10⅛ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5¾ 6¼ | 6¾ 6¾ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ 5 | 4¾ 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅞ 1⅞ | 1⅞ 1⅞ | 3 3 7 | September | 1⅞ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2⅜ | Do. 3 per Cent. Pref. Non-Cum. | 2 2¼ | 2 2¼ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 103 | 4 7 5 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 16 | 14½ 15½ | 4 16 9 | ,, ,, | 15½ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5¾ 6 | 4 3 4 | ,, ,, | 5¾ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 109 113 | 109 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9⅜ | Castner-Kellner Alkali Co. (fully paid) | ⅞ 1⅛ | ⅞ 1⅛ | 7 2 3 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 98 | 95 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1⅛ | ¾ 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9⅜ | Crompton and Co. (Nos. 1 to 54,000) | 3¾ 4 | 3¾ 4 | 5 12 7 | January and July | 3¾ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 103 | 101 104 | 4 17 0 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£5 paid) | 1⅜ 2 | 1⅜ 2 | 9 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 3 4 | 3 4 | 6 12 3 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 89 | 87 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts (all pd) | 94 98 | 94 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5 ⅝ | 5 5⅛ | 7 14 7 | Half-yearly | 5⅜ | 5⅛ |
| 13,363 | 5 | 1 6½ | Do. Cumulative Preference xd | 5½ 6 | 5½ 6 | ... | ... | 6⅛ | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 105 106 | 105 106 | 4 5 1 | ... | ... | ... |
| 112,100 | 2 | 1/2⅜ | Electric ConstructionCo. (Limited) | 1⅜ 2⅛ | 1⅜ 2⅛ | 5 6 8 | January and July | 2⅛ | ... |
| 25,000 | 2 | 2/9⅜ | Do. 7 per Cent. Cumulative Preference | 2⅝ 3 | 2⅜ 3⅛ | 4 6 2 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | ... | Giffre Electro Chemical and Power Co. Ord | ¼ ⅜ | ¼ ⅜ | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15 16 | 15 16 | 6 5 0 | February and August | 15⅛ | 15½ |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6 | 5½ 6 | 3 15 0 | ,, ,, | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 111 | 107 111 | 4 1 1 | ... | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 10 11 | ,, ,, | ... | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30 9 | Telegraph Construction and Maintnce. | 38 40 | 38 40 | 5 4 6 | March and July | 39 | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908 | 101 104 | 101 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11½ | 5 12 6 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 7/0 | Willans and Robinson Ordinary ex new | 11 12 | 10 11 | 5 9 1 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref ex new | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | 6⅛ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,199. [Vol. No. 3. XLVII.] FRIDAY, MAY 10, 1901. PRICE SIXPENCE (by post, 6½d.), Abroad, 3d., or 15 cents, or 30c., or 70Rf.


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## NOTES.

THE electrical exhibits at the conversazione of the Royal Society on Wednesday were too numerous to allow of our mentioning them all. On the whole they were far above the average of previous years in interest and attractiveness. One of the smaller rooms was allotted to the telegraphone, which is exciting keen interest in scientific circles just now; in an adjoining room Mr. DUDDELL exhibited his musical arc. Dr. SILVANUS THOMPSON gave a short demonstration with a Paul kinematograph, showing the development of magnetic fields in various conditions of change. For example, one of the "living pictures" showed the variations in field around an alternating current circuit; another showed the behaviour of magnetic lines when a piece of iron is attracted up to the poles of a magnet and is then pulled away; while a third picture gave a representation of the field passing into a slot-wound armature. Among the exhibits in the larger halls we noticed an ingenious mechanical interrupter, devised by Dr. DAWSON TURNER, for working an induction coil off an electric supply circuit. Prof. J. C. BOSE showed some experiments in support of his electrical coherer theory of vision, about which we expect to hear more from his discourse at the Royal Institution to-night.

A NON-ELECTRICAL exhibit, so far as present knowledge goes, was the marvellous self-luminous bacteria from the Jenner Institute of Preventive Medicine. The luminous efficiency of these microscopic organisms must be astoundingly high, for a small glass tube filled with a culture of them continuously emits light sufficient to enable a clock to be read—about the degree of illumination, in fact, obtained with newly-exposed luminous paint. Their luminous properties depend merely on a free supply of oxygen and a suitable proportion of a soluble chloride in the nutritive medium. Physicists would do well to investigate the nature of the light-emitting organs of these bacteria as a possible solution of the "light without heat" problem; but we do not share the alarm of some of the onlookers that the stronghold of electric light is menaced by these brilliant little germs.

ONCE again our columns testify to vigorous activity in electrical matters in Parliament, and to an almost equally prolific multiplication of electrical lawsuits. With the former, so far as may relate to bonâ fide electrical schemes, everyone in the profession should be pleased; the latter perforce cannot please all parties, and will usually delight more the legal than the electrical fraternity. The Caledonian Electric Power Bill is still under consideration by its Parliamentary Committee, and Sir WILLIAM HOULDSWORTH'S Committee have decided that the preamble of the Cleveland and County Durham Bill has been proved. On the other hand the Mond Gas Bill is also of considerable interest to the electrical engineer, even though indirectly. The bill for the Bexley electric tramways, which are being engineered by Messrs. MORDEY and DAWBARN, has led to another conflict between trolley advocates and the owners of underground metal pipes, on the score of alleged electrolytic dangers—this time, we are glad to record, with a complete victory on the part of the trolley experts and the Bexley District Council, who are promoting the bill. On this question, however, of the much over-rated dangers of electrolysis we shall have more to say in a future issue. Meanwhile we recommend interested readers to peruse our report in the "Parliamentary Intelligence" columns this week. As to legal matters, the most conspicuous is a development of the Castner-Kellner litigation, the present case relating to alleged infringement of Messrs. ATKINS and APPLEGARTH'S patent, No. 20,768 of 1890. We give an illustrated abstract of the specification of this patent.

FROM time to time we have alluded to the singular policy of the Council of the Institution of Electrical Engineers with regard to the formation of special committees. Last week, for instance, an announcement was made (duly reported in our columns) of the appointment of a legislation committee to inquire into the matters dealt with in connection with Mr. MADGEN'S recent Paper on the electric power bills. But



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the appointment of such committees are only announced spasmodically, the Council for some reason or other not always seeing fit to take the members of the Institution into their confidence. Thus it is often only indirectly that we learn the objects of certain committees selected for the consideration of important subjects, although sometimes they may be even for the purpose of making representations to governmental departments or other public bodies. In the same way, the names of the members constituting these committees are never announced formally, and members generally are left in the dark as to who have been chosen to look after their interests. This is the more important as members outside the Council frequently sit on these committees—an excellent provision certainly, but a dangerous one unless their names are first submitted to the members as is done in the case of Parliamentary Committees. Take the instance once more of the present legislation committee. The President and one of our Past-Presidents have recently given evidence in favour of legislation of a nature to impede the progress of the electric tramway industry, and the last-named gentleman has also advocated the retention by the Board of Trade of a regulation which hampered the progress of electric supply on the most modern lines; and yet members are uninformed as to whether these gentlemen are or are not serving on the newly appointed legislation committee. It is greatly to be regretted that in this direction, as in many others, the body of members and the Council are not kept better in touch with one another.

Upon another page of this issue we publish a brief illustrated article upon the Haas and Oettel form of cell for the electrolytic production of hypochlorite solutions. It is strange that so little attention has been paid to this branch of electrochemistry in our own country, in view of the rapid progress which electrolytic methods of bleaching are making abroad. No doubt one of the leading bleaching firms in Bradford has recently been carrying out trials with the electrolytic process, but when we inspected the experimental plant in September last the cell was out of order, and we have since learned that the experiments have been entirely suspended. This plant was, we believe, the only electrolytic bleaching plant in existence in the United Kingdom, and it is unfortunate that the trials have not resulted in any satisfactory information concerning the practical value of the new processes. That the cell or its management, and not the process, is responsible for the partial failure at Bradford would seem evident, from the success of electrolytic bleaching plants abroad. We hope that the attention which is now being given to the subject by the textile press may result in renewed trials in this country, with the best types of hypochlorite cell under satisfactory conditions as regards technical supervision.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |

**Royal Society.**—The meeting of the Royal Society yesterday was devoted to a discussion of the Report already in the hands of the Fellows. The meeting was restricted to Fellows of the Society.

**Wireless Telegraphy in Sweden.**—The Swedish Admiralty has contracted with the Allgemeine Electricitäts Gesellschaft to equip four stations and some warships with wireless telegraph apparatus on the Slaby-Arco system.

**The Secrecy of the Telephone.**—The secrecy of the telephone in Sweden is to be assured by an apparatus adopted by the authorities which indicates whether the telephone operator is listening to the conversation. The hire of the apparatus is 6kr. a year.

**Appointment Vacant.**—The Chair of Mechanical Engineering at University College, London, will be vacant at the end of the present session owing to the appointment of Prof. T. Hudson Beare as Regius Professor (elect) of Engineering in the University of Edinburgh.

**A Railway Safety Apparatus.**—At the Stockholm eastern station an electrical apparatus has been installed which shows at a glance in the stationmaster's and pointsmen's rooms whether all the points at the station are in order, and the in and out-going signals are right. If any are out of order the apparatus indicates this at once.

**Massachusetts Institute of Technology.**—This Institute will hold entrance examinations at London on June 27th and 28th. Applicants desiring to take examinations in London are requested to notify Mr. Ball, 5, Cross-street, Manchester, not later than June 8th. The examinations will be conducted by Prof. H. W. Tyler, Secretary of the Institute.

**Iron and Steel Institute.**—The Council having elected Mr. William Whitwell, honorary treasurer, to succeed Sir William Roberts-Austen as president, have chosen Mr. W. H. Bleckly, vice-president, who has served on the Council for 21 years, as honorary treasurer, to fill the vacancy caused by Mr. Whitwell's election to the presidency.

**Electrical Equipment of the New Swedish Battleships.**—In each of the Swedish battleships now building three direct-coupled plants are installed of 22, 44 and 65 B.H.P., running at 425, 350 and 280 revs. per min. respectively, the dynamos working at 70 volts. The smallest unit is used for incandescent lighting, the 44 H.P. set for four search-lights, and the largest unit operates 12 motors from 3 to 45 H.P.

**Royal Institution.**—A meeting of the Royal Institution was held on the 6th inst., when it was announced that His Grace the President had nominated the following Vice-Presidents for the ensuing year:—Sir Frederick Bramwell, Bart.; the Right Hon. Sir James Sterling, Sir William Abney, K.C.B.; the Right Hon. Lord Kelvin, G.C.V.O.; Mr. George Matthey, Mr. Frank McClean, Sir James Crichton-Browne, treasurer; and Sir William Crookes, hon. sec.

**Manchester Section of the Institution of Electrical Engineers.**—The following gentlemen have been elected members of the committee for the ensuing year:—

*Chairman*—Mr. C. H. Wordingham.
*Vice-Chairman*—Mr. H. A. Earle.
*Hon. Secretary*—Mr. E. W. Cowan.
*Members of Committee*—Messrs. S. V. Clirehugh, C. M. Dorman, W. P. J. Fawcus, A. H. Gibbings, A. S. Giles, J. S. Highfield, A. B. Holmes, H. Lindley. G. F. Metzger, A. B. Mountain, R. C. Quin, C. D. Taite.

**Indian Section of the Institution of Electrical Engineers.**—The inauguration of the Indian section of the Institution of Electrical Engineers took place on March 15th at the Central Telegraph Office, Calcutta. The Director-General of Telegraphs, Mr. F. G. Maclean, described electrical progress in India from 1839, when an experimental telegraph line was erected in Calcutta, to the latest scheme for the transmission of power from Courcy Falls to the Kolar Gold Fields.

**Glasgow Section of the Institution of Electrical Engineers.**—The following is a list of the office-bearers nominated by the Council for the Glasgow local section. No further nominations having been received, in accordance with clause 45 of the articles of association these gentlemen are duly elected:—

*President:* Prof. Magnus Maclean.
*Vice-President:* Mr. Henry Mavor.
*Ordinary Members of Council:* Messrs. A. R. Bennet, W. A. Chamen, J. D. Cormack, M. B. Field, W. Whackie, W. McWhirter, J. M. M. Munro, W. B. Sayers, and Thomas Young.

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**Royal Society.**—The following 15 candidates have been selected by the Council of the Royal Society to be recommended for election into the Society:—Prof. A. W. Alcock, M.B., Mr. F. Watson Dyson, M.A., Mr. A. J. Evans, M.A., Prof. J. W. Gregory, D.Sc., Capt. H. B. Jackson, R.N., Mr. H. M. Macdonald, M.A., Mr. J. Mansergh, M.Inst.C.E., Prof. C. J. Martin, M.B., Major R. Ross, M.R.C.S., Prof. W. Schlich, Ph.D., C.I.E., Prof. A. Smithells, B.Sc., Mr. M. R. O. Thomas, F.Z.S., Mr. W. Watson, B.Sc., Mr. W. C. D. Whetham, M.A., and Mr. A. S. Woodward, F.G.S.

**The Amended Board of Trade Regulations.**—A meeting of some of the consumers dissatisfied with the recent Board of Trade decision was held on Thursday, last week, in one of the committee rooms of the House of Commons under the presidency of Mr. Beresford Melville, M.P. Members of the Press being excluded, our representative was not admitted, but we learn that the following resolution was passed:—"This meeting hereby resolves itself into a committee to establish an Electric Consumers' Protection Association with a view to taking all necessary measures to safeguard the rights of the public in respect of the electric supply companies serving the metropolitan area under provisional Orders in Council."

**Obituary.**—Mr. John E. Ritter, engineer and part owner of the small water-driven electric lighting station at Limavady, co. Londonderry, Ireland, died suddenly on the 1st inst., at the age of 47.——We have also to record the death of Mr. James Edmund Naylor, of Headingley, Leeds, formerly assistant superintending engineer of the Postal Telegraph Department for the North-Eastern District of England. Mr. Naylor joined the telegraph service in 1855, at Wakefield, and after serving there and at other places, was transferred to the engineering staff in 1868. Subsequently he occupied the position of engineer at York and Leeds, and was appointed assistant superintending engineer at Leeds in 1891. He retired in 1895.

**An Electrical Sounding Apparatus.**—A Swedish engineer, Herr P. Sjöstrand, has invented an electrical sounding apparatus which has been tried on a steam-tug in the Stockholm waters with satisfactory results. The apparatus consists of a steel wire, to which is attached a piece of aluminium, sloped so as to cut down into the water, and below it an iron attachment for sounding. This touching the bottom causes a subsidiary length of wire to be unloosened, thus momentarily slackening the main wire. The jerk caused by the wire becoming taut again rings a bell on the ship's bridge for one minute, and at the same time the depth is indicated. The apparatus operates to a depth of 62 metres, with a maximum speed of 15 knots.

**The Electrolytic Arc Lamp.**—Herr Ewald Rasch contributes a long letter to the *Elektrotechnische Zeitschrift* of April 25th, in which he replies to various criticisms on his electrolytic arc lamp (see *The Electrician*, Vol. XLVI., p. 925). In the course of it, he mentions, in reply to Dr. Nernst, that by employing a more refractory material than that used in the Nernst lamp, his electrodes do not burn away at a prohibitive rate, and that his arc usually burns 15 minutes and sometimes three or four times as long without being regulated. In the Nernst lamp, he points out, the incandescent rod has to be made of a material that becomes a conductor at a comparatively low temperature, and is therefore unsuitable for an electrolytic arc as it burns away too quickly at higher temperatures, as Dr. Nernst has observed.

**Power Consumption at the Paris Exhibition.**—In a recent Paper before the Société Internationale des Electriciens, M. Picou, who was the engineer-in-chief for the electricity supply service at the exhibition, gave some interesting figures as to the total output and power consumption. The total duration of the electricity service was 2,756 hours, during which public lighting was supplied for 909 hours, and the average number of hours of running of the generators was 718·5. The total connections to the mains represented 11,265kw. (practically 20,000 H.P.), of which 8,710kw. were for private lighting, 2,000kw. for public lighting, and 5,555kw. for motors. The mean daily output of the generators was 25,336 kilowatt-hours (14,211 continuous current, and 11,125 alternating), and the maximum output 38,572 kilowatt-hours (16,822 continuous and 21,750 alternating), the mean daily load being 8,393kw. (1,682 continuous, and 1,761 alternating) and the maximum 5,740kw. (2,350 continuous, and 3,390 alternating).

**Small Telephone Exchange without Cords.**—The principle of the old "Umschalter" telephone board has been revived in a modified form by Messrs. Mix and Genest in a cabinet board for small exchanges which they are now introducing with the idea of avoiding the troublesome flexible cord. In it the jacks are arranged in a triangle so as to give the necessary number of combinations, the jacks being marked with the two lines which they connect. There are thus 15 five-point connecting jacks for a six-line board, the top one being marked 1—6, and the lower row consisting of five. Below this is the row of six local jacks, which are connected to the operator's set merely by the insertion of a loose plug, just as in the case of the main jacks. At the top of the board is a row of six drop indicators employed both for calling and clearing signals, and a corresponding row of jacks in case connections are to be made to other boards, and to the right and left of the triangle are jacks to connect in the bell and extension bell if required. These boards, which are made in sizes for from 3 to 20 lines are described in the *Elektrotechnischer Anzeiger* of May 5th.

**Development of Steam Engines.**—In his recent presidential address before the Institution of Mechanical Engineers, Mr. W. H. Maw remarked that the engine builders of this and other countries are under a deep debt of gratitude to electrical engineers for the improvements in steam-engine construction which have taken place during the past few years. This is but another instance of the benefit to be derived from exact knowledge. Prior to the introduction of electric lighting on a large commercial scale, improvements in the economy of our steam engines went on but slowly. Really satisfactory engine tests were comparatively rare, and it was but seldom, except in the case of large pumping engines, that strict guarantees of performance were demanded and enforced. The extended use of electric lighting plant has changed all this, partly owing to the importance of economical motors in such cases, and partly owing to the facilities afforded by the driving of dynamos for determining accurately the power developed by engines of large size. The result has been a marvellous reduction in the steam consumption per horse-power; and it is remarkable that this has for the most part been effected, not by any radical change in engine design, but by careful attention to points of detail, and by securing a number of small economies.

**Polyphase Working.**—Mr. Eborall devoted his second Howard lecture at the Society of Arts last Friday to a consideration of the actual designing of a polyphase generator. He first pointed out the considerable influence of the wave-form factor on the E.M.F. of the machine. The calculation by Mr. Kapp, several years ago, of the ratio of pole-width to pole-pitch, on which this form factor depends, gave too high a figure, as he did not allow for the spreading out of the lines at the pole face, and he assumed the width of the connecting wires between the actual useful winding to be zero. The lecturer then added a few more constants and data, among which were that the ampere-wires round the periphery of the armature per centimetre should not exceed 200, and that the iron losses in a good machine were generally 40 per cent. greater than the copper losses, because of forcing the magnetism in the teeth. Mr. Eborall then obtained a simple expression for the reactive ampere-turns. Assuming the phases to be exactly at 120deg. and also a sine wave-form, these would be calculable by the formula 1·5 × 1·41 × amperes per phase × turns per phase, but in reality the numerical constant becomes something between 2·2 and 2·4 instead of 2·12. Next the method of determining the requisite ampere-turns on the field-magnets by a series of simple vector diagrams was shown, first for the ideal case of no copper drop, no armature magnetic leakage and a power factor of 1, and then the manner of taking account of the actual value of

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these three quantities. The magnet ampere-turns required for compensating the armature reaction are easily ascertained for any particular design of machine by short-circuiting it and noting the amperes passing through the field coils and the circuit of one of the armature phases. The ratio of the observed field ampere turns to the observed armature turns, which varies from 2·5 to 3·5 is what is thus obtained. Similarly, a good method of computing the field and armature leakage, and the extra ampere-turns required to make up for them is to run the machine up to speed and connect choking coils to it until it delivers the full-load current. Then by noting the field current, voltage and output current, and taking the no-load and short-circuit characteristic, a simple graphical construction will give the quantities required, which may be employed in designing any other machine with the same ratio of pole-breadth to pole-pitch. The next lecture, which takes place this evening, will deal with polyphase transformers and motors.

**The Motor Car Exhibition at Islington.**—During the past week the Automobile Club has held an exhibition of motor cars at the Agricultural Hall, Islington, and the exhibition is to remain open until to-morrow evening. Taken as a whole the exhibition marks a considerable advance in the manufacture of motor cars, both in regard to improvement in the engineering features, and also in the development of a greater variety of types. From the electrical point of view, however, it is unfortunately to be noted that the exhibition points to a steady ascendency of oil over other forms of motive power, the prominence of the petroleum-driven vehicle being most marked. Passing from this, however, to the small minority of electrically-driven cars, we may note that the few manufacturers who do exhibit have made a much better show than at the previous exhibition. Among the important electrical exhibitors are Messrs. Shippey Bros., of London, and the Canadian Electrical Vehicle Co., for whom the former are the London agents. Among the exhibits is a handsome victoria carrying battery power sufficient to run 40 miles with a top speed of 30 miles an hour. There is also a cheap and serviceable little run-about for town use, which probably represents the latest development towards the production of a cheap private electric vehicle. Mr. Carl Oppermann exhibits an electric "victoriette" weighing 18 cwt. and capable of running from 40 to 50 miles; also an electric run-about for from 25 to 30 miles' run. These vehicles are compactly and artistically built, and also indicate the improvement which is gradually taking place in electric automotor vehicles. Among the other exhibitors of electrical cars are the National Motor Carriage Syndicate, Messrs. Ernest Hutton & Co., of Northallerton (who show two small cars), the British and Foreign Electrical Vehicle Co. (who exhibit a solidly built delivery van, a handsome victoriette, and a rather formidable-looking chariot, which, from its construction in the front part suggests the ram of a man-of-war), and the City and Suburban Electric Carriage Co. (who show several types of battery cars ranging from a light victoriette to an omnibus costing £910 and capable of carrying 15 persons 25 miles at 10 miles an hour). Among other electrical exhibitors, who do not show cars, we noticed the stand of Messrs. Peto and Radford, who exhibited primary and secondary batteries, coils, &c., including their "Dinin" accumulator; also the Doe Portable Electric Light and Power Syndicate's stand, in which the new Doe primary battery of American origin is brought before the public.

**German Regulations for the Protection of Telegraph and Telephone Wires.**—The German Telegraph Department has issued a series of revised regulations for the protection of their telephone and telegraph wires from the effects of currents passing through cables used for electricity supply, except such as are used for electric railways and tramways. The earth must not be used as a part of the circuit, and in the case of three-wire systems with bare or earthed middle wires, the latter may not be connected to the gas and water pipes if the telegraph or telephone wires in the particular case are connected to either of these services. The go and return cables must be as near together as possible, and, so far practicable, everywhere at an equal distance from one another. Where overhead conductors cross the telephone or telegraph wires, they must either be insulated, or protecting devices, such as earthed guard-nets, must be employed; but insulated wire is only considered sufficient protection for voltages up to 1,000. The vertical distance between the wires of the two services must not be less than 39in., and the horizontal distance about 4ft. When the supply cables run alongside the telegraph or telephone wires at distances less than 33ft., arrangements are to be made to prevent the possibility of the wires touching one another. Insulated cables will be considered sufficient for this up to 10,000 volts, the insulation in all such cases to be capable of standing twice the working pressure. Underground supply cables must be as far as possible from the telegraph and telephone wires, and, where possible, on the other side of the road. In the case of the cables crossing the wires or running alongside them at a distance less than 20in., the supply cable must be provided with a half sleeve of cement on the side towards the telephone or telegraph cable, this sleeve being at least 2½in. thick, and being lined inside with a material (such as loam) which is a bad conductor of heat. In the case of crossings, these sleeves must extend at least 20in. on either side of the crossed cable. When the supply cable crosses beneath the telephone or telegraph wire, or is beneath it at a distance less than about 20in. from it, the latter must be protected from mechanical damage by a split iron tube or sleeve extending for more than a yard on each side of this place. Exceptions to these regulations may be made when either the supply cable or the telegraph and telephone cables are laid in ducts made of brick, cement, &c., of at least 2½in. thickness. If, in spite of these precautions, disturbances occur in the telegraph or telephone cables, the Post Office Administration has a right to insist on alterations of the arrangements, and may order the offending cables to be put out of service until the disturbances are removed.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), May 10th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Papers to be read: (1) "Applications of Elastic Solids to Metrology," by Dr. C. Chree. (2) "The Thermal Properties of Isopentane compared with those of Normal Pentane," by Prof. S. Young and J. Rose-Innes.

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture III., on "Polyphase Electric Working," by A. C. Eborall.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. J. C. Bose. Subject: "The Response of Inorganic Matter to Mechanical and Electrical Stimulus."

**MONDAY, May 13th.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture IV. on "Alloys," by Prof. W. C. Roberts-Austen, F.R.S.

**TUESDAY, May 14th.**

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

*7:30 p.m.* Meeting at the Finsbury Technical College, Leonard-street, E.C. Paper to be read: "Rotatory Converter Problems," by F. Vigor.

**WEDNESDAY, May 15th.**

ROYAL MICROSCOPICAL SOCIETY.

*7:30 p.m.* Ordinary Meeting at 20, Hanover-square, W.

SOCIETY OF ARTS.

*8 p.m.* Ordinary Meeting. Paper to be read: "Syntonic Wireless Telegraphy," by Signor G. Marconi.

**FRIDAY, May 17th.**

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture IV. on "Polyphase Electric Working," by A. C. Eborall.

**SATURDAY, May 18th.**

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

*10 a.m.* Visit to the Works of Messrs. Elliott Bros., Lewisham.

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## ELECTROMAGNETIC THEORY.—CXXIII.*

BY OLIVER HEAVISIDE.

(*Continued from page 867, Vol. XLVI.*)

§ 488. The equivalence in external results of convection current $\rho u$ and current of intrinsic electrisation $cpe$, both being impressed currents, enables us to immediately interpret worked out problems in impressed e in terms of the equivalent convection current. An important fundamental problem concerns the wave generated by the sudden establishment of e at a point, or rather, in a spherical portion of the ether. This will be found fully worked out and interpreted in *El. Pa.*, Vol. II., pp. 409 to 412. Only a small part is required here for present purposes. Changing from $cpe$ to $\rho u$ is the same as changing from $ce$ to $p^{-1}\rho u$. If, then, e is suddenly established in a sphere of radius $a$, the magnetic wave sent out is the same as that due to the impulsive time integral of $\rho u$ throughout the sphere—that is, to the displacement of $\rho$ through the distance $p^{-1}u = dx$. So $ce = \rho dx$ is the equivalence.

The intensity H of the circular magnetic force at the point $r$, $\theta$, at time $t$, is

$$H = \frac{a\sin\theta}{2\mu v r}\left\{\epsilon^{-q(r-a)}\left(1-\frac{1}{qa}\right)\left(1+\frac{1}{qr}\right) + \epsilon^{-q(r+a)}\left(1+\frac{1}{qa}\right)\left(1+\frac{1}{qr}\right)\right\}e, \quad (1)$$

the origin being at the centre of the sphere, and $\theta$ being measured from the line along which e acts. (*El. Pa.* Vol, II., p. 409, equation (139)). Here $e$ may vary anyhow, it being the operational solution that is written. Making $e$ simply periodic produces the spherical wave trains used by Hertz as a first approximation to the theory of his vibrator, together with an impulsive wave at the front. By taking $e$ constant, beginning when $t = 0$, by an easy algebrisation we obtain an inward and an outward wave from the spherical boundary of e, leading ultimately to a shell wave of H of depth $2a$, given by (*loc. cit.*, p. 410, equation (142))

$$H = \frac{e\sin\theta}{4\mu v}\left(1-\frac{v^2t^2-a^2}{r^2}\right). \quad (2)$$

This formula expresses the magnetic force from the first moment between the limits $r = a \pm vt$, until $vt = a$; but after that, between the limits $r = vt \pm a$. It is a double shell of H, positive outside, negative inside, vanishing at the distance $r = (v^2t^2 - a^2)^{\frac{1}{2}}$.

The time-integral of H during the passage of the wave past the point $r$, $\theta$ is

$$p^{-1}H = \frac{ce_0}{4\pi r^2}\sin\theta = \frac{Q dx}{4\pi r^2}\sin\theta, \quad (3)$$

where we write $ce_0$ for the product of $ce$ and the volume of the sphere. It is the moment of the electrisation. Its equivalent is $Q dx$, if Q is the total charge, or density × volume.

But the formula is somewhat deceptive, because it is only a difference. If $H_1$ and $H_2$ refer to the outer (positive) and inner (negative) shell, their time integrals are

$$p^{-1}H_1 = \frac{e\sin\theta}{6\mu v^2}r\left\{-1+\frac{a^3}{r^3}+\left(1+\frac{a^2}{r^2}\right)^{\frac{3}{2}}\right\} = \frac{cer\sin\theta}{6}\left(\frac{a^3}{r^3}+\frac{3}{2}\frac{a^2}{r^2}+\ldots\right), \quad (4)$$

$$p^{-1}H_2 = \frac{e\sin\theta}{6\mu v^2}r\left\{+1+\frac{a^3}{r^3}-\left(1+\frac{a^2}{r^2}\right)^{\frac{3}{2}}\right\} = \frac{cer\sin\theta}{6}\left(\frac{a^3}{r^3}-\frac{3}{2}\frac{a^2}{r^2}-\ldots\right). \quad (5)$$

The sum depends on $r^{-2}$ as just seen. But when $a/r$ is small, the two impulses are sensibly equal and opposite, and depend upon $r^{-1}$. Their values are nearly

$$= \pm ce_0\frac{3\sin\theta}{16\pi ar} = \pm Q dx\frac{3\sin\theta}{16\pi ar}, \quad (6)$$

in terms of the electric moment. With $a = 0$ we get $\infty$. That is nothing unusual. We cannot have a finite charge at a *point*. If it existed it would be immovable by a finite force.

The electric fields of $ce_0$ and $Q dx$ only differ in this respect. There is no E to begin with in the case of the electrisation. There is in the case of the electrification—say the stationary polar force of Q. So add this on to the electric force produced by establishing $ce_0$ to get the electric force which exists when Q is shifted. Now, what $ce_0$ does is to set up circuital displacement similar to the induction of a spherical uniform magnet. This state is fully formed right up to the rear of the wave of magnetic force at any moment. So when Q is shifted its polar displacement persists at any point until the front of the shell wave reaches it, and when the wave has passed it is turned into the slightly changed polar displacement of Q in its new position. It is the electric force in the shell wave itself that lays down the change in the internal electric force (see also Vol. I., p. 314). At a great distance $E = \mu v H$ in the wave.

The magnetic energy in the shell being always positive need not be divided into two parts. It amounts to (*El. Pa.*, Vol. II., p. 412)

$$T = \frac{ce_0^2}{8\pi a^3} = \frac{(Q dx)^2}{8\pi c a^3}, \quad (7)$$

and is constant on the whole journey, as soon as the wave is fully formed. Compare with the usual static energy of Q. It is

$$\frac{Q^2}{8\pi ca}, \text{ external, and } \frac{Q^2}{40\pi ca}, \text{ internal.} \quad (8)$$

So $$T = \left(\frac{dx}{a}\right)^2 \times \frac{5}{6} \text{ of stationary energy.}$$

This energy is wasted. But the total waste is 2T, because there is equal electric energy in the shell ultimately. 2T is, therefore, the work done in shifting Q.

I expect, in passing, that Maxwell's characteristic expression, "electric displacement," may need to be changed. It did not formerly present any trouble that I know of. I never heard of anyone mistaking it for the spacial displacement of electrification, until one day I heard that I had been supposed to have done so myself. But in reading Dr. Larmor's book it occurs to me that trouble may very easily arise in the way mentioned, particularly because the spacial displacement of charges is so much in evidence at present. Maxwell's electric displacement D was (and I suppose is still) primarily a phenomenon in the ether, not necessarily connected with a spacial displacement in the direction of D. In matter D is increased. The excess is also not necessarily conditioned by the spacial displacement of positive and negative charges, but it is a reasonable hypothesis that it may be so, and the facts of electrolysis show that it is a probable hypothesis. The resultant makes up the excess displacement, to be coupled with the other and counted with it to make the total D called by Maxwell the electric displacement. Here the word displacement has no reference to the supposed spacial displacement of charges. So a new word, and a good word, is wanted for D. This would also be the case if an ether theory were elaborated in which D in the ether itself involved spacial displacements of + and − charges. There is room in the ether for much speculation.

§ 489. There is another sort of impulsive magnetic wave, not to be confounded with the above, which is supposed by J. J. Thomson to represent the elementary portion of Röntgen rays. Presumably also, previously by Sir G. Stokes, though he did not express himself in magnetic language (Wilde lecture, 1898). This is the magnetic pulse arising when a moving electron suddenly changes its velocity. By "electron" I only mean an electric charge, without hypothesis that it is really a "singular point" in the ether. I do not think Larmor has established that point. I wish he may, for the matter of ether and matter is in a very obscure state. Personal opinions at second-hand count for little, but I may as well say that I incline at present to J. J. Thomson's idea that his corpuscles are electrified *matter*. This does not exclude altogether the

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idea that the matter may be conditioned by ether and electrification. To show this pulse go back to (1). Put $a=0$ and reduce. The operational solution becomes

$$H = -\sin\theta\frac{d}{dr}\frac{\epsilon^{-qr}}{4\pi r}cpe_0 = -\sin\theta\frac{d}{dr}\frac{\epsilon^{-qr}}{4\pi r}Qu. \quad (9)$$

Or, in full, $$H = \sin\theta\left(q+\frac{1}{r}\right)\frac{\epsilon^{-qr}}{4\pi r}Qu. \quad (10)$$

So, if $u$ at the moment $t=0$ suddenly changes by the amount $u_0$, the impulsive H, say, $H_0$, the time integral of H at $t=0$ is,

$$H_0 = \sin\theta\frac{\epsilon^{-qr}}{4\pi rv}Qu_0. \quad (11)$$

This shows a spherical pulse out from the place where the change of velocity occurred. The operator $\epsilon^{-qr}$ only fixes the position of the pulse. Strike it out to express its intensity. That there are such pulses produced by the collision of electrons with obstacles can hardly be doubted. That they fully express the Röntgen rays is not so clear. For there is the body struck to be considered, and the special vibrations emitted by it when struck.

To see the state of things in the pulse itself, we must take $a$ finite. Use the full operational solution (1). It is the same as

$$H = \frac{a\sin\theta}{2qr}\left(1+\frac{1}{qr}\right)\left\{\epsilon^{-q(r-a)}\left(1-\frac{1}{qa}\right)+\epsilon^{-q(r+a)}\left(1+\frac{1}{qa}\right)\right\}\rho u. \quad (12)$$

Here let $u$ at the moment $t=0$ jump from 0 to $u_0$. An easy immediate algebrisation makes

$$H = \frac{\rho u_0 a\sin\theta}{2r}\left\{vt_1 - \frac{v^2t_1^2}{2a}+\frac{v^2t_1^2}{2r}-\frac{v^3t_1^3}{6ar}\right\} + \frac{\rho u_0 a\sin\theta}{2r}\left\{vt_2+\frac{v^2t_2^2}{2a}+\frac{v^2t_2^2}{2r}+\frac{v^3t_2^3}{6ar}\right\}. \quad (13)$$

The algebrisation is done by $q^{-n}1 = (vt)^n/n$, and then Taylor's theorem to translate, making

$$vt_1 = vt-r+a, \qquad vt_2 = vt-r-a, \quad (14)$$

confined to positive values only of $t_1$ and $t_2$.

We have assumed that the charge has not sensibly shifted its position. Now the first line in (13) expresses the wave out from the surface of the sphere. The second line is the wave going in, and then out again, following the first, and cancelling it partly by overlapping. If, therefore, we take the sum, it expresses not the impulse, but the internal dregs. The sum makes

$$H = \frac{Qu_0\sin\theta}{4\pi r^2}, \quad (15)$$

which is recognised to be correct under the circumstances considered, that the positions of the origin with respect to the point $r,\theta$ does not sensibly change, for (15) is the magnetic force due to the steady convection current $Qu_0$. But the impulse is expressed by the first line only of (13), for it is the part of the primary wave, between the limits $vt=r\pm a$ which is free of the second wave. To verify take the time integral between these limits. We get

$$p^{-1}H = \frac{\rho u_0 a\sin\theta}{2rv}\frac{2a^2}{3}\left(1+\frac{a}{r}\right) = \frac{Qu_0\sin\theta}{4\pi rv}, \quad (16)$$

which agrees with the result (11). The first line of (13) may be used to calculate the energy of the pulse.

If it is desired to draw the lines of displacement, we may make use of

$$2\pi r\sin\theta.H = pD_0, \quad (17)$$

where $D_0$ is the total displacement through the circle $r$, $\theta$, as is obvious by the circuitation of H. Then, in terms of $D_0$, we have (17) to derive H, and

$$D_r = \frac{1}{2\pi r^2\sin\theta}\frac{dD_0}{d\theta}, \quad D_0 = -\frac{1}{2\pi r\sin\theta}\frac{dD}{dr} \quad (18)$$

to find the two components of D along and perpendicular to the radius vector r. And $D_0$ = constant expresses a line of D.

If $e_0$ is a damped vibration, say $=f_0\epsilon^{-mt}\sin nt$, beginning when $t=0$, then

$$D_\theta = -\frac{cf_0}{2}r\sin^2\theta\frac{d}{dr}\frac{\epsilon^{-m(t-r/v)}\sin n(t-r/v)}{r}, \quad (19)$$

by equation (17) above. There is an impulsive wave at the front. Ignoring that, we obtain for the state of things in the rear of the wave front,

$$H = cf_0\sin\theta\epsilon^{-mt_1}\frac{n}{4\pi vr}\left\{\left(\frac{v}{r}-2m\right)\cos + \left(\frac{m^2}{n}-n-\frac{mv}{nr}\right)\sin\right\}nt_1, \quad (20)$$

$$D_0 = \frac{H}{v}+\frac{cf_0\sin\theta}{4\pi r^3}\epsilon^{-mt_1}\sin nt_1, \quad (21)$$

$$D_r = \frac{cf_0}{r}\epsilon^{-mt_1}2\cos\theta\frac{n}{4\pi vr}\left\{\cos+\left(\frac{v}{nr}-\frac{m}{n}\right)\sin\right\}nt_1, \quad (22)$$

where $t_1 = t-r/v$.

To find the speed of a particular phase, let $H \propto \sin n(t-r/v+\beta)$, then

$$\tan n\beta = \frac{m^2/n-n-mv/nr}{v/r-2m}. \quad (23)$$

Let $t-r/v+\beta$ be constant, and $r=V$. Then

$$1-\frac{V}{v}+\frac{d\beta}{dr}V = 0; \quad (24)$$

leading to

$$\frac{v}{V} = 1-\frac{(v/nr)^2}{1+(v/nr-m/n)^2}. \quad (25)$$

Similarly, let $D_r \propto \sin n(t-r/v+\beta_1)$, then

$$\tan n\beta_1 = \frac{1}{v/nr-m/n}, \quad (26)$$

and $$\frac{v}{V_1} = 1-v\frac{d\beta_1}{dr}, \text{ leading to } V = V_1. \quad (27)$$

So the speeds of phases of H and $E_r$ are the same—viz., V, and so is the speed of the part $\mu v$H of $E_\theta$. The other part of $E_\theta$ has speed $v$. V becomes negative near the origin. But the idea of V being a wave speed becomes very artificial then; there is such huge distortion. A Paper by Pearson and Lee, *Phil. Trans.*, 1899, on this subject contains a series of diagrams showing how the tubes of displacement behave as the vibrations decay. The behaviour is, of course, not so simple as in the maintained vibrations assumed by Hertz in his theory of a vibrator.

§490. Now consider comprehensively the state of things arising when a charge is brought from rest suddenly to

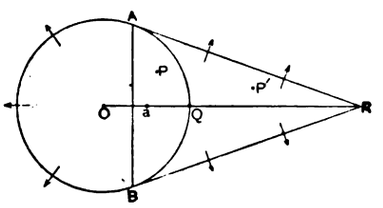


FIG. 34.

rectilinear motion at any steady speed. Previous investigations discuss the steadily travelling electromagnetic field or else the impulses. But there is a variable field as well. Its investigation is by no means so difficult as might be anticipated. We can ease matters in two ways. First, by discussing the easier theory of a growing straight line of impressed current. The results for a solitary charge will follow by differentiation. Secondly, by working it out for the case $u>v$. This will save a separate investigation for the case $u<v$, which might be expected to be easier, but is not. The results when $u>v$ may be used to find those when $u<v$. But we cannot pass the other way. The process is similar to that employed in § 468 and § 480 to find the magnetic force due to a growing plane source. The formulæ are all different, but the same diagram will serve, with a fresh interpretation.

Let it be given that there is an impressed current C along the line O$a$QR, whose length is $ut$, increasing uniformly with the time at the end Q, and beginning at the origin O when $t=0$. Find the magnetic force at any time $t$.

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Let $u>v$. Then the wave front is the cone RAB with a spherical cap on the left side, the radius of this sphere being $vt$. To find H at any point P′ inside the cone, but outside the sphere, we must sum up the magnetic forces at P′ due to all the elements of C which are within speaking distance of P′ at the moment. They are comprised between those two points on the line of C, whose distances from O are $u/v$ times their distances from P′. That is, if $z$ and $h$ are the co-ordinates of P′, and $z_1$ the distance of the apex from the origin, the equation

$$\frac{h^2+(z-z_0)^2}{v^2}=\left(\frac{z_1-z_0}{u}\right)^2 \qquad (28)$$

finds the values of $z_0$ required. This quadratic gives

$$z_0=z\sec^2\theta-z_1\tan^2\theta\pm\sec\theta\sqrt{(z_1-z)^2\tan^2\theta-h^2} \qquad (29)$$

These are the limiting values of $z$ required, provided they are both positive. But shifting P′ towards the sphere sends the lower $z_0$ down to 0. This is proved by equating $z_0$ to 0 in (29), when there results

$$z_1^2\sin^2\theta=h^2+z^2, \qquad (30)$$

which belongs to the sphere.

Formula (9) above shows the H due to any element. Writing it in the form

$$\mu\mathrm{H}=-\frac{d\mathrm{A}}{dh}, \qquad (31)$$

we have

$$\mathrm{A}=\int\frac{\mu\mathrm{C}d(z_0-z)}{4\pi\{h^2+(z-z_0)^2\}^{\frac{1}{2}}}=\frac{\mu\mathrm{C}}{4\pi}\Big[\log\{z_0-z+[h^2+(z_0-z)^2]^{\frac{1}{2}}\}\Big]. \qquad (32)$$

By (29), the limits are

$$z_0-z=(z-z_1)\tan^2\theta\pm\sec\theta\sqrt{(z_1-z)\tan^2\theta-h^2}, \qquad (33)$$
$$=m\pm n, \text{ say,}$$

outside the sphere. This makes

$$\mathrm{A}=\frac{\mu\mathrm{C}}{4\pi}\log\frac{m+n+\{h^2+(m+n)^2\}^{\frac{1}{2}}}{m-n+\{h^2+(m-n)^2\}^{\frac{1}{2}}}. \qquad (34)$$

But inside the sphere the limits for $z_0-z$ are $-z$ and $m+n$, making

$$\mathrm{A}=\frac{\mu\mathrm{C}}{4\pi}\log\frac{m+n+\{h^2+(m+n)^2\}^{\frac{1}{2}}}{-z+(h^2+z^2)^{\frac{1}{2}}}. \qquad (35)$$

Here $m$ and $n$ are defined in equation (33), so the two A solutions look very complicated. But they may be much simplified by some troublesome algebraic reductions which I omit for brevity. We come finally to

$$\mathrm{A}=\frac{\mu\mathrm{C}}{2\pi}\log\frac{l+\sqrt{l^2-h^2}}{h}, \qquad (36)$$

outside the sphere, where $l$ is the semidiameter of the cone, that is

$$l=(z_1-z)\tan\theta. \qquad (37)$$

And inside the sphere, we come to

$$\mathrm{A}=\frac{\mu\mathrm{C}}{4\pi}\log\left[\left(\frac{u-v}{u+v}\right)^{\frac{1}{2}}\frac{l+\sqrt{l^2-h^2}}{-z+\sqrt{z^2+h^2}}\right]. \qquad (38)$$

Though much work remains to derive the electrical results, the solution of the problem is now virtually complete. For, if we reduce $u$, the cone dwindles and disappears when $u=v$; and after that we have merely the spherical solution (38). As, however, it is expressed in terms of $l$, $l$ should be got rid of in discussing the case of $u<v$. Put it in terms of $u$ and $v$, by (37) and the relation $\sin\theta=v/u$. Thus (38) takes the form

$$\mathrm{A}_0=\frac{\mu\mathrm{C}}{4\pi}\log\frac{(z_1-z)v+\sqrt{(z_1-z)^2v^2+h^2(v^2-u^2)}}{(u+v)\{-z+\sqrt{h^2+z^2}\}}. \qquad (39)$$

The magnetic force inside the cone is given by (31) applied to (36). It gives

$$\mathrm{H}=\frac{\mathrm{C}}{2\pi h}\frac{l}{(l^2-h^2)^{\frac{1}{2}}}, \qquad (40)$$

in agreement with § 465. This remarkable result follows, that the state of E and H in the cone which was previously investigated is established *instantly*; that is, it is not the final result of a variable state, but begins at the moment $t=0$. We may also see this in (36), which is independent of the time in the sense required. On the other hand, there is a variable state of things inside the sphere which has to be elucidated.

The above A and the travelling potential called V in the previous investigation are in constant ratio, for we obtained by the operational process

$$\mathrm{V}=\frac{\sigma}{2\pi c}\log\frac{l+\sqrt{l^2-h^2}}{h}, \qquad (41)$$

when $\mathrm{C}=\sigma u$. That is, the relation of the two potentials is

$$\mathrm{A}=\mu c u\mathrm{V}=\frac{u}{v^2}\mathrm{V}. \qquad (42)$$

The electric field demands separate consideration, to follow.

*(To be continued.)*

## ELECTRIC STAGE MECHANISM AT THE COVENT GARDEN OPERA HOUSE.

A large number of improvements have been effected at the Covent Garden Opera House for the opening of the season next Monday, and these include entire re-modelling of the stage and scene-shifting appliances, a similar system of electrically-raised bridges to that employed at Drury Lane Theatre (see *The Electrician*, Vol. XLII., p. 825) having been designed by Mr. Edwin O. Sachs and put in under his supervision.

Without entering into detail, the stage may now be described as comprising a series of six horizontal sections 8ft. wide, running parallel with the curtain line from front to back, behind these sections being the large back stage or rear stage. The first section contains nothing but a plain "carpet cut," and openings to take the old-fashioned "grave" trap, "star" trap, or other similar contrivances. The second and third sections comprise large bridges, which can be raised 6ft. above the stage, or lowered 8ft. below the stage, constructed in two levels, on the lower level of which appliances can be installed for the purposes of raising minor platforms above stage level, or sinking traps and the like. These are not often raised and lowered, so electrically-operated winding gear has not yet been fitted to them. The fourth, fifth and sixth sections, seen in Fig. 1, comprise large bridges, running right across the stage front, which can be raised 9ft. above the stage, or lowered 8ft. below, by means of the winding gear shown in Fig. 3. The "back stage" has no openings or mechanism beyond certain trap doors to a scenery store and the necessary electrical mechanism for raising and lowering scenery for storage purposes. Between the various sections of the stage are long longitudinal flaps, 2ft. wide, and these can be easily opened to allow scenery to be passed through below for transformation scenes and the like. They are hinged to the moving floors, as seen in Fig. 1.

Each section is equipped with what is termed a pair of chariots, to hold "wing" lights placed on so-called wing ladders. These are girder constructions covered with incandescent lamps of different colours, running on an iron rail parallel to the curtain line and supported at the top between two channel irons, the connection to the lamps being made through flexible cable. By varying the position of these wing ladders, the best effect of light from the wings can always be attained.

All three electrical bridges are worked from "mezzanine" level and from ordinary switch boards (Figs. 2); they can be raised and lowered at various speeds, and take loads up to 2 tons. Signals are conveyed to the man at the motor switchboard by means of coloured lamps, and a speaking tube.

Above stage level, each section has its series of lines to take cloths, borders, &c. Each section has a batten, from which the electric light battens are suspended, and also a large wooden lattice girder, from which heavy pieces of scenery can be suspended. There are, on the average, about ten lines for ordinary battens, a girder batten, and a light batten to each section; besides these lines, there are the equipments of flying apparatus and the like, whilst in front

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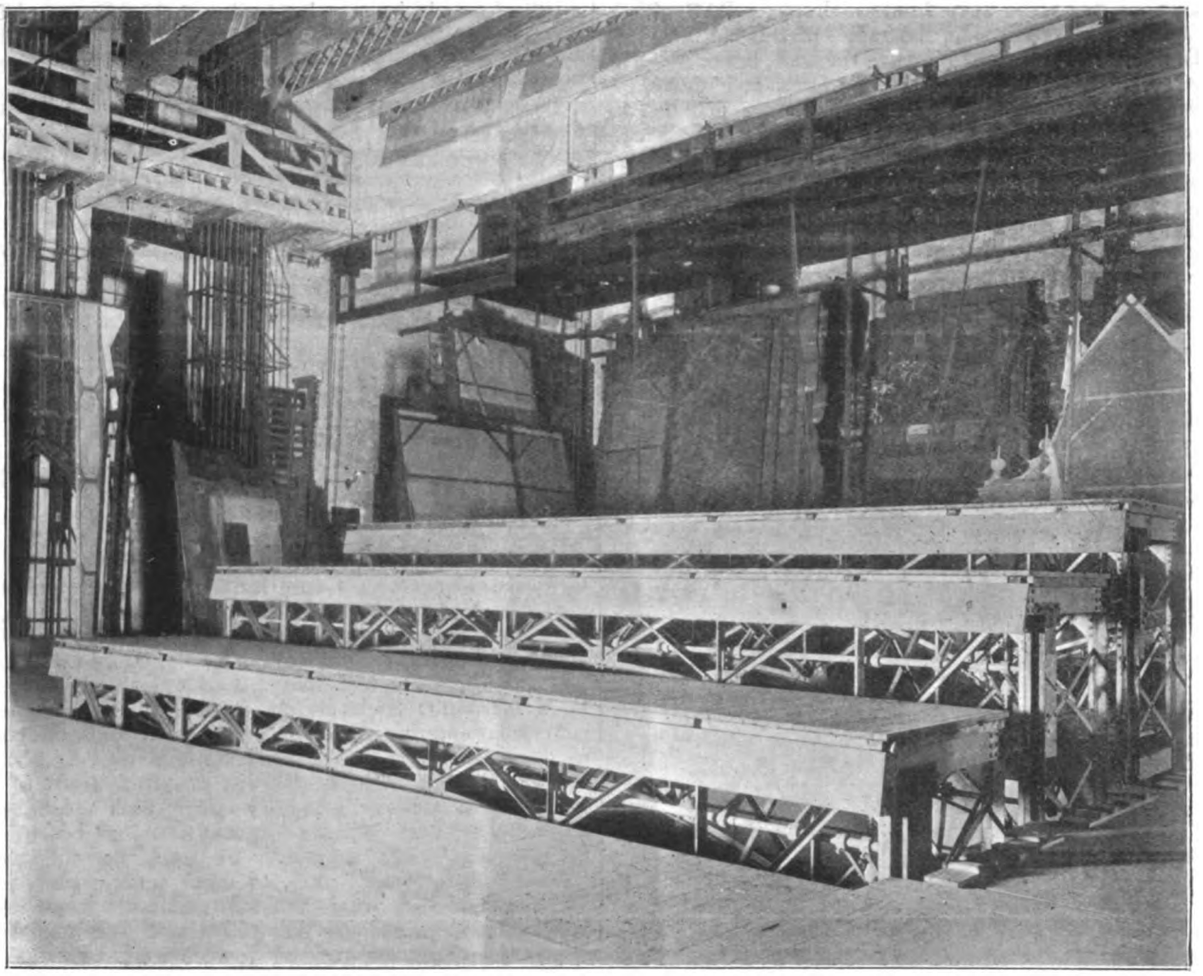

FIG. 1—THE THREE ELECTRICALLY OPERATED BRIDGES FORMING THE BACK HALF OF THE COVENT GARDEN STAGE.

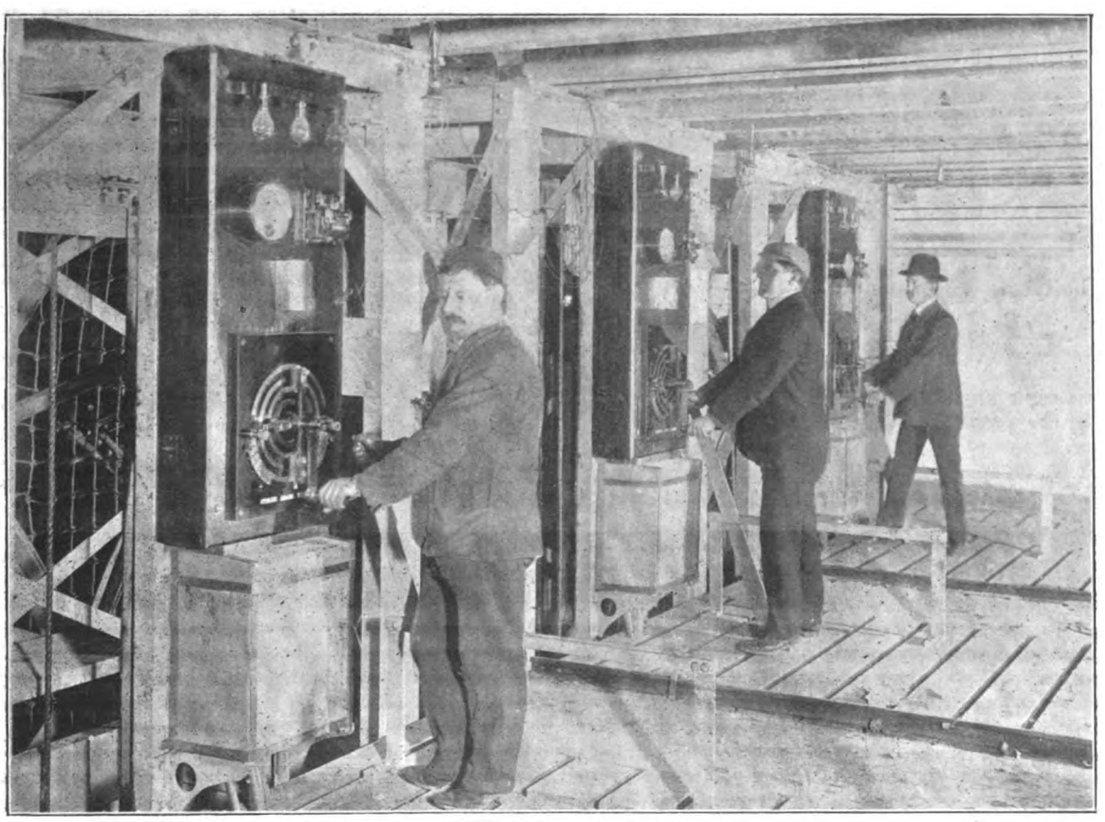

FIG. 2.—SWITCHBOARDS FOR CONTROLLING ELECTRICAL BRIDGES.

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there are, of course, the necessary lines for tableaux curtains, act-drops, and draperies.

Everything that is suspended from above can be worked at stage level, or at either of the gallery levels, every scene being counterweighted to a nicety; and one man can easily handle any scene, and in practice quite a number of scenes can be rapidly changed in a minimum of time. Throughout the structure and mechanism, steel has been used, iron pullies, and wire cable; and the inflammable materials have been absolutely reduced to the flooring of the "gridiron" (the framework at the top carrying the pulleys over which the wire ropes pass), and galleries, and the hard wood flooring of the stage and mezzanine. In other words, an absolute minimum of inflammable material replaces what was almost a maximum; and seeing that electric light is fitted throughout, and that there is an iron curtain to the stage, the risk of an outbreak of fire or its spread has been materially reduced.

The arrangements for the electrical illumination of the stage had naturally to be re-modelled and elaborated to meet the altered circumstances, the whole of the plant installed some two years back, of course, being re-used. Similarly, the steam appliances, telephone, speaking-tube, and other minor technical installations to be found on a modern stage were re-modelled. The system of gas lighting has been entirely abolished, and, similarly, the system of limelight for special effects.

We now come to the detail of the electric mechanism which elevates the three bridges. This is placed entirely below in order to allow a clear uninterrupted floor when the floors of the bridges are flush at ordinary stage level. Each lift has a totally independent and complete set of mechanism to work it. Power is supplied at 200 volts from the mains of the Charing Cross and Strand Company to a four-pole enclosed type motor which is shunt-wound and develops from 7 B.H.P. to 10 B.H.P. when running at 520 revs. per min., but is capable of working at higher rates on emergency. The three motors and gear are placed side by side in a sort of wire cage at centres corresponding to the centre lines of the bridges. The speed is reduced through a large worm and worm-wheel, as shown in Fig. 3 (which illustrates one of the three motors and its gear), the worm-wheel being keyed to a shaft which carries two winding drums. Upon these drums are wound steel wire ropes which pass under guide pulleys, and are connected to four places on the legs of the lift, one near each corner. The motors are entirely enclosed, the portion of the cover over the commutator and brush-holders being removable by itself, however. The movements of the lifts are controlled by the combined starting and reversing switches (Fig. 2), which are operated by a man at a station below stage level on the mezzanine floor, prompt side, so placed that he can see the elevators.

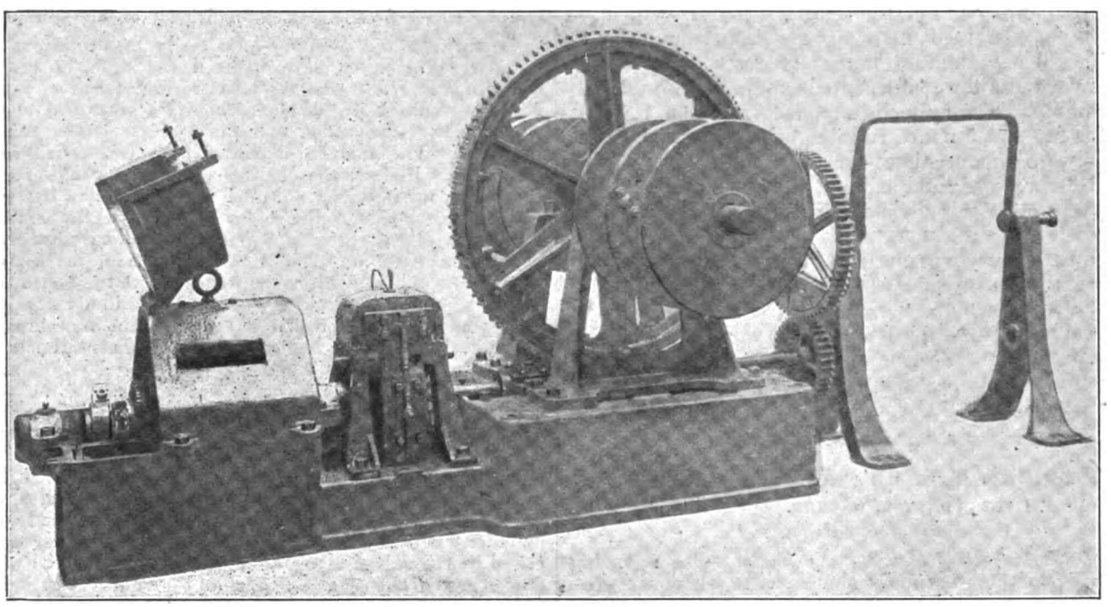

FIG. 3.—MOTOR AND GEAR FOR LIFTING BRIDGES.

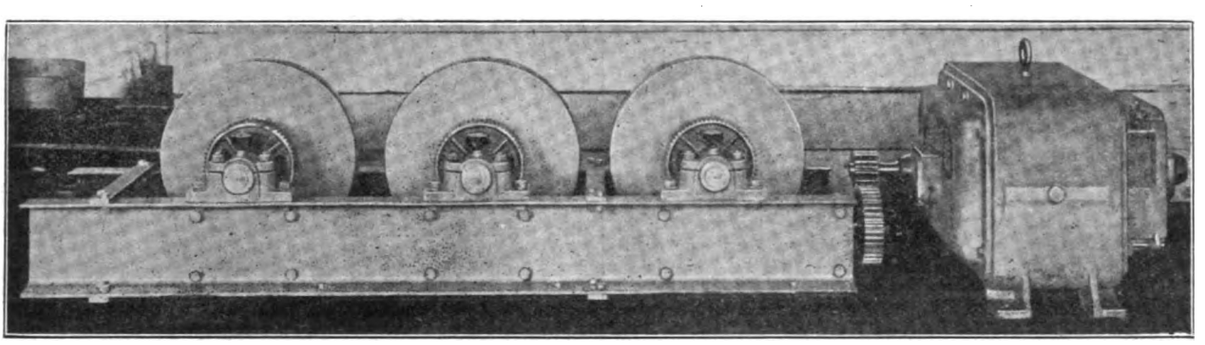

FIG. 4.—MOTOR AND GEAR FOR RAISING AND LOWERING SCENERY.

As is usual in lifts which have to carry people, safety catches have been fitted for holding the lifts stationary in the event of a rope breaking, and automatic switches have been provided for cutting off the current from the motor in case the attendant should forget to switch off in the right place. These switches are fitted on the upright guides of each bridge, so placed as to cut off the current immediately the bridge arrives at the highest and lowest points; an arm which projects from the closed box containing the switch, is knocked over as soon as the framework of the lift comes in contact with it. In addi-

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tion, there is a magnetically controlled brake on the motor shaft, which effectually stops the motor as soon as the current is cut off from it. In the event of breakdown of the motor, the hand gear at the right-hand of Fig. 2 can be brought into action.

The scenery-lifting gear (Fig. 4) is placed in a niche in the wall at the back of the stage on the prompt side, and comprises electric motor working by means of worms and worm-wheels three sets of twin winding drums, taking in all six ropes, which pass over leading pulleys and down to the scene store. The scenery is taken from the storing racks and banded in six places, the six wires attached, and the whole length, which is some 70ft. long, is drawn up by means of the winding gear actuated by the electric motor which is controlled by a combined starting, regulating and reversing switch. The maximum weight of scenery is 15cwt., and this is raised and lowered at speeds varying from 60ft. to 100ft. per minute. The motor is supplied from the 100 volt mains, and is rated at 5 B.H.P., running at 500 revs. per min.

Mr. Sachs, who was architect for the whole of the alterations at the theatre, was kind enough to give us every facility for the preparation of this article, and to place all the information as to stage technical particulars at our disposal; and we have also been greatly assisted by the Thames Ironworks, who were contractors for the electrical part of the plant, and by Mr. Lister, Mr. Sachs' assistant, who showed us over the theatre and explained to us the details of the various appliances. Mr. Sachs himself was unfortunately taken seriously ill after having the final machinery rehearsal last Friday, but is now progressing favourably.

## ELECTRICAL MINERS' SAFETY LAMPS.*

BY SYDNEY F. WALKER.

(*Concluded from page 53.*)

*The Cost of Working Secondary Battery Lamps.*—The following figures referring to the working of the Sussmann lamp at some collieries in the county of Durham, for which the writer is indebted to his old pupil, Mr. Edward Evans, and Mr. Turquand, who were in charge of the lamps at the colliery in question, will be of interest and are very instructive. The figures all relate to a batch of 600 lamps, in use at the same colliery, but used in three shifts by three sets of men working at different portions of the 24 hours. The number at the colliery is now, the writer understands, 1,000.

The power consumed for charging the 600 lamps was 2kw., which may be taken as 4 H.P. at the engine. The current was furnished from a 100 volt supply service that was used for lighting the colliery.

The attendance on the 600 lamps, inclusive of repairs, charging, &c., was £6. 17s. per week.

The life of the incandescent lamps themselves—the bulbs—was 800 hours, but the writer understands that this has been increased to 1,000 hours for lamps of the Edison-Swan Company's manufacture; for lamps of a French manufacture, the life was 500 hours; the cost of the lamps being, for Edison-Swan, 1s. 1d. each, and for the French lamps, 7d. per lamp.

The life of the battery was nine months. At another colliery in Durham, at which 300 lamps are in use, the life of the battery was stated to be six months; the life of the lamp bulbs 1,000 hours. The breakage of batteries from falls, &c., was from 4 to 5 per week.

Putting these figures together, allowing 10s. per ton for coal used for the boilers, which can hardly be neglected in these days, 10s. per battery for renewals, and 1s. 1d. per lamp for bulb renewals, the writer makes out the running cost to be 7·8d. per lamp per week, probably with sundries which are not ascertainable, 8d. per lamp per week. It is only fair to mention, however, that the attendants could probably have dealt with 1,000 lamps, in which case the running cost would have been 6·5d. per lamp per week, as compared with 2d. per lamp per week with the old oil lamp.

Mr. Evans has also given the writer the following information on the working of the lamp:—The percentage of failures of lamps which were taken into the pit was, when he left the colliery, 0·25, though at first it was as high as 4·25 per cent., the percentage of failures of oil lamps under the same conditions being 1·25 per cent.

The measured candle-power of the lamp was 0·5 c.p., which, with the bonnet reflector, produced 1 c.p. in the beam.

The greatest output from the battery was 6·87 ampere-hours, and the greatest efficiency 73 per cent., but both of these measurements were taken without the vegetable absorbent in the cells. Mr. Evans found that the addition of this vegetable absorbent, by raising the variation of the density of the acid in the cells, tended to soften the plates somewhat quickly, with the result that pieces of paste chipped off the plates and formed at the bottom of the cells, working down through the absorbent, with the well-known results, so that by the end of seven to eight months the plates began to come, the worst of them, for renewal.

The iron cases were made, Mr. Evans states, intentionally as cheap as they could be made, it being recognised that they would be soon eaten through when acid was spilt on them, and it being the intention that they should be renewed, when required, at a small cost.

The two colliery firms who are using the Sussmann lamps are now making their own storage batteries, and making them very fairly too. The writer saw them being made at one of the collieries, by ordinary colliery workmen, very neatly, and apparently with very good results. This, again, would reduce the running costs.

In Mr. Evans's opinion, the Sussmann Company sacrified mechanical strength for the electrical efficiency of the plates.

*Primary Battery Lamps.*—As already mentioned, a very large number of inventors have attacked the problem from this side, including Mr. Coad, who has made several forms of lamps, several French inventors, Mr. Maquay, who did a great deal to advance the matter, Mr. Schanschief, and the present writer. All, with the single exception of Mr. Schanschief, have used some form of salt of chromium. In fact, the changes have been rung on the salts of chromium, *ad infinitum*, so much so that a mere list would fill a good space. So far as the writer is aware, the first really practical attempt to solve the problem by means of a primary battery was made by Mr. Maquay, on the writer's suggestion, in the year 1884. The lamp was exhibited by the writer before the South Wales Institute of Engineers. It consisted of three cells in a vulcanite cylinder, the cylinder being divided vertically to form the compartments for the cells. The cells were double fluid, a porous cell being contained in each. The elements were zinc and carbon, the zinc being in the form of a hollow cylinder surrounding the porous cell, and the carbon in the form of a plate inside the porous cell—the whole, carbons, zincs, and porous cells, being suspended from the top of the outer cylinder, which was also of vulcanite. The incandescent lamp was on the side of the outer cylinder, and the arrangement was much the same as in secondary battery lamps, which were brought out at the time. A leather handle, attached to the outer cylinder was used for carrying the lamp. The outer cylinder was closed by the vulcanite top, a screw, working into a rod which passed down through the central division of the vulcanite cylinder, serving to keep the whole liquid proof. This lamp never came into practical operation. It was merely constructed to show what could be done in the matter.

Subsequently the present writer, with Mr. Maquay's assistance and consent, worked at the problem, and produced a lamp, in which two and three cells were employed, according to the light required. The cells were of zinc and carbon, the carbon being in the form of half cylinders, hollow, except at the bottom, which was closed, the semi-cylindrical vessel forming the outer containing vessel of the cell. Inside the carbon cell was a semi-cylindrical porous cell, and inside that again a zinc rod. Two of these cells, forming together a complete cylinder, were placed in a copper cylinder, fitted with a bayonet-jointed cover and a substantial handle of the same material, the incandescent lamp being carried in a projection on one side of the outer cylinder, in a metallic reflector, and protected by an outer glass of the bull's-eye pattern. The carbon cells were coated with an insulating compound, as was also the inside of the copper vessel.

As it was found that mining men wanted a larger light than was afforded by the current from two cells of this pattern, three cells were arranged inside a copper vessel of elliptical section, the other arrangements being the same as with two cells. The solutions were the same as in Mr. Maquay's own lamp—viz., in the zinc cell a very dilute solution of sulphuric acid—1 of acid to 20 of water—and in the carbon cell, a solution consisting of certain proportions of bichromate of potash and sulphuric acid, with a small quantity of nitric acid. A rubber pad covered the tops of the cells, maintained in its place by the copper top of the outer cylinder.

This lamp never came into practical use, nor did it ever get beyond a very cursory trial. Many difficulties arose. The carbon cells refused to remain liquid-proof, notwithstanding various materials with which they were treated. The matter of the connections between the cells, and between the cells and the lamp, proved a great stumbling block to the mining men. They could not manage them, and the liquid from the cells was constantly spilled into the copper vessels and quickly ate holes in them. Added to this, the working out of the problem proved to be a very expensive matter, while absolutely no encouragement was given by the great majority of colliery owners.

Mr. Maquay worked on at the problem for a considerable time afterwards, and, the writer understands, produced one or two forms of single-fluid lamps, in which carbon and zinc were the elements, various combinations of bichromates, with sulphuric acid, nitric acid, and other salts being used for the solution, the zinc and the carbon, the writer believes, being held suspended from the cover of the outer cylinder, which was always of vulcanite and the closing of

* Abstract of a Paper read before the Institution of Electrical Engineers, March 28.

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which was, the writer understands, by means of pitch, or paraffin, or some similar substance run in hot. Mr. Maquay also devised an arrangement for allowing the gases formed in the working of the battery to escape, by means of vent-holes leading into a sort of gas chamber above the cells. The writer believes that no serious attempt was made to introduce either of these lamps to practical work.

The next important lamp that was introduced was that of Mr. Schanschief, in which carbon and zinc were the elements, immersed in a salt of mercury. The battery was a single-fluid one, and it had the peculiar feature that the current was switched off by inverting the whole apparatus. The apparatus consisted of a vulcanite case, rectangular in section, with an inner case containing the elements attached to the usual block of vulcanite, and it was arranged that when the outer case was in one position the elements were out of the solution, while when it was inverted the elements were immersed. The incandescent lamp was carried in a reflector, and protected by a bull's-eye on one face of the rectangle.

Mr. Schanschief also arranged a gas indicator, attached to one face of the outer case, consisting of a platinum wire inside a cylinder protected by a gauze front and controlled by a switch. When the current was turned on to the platinum wire it glowed very dull red in an ordinary atmosphere, but with more or less brilliancy if an inflammable mixture was present. In the writer's opinion the gas indicator was of very little value, as the current taken by the platinum wire was too considerable to allow of its being constantly connected to the battery; and to be of service to the collier it should have been automatic. In addition, it appeared to the writer to surrender a large portion of the most important advantage claimed for the electric miner's lamp—the absolute severance of the source of light from the surrounding atmosphere. Mr. Schanschief's lamp was made in three sizes, weighing, when fully charged, 3¼lb., 4½lb. and 5lb. The smaller one contained three cells, and measured 4in. square by 4in. high. Each cell contained 15 fluid ounces of liquid, which, in consuming ⅛lb. of zinc in 48 hours, was stated to furnish a light of nearly 2 c.p. in the direction of the beam. It was guaranteed to give a good light for from eight to nine hours, and the working cost was given at ⅜d. per shift, or 3¾d. per lamp per week.

The writer believes that in this estimate nothing was allowed for the renewal of lamps, nor for other repairs that would be sure to be necessary. In addition, the estimate was formed on the supposition that the old material taken from the battery was returned to the makers, to be used up again. Mr. Schanschief gave the price of the liquid new as 4s. per gallon, while 3s. 7d. was allowed for the old material; but it was not stated where the old material was to be delivered for that price, and in the early stages, at any rate, the cost of collection would have an important bearing on the matter. Mr. Schanschief's battery gave a remarkably steady current, though it was not tested, the writer believes, for any great length of time; and it is probable that the mercury salts formed in the working of the battery would have attacked the carbon plates, unless they were specially protected.

In the lamp which the writer worked out during recent years, and which he hoped to have placed on the market, aluminium was very largely employed. The writer's first idea was to have simply an aluminium jar, with a vulcanite top, the top carrying the zinc, the incandescent lamp and any protection that was required; but his idea was also to have rendered any protection to the lamp unnecessary by making the lamp itself—the lamp bulb—of very strong glass, strong enough to withstand the ordinary wear and tear of a mine. He is aware that the strong glass would have absorbed some of the light rays, but probably less than are now absorbed by the protecting glasses of other forms. If he had been able to carry out his idea in full—the first idea—the writer believes that it would have been difficult to find a simpler lamp, and he believes that when manufacturers turn their attention seriously to the problem of producing incandescent lamps of very low voltage and low candle-power, the portable primary battery lamp may still assume the simplicity he designed for it. He was unable to carry out his design because, in the first place, he was unable to get any incandescent lamp-maker even to consider the matter at any price; they were all too busy with lamps for the 200 and 230 and 250 volt circuits, and could not spare the time.

The apparatus, in its final form, consists of two single fluid cells of ebonite, enclosed in an aluminium jar. The elements are zinc and carbon, the zinc being in the form of a rod of sufficient size to last out a shift, just leaving the end which holds it in its place, which comes to cast up again. The zinc is not amalgamated. The carbon is in the form of a hollow cylinder, with a number of holes drilled in its length, and with its pores impregnated with sulphur. The zinc and carbon are held by the cover of the battery, on which is also mounted the lamp, with its protecting glass. The protecting glass is surmounted by an aluminium plate, which supports the hook by which the lamp is carried, as in the Sussmann lamp.

The cover of the battery is of ebonite, and it is held in its place by a collar of aluminium, which screws on to a flanged ring on the top of the aluminium jar containing the cells. The ebonite cover is made in two parts, so as to form a bed for the connections, and for the arrangements for holding the zincs and carbons. One portion of the ebonite top consists of a thick disc, in which circular spaces have been cut, partly through its thickness, and in which slots are also made to form bayonet joints for the carbons.

The carbon cylinders are coppered for a short distance from the top, the sulphur being removed for the purpose from the end, and to the coppered portion are soldered two brass cylinders, one having a flange and pins to form a bayonet-joint. The flanged brass ring which is on the outside of the carbon cylinder fits in the space prepared for it in the ebonite disc, the pins locking it in position, after a quarter-turn has been given it, in the usual manner. The inner brass cylinder, in the carbon cylinder, has a thread screwed on its inner surface, and in this a small cylinder of ebonite screws, carrying another brass disc having a projection which, when the cover is in its place, is inside carbon cylinder, and to which a brass cylinder is attached to the top of the zinc rod screws. Slots in the ebonite disc also carry the connecting pieces, which consist of flat strips, substantial in section. All parts which are exposed to the possible action of the acids are given several coats of a special varnish, which is put on at a temperature of 600°F. Thus the connecting pieces—the brass caps of the carbons and of the zincs—except where actual connection is to be made, are all protected in this manner, as well as the inside and outside of the aluminium jar.

When the carbon cylinders are in their places, a thinner ebonite disc, having circular apertures for the passage of the carbon cylinders, is slipped on, and a special cement having been run into all the cavities, the two ebonite discs are brought together under pressure. On the upper side of the ebonite disc is placed the lamp holder, which is also of aluminium, the protecting glass, which is also protected by three aluminium wires, and which are screwed into the aluminium flanged annular ring which closes the cells, and into the aluminium plate which is placed on the top of the protecting glass, and to which the hook is attached. The built-up cover, with its zinc and carbon elements, is simply dropped into the cells, the annular aluminium ring is slipped over them and screwed down, and the glass and top plate put on, the whole presenting the appearance shown. The incandescent lamp can be changed by removing the top aluminium plate.

The solution consists of a mixture of chromic acid and hydrochloric acid, with a small quantity of sulphate of soda, and each cell gives rather over 2 volts, and will maintain it, with the proper quantity of the components, for eight hours without appreciable fall, and will continue to give a gradually falling current for another four hours, or longer if a larger proportion of chromic acid be put in the solution. Gases are given off during the working of the battery, but, provided the cover is properly made, and the flanged ring properly screwed down, no harm results beyond a slight rise in temperature, the gases being dissolved in the solution. The aluminium also does not appear to suffer from the acid which is spilled when the lamp is re-charged, a sort of skin appearing to form, which protects the metal from further action.

As will be understood, there were a great many difficulties met with during the process of working this lamp out, which occupied five years altogether, the author's son, Mr. C. J. Walker, superintending the manual part of the work. Only the purest carbons, of French manufacture, would answer the purpose, and it was found necessary to impregnate them with sulphur, just as the tops of carbons of Leclanché cells are impregnated with paraffin to protect them from attack by the chromic acid. In this the writer was assisted by Mr. R. W. Atkinson, an able analytical chemist of Cardiff, whom he consulted in this and other matters which arose during the working out. Difficulties were experienced with the chromic acid (which at first was never of the same analysis, in two successive lots, and in portions of the same barrel), with the glass for the protection of the lamp, with the working of the aluminium, and other matters; but all of them had been fairly well surmounted when the matter had to be abandoned for the reasons given, though not until it had been tried in several mines, and had been in the hands of practical colliers, who had done their ordinary day's work with it, to their great satisfaction.

The lamp weighed 3½lb. when fully charged, and gave a light of 1 c.p. for eight hours, with a gradually falling light for another four hours, the light at the end of the 12 hours being about from one-third to one-half of a candle. The working cost, the writer made out would be, at first, 1½d. per lamp per shift, or say 9d. per week. This cost, however, was based upon the assumption that the materials would be all used, the unused residue being thrown away. As the whole of the materials were by no means used up, it follows that if the residue could be collected and worked up again, the cost would be very much less; and on this basis, which is perfectly practicable, by proper organisation, where a large number of lamps are employed, the writer made out that the cost would have come down immediately to ½d. per lamp per shift, with every probability of a further fall, which, considering the advantage to be gained by the use of a portable electric lamp in collieries, he felt sure would command universal acceptance, though it was higher than the cost of the present lamps.

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In fact, the writer has been told by many eminent mining engineers that even the full price of 1½d. per lamp per shift would not have been prohibitive, provided the lamp was absolutely safe and thoroughly practical.

The writer was making arrangements to try a number of lamps for an extended period at the colliery in South Wales when he was obliged to give the matter up.

Another form of primary battery lamp which has been brought to the writer's notice since the above was written, which is based upon completely new ideas, will probably be of interest to the Institution. Many members will have heard of it, the late Dr. Hopkinson having reported very favourably of the battery for another purpose. It is called the Doe battery, and comes from America, and is a single fluid battery. In the electric miner's lamp which has been constructed with this battery four cells are employed. The four cells form the four equal sectors of a cylinder of ebonite. The divisions do not come up to the top of the cells. This is one of the peculiarities of the battery. In each cell is a grooved and perforated carbon cylinder, and inside the carbon cylinder is a cylinder of ebonite, also hollow, and also perforated, the object of the perforations being in each case to secure the flow of the exciting liquid. Running down between the vulcanite cylinder and the carbon cylinder is a platinum wire enclosed in a vulcanised rubber tube. One end of the platinum wire forms a lacing, a sort of cat's cradle across the bottom of the vulcanite tube, and the other is pegged into the carbon of the next cell, a carbon peg being used, a hole having been drilled in the top of the carbon for the purpose. Into the vulcanite cylinder is dropped a hollow cylinder of zinc, after the cell has been charged with the exciting liquid, which consists of sulphuric and other acids, and other chemicals which are kept secret. As will be seen, though the arrangement is a complete inversion, when the zincs are in their cells they complete the circuit by the fact of their immersion and by the fact of their contact with the platinum wire, which is again in connection with the next cell.

The weight of the lamp, one of which is shown, is stated to be only 2lb. when fully charged. The zincs are amalgamated. The liquid is sold by the owners of the patent at 2s. per gallon, and the zincs, ready for use, at 2s. per pound. One gallon of liquid is stated to last for 14 charges, and 1lb. of the zincs for the same time in the miner's lamp made with this battery. This would give 1s. 8d. as the running cost of the battery without allowing anything for attendance, lamps, repairs, &c. The first cost of the battery is also high, owing to the necessity for using platinum in the manner described. On the other hand, the marked simplicity of the battery speaks very loudly in its favour, and the writer is of opinion that further investigation would probably enable the inventors to reduce both working and running cost. He is informed that they have hardly touched the problem of a miner's lamp seriously yet.

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This Paper was discussed in conjunction with Mr. Ravenshaw's Paper "Some Notes on the Electrical Transmission of Power in Coal Mines," published in our issue of April 19.

*Thursday, March* 28.

Mr. GISBERT KAPP especially thanked Mr. Ravenshaw for giving his list of failures, for, provided none had been withheld, it was a matter for congratulation that electricity in mining was such a safe agent. He noticed, under the heading "Switch gear for motors," that the author advocated the putting in parallel with the shunt coil, of a non-inductive resistance twice the resistance of the shunt. This was a very old and somewhat expensive device. A better plan was to have the shunt connected across the end of the starting resistance, and if the circuit broke the armature would act as a by-pass to the discharge of the shunt current. Another device consisted of a case containing graphite powder with the terminal dipping into it, and the deeper it dipped the less was the resistance. Therefore it was possible to switch off absolutely without spark by using the old device of connecting the shunt across the starting resistance on the one side and the brush on the other, and by adding this graphite resistance. Toothed core armatures were much to be preferred for rough work such as mining, and therefore he did not think it would be possible to utilise the author's somewhat crude safety device in connection with drum armatures. It was better to prevent the breaking down than to cure it, and this could be done by insulating properly. The chief question he asked was as to whether the author had purposely left out of the Paper any reference to the use of two or three-phase currents. With three-phase currents a good many of the difficulties would vanish, especially the choking up of the air passages of the armature with coal dust. It was perfectly possible to manufacture a polyphase motor which would stand any amount of rough usage. A good example of this had been afforded him some four years ago in connection with a large drainage scheme equipped with 60 H.P. motors. On account of limitations of space it was not possible to put down separate steam engines, but a large generating station was erected and the motors distributed over the dyke, the furthest being about 12 miles from the generating station. This latter was in a place which was under water for half the year. One motor before erection had fallen into the ditch and had a soaking, and it broke down when the full load was put on. But all the other motors which were on the damp ground, and worked with a thick sea fog round them, were running to this day. If polyphase motors would stand a fog from the sea with salt in it, it was obvious they would stand the difficulties encountered in coal mines. With a squirrel-cage armature there was absolutely no exposed metal part, and the insulation could not be damaged if a sack of coals were shot on the machine. Three-phase machinery was very suitable for pumping, especially nowadays when there were piston pumps arranged to run at a fairly high speed. If the large power schemes came to life he hoped the frequency in England would be reduced to 25 ∿. This was very convenient when using converters for tramway work, and it was certainly also very convenient for motor work generally. The three-phase motor could be put straight upon the shaft of the pump, which was a very simple arrangement. At present continuous-current motors were all geared, and any disadvantage due to the squirrel-cage was counterbalanced by not having gearing. The author had not mentioned hoisting, which was a very important part of electrical mine work, and recently motors for this class of work had been worked in combination with secondary batteries. He had had to go into this matter in connection with a 700yd. mine, which had not yet been carried out. The speed worked out at 60ft. per second, so that the whole time for hoisting from the bottom was 47sec. The plan was to use a balance system, with tail-ropes hanging down from the two cages. Such a mine as this, hoisting in the usual way with a generator and motor at the surface, would necessitate a generator with a capacity of 1,600kw. and the motor 1,500kw. But by using a battery of 1,000kw. the generator would only need to be of 950kw. and the motor 1,500kw. Thus there was a great saving. The cable could be smaller, and the generator was loaded very evenly all through. He would like to ask if such buffer batteries had been used in England. There was no objection to them so long as they were on the surface.

Mr. A. P. TROTTER said that coal mining work was in a happy position in one respect, inasmuch as there were no regulations for it. But some day somebody would make some regulations, and it was experience of the sort given in Mr. Ravenshaw's Paper that would be most useful in connection therewith. So little had been heard of coal mining work that it did not appear to be recognised that coal-cutting motors were to be bought as absolutely gas proof as it was possible to make them. As far back as 1886 they were made. Of course, there were disadvantages in an enclosed motor, but the machines he referred to which were designed by Mr. Ravenshaw, would work in the most fiery gas.

Prof. LE NEVE FOSTER, one of His Majesty's inspector of mines, agreed with Mr. Ravenshaw that the cable hanging down the shaft ought to be properly protected, but objected to the statement that corves and other trifles were in the habit of falling down the shaft. Mr. Ravenshaw had stated that he could not quote a single instance in which electric locomotives had been employed for coal mines, but on the Continent and in America these electric locomotives were in use. Even if Mr. Ravenshaw meant that he had not seen a locomotive worked from an accumulator, this sort of thing could be seen in the North of France, where the accumulators were carried in the tender of a locomotive. In this instance, the prevention of access of fiery gas into the case carrying the motor was effected by the use of compressed air, which was continually flowing ont of the case and so preventing the entry of any gas. Coming to Mr. Walker's Paper, he first dealt with the question of the extra weight of the electric lamp. It was perfectly true that the collier, having hard muscular work to do all day did not like to expend any of his energy in carrying more weight to and fro from his work than was absolutely necessary. But surely this could be prevented. Was not it a foolish policy, at the beginning of the twentieth century, to put a man to work flat upon his back, as had been shown in one of Mr. Walker's illustrations, simply to cut away a soft material? If a miner had only to hold a drill to do his work he would not grumble about an extra pound in the weight of his lamp. There were 2,000 Sussmann lamps in use in this country, 2,500 in Belgium, and 200 in Australia, so that really it might be spoken of as having a fairly large use, although perhaps not so when this number was compared with all the ordinary lamps at present in use. He disagreed with Mr. Walker that carbonic oxide gas was always present in old workings. He would probably only find it after a fire. Further on, Mr. Walker had given £60 as the average cost to a colliery company per man of a non-fatal accident, but he regarded this as too high. He had never seen in use the ingenious appliance of the Sussmann Company for detecting gas, and before speaking about it he would like to use it underground. As he understood it at present, it had the disadvantage that it would only reveal the presence of fire damp and not carbonic acid gas. In conclusion he remarked that, as one of a school which was fast dying out, he hoped in future every mining engineer of any descripion would be compelled to have a training in electrical engineering.

Mr. W. M. ATKINSON, referring to the question of danger from sparking, said that up to the present time the great majority of motors underground were either in pits where there was practically no danger from fire-damp, or in parts of a fiery pit where danger from fire-damp was very unlikely to reach them. But they were now being introduced for coal cutting, and if they were introduced into fiery mines for this purpose, the sparking question became a serious one. The only plan he had seen adapted to meet this danger was to enclose the armature and commutator in a solid metal case. The openings which had to be closed should be so designed that they were of the simplest possible character, and there should be plenty of bearing surface. His impression of the chief cause why electric lamps were not more largely used was their liability to get out of order. In every other respect the lamp was superior to the ordinary safety lamp except in the matter of weight, but he did not attach so much importance to this as many others did. He did not think the drawback of the want of an efficient gas detector would prohibit the use of a good electric lamp if one were manufactured, although mining engineers would be very pleased to see this difficulty got over. He did not like the mercury switch referred to by Mr. Walker. His experience was that they were likely to go out if they had a sudden jerk, and such a thing happening at a critical time was dangerous. With reference to the presence of carbonic oxide gas in mines, his experience proved that it was never found naturally. It was either due to explosion or combustion.

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Mr. G. A. MITCHESON agreed with Prof. Foster that it was not usual for corves to tumble down the shafts to the danger of the cables. Small pieces of coal did fall down, but how far these injured the cables was problematical. He would like to know how Mr. Ravenshaw would protect the cables. To his own mind this was not by any means a settled question. With large cables it was a serious matter to get them inside a pipe, for instance. Then again, if they were put in in sections and anything went wrong, a whole section had to be taken out and put in again. Another point about the shaft problem was that if the cables were hung in between the wooden clamps they must be secured in some way, and it would seem that the amount of moisture invariably met with in a shaft would attack the insulation at the point of contact between the timber clamp and the insulation. He did not look upon the risk of explosion from sparking in connection with coal cutting as a very serious matter. The motor had to be protected against dust, and this he thought sufficient for excluding gas. Personally, he thought the risk of fire more, because the cables were fixed to fairly warm and dry timber, so that if there was an arc there might easily be a fire. Then the switches ought to be protected as much as the motors. He had no doubt that with a little care and education a collier would take very much more care of the electric lamp than he ever bestowed on an oil lamp. As far as the collier was concerned, he did not think about the extra weight of the Sussmann lamp, but as a rule they did not care for these new things. Speaking of some instances with which he was acquainted, he said that it was the unanimous opinion of the men that an electric lamp was a great advantage to them, and they were strongly in favour of it. One electric lamp was used where previously two oil lamps had been necessary. He did not agree with Mr. Walker as to the weekly upkeep, because the lamps he had used cost much less than his figure. Personally, he did not think much of the detector. He had tried it and sometimes it worked and sometimes it did not, and if a good electric lamp were forthcoming they could very well afford to keep an oil lamp on the premises in the hands of a responsible person to test the mines.

Mr. R. HOLIDAY agreed that the question of the shaft cables was one of the greatest difficulties in putting electricity into a mine. Cables had been put in boxes and filled up with bitumen, and also lead-covered, but after a time the action of the water leaking out of the brickwork had caused the lead to come away and the motors had stopped. This very often meant ripping out the whole of the cables to find the fault. In his own mine he had 25 cables, but they were all suspended from top to bottom of the shaft without any support whatever; and further, instead of any expensive insulation, there was simply a triple braiding round the cable to protect the men who periodically examined the shaft. Otherwise he advocated having the cables bare. He tested them every Sunday evening with a megohmmeter, and a record was kept, but up to the present he had never had a leak or break. This method seemed to get over all the cable difficulties. It was very much cheaper in the first case, and much cheaper in upkeep. It also had the advantage that there was nothing for any falling obstacle to catch. The one weak point was where the cable turned into the mine from the bottom of the shaft. Here it was bent round and attached to an insulator, so that any water running down the cable fell off before the insulator was reached. He could not agree altogether that Callender's armoured cables were the best for this purpose. His mine had shafts 600, 400, and 330yd. deep, and the cables were of 19/12 hard drawn, carrying 500 volts. The factor of safety was 8. Up to the present there was no sign of any break due to stretching, and they had been working since 1893. The method of laying was to run a drum of cable into a cage, a lever put through it, a hole made in the floor of the cage, and the cage going slowly up laid the cable. His shunt motors were excited with the first step of the starting switch. As to liquid resistances, he said he would not have one near his colliery. In his opinion the Gramme armature was the armature for coal mining. His reason was contrary to Mr. Ravenshaw's. One of the conditions of coal mining which must be borne in mind was that there was only a certain time in which coal could be drawn up to the surface. Every half-minute lost was of importance. If everything went well coal was being constantly sent up from six o'clock in the morning until two in the afternoon with the exception of half an hour for lunch, so that the thing to be considered about any machinery in the mine was that if anything goes wrong, what was the quickest time in which it could be repaired. Mr. Ravenshaw had advocated the drum armature and the enclosed motor. Looking at the present-day motor undoubtedly the winding was very beautifully laid, but if anythiug went wrong the whole armature had to be pulled out to repair it. With a good thumping big Gramme armature all that was necessary was to telephone to the surface and say that the motor was smoking, and down went a man with a pair of pliers and a bit of wire, cut the coil out, wrapped the wire round the commutator segments, and away went the motor again. This had happened over and over again. They were rough and ready electricians. He had some drum armatures but wished he had not, because it was always four drum armatures to one Gramme armature going wrong. Haulage was very similar to tramway work; the generating plant load was almost identical. He next related his experiences with steam turbines. He had several 200 H.P. machines, and in 1895 when he first used them, colliery engineers particularly, and electrical engineers generally, scoffed at the idea. But his experience had proved them to be most useful machines. The load went on and off very quickly and the turbines stood it perfectly. He had also been told that they were fancifully designed machines, and that miner fitters could not repair them. There were only four bearings in the turbine, and the result was that the bearings sometimes wore away, and let the plates of the spindle on to the casing of the turbine. All he did then was to send a man down with a hammer and chisel and knock three or four rows of plates out and put the cover on, and at the end of the week the whole thing was properly repaired. It was as easy as setting type. His experience of steam turbines was certainly satisfactory, and he contemplated going in for 360 H.P. more. There were no foundations to them, and they were not bolted. The steam consumption was not nearly so bad as ordinary colliery engines, although it was worse than the type of engines used in some central station plants—viz., about 39lb. to 40lb. per kilowatt. This was after running two years. He had also experimented a little in three-phase coal cutting motors of the Brown, Boveri make. This was about the very worst form of work for a motor to be put to. If it was a disc cutter it often got stuck dead and the motor had to start against an absolute fixture. The other point was the excessive vibration. The motor was not fixed to any foundation, and it was dancing about all the time, there being nothing to hold it. A three-phase motor would stand the moisture but not the vibration. At present sufficient care was not taken where the wires were brought through the slots, and round corners. All new motors broke down from this cause, and the motors he had in use had had the corners rounded after he got them. To get over the trouble of the armature going when the cutting wheel got jambed fast, he had constructed a switch which cost about 8s. to make. It was a box about 18in. long, with three contacts each side. It really consisted of a straight bar pulling backwards and forwards, and had never burned out. It was strong enough to pull the wheel out of anything by reason of the sudden jerk it gave to the machine at the moment of switching on. He had also tried the friction clutch on a three-phase motor, and by this means the machine could be run up to full speed light, and the wheel jerked out when the friction clutch was put into action. However, by the arrangement of his switch gear he was able to work without slip rings. The results of his experiments had induced him to instal a number of three-phase motors for coal-cutting purposes.

*Thursday, April 18.*

Mr. S. F. WALKER replying, desired first to correct a misapprehension with regard to the gas-detecting apparatus shown at the previous meeting. This apparatus was not the Sussmann Company's, but was a patent of Mr. Prested's which acted on a totally different principle. The Sussmann apparatus acted upon the well-known principle of the impingement of the light carbon hydrogen gas upon finely divided platinum or palladium. This generated heat which expanded a column of mercury, which, in its turn, operated an electrical contact. The Prested apparatus acted upon the equally well-known principle of the diffusion of gases. A certain quantity of the ordinary atmosphere of the mine was enclosed in a porous chamber, and when the light carbon hydrogen gas rushed in it worked a contact and lit the lamp. Mr. Mitcheson had objected to his statement as to the cost of upkeep of the Sussmann lamp. Since the last meeting, however, Mr. Wood, manager of the South Hatton Coal Co., where 1,000 Sussmann lamps are in use, had read a Paper before the Institution of Mining Engineers, and his figures for the total upkeep of these lamps at his colliery was 4·82d. per week. His own estimate for 600 lamps was 7·8d. per week. If the same attendants could run 1,000 lamps the cost would come down to 6·5d. per week, and he had further stated that this calculation was on the supposition that the colliery bought the batteries in London or some other place. At South Hatton they made the batteries themselves, and this would bring his figure to pretty nearly what Mr. Wood's was. Mr. Mitcheson had only just taken to use the Sussmann lamp, and it was possible that when he came to renewals this would alter his figures. Mr. Hall had written to ask if electrical engineers could not produce a lamp to carry on the miner's cap. If mining engineers were prepared to accept a lamp which could be worn on the coat or in the buttonhole of the miner, and to have the battery strapped on his back or somewhere on his body, the problem was practically solved and they could have one to-morrow.

Mr. H. W. RAVENSHAW, in his reply, referred first of all to the doubt raised by Prof. Foster and Mr. Mitcheson as to corves falling down the shaft. As a matter of fact, he knew of several instances in which this had been the case, and, curiously enough, only yesterday he had been been told by a colliery manager at a mine he was inspecting, that two corves had been maliciously pushed into the shaft on a Sunday, one on the top of each cage, resulting in the smashing of the cages and the shutting down of the pit for four or five days. Anything of this nature falling down 500yds. or 600yds. naturally did a great deal of damage. He had never known any cables to be actually cut through. It was an easy matter in timbered shafts to protect them from falling objects by putting them behind the cross timbers. In shafts where there were no timbers it was advisable to put them down at the side of the cages. The method of laying cables in a shaft which he generally adopted was as follows:—Wherever it was possible he took the drum down to the bottom of the shaft and then, fastening the cable on to the cage, wound up to the top. This was a very quick matter, and he had laid a cable by this means on a Saturday afternoon. Where there were timbers in the shaft, although the cage could not be used, the cable could be drawn up in a very similar way. The best plan for fastening cables in a timbered shaft was to get some 4in. planks and cut grooves in them big enough to take the cable, and bolt these together with the cable longitudinally between them. Such cleats, which would be something like 6ft. long, were put every hundred yards or so, and hung from yokes with a tension apparatus. All this applied to armoured cables. Mr. Mitcheson had mentioned the question of joining cables in the shaft. He had never done this. The deepest shaft he had worked in was 600yds., and cables of this length could easily be obtained in one piece. Mr. Holiday's arrangement of cables, where he used a plain conductor with merely a coating of braid round it, was very interesting. It was a very good plan, but it must be remembered that Mr. Holiday was an electrical expert, and was constantly in touch with that particular colliery. Many collieries had not electrical experts on the spot, and he did not think such a method would be very suitable where ordinary rough labour was employed. In reply to Mr. Mitcheson's query as to the finding of any corrosion at the cleats, he mentioned that he had not done so as yet. Mr. Kapp had taken exception to his non-inductive resistance and thought it extremely wasteful. But he had always been in



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the habit of using a non-inductive resistance in parallel with any magnetic coil, having it permanently connected, so that in case of any break the spark was kept down. On the question of wastefulness he said he had some motors which only took ½ per cent. in the shunt coils, and as a rule the percentage varied from ½ to 1½ per cent. The resistance he generally used was about equal to this, so that only a very small percentage was lost. The great point was that if this non-inductive resistance was permanently connected, the great flash which sometimes happened with 500 or 600 volts was done away with. He had been surprised that there should have been any discussion as to drum versus Gramme armatures. The modern barrel-wound drum armature was far superior to anything else ever made in the way of continuous-current machines and particularly superior to the Gramme. Mr. Holiday and others seemed to have been very unfortunate with their drums. Probably they used the old-fashioned wire-wound drum; the barrel-wound drum was certainly a very much better idea. He had designed some for coal cutters and never had one breakdown. In all work with which he was connected he had always been in the position of having to regulate speed or to use gas engines, and so he had never used multiphase machinery in a colliery. However, if polyphase people would produce motors with no slip rings and a good starting torque, there was an immense field for them. The general feeling seemed to be that in using slip rings they were spoiling a really good thing.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"Professional Papers of the Corps of Royal Engineers." Edited by Capt. R. F. Edwards, R.E. Vol. XXVI. 1900. (Chatham: W. and J. Mackay & Co.) 10s. 6d.

"Central Electrical Stations: Their Design, Organisation, and Management," by C. H. Wordingham. (London: Charles Griffin & Co.) 24s.

"American Street Railway Investments" for 1901. (New York: The Street Railway Publishing Co.) $5.0.

"Electric Light Cables and the Distribution of Electricity," by Stuart A. Russell. 2nd edition. (London: Whittaker & Co.) 10s. 6d.

"A Manual of Laboratory Physics," by H. M. Tory and F. H. Pitcher. (New York: John Wiley & Sons.)

"Annual Report of the Board of Regents of the Smithsonian Institution for the Year ending June 30, 1898." (Washington: Government Printing Office.)

"Science Abstracts" for April. Edited by W. R. Cooper. (London: E. and F. N. Spon.) 2s.

"*Proceedings* of the Forty-ninth Meeting of the American Association for the Advancement of Science," held at New York, June, 1900. (Easton, Pa.: The Permanent Secretary.)

"Guide to the Search Department of the Patent Office Library, with a Dictionary of Trade or Fancy Words." (London: The Patent Office.) 6d.

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Strecker. No. 2. 1900. (Berlin: Julius Springer.)

"L'Electricité à l'Exposition de 1900," by E. Hospitalier and J. A. Montpellier. No. 6. (Paris: Vve. Ch. Dunod.)

## ELECTRICITY WORKS ACCOUNTS.

### Brighton Municipal Electric Supply Works.

In considering the results of working during 1900 of this undertaking, as shown in the accompanying analysis, it is necessary to make some explanation in regard to the revenue account. Included in the charges on revenue, shown in our table, is the whole of the salary of the consulting engineer for the new power station at Portslade, while the cost of doubling the standard pressure has been charged to the depreciation reserve fund, as has also the extraordinary expenditure on cables and joints occasioned by the tramway works and the laying, in certain streets, of wood paving. It is difficult to discover the reasoning by which the Council were led to make these palpably unfair charges on the reserve and revenue accounts. The cost of altering the pressure amounted to £1,690—a charge which, like that of the consulting engineer's salary, might reasonably have been charged to capital, while the cost (£1,588) of inspecting and moving the cables from under the tramway tracks would appear to have been fairly chargeable to the tramways.

Mr. Arthur Wright, the consulting engineer and manager, informs us that of the increase in the coal bill £1,500 (or 0·097d. per unit) is accounted for by the higher price of coal.

Following the course taken before, we have allowed £4,184 expended in the maintenance of public lamps and appearing on both sides of the revenue account to disappear from the costs column. Were this charge included the works and total costs would be higher by 0·27d. per unit.

It is hardly surprising in view of the extraordinary charges on revenue noted above to find that the costs have remained constant at practically 1·8d. per unit, although the nature and extent of the load has improved. This figure of 1·8d. moreover represents the best average results obtained in 1899 in municipal stations of similar output and demand, and Brighton is by no means favourably situated for cheap fuel supply. In the aggregate, as well as in the proportion in which the expenses are distributed, the cost items shown are very representative of the best practice. The output for the year exceeded that of 1899 by 16·2 per cent., and the total lamp connections were 22·3 per cent. higher.

### Hove Electric Lighting Co. (Ltd.).

The Hove results for last year were less satisfactory than those of 1899. The two items of fuel and repairs exhibited increases which affected the total costs, notwithstanding diminished expenditure in other respects. It may be noticed that the increment in the total costs is but little in excess of the increase in the fuel item. Owing to the increased business done, the financial results are better than might have been expected. £1,934 net was placed aside to reserve, and interest charges absorbed £1,011. Out of the net profit a dividend of 8 per cent. was declared, leaving a balance of £545 carried forward.

Even at the increased figure the total costs, at 2·87d., are only about 0·1d. above the normal. The lamp connections during the year raised the total at December 31 last nearly 18 per cent. above the equivalent at the end of 1899. The year's output was 21·8 per cent. above that of 1899, but the load factor was slightly lower.

The whole of the preliminary expenses have now been written off; and the premiums on the 1,000 shares issued last year, together with the allocation from revenue, increased the reserve fund to £17,038. Of the repairs expenses of £916, £600 only were paid out of revenue, the remainder, or £316, being taken out of the depreciation and maintenance fund, thus reducing the balance in the latter to £946.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 19, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | May 3, 1901 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.)(Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | May 3, 1901 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | April 19, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 26, 1901 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Eastbourne (Company) | May 4, 1900 | Southport (Municipal) | July 7, 1899 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Stafford (Municipal) | Aug. 17, 1900 |
| Folkestone (Company) | April 26, 1901 | Sunderland (Municipal) | Nov. 9, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | April 19, 1901 |
| Hanley (Municipal) | July 27, 1900 | Westminster (Company) | Mar. 29, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | Oct. 26, 1900 |
| Hastings & St. Leonards (Mun.) | Sept. 7, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Woolwich (Company) | Jan. 18, 1899 |
| Kensington & Knightsbr'(Co.) | Mar. 16, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-upon-Hull (Mun.) | July 18, 1900 | Great Yarmouth (Mun.) | Dec. 29, 1900 |

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|---|---|---|---|---|
| *Undertaking Worked by* | Corporation of Brighton. | | Hove Electric Lighting Co. (Ltd). | |
| *Date of Commencement of Supply* | September, 1891. | | November, 1892. | |
| *System of Supply* | 3-wire with batts. combined with H.T. (alt. | | 3-wire continuous-current with batteries. | |
| *Chief Engineer* | Arthur Wright. [curr. trans. sub.-stations.) | | C. B. Smith. | |
| **YEAR ENDED** | DEC. 31, **1899.** | DEC. 31, **1900.** | DEC. 31, **1899.** | DEC. 31, **1900.** |
| **QUANTITIES—** | | | | |
| Units generated | 3,815,743 | 4,391,255 | 520,967 | 625,828 |
| „ **SOLD (TOTAL)** | **3,206,623** | **3,726,723** | **444,499** | **539,208** |
| „ sold to consumers | 2,604,039 | 3,056,857 | 440,476 | 539,208 |
| „ sold for public lighting, &c. | 602,584 | 669,866 | 4,023 | nil |
| „ used on works | 160,650 | 180,915 | 21,486 | 26,776 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 24·4 | 25·3 | 13·6 | 14·3 |
| Maximum supply demanded | 2,538 kilowatts[i] | 2,968 kilowatts[i] | 465 kilowatts | 605 kilowatts |
| Number of public lamps | 257 arc, 1,027 inc. | 262 arc, 1,242 inc. | No arc, 20 8 c.p. glow | nil |
| Number of consumers | 2,410 | 2,855 | 671 | 801 |
| Connections to mains in 8-c.p. lamps | 129,950 | 158,884 | 44,892 | 52,913 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | **131,500** | **147,100** | **32,640** | **37,600** |
| **CAPACITY OF PLANT IN KILOWATTS** | **4,210** | **4,710** | **1,015** | **1,203** |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | **£354,881 / £84·3** | **£754,881 / £160** | **£150,000 / £144** | **£150,000 / £125** |
| Share | nil / — | nil / — | 100,000 / 95·7 | 100,000 / 83·0 |
| Loan (including Debenture charges) | 354,881 / 84·3 | 754,831 / 160 | 50,000 / 47·9 | 50,000 / 41·6 |
| **RECEIVED (TOTAL)** | **273,155 / 64·9** | **338,269 / 71·8** | **84,362[a] / 80·7** | **92,226[i] / 76·7** |
| Share | nil / — | nil / — | 51,174 / 49·0 | 56,538 / 47·0 |
| Loan (including Debenture charges) | 273,155 / 64·9 | 338,269 / 71·8 | 25,000 / 23·9 | 25,000 / 20·8 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | **81,726 / 19·4** | **416,612 / 88·4** | **73,826 / 70·7** | **68,462 / 56·9** |
| Share (unissued) | nil / — | — / — | 45,000 / 43·1 | 43,462 / 36·1 |
| Share (uncalled) | nil / — | — / — | — / — | — / — |
| Loan (including Debentures) | 81,726 / 19·4 | 416,612 / 88·4 | 25,000 / 23·9 | 25,000 / 20·8 |
| **REPAID (TOTAL)** | **9,611[a] / 2·28** | **9,611[a] / 2·04** | — / — | — / — |
| **RESERVE OR SINKING FUND** | **33,856 / 8·04** | **43,519 / 9·23** | **12,288 / 11·8** | **17,038 / 14·2** |
| **DEPRECIATION FUND** | **4,881 / 1·16** | **1,792 / 0·38** | **1,261 / 1·21** | **946 / 0·786** |
| **EXPENDED (TOTAL)** | **290,930 / 69·1** | **339,602 / 72·1** | **93,661 / 89·6** | **100,523 / 83·5** |
| Lands and buildings | 36,482 / 8·66 | 42,009 / 8·91 | 9,353 / 8·95 | 9,447 / 7·85 |
| Plant | 117,178 / 27·8 | 136,413 / 29·0 | 40,317 / 38·6 | 44,263 / 36·8 |
| Mains | 127,973 / 30·4 | 151,326 / 32·1 | 42,641 / 40·8 | 45,836 / 38·1 |
| Miscellaneous | 9,297[b] / 2·21 | 9,855[b] / 2·09 | 1,350 / 1·29 | 977 / 0·812 |
| **BALANCE OF CAPITAL ACCOUNT** | **−17,775[c] / −4·22** | **−1,333[c] / 0·28** | **−9,299[b] / −8·90** | **−8,297[b] / −6·89** |
| **REVENUE—** | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold |
| **TOTAL** | **£40,857 / 3·058d.** | **£47,533 / 3·060d.** | **£12,070 / 6·525d.** | **£13,841 / 6·164d.** |
| Revenue from supply | 35,264[d] / 2·640d. | 41,584[i] / 2·677d. | 11,246 / 6·080d. | 13,069 / 5·820d. |
| „ meters, &c. | 1,122 / 0·084d. | 1,314 / 0·085d. | 684 / 0·369d. | 753 / 0·335d. |
| „ public lighting | 4,040[e] / 0·302d. | 4,456[j] / 0·287d. | 88 / 0·047d. | — / — |
| „ sale of lamps, &c. | 411 / 0·031d. | 115 / 0·007d. | — / — | — / — |
| „ miscellaneous sources | 21 / 0·002d. | 64 / 0·004d. | 52 / 0·028d. | 18 / 0·008d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | **£24,065 / 1·800d.** | **£27,932 / 1·798d.** | **£4,816 / 2·600d.** | **£6,442 / 2·867d.** |
| **WORKS COSTS** | **19,254 / 1·441d.** | **22,781 / 1·467d.** | **3,124 / 1·687d.** | **4,500 / 2·003d.** |
| *Generation of electricity* | *17,270 / 1·292d.* | *20,394 / 1·313d.* | — [e] / — | — [e] / — |
| Fuel (including cartage, &c.) | 8,331 / 0·623d. | 11,151 / 0·718d. | 1,641 / 0·886d. | 2,479 / 1·104d. |
| Oil, waste, water, stores | 1,213 / 0·091d. | 1,330 / 0·086d. | 103 / 0·056d. | 69 / 0·031d. |
| Wages at station | 4,460 / 0·334d. | 5,355 / 0·345d. | 936[c] / 0·505d. | 1,036[c] / 0·461d. |
| Repairs and maintenance at station | 3,265 / 0·244d. | 2,558 / 0·165d. | 444[c] / 0·240d. | 916[c] / 0·408d. |
| *Distribution of electricity* | *1,984 / 0·149d.* | *2,387 / 0·154d.* | —[c] / — | —[c] / — |
| Wages, &c. | 858 / 0·064d. | 665 / 0·043d. | —[c] / — | —[c] / — |
| Repairs, renewals of mains, &c. | 1,126 / 0·084d. | 1,722 / 0·111d. | —[c] / — | —[c] / — |
| *Public lighting* | — / — | — / — | — / — | — / — |
| Attendance | — / — | — / — | — / — | — / — |
| Renewals | — / — | — / — | — / — | — / — |
| **MANAGEMENT AND PROPERTY CHARGES** | **4,811 / 0·360d.** | **5,151 / 0·332d.** | **1,692 / 0·914d.** | **1,942 / 0·864d.** |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *1,091 / 0·082d.* | *1,237 / 0·080d.* | *302 / 0·163d.* | *314 / 0·140d.* |
| *Management* | *3,720 / 0·278d.* | *3,914 / 0·252d.* | *1,390 / 0·750d.* | *1,628 / 0·725d.* | |
| Salaries | 2,619 / 0·196d. | 2,977 / 0·192d. | 942[d] / 0·509d. | 1,102[d] / 0·491d. |
| Stationery, &c. | 380 / 0·028d. | 317 / 0·020d. | 67 / 0·036d. | 75 / 0·033d. |
| Establishment charges | 391 / 0·029d. | 285 / 0·018d. | 220 / 0·119d. | 285 / 0·127d. |
| Law charges, &c. | 330[f] / 0·025d. | 335[k] / 0·022d. | 161[e] / 0·087d. | 166[j] / 0·074d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | **£16,700 / 6·31%** | **£19,600 / 6·22%** | **£7,253 / 8·47%** | **£7,399 / 7·62%** |
| Sum carried to Depreciation Fund | 170 / 0·064% | nil / — | 156[f] / 0·182% | 600[f] / 0·618% |
| Sum carried to Reserve or Sinking Fund | 8,099 / 3·06% | 10,229 / 3·24% | 2,000 / 2·34% | 2,250 / 2·32% |
| Net interest on loans (incl. Debenture charges) | 7,146 / 2·70% | 9,264 / 2·93% | 1,018 / 1·19% | 1,011 / 1·04% |
| **BALANCE FROM LAST ACCOUNT** | **6,802 / 2·57%** | **1,455 / 0·462%** | **376 / 0·439%** | **346 / 0·356%** |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | **3,590[g] / 1·36%** | **1,562 / 0·496%** | **2,970[g] / 3·62%** | **4,681[k] / 4·82%** |
| *Deficit* | — / — | — / — | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | 7½% / — | 8% / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 58·9% | 58·8% | 39·9% | 46·5% |
| Expenditure per kilowatt capacity | £5. 14s. 4d. | £5. 18s. 7d. | £4. 12s. 2d. | £5. 7s. 0d. |
| **REVENUE PER KILOWATT CAPACITY** | **£9. 14s. 4d.** | **£10. 1s. 10d.** | **£11. 11s. 0d.** | **£11. 10s. 2d.** |
| Expenditure per 8-c.p. lamp capacity | 3s. 8d. | 3s. 9½d. | 2s. 11½d. | 3s. 5d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | **6s. 2½d.** | **6s. 5½d.** | **7s. 4½d.** | **7s. 4¼d.** |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | **6s. 3½d.** | **5s. 11⅞d.** | **5s. 4¼d.** | **5s. 2¾d.** |
| Price charged for lighting, per unit | 7d. (1 hr.) to 1d.[h] | 7d. (1 hr.) to 1d.[h] | 8d. (1 hr.) to 4d.[h] | 7d. to 1d.[h] |
| Price charged for power, per unit | | | 3d. | 3d. |
| Price charged for public lighting | 7d. (1 hr.) to 1d.[h] | 7d. (1 hr.) to 1d.[h] | — | — |

**BRIGHTON.**—REMARKS—*a* Being premiums on stock. *b* Includes £1,337 to purchase of patents, £1,497 engineer's commission, and £5,000 to purchase of undertaking of Brighton Electric Light Co. *c* Over-expended. *d* 976,339 units at 7d., 2,769 units at 1½d., and 1,624,931 units at 1d. *e* 61,152 units at 7d., and 541,432 units at 1d. *f* £137 to insurance and £180 registration of stock and stamp duty. *g* After deducting £4,497 paid to loans fund; of this £3,590 £2,135 was applied in aid of district rate, and £1,455 carried forward. *h* On "Wright" system. *i* 1,158,147 units at 7d., 1,898,710 units at 1d.; minimum charges (under special contracts) £66, less £172 bad debts. *j* 66,591 units at 7d. and 603,275 units at 1d. *k* Insurances £145, registration of stock and stamp duty £179, and law £11. *l* Max. load on station.

**HOVE.**—REMARKS—*a* Inclusive of premiums received, £4,188. *b* Over-expended. *c* Distribution, wages and repairs, and maintenance costs are included in the corresponding generating items. *d* Inclusive of £450 directors' remuneration. *e* £150 insurance and £11 auditing. *f* Set aside under contract with the Hove Commissioners. *g* After deducting £489 preliminary expenses written off, and £97 income tax. *h* By "Wright" system. *i* Inclusive of premiums, £10,688. *j* Insurance £150, auditing £16. *k* After crediting the account with £916 (repairs and maintenance) works costs paid out of depreciation, maintenance and repairs fund, and after deducting £119 income tax.

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*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

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## THE EDUCATION BILL.

The Education Bill introduced into the House of Commons by Sir John Gorst and read the first time on Tuesday is a measure which deals with a matter of vital importance to the nation. Its main object is to make provision for the secondary and technical education of the people, under local government control. Incidentally, the measure offers a step forward towards the consolidation of all grades of education, whether elementary, secondary, or technical, under one local governing body; but, in its immediate effect, the passage of the bill would not accomplish this highly desirable result, as it purposely leaves unaltered and untouched the functions of the School Boards as the controlling authority for purely elementary education. Practically, therefore, the new Education Bill relates only to secondary and technical education, and it is mainly with its technical aspect that the electrical profession is specially concerned. The future of our national electrical industries and profession—the future of all our national engineering and allied arts—must largely depend upon the provisions which are to be made for the intelligent instruction of youths and young men and women in the principles of the technical work in which they will become engaged. If these provisions are wisely and liberally framed, national prosperity will be enhanced by maintenance of our leading position among the nations. If, on the other hand, imperfect and ill-advised arrangements cause the machinery of technical education to work inefficiently and with friction, the inevitable consequences must be regarded as tending to national disaster, from an industrial point of view. The vital importance of Sir John Gorst's measure is, therefore, evident, in view of the fact that it is claimed that it provides for "a local education authority which is intended to supervise education of every kind, and which it is hoped may ultimately have the control and supervision of all schools, whether elementary, secondary or technical."

Three cardinal aspects present themselves for serious consideration, as being of supreme moment, in the elaboration of a national system of education. Firstly, there is the collection and control of the money for carrying on the educational machinery; secondly, there is the drawing up

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and operation of a system of teaching, comprising the selection of subjects and the compilation of a syllabus of instruction in each subject, together with the control of teachers and of what is taught; and thirdly, there is the elaboration of a systematic series of examinations, with arrangements for scholarships and other awards. With the full text of the new bill now in our hands, we discover that the nature and extent of the provisions under the last two heads is somewhat loose and vague. From a professional point of view, our concern must chiefly be in regard to the educational and examinational systems —the last two points enumerated; with the fiscal aspects, which partake of a more political nature, we are concerned more from the point of view of citizens and ratepayers. Parliament, however, whether as expressed in the speech with which Sir JOHN GORST introduced the bill, or in the speeches of those who debated upon it before the first reading, seems to have fixed its gaze almost exclusively on the fiscal and political aspects; and little is to be learned even from the bill itself with regard to the strictly educational character of the new national programme. Yet upon this character depends the utility of the measure as a solution of the permanent educational problem. We say "permanent," because there is in addition to be a temporary or transitory effect of the measure, in affording relief to the School Boards from the consequences of the Cockerton judgment; but this is of so transient a nature that it would be unwise to identify the measure with it. Nothing can be more misleading than to assert that the bill must be passed because of the urgency for this relief; a separate short bill would easily provide all that is necessary in this respect. We sincerely trust that Parliament will attach only its due importance to the Cockerton aspect of Sir JOHN GORST'S measure, and that the bill will stand or fall entirely on its merits or otherwise as a permanent educational programme.

Criticising the measure in the light of the outline thus far made visible, we regard it, broadly speaking, as an important step in the right direction, but as a step that does not go far enough nor as far as might have been quite feasible in so large and important a measure. Unification is admittedly the grand purpose of this piece of legislation; but unification is just the point short of which the measure abruptly stops. In many of the details that have been announced, moreover, there is a "go-as-you-please" character suggestive of hasty and immature draughtsmanship. The main principle is excellent, but the evolution of its details and the extent of its application are defective and bear evidence of either hastiness or timidity. All this, however, can be, and we trust will be, remedied in the Committee stage, when elements of weakness can be strengthened and stiffened, greatly to the enhanced utility of the measure as a whole. We have already alluded to the shortcomings of the measure as a truly unifying enactment; a single example of its weakness of detail may suffice for the present. Instead of deliberately embodying in the bill a system upon which the relationship of the local education committee to the county council is definitely specified, these matters are left to the individual tastes of the county councils, who will be authorised to submit their own schemes to the Board of Education. The patchwork thus created will, it is claimed, afford greater elasticity than if the whole matter were to be stereotyped once for all, and for the entire country, in the bill. There is no denying the greater elasticity; the question is as to whether this will lead to greater efficiency from an educational point of view. We are aware that it is only the composition and mode of nomination of these committees that is thus left "elastic"; but it cannot be contended that this limitation will not influence the educational machinery of the counties. Inasmuch as the local committees must, in the nature of things, receive important discretionary powers, the character of these committees will inevitably influence the manner in which these powers will be exercised. In these days when local political influences strike so deeply into every form of local government control, it is impossible not to discern a danger that the entire machinery of an educational system, throughout a whole county, may be made the plaything of a political propaganda, or the *corpus vile* for the experiments of a clique of educational faddists.

We regard it, then, as desirable that the character and functions of the local committees should be more severely unified and brought under the control of the central educational authority. So far, indeed, as the collection of the educational rates and the control of their expenditure are concerned, these are matters which may, perhaps, safely be left to the county authority. But, as regards the mode of forming the committees controlling the educational machinery, and as regards the systems of education and examination, we look for more rigid specification. Parliament should decide the former, and embody its decision rigidly in the bill; and the scheme of education and the provisions for adequate examination should be under the absolute control of the central Board of Education. Nothing could be worse than to foster a patchwork of educational systems throughout the country; in place of the unity promised us, we should then be burdened with chaotic diversity of the worst type.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Influence of Temperature upon Becquerel Rays.*—E. Rutherford has shown that thorium compounds continually send out a kind of radio-active particles which retain their power of ionising air for several minutes. These particles are capable of penetrating solutions and cotton wool stoppers without losing their efficacy. The same author has now investigated the effect of heating the thorium compounds. Red heat increased the radio-activity to about three times its original value. White heat destroyed it almost completely, and cooling the specimen led to no recovery. If the temperature never exceeded a red heat, the preparation would return to its normal activity on cooling, but a bright red heat considerably retarded the process. The behaviour of radium preparations was very much more remarkable. A bright red heat would increase the radio-activity 5,000 times. Further heating had no effect, and seemed indeed to interfere with or partly destroy the radio-activity at the lower temperatures. The author inclines to the conclusion that the radio-activity is due to some chemical process within the material. Dorn's observation that the radio-activity is increased by moisture confirms this supposition.

[E. RUTHERFORD, *Phys. Zeitschr.*, April 20, 1901].

*Abnormal Ionic Velocities.*—The greater velocity of the negative ions over the positive ones has been so generally recognised that the discovery of the reverse case is of special interest. C. D. Child has shown that in order to account for the fall of potential through the arc it is necessary to assume that the positive ions move more rapidly than the negative ones. He has, therefore, attempted to demonstrate this by experiment, and although he is not able to bring any direct evidence with regard to the state of things within the arc itself, he is able to prove, by a study of the rate of discharge from an arc to a neighbouring body, that under varying conditions as to difference of potential, distance, and current in the arc itself the positive ions drawn out from the arc move

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more rapidly than the negative ones. This is not to be explained as an effect due to ultra-violet light or any phenomena previously studied. The positive ions from a carbon placed in an oxy-hydrogen flame also move the more rapidly. In cases of an arc between metals the negative ions move the more rapidly. The author believes that the positive ions move more rapidly within the arc itself, and that this curious phenomenon is somehow connected with the high temperature and the nature of carbon.

[C. D. CHILD, *Phys. Review*, March, 1901.]

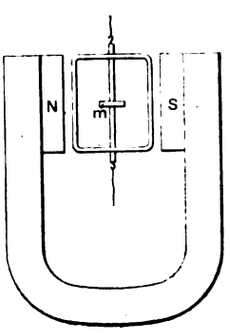
*The Speaking Arc.*—That the current through the arc is profoundly influenced by aerial vibrations is shown by the successful attempts to use the arc as a telephone receiver. The converse fact, that the arc fed by a continuous current and an alternating current superimposed upon it shows marked fluctuations of intensity, has been shown by E. Koenig. He fed the lamp by a continuous current of 120 volts and an alternating current of 18 volts, making 40 ∿ per sec. The lamp showed visible fluctuations, with a period of 20 per second. These became stronger on increasing the alternating voltage, without altering their frequency.

[P. WEISS, *Comptes Rendus*, April 22, 1901.]

*Phosphorescent Glow in Gases.*—An exhaustive study of the electrodeless ring discharge first described by J. J. Thomson has been made by J. B. B. Burke. It will be remembered that the glows can be produced by discharging a Leyden jar through a few turns of wire wound round a vacuum bulb. The author shows that the glow is not confined to the surface of the glass, but is a true volume effect. It is of unelectrified particles. It is not the result of the re-combination of ions liberated by the spark, as these ions in long tubes will travel away from the glow. An E.M.F. has no effect upon the glow, but the latter conducts as it passes through the gas. The destructive effect of sparks upon the glow is due to cathode rays or fast-moving negative ions. The glow is due to impurities, but oxygen is a necessary element, and most probably ozone also, but these are not sufficient by themselves. The glowing particles appear to be large molecular groups formed by the spark, whose existence may be maintained for some time, notwithstanding the bombardment from the other molecules, since they exert a repulsion on the latter. The glowing particles show several points of resemblance to thorium rays.

[J. B. B. BURKE, *Phil. Mag.*, March and April, 1901.]

*New Type of Measuring Instruments.*—Electrical measuring instruments, in which the action of a current upon a magnet




is utilised are liable to changes in their sensitiveness owing to changes in the magnetic moment of the magnet. These changes may be an increase or a decrease, accordingly as the magnetic action produces or checks the deflection. P. Weiss proposes to make the magnet do both, and thus compensate the two effects. The manner in which this is done is shown in the diagram, where *m* is a small needle of soft iron, rigidly connected with the movable coil, and NS are the poles of a permanent magnet. When the latter increases in strength, the deflection is increased by the increased action upon the coil and diminished by the increased action upon the needle. If the needle is saturated, the deflection for the same current will be the same as before. In practice, the author compensates any lack of saturation by a slight antagonistic couple of elasticity in the suspension. He constructs ammeters and voltmeters on this plan.

[P. WEISS, *Comptes Rendus*, April 22, 1901.]

*Coherer Action.*—K. E. Guthe has made a somewhat novel experiment to study the real nature of coherer action. Two fine wires of the same metal were mounted at right angles to each other and brought into contact. A current was then sent through one of the wires, so as to heat the contact. During the heating a current was sent from one wire to the other. It was found that under otherwise equal conditions the resistance of the contact was the smaller the hotter the contact, and that the resistance returned to its original value on stopping the heating. The author believes that the first stage of the coherer effect consists in the heating of the junctions between neighbouring particles. But another process must take place as well, since the coherer does not recover its original resistance at once, whereas the wire junction does. If the coherer consists of mixed metals, and bismuth is one of them, the junction between bismuth and the other metal is heated rapidly, since bismuth is a very bad conductor of heat. This effect may sometimes be marked by a Peltier effect, since the heating of the junction between the bismuth and the other metal may give rise to a current opposed to the main current traversing the coherer.

[K. E. GUTHE, *Ann. der Physik*, No. 4, 1901.]

## THE HAAS AND OETTEL HYPOCHLORITE CELL.

BY JOHN B. C. KERSHAW, F.I.C.

The difficulties met with in the production of sodium hypochlorite by the electrolysis of solutions of common salt have been two in number. In the first place, secondary electrolytic and chemical reactions have caused the decomposition of the hypochlorite—originally formed; and in the second place, owing to the use of platinum as electrode material, the capital outlay upon the cell or apparatus has been high. Dr. Oettel, in recent issues* of the *Zeits. für Elektrochemie*, claims that both these difficulties have been satisfactorily surmounted in the latest form of Haas and Oettel cell. The production of solutions containing 10·6 grammes active chlorine per litre, with an energy expenditure per kilogramme of chlorine averaging 8·8 E.H.P. hours has been attained; and by the use of specially-prepared carbon plates as electrodes the first cost of the cell and apparatus has been greatly reduced without impairing its efficiency. The cell design was worked out practically at the wool-bleaching works of S. Wolle, in Saxony, where the new form of cell displaced a Gebauer-Knöfler apparatus. Dr. Oettel, however, admits that the latter worked satisfactorily until the platinum electrodes were destroyed.

The Haas and Oettel cell consists of an oblong box (see Fig. 1) made of any suitable material, provided with two terminal electrodes and a large number of intervening secondary or double-poled electrodes. One terminal electrode is of lead; all the others are of specially-prepared carbon 25mm. in thickness. The secondary electrodes, usually 27 in number, are kept in position by grooves in the sides of the containing vessel.

Ordinary carbon in such a cell would soon disintegrate, owing to the action of ClO compounds at the anodes; but the special carbon plates used have a comparatively long life, and little discoloration of the resulting hypochlorite solution is observed. The electrodes are quite submerged in the electrolyte, which flows in a zigzag fashion through the cell. A current of 1,000 amperes per square metre is used, with a salt solution testing 6°B.

The cell is mounted upon trunnions, so that it may easily be inverted for rinsing-out purposes, and the whole operation of cleaning can be carried out in this manner in a few minutes, without removal of any of the electrodes. A settling tank is provided to allow any solid particles of carbon or other

* Nov. 21, 1900, and Jan. 31, 1901.

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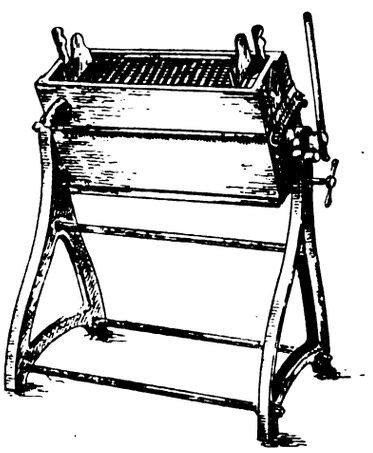
impurities to settle, and the electrolysed solution is then ready for use in the bleaching vats.

The cost of one of these cells, designed to utilise 60 amperes at 115 volts, and to yield 11·2kg. chlorine in nine hours, is £125, as compared with £650, the cost of a Kellner apparatus yielding 86·7kg. chlorine in the same time. The carbon electrodes, with proper use, last six months, but soft water and salt free from calcium, must be used to prepare the electrolyte, in order to avoid deposition of calcium hydrate at the cathodes. The depreciation with this form of cell is estimated to be 10 per cent. One hundred of the cells are stated to be in use in various bleaching works in Southern Germany, the size most generally adopted being that which utilises a current of 45 amperes at 110 volts, and under such conditions yields 9kg. active chlorine in 10 hours. This equals an energy expenditure of 7·5 E.H.P. hours per kilogramme of active chlorine.

The first of these cells was designed and used in 1895, and since that date the efforts of the inventors have been directed towards increasing the concentration of the bleach solution without undue increase of the electrical energy required. In the latest form of apparatus* the necessary cooling and circulation of the electrolyte have been obtained by utilising the hydrogen liberated at the cathodes for aeration of the cell solution, and in this type of cell a bleaching liquor containing 10·6 grammes active chlorine per litre has been obtained with an energy expenditure rising gradually from 5·4 to 12·3 E.H.P. hours per kilogramme of active chlorine.



The Haas and Oettel Cell.

By increasing the strength of the salt solution to 15°B, this energy expenditure can be slightly reduced, and in some localities the inventors consider this will be the cheapest plan of producing highly concentrated bleach solutions. Comparative tests made by Dr. Oettel with this form of hypochlorite cell, and with the Kellner cell, have shown that when making a solution containing 12·96 grammes active chlorine per litre the rise in the electrical horse-power-hours consumed during the electrolysis was greater in the Kellner cell than in the Haas and Oettel cell.

It has been urged by Engelhardt† that the conditions of these trials were dissimilar, and unfair to the Kellner cell; but Oettel points out in reply that the conditions chosen were those under which each cell gave *its best results*, and that the energy consumed in each case is, therefore, a criterion of their relative efficiencies. For weak solutions it is admitted the Kellner cell is the more economical, but for concentrated solutions, such as are demanded in many bleaching works, the Haas and Oettel electrolyser is maintained to be its superior.

In an article published in *The Electrician*, June 15, 1900, the writer gave descriptions of all the leading types of hypochlorite cell, with comparative figures for their yields and efficiencies. Only two of these yields were, however, based upon chemical tests of the electrolysed solutions, and these are reproduced below, with the corresponding figures for the Haas and Oettel cell, when producing dilute and concentrated solutions.

* English patent No. 9,331 of 1900.
† *Zeits. für Elektrochemie*, Jan 3, 1901.

Table I.—*Yields and Efficiencies of Hypochlorite Cells.*

| Name. | E.H.P. hrs. per kg. active Cl. | Energy, efficiency % | Remarks. |
|---|---|---|---|
| Hermite ..... | 10·2 | 46 | Roscoe & Lunt's figures. |
| Kellner ..... | 9·4 | 50 | Kellner's figures. |
| Haas & Oettel ... | 8·8 * | 53 | Oettel's tests. |
| | 7·5 † | 63 | |
| Theoretical figures | 4·73 | 100 | ..... |

If the figures upon which the above table is based are reliable, Dr. Oettel's claim that under the conditions chosen for his experiments the Haas and Oettel cell is the most efficient must, therefore, be conceded.

As regards capital outlay, it is evident that the economy of the Haas and Oettel cell will depend largely upon the first cost and life of the special carbon electrodes. Should the outlay upon these be comparatively high, the cost of constant renewal may ultimately equal the expenditure that would have been incurred had platinum been used.

From the figures published it would appear that for equal capacity the ratio of capital cost is as 400 to 650. This does not leave a very large margin for electrode renewals, and the gain in economy claimed for the carbon electrodes would appear to be somewhat problematical.

* Concentrated solutions. † Dilute solutions.

## TWO GERMAN METERS.

The Allgemeine Elektricitäts Gesellschaft has lately brought out a meter (Fig. 1) which has several novel features, and is intended for the measurement of small continuous currents. It is

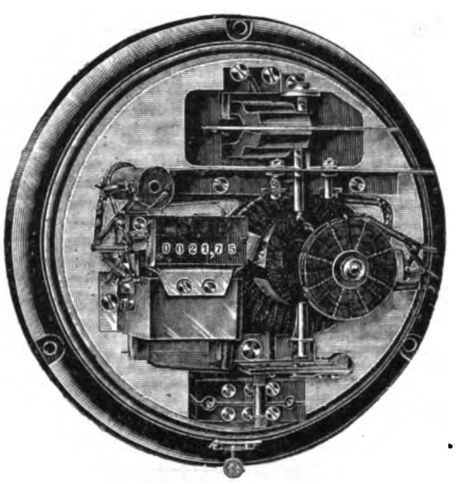


Fig. 1.

made up of two parts: The first (Fig. 2) consists of a fixed coil, H, through which the main current passes, and a moving shunt coil, S, on a spindle, A. On this spindle are also fixed the braking disc and a contact arm K, which at two positions makes electrical connection with contacts $K_1$, $K_2$ respectively. Two fixed resistances $W_1$, $W_2$ are also alternately in parallel with the shunt coil. The second part (Fig. 3) of the apparatus is a relay which works the clockwork, and is made up of an armature pendulum R, which is alternately attracted to the electromagnets $E_1$, $E_2$, thereby making connection with contacts $C_1$, $C_2$ respectively.

The action of the meter may be traced from the diagram (Fig. 4). In the position shown, the coil S and resistance $W_2$ are in parallel, and the direction of the current is such that the contact-arm K is moved to $K_2$. This short-circuits the electromagnet $E_2$, and the pendulum is attracted to the magnet $E_1$, and makes contact with $C_1$. The coil S is now in parallel with the resistance $W_1$; the current, however, being reversed, the coil moves in the opposite direction, so that the arm K makes contact at $K_1$, and the magnet $E_1$ is short-circuited, and so on. The instrument is made for currents up to

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10 amperes and pressures up to 500 volts. The makers guarantee that the meter will not run on no-load, even with a pressure of 20 per cent. above the normal, and it will also start at 1 per cent. of the maximum. They also claim that only 1·2 watts is lost in

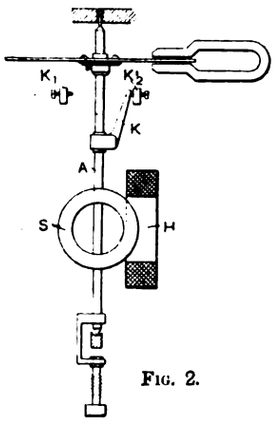



FIG. 2.

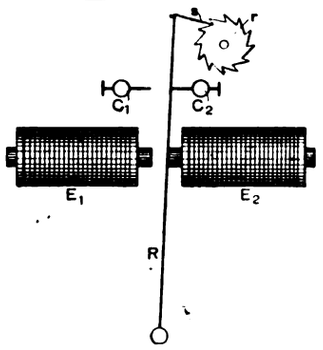



FIG. 3.

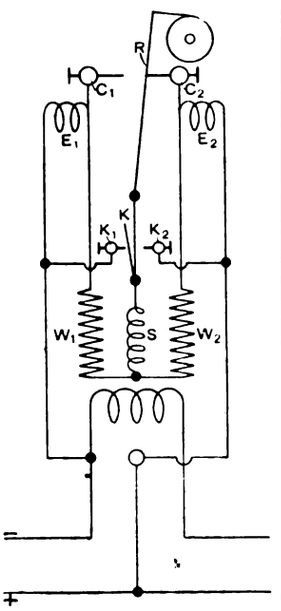
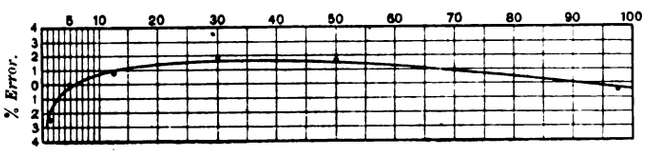



FIG. 4.

the shunt for the 100 volt meters, and 8 watts in the main coil. The diagram (Fig. 5) gives the percentage error at different loads. The meter is about 12in. in diameter, with a projection of about 6in.




*Percentage Load.*

FIG. 5.

The same company has also brought out a small alternating-current meter (Fig. 6), which consists of an electromagnet with three poles, $S_1$, $S_2$, H (Figs. 7, 8 and 9), and a common keeper, R. Between the

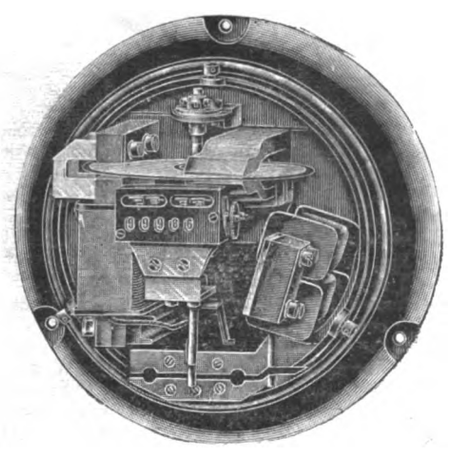


FIG. 6.

keeper and the magnet a metal disc, A, revolves in the air-gap L. At the far side of this disc is placed a braking magnet M, and the spindle is connected to the counter train through worm gearing Z. The two poles $S_1$, $S_2$ are wound with shunt coils, and the poles $S_1$, H have series coils. When no current passes through the main coils it is arranged that there is a small torque which exactly compensates for the friction in the meter, and which can be regulated at will by adjusting the length of the air-gaps $L_1$, $L_2$. When current passes through the series coil a reciprocal action takes place between the

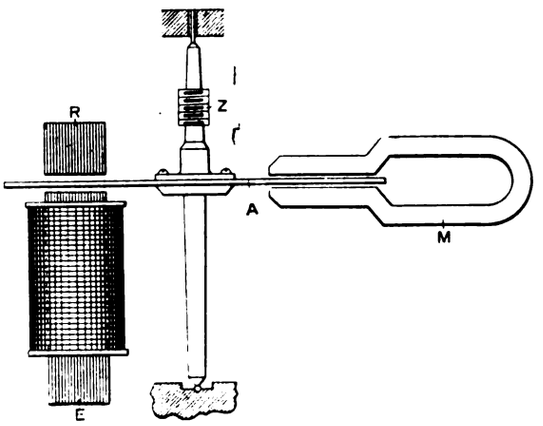



FIG. 7.

magnetic field of the series coil and the eddy currents produced by the shunt coils on the one hand, and between the magnetic field of the shunt coils and the eddy current produced by the series coil on the other hand, and this action causes the disc A to revolve. The current through the series coil H strengthens the magnetic field in the pole $S_1$, and weakens it in the pole $S_2$, which causes the former to be satu-

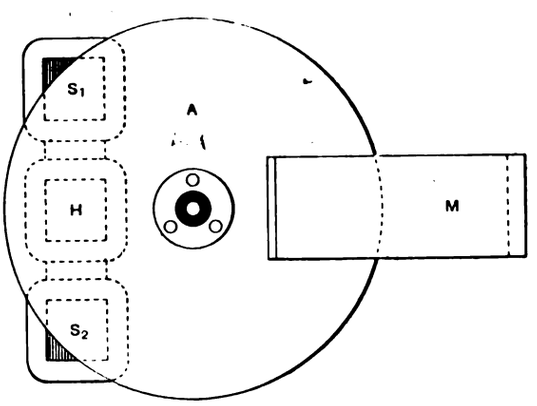



FIG. 8.

rated with increasing load much sooner than the other, so that the proportionality will be disturbed. To prevent this a part of the series coils is wound on the pole $S_1$, and by this means the turning moment is made almost directly proportional to the watts. The

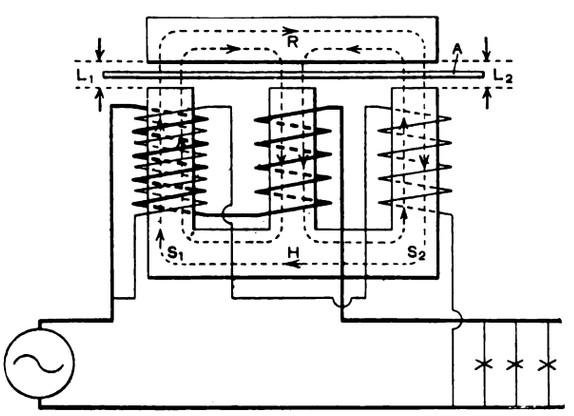



FIG. 9.

saturation effect could also have been compensated for by different winding of the shunt coils, but in that case the meter would have run at no-load. The curve connecting percentage error with per-

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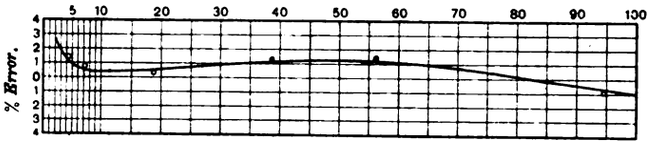
centage load (Fig. 10) shows that after 4 per cent. of full load is reached the maximum error is never more than 1 per cent. The instrument is built for currents up to 10 amperes with pressures up to 250 volts, and the makers inform us that it will start at 1 per cent. of the maximum load and does not register at no-load. In 100 volt




*Percentage Load.*
FIG. 10.

instruments only 1 watt is absorbed in the shunt coils and 2 watts in the series coils. The meter is the same size as the one for continuous currents described above.

## THE ACOUSTIC AND ELECTRIC CONSTANTS OF THE TELEPHONE.*

BY MAX WIEN.

The fundamental condition of distinctness in the transmission of speech through the telephone is that the relative amplitudes of the different notes constituting speech should remain the same, all the notes being reduced in the same proportion. It is not intended here to discuss the influence of the wire and microphone receiver, but to examine whether in the telephone itself, considered as an electromagnetic apparatus on the one hand, and as an acoustic apparatus on the other, there are causes for the different transmission of different notes.

The tone of the telephone is due to the motion of the diaphragm. The force moving the diaphragm is the magnetic induction in the iron core of the telephone coil, and the variations of magnetic induction are produced by the alternating current in the coil. The following questions, therefore, crop up :—In what way does (1) the current intensity at constant E.M.F. ; (2) the magnetic induction at constant current ; (3) the amplitude of the diaphragm at constant magnetic induction, change for the various frequencies. The current intensity depends in a known manner upon the resistance and the inductance, but the matter is much complicated by the fact that the "effective" resistance and the "effective" inductance † of the telephone depends to a very great extent upon the frequency, since owing to the Foucault currents in the iron core of the telephone coil the resistance must rise with the frequency and the inductance must fall. It is also evident that the magnetic induction falls with increasing frequency, since the Foucault currents exert a screening action upon the central portion of the iron core. Finally, the amplitude of the telephone diaphragm must show a series of maxima for its proper notes if the moving force remains the same.

The notes contained in the human voice range from the lowest audible notes—*i.e.*, of 16 vibrations per second, up to 10,000 and more in the characteristic components of many vowels and in the hissing consonants. Between those limits the acoustic and electric quantities are to be determined for the following telephones :—(1) A Bell telephone ; (2) an older telephone by Siemens and Halske (No. 13,306) ; (3) a newer telephone by Siemens and Halske (No. 353,968) ; (4) a box telephone made by Apel, of Göttingen, as used in Nernst's method of determining dielectric constants. The distinctness of speech was about the same in all the four telephones. The vowels were clearly rendered, and similar words like "Pfirsich" and "Vierzig" were always distinguished with absolute certainty. The older Siemens telephone rendered the hissing sounds only softly. The timbre was nasal in the Apel telephone. The currents used were produced by the alternate-current siren already described (see *The Electrician*, Vol. XLVI., p 967), which is capable of furnishing nearly pure sine currents up to frequencies of about 17,000. The currents of frequencies 64 and 128 were produced by a sine inductor. The effective inductance and the effective resistance were determined by Maxwell's bridge method. The sine current sent through the bridge system was made so weak that the magnetic induction in the telephone electromagnet did not go beyond the first linear portion, so that the inductance was independent of the current strength. This was determined in such a manner that on doubling the current the bridge readings did not change. As a bridge instrument I used the Bellati-Giltay dynamometer. The results of the measurements of the various telephones were the following, where N denotes the frequency per second, N = 0 a constant current, W′ the effective resistance in ohms, and L′ the effective inductance in centimetres :—

**Table I.**—*Effective Resistance and Inductance of the Telephones for Various Frequencies.*

| — | Bell. | | Siemens I. | | Siemens II. | | Apel. | |
|---|---|---|---|---|---|---|---|---|
| N | W′ | L′ | W′ | L′ | W′ | L′ | W′ | L′ |
| 0 | 6·67 | ... | 186·6 | ... | 199·7 | ... | 96·2 | ... |
| 256 | 6·90 | $3·53\times10^6$ | 238·6 | $1·17\times10^8$ | 286·5 | $1·93\times10^8$ | 108·7 | $3·73\times10^7$ |
| 1,000 | 9·52 | $3·28\times10^6$ | 422·6 | $7·45\times10^7$ | 586·2 | $1·23\times10^8$ | 159·0 | $3·08\times10^7$ |
| 4,000 | 21·7 | $2·75\times10^6$ | 963·0 | $3·97\times10^7$ | 1,494·0 | $8·87\times10^7$ | 329·7 | $2·50\times10^7$ |
| 8,000 | 33·2 | $2·42\times10^6$ | 1,275·0 | $2·94\times10^7$ | 2,100·0 | $6·8\times10^7$ | 482·0 | $1·96\times10^7$ |
| 16,000 | 37·5 | $2·16\times10^6$ | 1,457·0 | $2·30\times10^7$ | 2,590·0 | $5·8\times10^7$ | 609·0 | $1·63\times10^7$ |

We see that the effective resistance, in accordance with the greater loss of energy through eddy currents, rapidly rises with increasing frequencies, and even attains the 13-fold value of the original resistance in the newer Siemens telephone. The effective inductance, on the other hand, decreases, most of all in the old Siemens telephone, when it falls to about one-fifth of its value for 256. The inductance is little influenced by eddy currents at N = 256, as shown by comparative measurements with N = 128. The difference between the values for N = 8,000 and N = 16,000 is comparatively slight ; it is really only the outermost layers of the iron which take part in the magnetisation at this stage, and the number of lines of force is not much larger than it would be if no iron were present. Assuming, with Helmholtz,* that the E.M.F. in the telephone circuit increases in proportion to the frequency, the current is proportional to $n\sqrt{W'^2+n^2L'^2}$, where $n=2\pi N$ means the frequency per $2\pi$ seconds. If L′ is large in comparison with W′, the expression is sensibly independent of $n$, assuming that W′ and L′ do not vary with the frequency. But, as we have just seen, they do to a great extent, W′ rising with the frequency, while L′ falls. The latter change is of great influence at the higher frequencies, so that, for instance, for the telephone Siemens I. the expression

$$\frac{n}{\sqrt{W'^2+n^2L'^2}}$$

is 3·4 times as large for N = 16,000 as it is for N = 256, and hence the loudness of the corresponding note would be $(3·4)^2 = 11·5$ times as great. On the other side, the magnetic induction falls with increasing frequency in proportion to L′, and reduces the amplitude of the diaphragm and the intensity of the higher notes. In the telephone Siemens II., the intensity of the note N = 16,000, will for this reason be more than 25 times smaller than that of the note 250, for the same intensity of the alternating currents. It is evident that here we have two opposing influences. Whether they just compensate each other at a certain point, or whether the higher notes are strengthened or enfeebled, depends upon external conditions, such as the resistance and capacity of the line, &c. In any case, this change of the electromagnetic constants with the frequency plays a prominent part in the transfer of speech, and it is not permissible to base all calculations simply upon the resistance to a constant current.

Of still wider influence are the purely acoustic properties of the telephone. If the diaphragm had only a single proper note $p$, its amplitude, when driven by a sinusoidal current of frequency $n$ in $2\pi$ seconds would be inversely proportional to $\sqrt{(n^2-p^2)^2+n^2k^2}$, and would thus show for $p=n$ a more or less pronounced maximum according to the degree of damping $k$. The latter depends upon the diaphragm itself, the way of fixing it, and the strength of the telephone magnet. Of the four telephones examined the Bell telephone has the least and the Apel telephone the greatest damping. If, by means of an alternate-current siren, a sinusoidal current is sent through the telephone, and its frequency is gradually changed, the proper tones of the diaphragm are marked by an increased intensity. Accordingly, as they are more or less marked, and according to the damping they produce a sharp shriek or a slow increase and decrease of the note. The lower proper notes are easier to pick out than the higher ones. The maxima, as a rule, cover a pretty large range of pitch, amounting to several hundred oscillations in the higher notes. The pitches of the proper notes are noted in the following table :—

| | | | |
|---|---|---|---|
| Bell..... | 1,100 | 2,800 | 6,500 |
| Apel ..... | 1,060 | 2,500 | 5,600 |
| Siemens I..... | 720 | 2,100 | 5,000 |
| Siemens II. ... | 750 | 2,350 | 5,400 |

In all these telephones there are some feebler notes in the higher pitches, especially in the Apel telephone.

It is evident that in the Siemens telephones all the proper notes are somewhat lower than in the two others. It is a striking circum-

* Translated from *Annalen der Physik*, 4, 3, pp. 450-458, 1901.

† For an alternating current of given frequency and strength a coil with iron core can be replaced as regards its effect upon the current by a coil without iron core of suitable resistance. The "effective" resistance and the "effective" inductance of the coil with iron core are equal to the resistance and the inductance of the replacing coil respectively.

* Helmholtz, *Wissensch. Abhandl* 1, p. 465.



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stance that in several instances there is in the higher proper notes instead of one decided maximum, a series of two or three maxima of pretty equal strength close together. This is especially noticeable in the two notes 5,000 and 5,400 of the two Siemens telephones.

Another method of investigating the position of the proper notes and their influence upon the intensity of the notes reproduced by the telephone consists in measuring the feeblest currents which produce a just audible note in the telephone. Such investigations have already been carried out previously and some very small currents indeed have been thus found. The differences in the results obtained might be chiefly due to the fact that usually, instead of a simple sinusoidal current, the alternate current of an induction coil with pointed break-currents was used. These pointed current impulses are heard in the telephone even when the mean intensity of the whole current is very small. An analogy to this might be found in the records produced on a phonograph cylinder, which is placed at such a distance from the recording stile that only the largest excursions of the latter produce a record.

Lord Raleigh* has worked with a sine inductor, and for higher frequencies with the approximately sinusoidal currents produced by magnetised tuning forks in coils mounted between their prongs. Even with the latter he only attained frequencies of about 768, and the observations were rendered difficult by the very short duration of the vibration. His results for a telephone of 70 ohms resistance were the following:—

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N..... | 128 | 192 | 256 | 307 | 320 | 384 | 512 | 640 | 768 |
| C..... | 2,800 | 250 | 83 | 49 | 32 | 15 | 7 | 4·4 | 10 |

C being the current in $10^{-8}$ amperes, and N the pitch. These figures agree well with those given below. To determine the sensitiveness of the four telephones for various pitches, the current of the alternate-current siren was conducted into a distant undisturbed room, and by shunting the limit of hearing was found for the note and telephone in question. The results are given in the following table. They were referred to my right ear, and give the current strength in $10^{-8}$ amperes, which produced a current, I could just perceive with certainty at break and make:—

**Table III.**—*Sensitiveness of Different Telephones.*

| N. | Bell. | Apel. | Siemens I. | Siemens II. |
|---|---|---|---|---|
| | Amperes. | | | |
| 64 | $190{,}000 \times 10^{-8}$ | $5{,}000 \times 10^{-8}$ | $1{,}800 \times 10^{-8}$ | $1{,}200 \times 10^{-8}$ |
| 128 | 15,000 | 500 | 220 | 150 |
| 256 | 1,050 | 40 | 26 | 13·5 |
| 512 | 150 | 10 | 1·7 | 2·7 |
| 720 | ... | ... | *1·5* | *0·8* |
| 1,024 | *18* | 3·5 | 3·0 | 1·35 |
| 1,500 | 30 | *2·3* | 6·0 | 2·4 |
| 2,030 | 130 | 3·5 | *0·8* | 3·0 |
| 2,400 | ... | 0·5 | 2·0 | *1·0* |
| 2,800 | *70* | .. | ... | ... |
| 4,000 | 230 | 70 | 50 | 30 |
| 8,000 | 2,500 | 170 | 700 | 400 |
| 16,000 | 12,000 | 1,000 | 2,200 | 1,700 |

The Bell telephone has all along a smaller sensitiveness than the other three instruments, in accordance with its smaller resistance (see Table I.). All the four telephones show a specially high sensitiveness for the currents between the pitches 500 and 3,000; both downward and upward the sensitiveness decreases rapidly, so that, for instance, in a Bell telephone for N=64 a nearly 10,000-fold current intensity, or a more than 100 million-fold current energy is required to produce an audible note than for N=1,024. This steep fall in the sensitiveness for high and low pitches cannot be explained solely by the acoustic properties of the telephone or the proper notes of the diaphragm; it is most largely due to the variations in the sensitiveness of the human ear. I hope to deal in another Paper with the conclusions to be drawn from this. The numbers given in italics in Table III., which denote the maxima of sensitiveness, agree in general with the proper notes, as determined above. This is shown most clearly in the Bell telephone, which also possesses the least damping. In the two Siemens telephones also the proper notes are distinguished by particularly small current intensities, but in the strongly-damped Apel telephone the maximum of sensitiveness (N=1,500) lies between two proper notes (1,060 and 2,500).

The most important and characteristic notes of the human voice fall between the pitches 500 and 3,000, where all the four telephones show the greatest sensitiveness. This circumstance probably conduces greatly to the distinctness of transmission. On the other hand, the differences in sensitiveness for comparatively small differences of pitch are very great just within this range, since the most important proper notes of the diaphragm fall within it. The relative intensity of the higher notes must, therefore, be very different, in accordance with the telephone used. Thus, for instance, in the Bell telephone the ratio of the sensitiveness for N=256 to that for N=4,000 is as 230 : 1,050—no decided proper notes intervening— whereas the same ratio for the Siemens II. telephone is 30 : 13·5. If, therefore, the note 256 has the same intensity in both cases, the Siemens telephone must render the note N=4,000 some 100 times as loudly as the Bell telephone. With full and loud speaking into the microphone the proper notes are known to be often unpleasantly prominent. But in general an intelligent communication is possible by every telephone and every kind of voice. This can only be explained by the astonishing sensibility of the human ear for the characteristic marks of the vowels and consonants, which are not even obliterated by the great changes in the timbre bound to take place, as we have seen, in consequence of the acoustic and electromagnetic properties of the telephone.

* *Phil. Mag.*, Vol. 38, p. 294, 1894.

## CORRESPONDENCE.

### ALTERNATING MEASUREMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with pleasure Mr. Drysdale's letter on the subject of his visit to my laboratory in your last week's issue. So many distinguished men have worked at the electrometer that it is necessary to be modest in putting forward the results of one's own work. It is therefore very gratifying to find that a competent observer like Mr. Drysdale considers I have made really solid progress. Although my work has been directed specifically to getting out a complete system for the measurement of alternating currents, I have felt all along that even if the system did not prove commercially the best, yet that improvements in electrostatic instruments would have value in connection with science generally. It will give me pleasure to give some account later of the manner in which I have met the various difficulties which had to be conquered; but for the present it seems more desirable to utilise all the time which can be spared to consolidating what has been done and to advancing further in the field which has been opened up.

Coming to Mr. Drysdale's comparison of the dynamometer with the electrometer as a wattmeter, I have, of course, used dynamometers myself and have kept myself well informed of what was being done in this field, especially in Germany. For some years I have been quite clear that a practical dynamometer wattmeter could be made which would give very fairly accurate results when used under well defined conditions, and at times, when the difficulties in adapting electrostatic instruments to this work for general purposes appeared unsurmountable, I have carefully considered whether it would not be better to throw up the work, and more than once I have consulted competent friends on the subject. Some months ago I went to the trouble of working out carefully a complete scheme for calibrating and operating a set of instruments on the dynamometer principle, on as similar lines to my own as I could, and I came to the conclusion that to ensure equal accuracy and equal facilities the dynamometer set would be much the more cumbrous and costly, besides which several advantages are wanting which are readily obtainable with an electrostatic method.

Anything I could say on the subject is, of course, liable to the retort that my opinion is biassed, but perhaps the following facts in support of it may have weight:—It is known, no doubt, to many of your readers that the Westinghouse Company have for a long time employed an electrostatic wattmeter for their meter calibration work. Although the method they use is cumbersome and expensive, Mr. Belfield told me some time since that he greatly preferred it to any dynamometer system he had tried. The particular methods they adopted were, if I am not mistaken, arranged for them by the late Dr. Hopkinson, who devoted much time to the consideration of electrostatic methods of measurement, which have been followed up by valuable work by Prof. E. Wilson, his successor. Some time since Messrs. Willans and Robinson (Ltd.) asked me to arrange their alternating measuring appliances on the basis of using my system, which has now been at work at Rugby for several months, and recently in connection with voltages as high as 6,000, and some months since Mr. Ferranti also arranged with me to make it the standard system at his works. It is not probable that in either of these cases the use of an electrostatic system was determined on

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without careful consideration of the claims of the dynamometric method, since the dynamometer was already largely used in both cases.

Personally, I look on the dynamometer very much as I look on the sine galvanometer, which it resembles in many respects. It is an excellent instrument, and, if you have no other instrument, good results can be got with it; but just as with continuous currents a system of making measurements by taking a drop across a resistance is coming more and more into vogue simply on the basis of a survival of the fittest, so I am inclined to think that with alternating currents a similar system, only with electrostatic instead of moving coil instruments, will ultimately supplant other methods. I do not say for every purpose, but, at any rate, for the work which is required to be done in manufactories and central stations and for much research work.—Yours, &c.,

London, May 6. G. L. ADDENBROOKE.

# PARLIAMENTARY INTELLIGENCE.

## BEXLEY TRAMWAYS BILL.

The consideration of this bill was commenced on May 2 by the Select Committee of the House of Commons, presided over by Mr. Seale Hayne.

Mr. FITZGERALD, K.C., for the bill, said it was promoted by the District Council of Bexley, Kent. It was proposed to construct some 5 miles of tramways, to be worked by electricity on the overhead system, to form a connection with the existing line running from Greenwich to Woolwich. The Bexley Council had obtained a provisional order for electric lighting and for the supply of electric energy throughout their district, and were about to put the order into effect. They proposed to carry out the system of tramways proposed by the bill. The cost of the present scheme would be about £90,000. In a very short time the Greenwich line would pass into the hands of the London County Council, and there would then be, if the present scheme were carried out, a system of electric tramways from the far side of Bexley through Woolwich to Greenwich, and so on to London. The only opponents were the South Metropolitan Gas Co. and the Kent Water Co., who wanted a provision inserted making the Bexley Council responsible for any damage done to their pipes through electrolytic action. The model protective clause drawn up by the Board of Trade had been inserted in the bill. The companies, however, asked that if, notwithstanding reasonable precautions being taken, damage occurred, the promoters should be made liable. But (urged counsel) ought not they rather go to the Board of Trade and point out that the regulations were insufficient to prevent damage.

Mr. R. A. DAWBARN (Messrs. Mordey and Dawbarn) said the tramways would be a paying enterprise for the Council, and would give an estimated profit of £1,400 a year. Under the Board of Trade clause the amount of electricity which would escape would be quite a negligible quantity. It was unreasonable, on the part of the gas and water companies, to ask for more than was given under the Board of Trade regulations. He calculated that the electrolytic action in such a case as this would not waste the pipes for hundreds of years. The weight of iron eaten away would be very small. He knew of no case of damage done by electrolytic action where the Board of Trade regulations had been adhered to.

Mr. H. M. SAYERS, electrical engineer to the British Electric Traction Co., said the leading facts of electrolysis had been known for 45 or 50 years past, although new experience had been gained in connection with the working of tramways. Where the Board of Trade regulations had been adhered to electrolysis had not arisen. Where the pipes were negative to earth corrosion would not take place, and he would suggest that that could be ensured by connecting the pipes with the rails. The only objection to that might be that it would tempt stray currents to return by the pipes, and if there were breaks in the metallic connection the electricity might leave the pipes and cause damage. The heavy rails used in tramway work were connected with copper bands so that in the rails an extremely good conductor was furnished. He should say it was impossible to distinguish corrosion due to the natural action of the soil from that due to electrolysis. It would be a serious hindrance to tramway enterprise if the clause asked for by the gas companies were granted, as it would render traction companies liable to actions which would involve large outlay on expert evidence even if won, and, under such circumstances, he should advise the dropping of electric tramway schemes until the matter was reconsidered. His first opinion was that it was better not to connect the pipes with the rails, but that was a matter for the pipe owners.

On behalf of the South Metropolitan Gas Co., Mr. GEO. LIVESEY gave evidence as to the damage to his company's pipes from electrolysis, disclaiming any personal objection to electric traction. He could not, he said, understand the action of the electric section of the Chamber of Commerce in taking up the cudgels against the gas section. In this case electric returns were not, on account of the expense involved, asked for, but that must not be taken as a precedent.

Prof. JOHN PERRY said he had from experiment found that electrolysis might occur with almost any voltage, even with 0·01 of a volt. A great deal more was known now on the subject than in 1893, when the Joint Committee sat. When electricity went into the metal no harm was done, but when it went out of the metal into a liquid electrolysis occurred. So if 1 ampere flowed for one week, and the soil was damp, there would be removed 1 cubic inch of iron. If he was being examined by a water company he would tell a worse story. If, however, the soil were dry there would not be much damage. If the soil had soluble chlorides there would be three, four or five times the amount of evil as there would then be secondary chemical action. Where there was rapid action at one point of a pipe, there would be protection for the remainder of the pipe. The Board of Trade regulations did not afford sufficient protection to the owners of pipes. He was not aware there was evidence of this, but electrolysis was continually going on. From his general knowledge he should say that ordinary corrosion would extend for a considerable distance wherever the soil was bad. There was not only a chance, but there was danger under the Board of Trade regulations, which might become in 20 years extremely serious. It had been found by careful measurement that the electric resistance at the joints of pipes was nine or 10 times that in the rest of the pipes, and when electricity came to a joint a little passed through and the rest went into the earth, and where it left the pipe there electrolytic action was set up. An escape of 2 amperes would remove 26lb. of iron in a year with a moist soil, especially if the water were salted. With the overhead trolley system the extreme extra cost of an insulated return would be 15 per cent.

Prof. DEWAR gave corroborative evidence.

Prof. AYRTON also supported Prof. Perry's evidence, and said Mr. Dawbarn had made the mistake in his evidence of confusing ounces with pounds. He should have said that the amount of iron which would be eaten away in a year for a leakage of 0·01 would be 15lb. per annum, not 15oz. One ampere of electricity leaving an iron pipe took with it about a cubic inch of iron in a year, weighing about a quarter of a pound. He had, to make the matter definite, experimented during the previous four days with the apparatus on the table. [Apparatus produced.] He had placed two iron plates in a solution of salt equivalent to one pint of salt to 200 pints of water. The iron plates were placed far apart in this weak salt solution; two lead plates also were put near together in a strong solution of sulphuric acid. The small iron plates put far apart tended to diminish the current, the two lead plates near together tended to increase the current. The current of electricity maintained from the previous Friday till that (Tuesday) morning had always been under the 1·5 volts prescribed by the regulations of the Board of Trade. The result was that in the case of the lead practically no current could pass, and no decomposition of the lead had, therefore, taken place. But in the case of the iron plates the current had passed steadily day and night, and he had in careful measurement found that the amount of iron removed was a trifle more than the amount to which he had already referred. By this experiment it was reduced to a certainty that, if a current of 1 ampere flowed out of an iron pipe, and the soil around contained a trace of chlorine, there would be removed from the iron pipe over 14lb. of iron in one year. The Board of Trade regulations did not specify the current, but said there must not be a greater pressure than 1·5 volts between the pipes and the rails. Water pipes formed a better conductor than gas pipes, and, therefore, there was a greater chance of a current entering a water pipe, going along it and leaving it. The tendency of a current to leave the pipe would be more marked in the case of a water pipe if the joints were electrically bad, though mechanically good; but instead of travelling round the joint by the soil it would pass into the water, so that there was more probability of water pipes being damaged from the inside than with gas pipes. There was no point below which electrolysis could not take place.

Mr. MORRIS, chief engineer to the Kent Water Company, described the mains and pipes of his company to the Committee, and the case against the bill was closed.

Mr. A. P. TROTTER, electrical adviser to the Board of Trade, called and examined by the Committee, said he had practical knowledge of electric traction, and he had made a special study of stray or leakage currents. He inspected the electrical equipment of railways and tramways in the United Kingdom. He did that rather with a view to the public safety, but he satisfied himself generally that the Board's regulations had been carried out. Under those regulations no cases of electrolysis had been shown to have occurred. With an electric tramway there was a considerable area, very closely defined, in which it was possible for corrosion to take place, and outside which the pipes were absolutely protected. Near the works where some currents leaked back from the pipes to the rails danger was to be feared, but with the aid of a simple galvanometer and two steel rods it was perfectly easy for anyone to make a test. The neutral zone could be measured very closely. So far from saying that corrosion could not take place below 1·5 volts, he said that if in the danger area there was 1 volt and at another place less pressure the actual presence of the lesser pressure would be suspicious and might be the result of serious leakage between pipe and rail. He did not agree that water pipes were a better conductor than gas pipes. He believed the regulations were sufficient as during 16 years he had not heard of a single case of corrosion occurring under them. Of course, the regulations could be amended if experience showed the necessity for amendment. If the theory as to damage put forward held good there would be no pipes left at all in the Clapham-road; they would long ago have been corroded away. The practical was far less than the theoretical corrosion, the laboratory conditions not holding good.

Sir COURTENAY BOYLE, K.C.B., permanent secretary to the Board of Trade, said it was desirable that Parliament should make up its mind upon this class of question, and it was with a desire for uniformity of action that the Joint Committee had been appointed. The Board's regulations were based on the advice of the most capable men in the United Kingdom, and the Board hoped they were a sufficient protection of the interests involved. Electrolysis might be going on and might be felt in the future, but there was at present no proof of it. The evidence of the eminent gentlemen given before the Committee deserved careful attention. The Board had received, a few weeks ago, a deputation on this subject from

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the gas and water companies, but the Board was waiting for evidence of damage. Since the gas and water companies were innocent users of the road, and could not, like the telephone companies, protect themselves, they had a great claim for consideration.

After hearing counsel the Committee deliberated.

The CHAIRMAN said: The Committee have decided that the preamble of the bill is proved.

Replying to counsel for the Kent Water Company, the CHAIRMAN said it would be rather hopeless, after the decision of the Committee, to again raise the subject of electrolytic action on the consideration of clauses.

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Later on, at the outset of the proceedings before the same Committee on the London County Council Tramways Bill (reported on a subsequent page), Mr. Balfour Browne intimated that the Gas Company would not raise the same question, as they had intended to do, on the bill, but would reserve the matter for another place.

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## CLEVELAND AND DURHAM COUNTY ELECTRIC POWER BILL.

The consideration of this bill was resumed before the Select Committee of the House of Commons on Friday last, Sir William Houldsworth presiding.

Ald. T. METCALFE BARRON said he was chairman of the Gas and Electric Lighting committee of Darlington Corporation. In Darlington electricity works 7,500 H P. was erected, and the Corporation could well supply all the electric power required. There was no place beyond Darlington which the promoting company could supply profitably from any of their generating stations, or if there were, they could do so without laying their mains through Darlington. The Corporation had recently arranged the price for the purchase of the local tramway system. They obtained their provisional order for electric lighting in 1890, and their area was confined to Darlington proper. Apart from the works within the borough there was only one establishment outside, within 10 miles, which would require power. They had spent up to the present £25,000 on their generating station, and there was room for any necessary extension. They were prepared to supply current both for lighting and for motive power, and had further proposed a system of "free" wiring. One of the large firms in Darlington (Messrs. Maddison) were willing to agree to very favourable conditions of supply for power—that the Corporation should carry the cable direct to them and they would give the Corporation permission to switch the current off at any time when the load in any other part of the town rendered it inconvenient that they should be supplied with current. The Corporation had also approached other large consumers.

The CHAIRMAN: It is apparent you have been doing all you can.

Cross-examined: If the company asked the Corporation to allow them to go through any of their side streets witness was quite sure the Corporation would not raise any difficulty. He considered Darlington was in the same position as Hartlepool—there was nothing beyond them that would require electric power. The largest dealing in regard to supplying power that they had ever contemplated was 50,000 units, although they were disappointed in not getting another large firm's supply. He did not know how much horse-power 50,000 units represented, because he was a lawyer and not an engineer. They objected to the company opening up their streets and becoming competitors with them.

The CHAIRMAN: They cannot do that without your consent. Supposing they were going through your town, which they do not require your consent for, and that you withheld your consent to them distributing within the borough, and the Board of Trade upheld you in that, then you are safe. So the only point you could raise would be the tearing up of your streets.

After Mr. FITZGERALD, K.C., had addressed the Committee on behalf of Hartlepool and Darlington,

Mr. BALFOUR BROWNE contended there was no real opposition to the preamble of the bill.

The CHAIRMAN: The Committee have decided that the preamble of this bill is proved. Of course they have given very careful consideration to the position of the authorised distributors in the area, and have come to the conclusion that they are sufficiently protected under the bill except in one point. That point refers to the price which the company may charge the authorised distributor in the area when he takes in bulk under clause 43 of the bill. The Committee think that it will be necessary to insert in that clause either a substitution for the words "at a price not exceeding" the prices stated in the second schedule, or, leaving that, as a proviso, what is known as the most favoured nation clause, which will be found in the South Wales Act in sec. 51, sub-sec. 3. With that addition to clause 43 of the bill, the Committee think that ample and reasonable protection is given to the local authorities. There are only two other points. One has been already referred to, and that is with regard to Stockton Bridge. I think it was understood that the Committee thought there ought to be consent on the part of the authorities of the bridge, and possibly some provisions. I think it was left to counsel to see if they could arrange a satisfactory clause with reference to Stockton Bridge. The other point is this, that in the sliding scale, clause 51 of the bill, the Committee wish to substitute 4s. for 5s., leaving the 8 per cent. dividend as it was in the South Wales Bill, in order to make it more logical and consistent with the original idea.

Mr. BALFOUR BROWNE said a clause should be brought up dealing with the charge for bulk supply to the authorised distributor. With regard to Stockton Bridge, the bridge roadway would not be broken without consent.

The CHAIRMAN said there must be absolute consent and agreement if wires were to be carried over the bridge, and subsequently intimated that the bill would be reported to the House for third reading.

## TYNESIDE TRAMWAYS BILL.

This bill was considered on Thursday and Friday last before a Select Committee of the House of Lords, presided over by Lord Ribblesdale. The measure proposes the construction of a series of tramways and tramroads to serve the district between Newcastle and Tynemouth commencing at the boundary of Newcastle, running through Walker and Wallsend, through Willington, coming down to the Tyneside and terminating with a junction with the Tynemouth tramways. The total length is about 10 miles, and the population 358,487. The lines are to be worked on the overhead system. The only opponents are the Walker District Council, the Newcastle-on-Tyne Corporation, and the North Eastern Railway. On behalf of Newcastle and Walker it was urged that an agreement had been come to by which the Newcastle Corporation, who were the freeholders of Walker, were next year to come to Parliament for powers to construct tramways in Walker which would better serve the district than those proposed by this bill. It was, therefore, asked that the powers of the bill in this respect should be suspended until Newcastle should have placed their proposals before Parliament. The opposition of the North Eastern Railway was based on the ground of competititon.

The Committee, after a lengthy hearing, decided to pass the preamble subject to the undertaking offered by the promoters that they would come next year to Parliament and give to Walker whatever Newcastle had undertaken by the agreement mentioned. It was intimated that the Committee were struck by the arguments in favour of additional tramways in Walker, and they only passed the preamble of the bill subject to this want being amply met by the promoters.

## BIRMINGHAM (CITY) TRAMWAYS BILL.

The Select Committee of the House of Lords presided over by Lord Ribblesdale, on Monday considered the bill promoted by the City of Birmingham Tramways Co. authorising further extensions of the tramway system.

Mr. J. D. FITZGERALD, K.C., for the bill, said the company's lines, which started from the centre of the city, radiated into districts controlled by outside urban authorities. Speaking generally the lines within the city were owned by the Birmingham Corporation and leased to the existing company, and that lease expired in 1907. Outside the city the pieces of tramways or ends of routes were the property of the tramway company subject to the purchase clauses of the Tramway Act, 1870. These lines had been authorised at various times, and would be purchasable by the local authorities in the years 1903-4-5-6. To prevent the inconvenience of ends of routes thus passing into other hands, and passengers having to change cars at the city boundary, the bill proposed that until the lease of the central portion of the tramways expired, if the outside local authorities exercised their powers of purchase, running power should be granted to the company, so as to preserve continuity on the different routes. It was not proposed that the outside authorities should be compelled to grant a lease, but there was an enabling power for them to grant leases if so disposed. The terms on which running powers were to be granted would be settled by the Board of Trade or by arbitration. The Birmingham tramways had been authorised at different times, and as they were constructed different means of locomotion were adopted, and so the position was a difficult one. If the company wanted to carry out any alteration in tractive power, they had to agree not only with the Corporation of Birmingham, but also with the smaller outside authorities. The system was at present worked in four different ways—horse, steam, cable and one route by electricity on the accumulator system. Electrical experts looked forward to the day when such a system would be made convenient and commercially successful, but at present that method had not been discovered. This line was practically the only one on which the accumulator system had been tried, and it had been found both inconvenient and expensive. It was, therefore, by this bill proposed to alter this line and to work the route by the electric overhead trolley system. Terms had been agreed with the Birmingham Corporation, but he understood they had only got the assent of the outside authority, King's Norton, for one year. If refusal of that consent was made at the end of a year, the reasonableness of the refusal was to be decided by the Board of Trade. That arrangement they asked might be made binding in regard to the outer tramways in other cases of conversion into electric traction. He thought that it was fair that in going to the very large expense of conversion to electric traction, the tramway company should be placed in as good a position as if they only had to deal with the Corporation of Birmingham. The bill was opposed by the District Councils of Handsworth and Aston Manor, chiefly on the ground that it would be necessary for the purposes of electric traction to have generating stations which they would be called upon to acquire when they took over the tramways in 1903, even though some better system of electric traction might in the meantime be devised. They also objected to the proposals in regard to running powers and the arbitrament of the Board of Trade.

After evidence had been given for the bill by Mr. Charles Pepworth, secretary, and Mr. Alfred Dickinson, consulting engineer to the tramway company, and also for the petitioners,

The Committee decided that the preamble of the bill was proved, subject to the elision of Clause 42, making the Local Government Board arbitrator in the case of a local authority refusing to renew its consent to the use of any system of mechanical power, and of Aston Manor and Handsworth from Clause 58, requiring the local authority to purchase all mechanical plant at the time of taking over a tramway.

## WORCESTER TRAMWAYS BILL.

Opposition to this bill has been withdrawn, and it will now proceed as an unopposed measure.

(*Parliamentary Intelligence is continued on a subsequent page.*)

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# LEGAL INTELLIGENCE.

## Atkins and Applegarth v. Castner-Kellner Alkali Co. (Ltd.).

This case was continued in the Chancery Division before Mr. Justice Buckley on Thursday. A portion of Thursday's proceedings was reported in our last issue.

Mr. T. TERRELL, K.C., for plaintiffs, said that before dealing with the specifications he wished to explain the subject in respect to which the invention related, because it involved very interesting but somewhat compli·ated points of chemistry, and also interesting problems with rela·ion to electrical energy. The invention was one for decomposing salt by means of electric currents. It had long been known that if you had a combination of two substances, such as chlorine and sodium, or hydrogen and oxygen, or any other similar elements which produced a salt, and if you passed an electric current through the solution of the salt you decomposed it. The energy of the current would break up the salt and one of the elements would fly to one pole and the other element to the other pole. He would take, for example, water, which was composed of hydrogen and oxygen. If he dipped two poles into a slightly acidulated quantity of water and then passed an electric current through the water and between the two poles he would, in the course of the transit of the current, get oxygen developed and bubbling through at one pole, and hydrogen developed and bubbling through at the other. He was not aware to what extent his lordship was familiar with this branch of science. It was not his desire to be too elementary, but it was important that this should be made clear.

Mr. Justice BUCKLEY: Be as elementary as you please. I am not wholly unacquainted with the science, but my views on the subject may in some respects be erroneous.

Mr. TERRELL said it was particularly important that his lordship should have as accurate a knowledge as possible of the very beginning of the science to which the case related. Mr. Terrell then gave a practical illustration in court of what he had explained. If, in his illustration, he had used a solution of common salt instead of water what would have happened would have been this. At one pole there would have been developed the metal sodium, and at the other pole chlorine gas. Atkins and Applegarth's apparatus caught hold with one hand of the sodium which had been released from the molecule before it and gave off the chlorine which it ceased to want. Thus they obtained a continuous flow of chlorine on one side and a continuous deposition of sodium on the other. So long ago as the time of Sir Humphrey Davy it was ascertained by electrolysing chloride of sodium in this way you could get a metallic sodium, but nothing was done with it because, first of all, the sources of electrical energy had not been developed in such a way that it could be devoted to such a purpose with economic results, but also because the moment the sodium was set free as metallic sodium, being in a solution which contained water, it itself, in its turn, decomposed the water and so became soda and gave out hydrogen. Although they knew perfectly well they could decompose chloride of sodium by means of an electric current, getting sodium and chlorine, it was a very great problem how they were to use that in such a way as to be able to separate the soda from the chloride solution. Many years ago chemists would have laughed if they had been told that the process for making common soda was just a process of making sodium and then oxidising the sodium. Still, that was what it came to, and that was entirely due to the fact that the mercury would absorb the sodium from an amalgam and protect it from the action of the water. Great difficulties were in the way of carrying that into practice. It was obvious that by making a substance so cheap as common soda by electricity that economy of electrical energy was one of the first considerations, and if they wanted to make the process commercially successful they must economise their electrical energy. Then mercury was an expensive article, worth about 3s. a pound, and when you were going to use an article worth 3s. a pound in the manufacture of an article worth 1d. a pound, it was obvious you must be economical in the use of the dearer article. It was necessary, therefore, to devise a plan which would economise the mercury. Then, again, you had to protect your anode from being attacked and you had to take care that the evolution of chlorine was arranged in such a manner that your apparatus was not destroyed. Then you had to get the chlorine away. A great many attempts were made to bring the theory to commercial use. One of the greatest difficulties was wasted energy. When your mercury absorbed a certain amount of sodium, there immediately began to be set up a more or less mobile action between the mercury and the soda and the water or liquid in which it was. That set up what was called and what was known as counter electromotive force. You had the current going to do the decomposition travelling from the anode to the cathode, but immediately it operated and made sodium you began to get sodium trying to be decomposed in the electrolyte and setting up a counter electromotive force which was negativing and utilising the current doing the work. That was one difficult thing. Then if it did decompose the water you got no longer a pure solution of chloride of sodium, but that which was a solution of chloride of sodium and caustic soda, and that caused an enormous waste of electrical energy. Then if you got too much sodium into your mercury your soda and mercury amalgam got solid, and you could not work it any more; it ceased to operate. This is what the plaintiffs did: They said, first of all you must have a very weak amalgam formed, and he (counsel) thought that in actual practice they found that 0·2 per cent. of sodium was the most that you could usefully get into the mercury. Then the next thing was to get rid of the electromotive force, and to do that you had to keep your mercury flowing all the time it was absorbing sodium. So that the mercury, when presented to the electrical action, should always be worked in sodium, and should get taken away from the electrical action as strong as possible in sodium. He thought his lordship would have established in evidence that the counter electromotive force increased enormously with the increased richness of the sodium in the mercury. So what the plaintiffs said was this, that you must get your body of mercury brought into the operative part of your apparatus perfectly free of sodium, and during the whole time it is absorbing sodium you must make it move, and the moment it is rich enough in sodium take it away, and you must not let it touch the electrical energy a moment. By that they got rid of the counter electromotive energy. The learned counsel then read Atkins and Applegarth's complete specification.

On Friday, after dealing briefly with the objections to plaintiffs' claims, the learned counsel (Mr. Terrell) proceeded to explain that the previous case which had been before the Court was an action by the Castner-Kellner Co. against the Chemical Development Co., the latter being practically the plaintiffs in the present case. That action was against his clients for an infringement of a Kellner patent of 1894, No. 2,259. His clients lost the case before Mr. Justice Bigham, but the Court of Appeal of the House of Lords held that there was disconformity in the patents. Mr. Terrell described the Castner patent of 1892, dealt with in the present action, and hoped that his lordship would be satisfied by the evidence that the objections to the plaintiffs' patent failed, and that their patent had been infringed.

Mr. M. ATKINSON ADAM, examined by Mr. ASTBURY, said he had made a special study of the electro-chemical industry. He had carefully examined and considered the plaintiffs' specification. The production of caustic soda by electrolysis and the use of the mercury cathode was not in commercial use at the date of plaintiffs' patent. No apparatus with a mercury cathode had been brought to his attention by which caustic soda could be produced electrically before the date of plaintiffs' patent. The fact of using electrolysis on chloride of sodium was well known before that date. The fact that you could use mercury as a cathode was equally well known as a scientific fact. There were great difficulties in the employment of mercury cathodes in the manufacture of caustic soda, because mercury was very expensive in proportion to the output. With regard to the electromotive force necessary to produce electrolysis, witness confirmed the opening statement of counsel. The anodes in the plaintiffs' apparatus were formed of carbon rods. The fact of decomposition for soda on the anodes tended to make them weak, and they would not last long. In his view the plaintiffs' apparatus, which worked by means of a thin continuous flowing mercury cathode, solved the difficulties which existed at the date of the specification in the commercial production of caustic soda.

Supposing you put mercury containing sodium into a cell with water and decompose your sodium out of the mercury, does the mercury become free again and capable of being used again in the same process?—Yes; the mercury can be treated substantially without waste. He had seen the model made by Mr. Bevan of Fig. 1. He had seen it actually working in accordance with the directions contained in the specification and successfully producing caustic soda. In his opinion the rocking process which defendants used acted in accordance with the directions and in the manner described and pointed out by Atkins and Applegarth. There was no doubt in his opinion that the apparatus used by defendants with a flowing or moving mercury cathode to do the work did it in exactly the same way as was described in plaintiffs' specification.

Do you know of any apparatus prior to the date of the plaintiffs' specification in which a mercury cathode was used whereby the back electromotive force was avoided as in the case of the plaintiffs' specification?—No.

Is the saturation by caustic soda or electrolyte avoided by the plaintiffs' invention? And is the loss of electric power also avoided in plaintiffs' apparatus?—Yes.

Do you know of any apparatus using a mercury cathode in which these operations were performed at that date?—No.

Does the plaintiffs' apparatus make use of the whole of the mercury used for the purpose of drawing out the sodium from the electrolyte, and is the superficial area of mercury very large compared with the bulk of mercury used?—Yes.

Are the anodes in plaintiffs' apparatus protected from destruction by reason of the non-decomposition of caustic in the electrolyte, and are there adequate means used in the plaintiffs' apparatus for keeping up the strength of the electrolyte?—Yes.

Lastly, are the electric forces in plaintiffs' patent made as effective as it was possible to make them in this process?—Yes.

Was there any other apparatus prior to the date of plaintiffs' specification in which these occurred?—No. He had read the four so-called anticipations—viz., the two of Nolf, Petri's, and Donkin's—and did not find any indication of plaintiffs' invention explained in any of them.

Is the problem which plaintiffs' apparatus solved present in either Petri, Donkin, or Nolf?—No.

Cross-examined by Mr. FLETCHER MOULTON: If a mercury cathode was not used, the soda was formed in a salt solution. That was very bad, and what was most wanted to be avoided. It could not be avoided altogether. If a mercury cathode was not used it produced caustic soda, but produced it in conjunction with a mixture of salt—a great commercial drawback. Atkins and Applegarth's was a better method commercially—better and cheaper. He had never seen the apparatus in question worked before this trial, but was quite satisfied it could be worked.

Questioned as to Nolf, Witness said that from the description given in that specification there was no idea of working the apparatus commercially. There was nothing in Nolf that was not perfectly well known in 1883 or 1890, in a sense. Every single thing that he described was then common knowledge to electricians. He showed the fact that you could electrolyse sodium in this way. His contention was that Nolf's was not a practical working method for a commercial purpose. The electromotive force used by Nolf, he should say, was about 6 volts, but perhaps 8 or 10 volts. In Nolf you could keep the mercury fluid, but you would require to draw off almost immediately. He had never worked Nolf down to the present day. He had never used any apparatus which ever used a film of

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mercury as a cathode for commercial use. If they passed mercury over copper it attacked the surface. In the amalgam they got a certain amount of copper. If you let the mercury flow over iron there would be a considerable proportion not covered because mercury would not amalgamate with iron. The moment any portion of the iron surface became bare they would have a fall of electromotive force, and that would be due to the failure of the surface, but not to the failure of the apparatus. Nolf endeavoured to get the electromotive force while his mercury was in the course of getting rich.

What is there to keep the richness of the film in Applegarth lower than the richness of the mercury in Nolf?—He says he wants a flowing mercury cathode.

In Fig. 5 what is there to keep the richness of that thin film of mercury less than the richness of the mercury in Nolf, who tells you not to make it too rich?—Nothing but the rotation of the band. Nolf did not stir the mercury; he stirred the electrolyte.

You cannot show me any words in plaintiffs' specification which warn against richness of amalgam?—Nothing, except that the mercury is to be circulated, and to be continuously circulated. The amalgam is removed from the sphere of action. That is plaintiffs' idea to my mind.

Where is there anything about continuously removing it. Everyone knows you have to remove it?—The essence of the idea is the removal of the amalgam from the salt continously.

You have told us that the back electromotive force is created by the richness of the amalgam?—Yes, but you have to carry the amalgam off, and plaintiffs' idea was that the amalgam was carried off.

But Nolf's idea was to carry off the amalgam from time to time before it got too rich?—He never got anything but the surface amalgam. Nolf's idea was to electrolyse the amalgam on to a surface of passive mercury, where it would not be distributed at all.

I put it to you that Fig. 5, having a thin band of copper—so thin that it was flexible—dipping into mercury and having sodium amalgam deposited on it, that that would rot so that it would not work. Is not that so?—That may be.

The mercury amalgam would rot the copper?—In time.

It would not stand industrial work for a day?—I cannot say. That depends upon how it is arranged upon the diameter of the poles over which you bend it. That is one factor that will affect it because it is bending over the copper while in contact with the mercury which will facilitate the rotting, and if you choose very small poles no doubt it will rot fast.

Take claim 1 of plantiffs' specification: "The cathode pole of which is composed more or less of a flowing or moving surface or body of mercury?"—They thought so; it is more or less flowing.

It cannot be more or less flowing—it is "composed more or less of a flowing" is the expression used?—Yes.

In other words it contemplates part of the cathode not being this flowing surface of mercury?

Mr. ASTBURY: I submit that this is a question for your lordship.

Mr. Justice BUCKLEY: This is something pointed to on the specification, and I think it is a very proper question.

Mr. MOULTON (to Witness):—If the surface is not amalgamated it would be very difficult to make the mercury always cover the surface if it was flowing in a thin film? In the case of a thin film on a non-amalgamated surface you could not insure it covering the whole?—It depends on the thickness of the film entirely.

Now let me turn to the anticipations and take Donkin. First, sodium amalgam was very well known at this date, was it not?—Yes.

As a matter of fact weak sodium amalgam decomposes very slowly?—Yes.

I put it to you that the real difficulty of applying this electrolytic process had nothing to do with the parts on which Atkins and Applegarth rely. The difficulty was that the decomposition of the amalgam went so slowly?—I do not think so. I think it was perfectly well known that that could be overcome in a separate vessel. Electrically everybody knew that sodium dissolved in mercury was exactly like copper in an electrolyte, and could be electrolysed out very rapidly. There is no difficulty about that. It was perfectly common knowledge at the time that that could be done.

But there is no suggestion before the Castner patent of a method of getting sodium out of mercury?—I do not think so. I know of no public knowledge except by heating it. Of course, with a hot solution you can get it out pretty quickly.

If it is weak it is difficult to get it out?—It was perfectly well known. I knew it myself at that date that a sodium amalgam decomposed was exactly the equivalent of copper in an electrolyte. It could be used in a battery as zinc is used in a battery. It is perfectly well known that zinc dissolves in sulphuric acid and gives off an electric current.

I am putting it to you as a fact that the only difficulty in the use of mercury at all for this purpose was that it was not a convenient way of getting the amalgam out unless it was very strong?—I do not agree with that.

Donkin says "My invention is intended for the production of a constant supply of an amalgam of sodium and quicksilver directly in or in contact with the quicksilver used for the amalgamation. It is well known that an alloy of quicksilver and sodium has a greater affinity for gold and silver and better resists the action of base metallic oxides or sulphides and impurities in the ore than quicksilver alone." This is a patent for producing sodium amalgam from chloride of sodium?—Yes.

Now, Atkins and Applegarth's patent does exactly the same thing, and no more?—I think it does do more. It does it in such a way as to economise the solutions.

I am not talking about which does it the best way. I am only saying that the object of the two is to produce sodium amalgam.—The problems before the two are quite different.

Atkins and Applegarth's patent ends by producing sodium amalgam?—It describes how to produce sodium amalgam—that is one of the objects—and in such a way that it is reasonably economical.

Let me see how Donkin does it. "I use an electrolytic cell of some material incapable of conducting electricity and which is not attacked by chlorine or caustic soda, and place in the bottom of it the cathode, consisting of a layer of quicksilver. Above the quicksilver I place a saturated solution of chloride of sodium in water, and in this solution I hang the anode of carbon. By making holes and fixing pipes in the sides of the cell below the upper surface of the quicksilver I can directly connect the main body of it to the quicksilver in an amalgamator, amalgamating pan or settler, or other form of apparatus for the amalgamation of gold or silver or for the saving of amalgam or quicksilver. And I cause a circulation of the quicksilver to and from the cell and the amalgamating device by means of gravity or by a suitable pump or otherwise."—Yes.

Now, what Donkin intends to do is to circulate the mercury of his cathode, drawing it off into his amalgamator?—Yes, and he intends to have such a thickness of body of mercury in the bottom of his pan that he can put in two pipes to let in mercury and draw off the mercury at different levels as he is intending to have a considerable body of mercury at the bottom.

If you want to get any amalgam, and therefore work it at a rate to carry off any of the amalgam, it will draw from all parts?—No doubt you will get some of the amalgam, but you have a surface there which is practically the surface into which the amalgam is being deposited, and that surface is not being changed in the sense of Atkins and Applegarth's patent at all.

I understand your objection to Donkin to be that the surface is not being continually changed in the manner that Atkins and Applegarth's does.—Yes, and, therefore, is not a moving cathode in that sense.

Now in Petri's case you deposit in the mercury an equivalent of sodium, or of potassiums, which happens to be the instance given, just as in the other case you deposit an equivalent of sodium, the difference being that in the one case you leave ferricyanide and in the other you leave chlorine?—Yes.

But so far the electrolytic operation is the same?—Yes, except that here you have the mercury against the porous partition.

Further cross-examined, Witness said that Petri's patent was not a moving mercury cathode in the sense of Atkins and Applegarth at all.

Re-examined by Mr. ASTBURY: With regard to Nolf, it has been suggested that if defendants' rocking process were rocked one way and then stopped for a few moments, then turned up the other way and rocked again and stopped for a few moments, it would be nothing more than Nolf. If it were do you think it would be any good?—I do not think it would.

No electrician reading plaintiffs' specification would imagine that Fig. 5 was intended to be a working drawing?—Plaintiffs recognised that there would be some caustic produced in the electrolyte. They provided means for counteracting the ill-effects of this amount of caustic which they thought would necessarily get back in some degree in the electrolyte. In the plaintiffs' specification he saw nothing else but directions to make the process continuous. It seemed to witness that in the whole of that apparatus the idea was to electrolyse into a moving surface of metal.

It was suggested that Donkin's specification was simply to produce sodium and that plaintiffs' specification was nothing more. Donkin was dealing, was he not, with the extraction of gold from ores and for the production of an article which was extremely valuable as compared with soda?—That was so, and Donkin gave no directions as to how much or how little sodium he required to put in his mercury. Donkin did not in any way suggest the advisability of avoiding the production of caustic soda in the electrolyte. He expected it to be produced, and provided a cell in which the caustic soda and chlorine so produced would not attack it. As to the Petri process, he had never heard of its being used. The date of Petri was 1886. In 1892 Castner took out a patent for an invention which, in his view, was similar to plaintiffs'.

Is there any passage in Petri's specification in which the difficulties which plaintiffs seek to solve was even suggested?—No, nor was there any possibility of a machine or apparatus if constructed and used as suggested by Petri avoiding or curing these difficulties.

Mr. DUGALD CLERK, examined by Mr. Terrell, said he had considered Atkins and Applegarth's specification. They did what they proposed to do to get rid of the effect of the local action and counter electromotive force. The invention in the first claim was general—viz., an improved means for separating alkaline from earthy metals by means of a moving or flowing body of mercury. In defendants' specification he found the same thing as was described in plaintiffs' specification operating with the same results and by the same means. He had considered the alleged anticipations, but he did not find in any one of them anywhere described the plaintiffs' invention. In Nolf he found a decomposing vessel for decomposing salt and getting the sodium into a body of mercury forming the cathode. There was not a flowing mercury cathode. The process described by Nolf was intermittent so far as the charging and discharging of the mercury was concerned. Nolf contained exactly the mischief which Atkins and Applegarth tried to get over. The difficulty was the fact that mercury when charged with sodium had a very great tendency to act upon the electrolyte, and notwithstanding the electrical forces acting there was a strong tendency for the sodium to go out of the water and produce caustic soda. The difficulty was to keep up the continuous strength of the cathode, and to prevent the sodium going into the water when it was not wanted. Petri's invention was not devoted to the economic production of caustic soda at all. The porous cells in Atkins and Applegarth did not contain in any way the mischief of the porous cells in Petri. The problem Donkin sought to solve was a different one to that of Atkins and Applegarth. In Donkin there was no suggestion or desire to produce soda. Donkin's invention might succeed very well for the purpose for which he proposed it. He did not find in Donkin Atkins and Applegarth's invention.

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Cross-examined by Mr. BOUSFIELD: There was no novelty at all in the plaintiffs' specification except the suggestion that you were continuously to remove your mercury amalgam and supply fresh mercury. The mere movement was nothing, but it was the removing which was important. That was the only point which could be suggested as novel at this date. There were only two ways of removing amalgamated mercury—one continuously and the other intermittently. Nolf proposed to remove it intermittently, Atkins and Applegarth continuously. In Atkins and Applegarth the amount of electromotive force was reduced to a minimum. The defendants' plan was to let the electromotive force be what it liked and to utilise it. He was, of course, of opinion that the flowing of the mercury was an advantage, but the most important factor was the removing. Atkins and Applegarth required to make their circulating apparatus go fairly fast.

In defendants' apparatus they were enabled to get out their sodium as quickly as they got it in by the use of the cathode?—Yes.

Prior to this date did anybody, either in text books or in specifications, tackle the problem of getting sodium out of mercury when once it was in?—They had to rely on getting it out by means of water.

I put it to you that in Donkin you had every essential feature of the plaintiffs' specification?—In words there was no essential difference. There was a circulation and a layer of mercury and there was a movement of the mercury so as to discharge. But Donkin showed no drawings and did not give anyone an idea of a flowing cathode at all, and in Petri there was no idea given of a moving cathode at the time of charging. In Nolf, taking his process as one for manufacturing amalgam intermittently, he did not say that it could not be done, but he did not think it would be successful commercially. There was no difficulty in the flowing of the mercury, or in anything else, which a practical electrician could not surmount. He had said that in Petri the amalgam would stick to the inside of the porous pot. He agreed with the evidence of Mr. Adam.

Re-examined by Mr. TERRELL: If you were treating your apparatus in such a way as to get hypochlorates, caustic soda, or chlorates, they were wasting current so far as the production of sodium was concerned?—The tendency to form those chlorates, hypochlorates, or soda, was greater when the sodium became rich. The process which in effect prevented the formation or discouraged the presence of rich amalgam was an invention which would tend towards economy of current, whether that was by reducing the electromotive force or by chemical action. When they had an amalgam of sodium and mercury in contact with water a chemical deposition took place, that was to say, when sodium was produced and hydrogen given off. That was a known chemical decomposition. The tendency for the decomposition to become accelerated was increased as you got richer in sodium. There was no doubt that defendants had improved on Atkins and Applegarth in regard to a flowing mercury cathode. Donkin in no way offered an explanation of the problem which Atkins and Applegarth tried to solve. In Donkin there was no idea of economising electromotive force or current. In Donkin the problem was not one to produce sodium economically at all. There was no sufficient indication in Donkin's specification to enable a skilled person to work Atkins and Applegarth at all. In Petri there was nothing to show a man working Atkins and Applegarth how you might economise current.

Mr. E. J. BEVAN, examined by Mr. ASTBURY, said when salt was electrolysed with a still mercury cathode the resistance of the current increased as the mercury became richer in metal. As soon as you turned your electric current into the electrolyte with a mercury cathode, hydrogen formed at the mouth of the cathode at once and increased as the sodium got richer. If it were desired to produce the amalgam sodium in the mercury to the best advantage it was advisable to prevent, as far as practicable, the formation of caustic and hydrogen. It was impossible to avoid it entirely. There was always a particular amount going on.

Witness gave the Court the results of different experiments which he had made for the purpose of determining the time and depth of diffusion in mercury of sodium deposited in it. Continuing his evidence, Witness said it was a fact that you could get your sodium out of your mercury by water, but if you coupled it up by a current you could do it more rapidly. That was scientifically known before the date of Atkins and Applegarth's patent. If the mercury was kept in a state of being mixed up you could get the sodium out of the mercury by means of water provided you made your water surface large enough. If you used a short-circuit arrangement you could get it with a much less superficial surface of water. Speaking as a chemist, he was of opinion that Atkins and Applegarth's specification was of value and useful and above anything which had been shown prior to that date. Atkins and Applegarth told them to at once remove the sodium from the action of the water, and, to his mind, that was the essence of the claim. He did not find in Nolf from beginning to end a suggestion of the useful process described by Atkins and Applegarth. He knew Petri's water system: electrically it would not work. The problem which Donkin wished to solve had no bearing on the problem which Atkins and Applegarth sought to solve. The purpose of Donkin's patent was to extract gold from ore.

This closed the plaintiffs' case.

Mr. TERRELL put in the patent granted to Atkins and Applegarth.

Mr. MOULTON said defendants did not admit plaintiffs had any title to it.

Mr. TERRELL then put in a number of agreements, &c.

Mr. MOULTON said he was quite prepared to fight out the case on the merits; but when the proper time came he should maintain that the patent in question did not belong to plaintiffs, but was registered in the name of somebody other than the plaintiffs.

His LORDSHIP, on looking through the agreements put in by Mr. Terrell, said he thought plaintiffs were entitled to go on.

Mr. TERRELL said that after that expression of opinion that would be the plaintiffs' case.

Mr. ASTBURY said that, before Mr. Fletcher Moulton addressed his lordship on behalf of defendants he should like to make some observations on the legal aspect of the matter and also on the evidence. The first point his lordship would have to decide was what was meant by a moving mercury cathode? He submitted that the value of a moving mercury cathode was enormous. A mis-statement of theory did not matter at all, unless it led the person who was working on the process to do his process wrongly. Counsel then cited to his lordship cases bearing on this proposition. He submitted it did not really matter whether the patentee in his specification stated the theory at all, or even stated it wrongly. His lordship knew that there was a very definite rule for the construction of patents *qud* infringement. The construction of a patent for the purpose of ascertaining whether or not a particular article or process is an infringement was according to whether or not the patent was a patent for the first application for what was the real merit contained in it. It had been said that a master patent was absolutely a wrong term, but it conveyed in a popular sense what he (Mr. Astbury) meant. If a man had an invention for a new discovery of principle, and showed a way to carry that principle into practical effect, if that was the first time that a patent had made use of that principle for a particular purpose, then the patentee had a far wider protection than if he took out a patent for merely improving the details of any apparatus for improving a result in a well-known way. He submitted that this was essentially a case of the first kind. It was not suggested, still less could it be proved, that there ever had been a patent previously taken out of a process previously known or worked in which a mercurial moving cathode was loaded with sodium during its movement, which movement was constantly taking the sodium as it got richer out of the action of electrolysis. That was really at the bottom of the patent in question. As to utility, counsel submitted that it was not necessary to show that a patent to be valid in law was useful in a commercial sense of the term. There were any number of authorities for that proposition.

His LORDSHIP asked counsel to explain what he thought was the real essence of the plaintiffs' invention.

Mr. ASTBURY said his contention was that the real essence of the plaintiffs' invention was the first application of a moving body of mercury which was thin, the movement being sufficient to give full diffusion. In other words, the plaintiffs' invention consisted in charging a moving or flowing body of mercury in such circumstances that when the mercury was sufficiently charged it was removed from the electrical cell, so that the whole of the mercury was being utilised during the whole of the process. It could not be suggested that a moving mercury cathode was not an absolutely new departure. No amount of addition to this ingenious invention used in conjunction with it could save the defendants from the consequences of infringement. It could not be controverted that the essential thing which the patentee was dealing with was the making of caustic soda by means of a current which passed from the anode to the cathode, the cathode being only the surface of the mercury. Referring to plaintiffs' Fig. 5, counsel said it had been suggested that if the band was used it would rot. It was no part of his business to say it would not rot. If the other side wished he would admit that it would rot. But there was no doubt that it could be used for a certain number of hours, and that was sufficient for him. The object of the plaintiffs' invention was to produce soda on a practical scale, but it did not matter if it could be shown that the plaintiffs' invention did not carry out to the full everything that they claimed.

Mr. FLETCHER MOULTON, in opening for the defence, said that if it had been merely a question of saving time he should have been tempted to submit that the plaintiffs' case had broken down on their own evidence that went to infringement. But he thought it would be best if they tried his lordship's patience and asked him to hear the whole case and the whole of the defence set up by defendants. He should submit to his lordship that both on invalidity and infringement the plaintiffs' case broke down. He should put before his lordship a short history of the theory and method of making caustic soda electrolytically by the use of mercury. There were two or three things here which, as far as he could see from the evidence, were in inextricable confusion. The words "back electromotive force" appeared to him to be used by the witnesses in two or three different senses. The theory and practice which defendants were about to prove was this: The first idea of making soda from salt electrolytically was the obvious way—and the way Sir H. Davy did it—of simply taking a solution of strong lime and passing a current through it, leading the current and the solution to electrodes or some substance which could not be attacked. Since that was tried it was discovered that there were two very great disadvantages. The first was that the caustic soda, by the sodium which came to the anode instantly combining with water, turned into oxide. That was done in the brine solution, and therefore you never could get your soda free from salt. Consequently, the product was a mixture of soda and salt, and useless for commercial purposes. The other difficulty was that this was formed in an electrolyte in which chlorine was set free. The tendency was for the chlorine to attack the caustic. So that this method of electrolytically decomposing brine got to be looked upon rather as a matter of making hypochlorates than making caustic soda, because the caustic soda was made in a form practically useless, as it was mixed with salt. They then interposed a porous diaphram between the two electrodes that to a certain extent kept them apart, in which case you would not get hypochlorates but a mixture of soda and salt on the one side, and the chlorine would mainly go off on the other. That was an improvement, but not what you would call a flourishing industry. Of course it was evident that if the soda was made in a form free from the salt it could not be solely by electrolysis, because, if so, it must be in the electrolyte and thus in the presence of brine. Therefore you had to get a decomposition of salt. Your sodium had to be formed in your electrolytic cell, but it must not attack the water. The idea struck many people of using mercury as a cathode because it amalgamated so immediately with the sodium, while the chlorine went off on the other side.

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The electrical consequences of that change was that you had to use a distinctly higher electromotive force, because it was harder to tear your sodium apart, and to hold it until it was absorbed in the mercury, than it was to decompose your sodium in circumstances when it at once attacked the water and turned into soda. To decompose with an iron anode, if an earlier process were followed, you would want 2·3 volts to do the work. To use a mercury anode you would want 3·2 volts, or less than half as much again. The amalgam, when taken off, could be made to give up its sodium. It was evident, apart from the mere cost of plant, that was a very much more practical method of making soda, because, although it required a certain unit extra of electromotive force to do it, it gave you up your soda with absolute purity. That represented the knowledge of the world prior to the date of the patent in question. Certainly the world knew that. He did not think that any more practical or plain description of a workable apparatus to obtain pure soda could be given than Nolf. That was a plain and very ingenious embodiment of those principles which were perfectly well known to electricians at the time. Although he should not stop then to describe Nolf in order to prove his words, he should, later on, ask his lordship to follow him with regard to Nolf, and to see if he had not described his invention properly. It might be asked, then, very prudently, that when they had got a way in which they could produce this pure soda with only a slight excess of electromotive force over an imperfect method, which gave them such products at so much less commercial value, why was not this practically used? It was not practically used for this reason—although sodium amalgamated in the presence of water, and ultimately gave up the sodium, it did so very slowly, and it was not at all easy to get it rapidly to disgorge the charge. His lordship must remember that they were not dealing with stuff which was sold by ounces but by tons. It was sold at about £6 to £8 a ton, or about 1½d. a pound, and it necessarily had to be made very cheaply, in order to compete with those chemical products which were made all over the country. This process was theoretically perfect, and you could make absolutely pure soda with very little electromotive force, and you could get it out, but it was troublesome to get it, and it would require a great deal of mercury to do it. That was more or less the state of knowledge at the date, which was important. So far as the manufacture of soda was concerned, the method of using mercury as a cathode had not taken practical shape. Here there came the plaintiffs' patent. He did not wish to say hard things of a patent he was attacking, but he did not think he should make his meaning clear to his lordship if he did not explain the light in which he presented this patent, and in which he should place it by his evidence. The main stream of invention was done by the inventors who really worked out problems, understanding them first and then working them out, and afterwards giving practical solutions which the world could take advantage of. But side by side with these inventors there was always a class of persons with imperfect knowledge, not very competent in learning or mastering the difficulties of a subject, who put forward patents which were absolutely useless, utterly non-practical, and those patents usually died from an attack of fees. But if they were kept alive for any reason whatever it might very well happen that the real inventor discovered a way of solving the problem, and that then these patentees sprang up and showed some apparent resemblance between what they suggest in this non-practical manner and what the real inventor has succeeded in showing, and then they come and claim he has infringed their invention. The alternative is their being paid off or an expensive law suit. His (counsel's) case was that this patent came at a time when what was wanted were practical improvements, when the theory was known that what was wanted was a useful machine from a practical point of view. The plaintiffs had invented nothing that was practicable or that could assist anybody. The defendants did not use it. There was merely a superficial similarity which when it was looked into completely disappeared. In 1892 M. Castner, an inventor of great ability—recently dead—came upon an idea which was a very clever one. It occurred to M. Castner that if he took the charged mercury as an anode and iron as a cathode, and passed his current through it, then he could accelerate the combination of the soda. By his invention he got his soda in a perfectly pure form and rapidly. He would charge it in one vessel and use it as an anode in the other, and use the whole in one circuit. The consequence was that he did it promptly and disgorged as he got it. There were many different ways in which he could do that. He ultimately decided on the simple method of rocking, which exactly carried out the theory. It was a system of pouring mercury from the gorging cell into another cell where it was disgorged. It was obvious you could use quite a moderate amount of mercury because you were able to disgorge so quickly. M. Castner did what Nolf did. Nolf tipped it up and drew it off. The defendants united the two cells, and by tipping they poured from the gorging to the disgorging cell. The description that Castner gave as to the management of this was the only good practical direction you could give.

His LORDSHIP: There is a continuous flow backwards and forwards?

Mr. MOULTON: Yes, it is like the tide. That is the substance of the step taken. That is the substance of what we did and by which we made the thing commercially useful. The only thing from Nolf was the intervention of the disgorging cell, and then we added the intermittent movement. What he was going to show was that the plaintiffs' invention was a useless one. He was quite prepared to admit that there was a distinction between the plaintiffs' and Nolf's and a difference which was clearly expressed in the specification. But it was a difference which made a question of infringement quite unsustainable. He was going to point out to his lordship that the very essence of the plaintiffs' invention was having a conducting support to a film of mercury. His learned friends had asked whether up to this time a moving mecury cathode had ever been used. The answer was "No." But none of these were used before Castner came. The right question would have been whether any were ever used until after Castner. The Castner which was improved upon by Kellner was the one that really solved the problem. Donkin's was a perfectly sensible and practical method and that instrument procured an excellent mercurial amalgam. There there was a rapidity of the circulation of the current density. There there was a regular circulation. In the defendants' it was intermittent—a tidal flow. The moving mercurial cathode of the plaintiffs had very particular characteristics, but it could not be better than Donkin's, which worked without the slightest "cooking," and nothing could be more simple in the whole of its construction than this, and it was exactly as described. The plaintiffs' specification had to be read fairly to everybody, to the plaintiffs, to the public, to future inventors, and to those who had previously been at work. And the most important thing to find out was what the plaintiffs said to the public they had done. He contended that there must be no false suggestion in a patent. He did not say that a man might not be ignorant of what he had done. He did not say that there might be no blunders, but the substantial suggestions in the patent must be true. The specification was evidently written by men who did not understand what they were writing about. The learned counsel then dealt *in extenso* with plaintiffs' specification, and contended that it was invalid for want of utility. He submitted that the invention in every respect was a retrograde step. Nobody suggested that it had ever been worked. That was an outline of the case the defendants proposed to make with regard to the utility of the patent.

Mr. JAMES SWINBURNE, examined by Mr. MOULTON, said he was acquainted with the plaintiffs' specification, and also with the alleged anticipations. These methods of working with mercury were on a considerable scale at the time of plaintiffs' specification. In the decomposition of chloride and sodium between iron and carbon electrodes, the electromotive force required would be between 4 and 6 volts. The back electromotive force was not a very definite thing. Nolf's was a practical scheme of producing amalgam of sodium by means of a mercury cathode. In that case you could get the sodium amalgam, but the question would be how to get the sodium out in order to make soda. In plaintiffs' specification there was no suggestion of how to get the sodium amalgam out. The first to suggest a practical commercial method of getting the sodium off the amalgam rapidly was either Castner or Kellner—he could not say which. That was the invention which made the process a commercial one. So far as the charging was concerned, he did not see any distinction between what defendants did and what Nolf did. With regard to discharging, defendants poured off their discharged mercury into a porous cell; Nolf ran his out by tilting—at least he suggested it. There was nothing corresponding to the disgorging cell in plaintiffs' specification. Donkin had got it out, but in an expensive way. Donkin's directions were quite clear. If you drew off like Donkin or Nolf you got mercury amalgam all right. Both Nolf and Donkin would work successfully if they had a method of disgorging rapidly. There was no difficulty in the charging, which was well known. In Donkin there would be a regular flow of the mercury. The flowing of the mercury made no difference in the charge. You must let the mercury lose its fluidity. He found directions in Nolf for that. Of course it was important that the mercury should be pure. So far as taking the sodium was concerned, plaintiffs' apparatus did not enable them to use any less electromotive force, or very little. But to get caustic soda they wasted it. There was nothing in the plaintiffs' specification to show that they contemplated charging less highly. Plaintiffs' Fig. 5 was not practicable at all. He did not see in defendants' arrangement any arrangement of film or lamina as spoken of in the plaintiffs' specification.

Cross-examined by Mr. TERRELL: When the plaintiffs' patent was addressed to the world it was known that mercury would absorb sodium when presented to it by electrolytic process. It was known that that electrolytic process could be done by chloride of sodium solution. It was known that a chloride of sodium solution submitted to electrolysis would in some conditions simply split up the chloride of sodium and in other conditions split up the water as well. You can find that in several books—undoubtedly in Faraday.

Was it known that under certain circumstances, instead of getting sodium or chlorine you might get hypochlorates and hydrogen?—Yes, it must have been known at that date.

You cannot say of your own knowledge whether it was or not?—I cannot remember whether it was known in 1891.

Was it known that by electrolysis of a solution of sodium you could evolve hydrogen and get chlorite of soda?—Yes. You have to apply heating to do that properly. I think I knew these things in 1882. They are quite old.

It was known that you could get by electrolysis something in the nature of an amalgam between ammonium and mercury?—Yes, that was old.

Ammonium was not a metal?—No.

Was it supposed at any time that hydrogen was a metal?—Well, some people believe it now.

Was it supposed that you could get an amalgam of mercury and hydrogen?—I think I have heard of it.

If hydrogen is on the cathode it will offer resistance to the current?—Yes, you can put it in that way.

It was also known that sodium in contact with water decomposes?—Yes.

Donkin brought back his mercury and had continuously to get back sodium in it?—The sodium in the slush or water had to be decomposed. At the date of plaintiffs' patent he did not think that people making caustic thought of mercury at all. That was only due to Castner's patent. Donkin did not try to put tons of sodium into the mercury. Economy of energy was comparatively a less important factor to Donkin than to plaintiffs. Probably economy of energy and keeping the electrolyte free from sodium were not present to Donkin's mind. The keeping of sodium from coming into the electrolyte was something which neither Donkin nor Petri had any reference to.

What is your definition of electromotive force?—The difference of potential between any two points in a circuit, measured by the amount of work done.

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What is your definition of counter-electromotive force?—An electromotive force going against the current. and thereby tending to prevent the flow. It does not act as a resistance, although a resistance also tends to prevent the flow.

What is a cathode? The words "cathode" and "anode" are only used electrically in connection with electrolysis?—Yes.

When you talk of anything else but electrolysis, you talk of terminals?—Yes.

And the cathode and anode must be conductors, and part of or connected with the conductor from the dynamo?—Yes, but the words "cathode" and "anode" were not used very strictly. In Atkins and Applegarth's specification the word "cathode" was used sometimes as meaning the mercury in combination with the metal support, and in some places as the place where the metal was.

Questioned as to the alleged infringement, Witness said the whole rocking process in defendants' machine was completed in 12 seconds. The rocking process was slow, steady and continuous. During the whole period of time that the electric current was passing and electrolysis was taking place the cathode was moving in relation to the anode, and then moved back again. The surface of the mercury was always the cathode. Attention was called to the benefits of a moving mercury cathode in consequence of what Castner did, not because of what Atkins and Applegarth did.

Re-examined by Mr. BOUSFIELD: Nolf's was a practical apparatus so far as it went, but Nolf's was not as good as defendants' apparatus. The real defect was that Nolf's apparatus was not complete because it did not show means for separating the sodium from the amalgam. Petri disclosed the continuous process. Donkin and the defendants produced quite a weak amalgam, but Donkin would probably make a stronger amalgam than the defendants.

Lord KELVIN, examined by Mr. BOUSFIELD, said he had read the specification of Atkins and Applegarth, had seen defendants' apparatus working, and had seen the other specifications. Nolf allowed the mercury to be at rest and removed the amalgam from time to time. The counter electromotive force was not a thing to be evaded, but to be overcome in obtaining a commercial product. You could not abolish counter-electromotive force, or substantially reduce it by anything referred to in plaintiffs' specification. He regarded Nolf's as being a practical arrangement. Donkin's arrangement of having an even layer of mercury was much better than plaintiffs' arrangement. He had studied the specifications of Petri, Nolf and Donkin, and he did not see any practical difficulty in any of them in carrying out the processes there described. He did not think the plaintiffs' specification foretold the world anything which it did not know before.

Cross-examined by Mr. TERRELL: The cost of electrical energy was a large proportion of the cost of electrolysing salt. It was well known that, according to the nature of the electrode you had in the electrolysis you would get different results. He was a patentee himself in this branch of electrolysis.

When you gave evidence in the last case you were of opinion that stationary mercury, as described in Kellner's provisional specification, was better than flowing mercury?—The best way was to move one or other of the two compartments over fixed mercury instead of letting the mercury flow. He thought that the mercury ought to be kept as quiet as possible relatively to the vessel containing it.

It is essential in this process for commercial success that the sodium should not be entirely discharged from the sodium amalgam in the water cell?—I do not agree with that. He took out a patent in 1898 (No. 18,522 of 1898) for flowing mercury. He thought that was a good invention at the time, and a great improvement on the method he was designing at the time.

By means of a flowing stream of mercury you got rid of the liability of the sodium coming out as soda in the electrolyte?—You are bound to get some.

I suggest to you that Atkins and Applegarth, although they say "you will get soda formed in the electrolyte," were mistaken in that except to an infinitesimal amount and that they really get very little soda?—I think they get a great deal of soda formed through inequalities in different parts of the cathode. The object of Atkins and Applegarth as disclosed by the specification was an impossible one in the way described because they could not evade the counter electromotive force. They had to overcome it. One of the things the patentees said was, that they wanted to get the sodium amalgam out of the region of the electrolyte. By that they would economise energy and would prevent the electrolyte being contaminated by caustic soda.

Does not the whole of the plaintiffs' specification, speaking as to a chemist, say this: "You will get oxide of sodium whatever you do, and we are telling you the means of getting rid of it so that it shall not interfere with your future electrolysis"?—Plaintiffs did not say that they wished to minimise the making of caustic in the outer chamber.

The specification did not convey to him the idea that they were trying to form a sodium amalgam as their principal object.

Re-examined by Mr. BOUSFIELD: At the date of Atkins and Applegarth's patent there was room for a practical apparatus working on known principles.

Yesterday Mr. R. M. SMITH, manager of the defendant company's works, gave evidence in support of defendants' case, and said that in his opinion Atkins and Applegarth added nothing to the theoretical or practical knowledge of the subject in question. They confused it. There was no advantage in Atkins and Applegarth's apparatus over either Nolf or Donkin. It was an advantage that mercury should be mixed up so that no part should be locally charged. He thought that Atkins and Applegarth's apparatus was the worst in this respect. He had actually worked Donkin's apparatus and it formed mercury amalgam with great ease. It worked with as good a percentage of efficiency as their own machine. It worked at an efficiency of 90 per cent. He had worked the Atkins and Applegarth apparatus as well as he could and gave it every chance that he could possibly give it. The total percentage of efficiency of caustic and amalgam was from 40 to 50 per cent., 25 per cent. was the most for amalgam. It went as low as 11 per cent. In his opinion caustic soda so mixed up could not be a commercial article.

This evidence closed the defendants' case.

Mr. MOULTON addressed his lordship on the whole of the evidence. He said the patent law had never forgotten the principle on which the monopoly for patents was originally declared to be within the English common law, viz., that there must be a new and useful invention, and that if it was so the Crown might make a grant for a monopoly for a limited time for the invention; but that grant was subject to all the conditions of validity to which grants from the Crown were subjected, viz., that there must be no false *suggestio* to the Crown. In the present case plaintiffs had a patent not for anything new but for a better way of putting in practice old knowledge. The more the case had gone on the more he felt it important to look exactly into what the patent was, because he thought they had been much too favourable to plaintiffs' specification, by reading in it a great deal which was of later date than the patent itself. So far as the formation of sodium amalgam was concerned it was well known at the date of plaintiffs' specification that by passing an electric current through a solution of brine between a carbon anode and a mercury cathode you could pass sodium into the mercury, and that you could draw it off and use it as sodium amalgam for any purpose that you wanted it. Counsel then referred to the specifications of Nolf, Petri, and Donkin, and submitted that from the evidence it was clear that Atkins and Applegarth had told the world nothing new, and that really their apparatus was a retrogression as compared with those of Donkin, Nolf, and Petri.

The hearing was then adjourned till to-day (Friday).

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The following is an abstract of the complete specification of Patent No. 20,768 of 1890, referred to in the foregoing report:—

Date of application, Dec. 19, 1890.

Complete specification left, Sept. 18, 1891; accepted, Oct. 24, 1891.

*Improved Means and Apparatus for Separating Alkaline and Earthy Metals and other Products from the Salts of such Metals, or from other Substances containing them.*

This invention relates to improved means and apparatus for separating alkaline and earthy metals and other products from the salts of such metals or from other substances containing them, as for example, for the separation of sodium and sodium hydrate from sodium chloride, or from the soda waste of paper works technically called "black liquor." It is well known that when a solution of the chloride of an alkaline or earthy metal is subjected to electrolysis it is split up, chlorine and oxygen being liberated at the anode or positive pole, while the metal and hydrogen are liberated at the cathode or negative pole of the chamber or cell in which the decomposition takes place. It is further known that if the cathode is composed of mercury, the metal and hydrogen deposited therein form an amalgam with the mercury, but heretofore, so far as we are aware, it has not been found possible to apply the electrolytic process to the purpose of separating the said metals from their salts, or from other substances containing them, because the counter electromotive force., set up at the cathode by the metal and hydrogen has been so great that the electromotive force required to effect the decomposition of the solutions and to deposit the metal in opposition to the said counter electromotive force has been out of all proportion to the industrial result obtained.

The object of the present invention is to provide means and apparatus whereby electrolysis can be utilised for obtaining on a practical scale the said metals, or compounds thereof with other bodies, from substances containing them without requiring the expenditure of so great an amount of power as would be required by the use of ordinary electrolytic apparatus. For this purpose we employ a novel method of using the mercury into which the metal and hydrogen are deposited at the cathode. This method consists in causing the mercury to flow in a thin continuous stream or lamina over the surface of the cathode (which may or may not be itself amalgamated with mercury) while the electrolytic process is going on—that is to say, while the metal is being deposited in the moving mercurial cathode. The mercury and the metal thus combined form an amalgam which flows or moves away while still forming a part of the cathode and while still subjected to the action of the electric current into a separate chamber or reservoir, from which the said amalgam may be removed continuously or from time to time, to be treated for the separation of the metal, or metal and hydrogen from the mercury, which can then be used again and again indefinitely as the flowing or moving cathode. The hydrate of the metal formed and held in solution in the decomposition chamber or cell can also be continuously or periodically removed along with the hydrogen gas given off. By this means the metal is removed continuously from the surface of the cathode, and the resistance set up by the gaseous hydrogen and the above-mentioned counter electromotive force of the metal are so much reduced that the power required to effect the decomposition and to overcome the said resistance and counter electromotive force is so materially reduced as compared with what is required in the ordinary arrangements above referred to, that the application of the electrolytic process is not only made possible, but can be made to produce highly economical results.

The apparatus for utilising the above described flowing or moving cathode may be varied according to circumstances. One arrangement that we have found suitable and convenient is shown in the accompanying sheet of drawings, in which Fig. 1 is a vertical section of the electrolytic apparatus, Fig. 2 a plan of same, Fig. 3 a section taken on line 1—1 of Fig. 1 and Figs. 4 and 5 views of modified arrangements. A vertical cylinder of metal A, preferably amalgamated on its internal surface with mercury in the usual way, is provided at its lower end with an outlet passage B, governed by a stop cock or valve or provided with a syphon $B^1$ which com-



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municates with a suitable vessel or reservoir, not shown in the drawings, to receive the mercury and amalgam as above described. The upper end of the said cylinder is shaped as a funnel or hopper C, and has inserted into it the lower end of a second cylinder D. A narrow annular space is left between the outside of the inner cylinder D and the inside of the outer one A, so that when mercury is allowed to run from an overhead tank through the pipe E into the said funnel or hopper it finds it way through the annular space and coming in contact with the amalgamated surface of the outer cylinder A, flows comparatively slowly down over the said amalgamated surface and through the aforesaid outlet passage B to the receiving vessel or reservoir. The aforesaid vertical metallic cylinder A forms a stationary cathode chamber, connected by a conductor $A^1$ with a dynamo or other suitable source of electricity. This cathode chamber contains a suitable solution, such as that of sodium chloride for example. In the centre of this cathode cylinder is inserted or suspended an anode

Fig. 1.

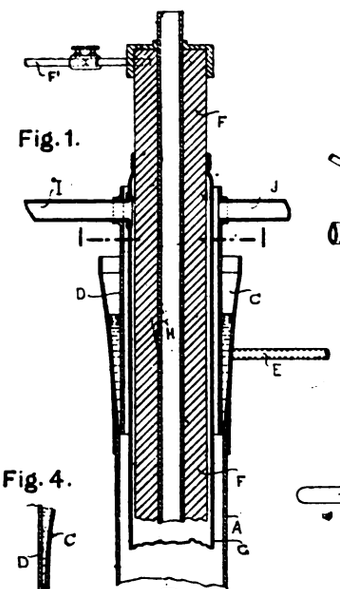



Fig. 2.

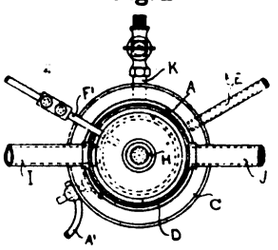



Fig. 3.

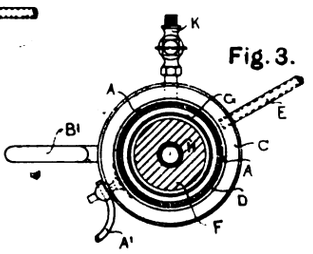
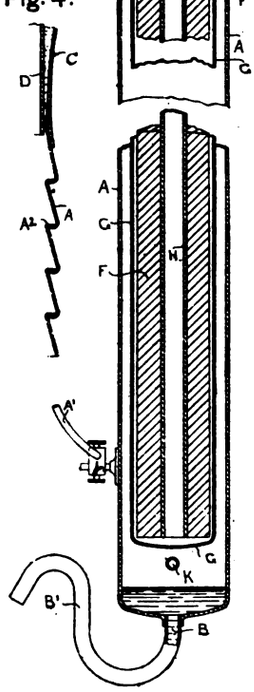



Fig. 4.



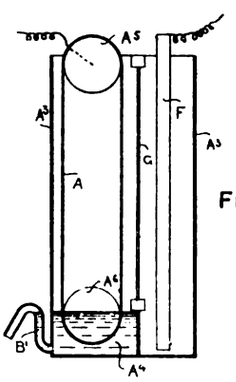




Fig. 5.

pole F of carbon, for example, surrounded by a hose pipe G, such as that used for fire hose, made of closely woven hemp or other textile material preferably closed at the lower end. This hose pipe G of textile material is preferably treated with silicate of soda in order to preserve it, more or less, from the rotting action of the solution. The carbon or other suitable anode F is placed in the said hose pipe G, and is connected by a conductor $F^1$ with the dynamo or other suitable source of electricity. The anode may consist of a hollow stem or pipe H having rings of carbon threaded thereon, or being otherwise surrounded with the carbon F. The material to be decomposed, chloride of sodium solution for example, is passed through this pipe H to the bottom of the hose pipe G, and while gradually rising to the top thereof round the external surface of the anode F, is subjected to electrolytic action, the bulk of the sodium passing through the sides of the hose pipe to the cathode A, and the solution, more or less deprived of its sodium, overflows at the pipe I near the top of the hose pipe G and passes off, together with the liberated chlorine gas, either to waste or to be utilised for any purpose to which the said solution or gas may be applicable; for example, the solution may, after being strengthened, be again used in the electrolytic apparatus. The solution in the cathode cylinder A external to the hose pipe G gradually becomes charged with sodium hydrate, and may be withdrawn continuously or periodically, along with the liberated hydrogen gas by the pipe J from the top of the cathode cylinder, water being admitted through the pipe K at the opposite end of the cathode cylinder to take the place of the sodium hydrate solution drawn off.

To facilitate the collection and removal of chlorine and hydrogen gases from the cathode and anode chambers respectively, these may be furnished with covers provided with outlet pipes leading to suitable chambers or gas holders. We sometimes separate the cathode from the anode by means of ordinary porous material instead of the woven hose pipe above described, and when such porous separating material is of such depth that it is not practicable to make it in one piece, it may be made of several separate lengths placed one on the other and jointed together by indiarubber bands placed over the joints or otherwise. In order to retard the descent of the mercury over the surface of the cathode A and to assist in maintaining the latter in a constantly amalgamated condition, the said cathode may be made with horizontal corrugations, as shown in Fig. 4 for example, each corrugation $A^2$ forming a gutter or ledge containing a small portion of mercury, which is gradually washed down by the mercury trickling over the edge of each gutter. The time of descent of the mercury and amalgam from the top to the bottom of the cathode is by this means considerably prolonged.

It will be understood that the cathode chamber A may be of rectangular or other suitable shape instead of round as shown in Figs. 2 and 3, and that instead of being placed in a vertical position the apparatus may be inclined at any desired angle, and instead of the mercury being supplied at the upper end of the cathode and caused to flow by its gravity over the acting surface thereof, the cathode itself may be moved by any suitable mechanical means so as to cause a film or lamina of mercury to move with it, as for example, in the arrangements shown diagrammatically in Fig. 5, in which $A^3$ represents an electrolytic cell constructed of any suitable material and having at bottom a tank containing mercury $A^4$. This tank may be provided with a syphon $B^1$ for removing the mercury and amalgam, as in the apparatus shown in Fig. 1. F is the anode pole and G a porous partition. The cathode A consists of an endless band of sheet copper for instance, which passes over the roller $A^5$ and under the roller $A^6$, the lower part of the said band or sheet of copper being immersed in the mercury $A^4$. Rotary motion being imparted to the roller $A^5$, the band A, the surface of which is amalgamated, is caused to pass through the said mercury $A^4$ and a thin film or lamina thereof is carried up by the band and receives the metal and hydrogen in the same manner as the flowing mercury in Fig. 1. Any suitable arrangement of scraper or brush may be employed to remove superfluous mercury or amalgam from the band as the latter moves. The said band A may be corrugated as illustrated in Fig. 4, and the electric connection thereof with the dynamo or other source of electricity may be effected by a contact brush or any other suitable means.

The above arrangement of apparatus are mentioned merely by way of example; it is obvious that any arrangements of apparatus which will allow of the use of a flowing or moving mercurial cathode may be employed.

We declare that what we claim is:—

First—The improved means for separating alkaline and earthy metals, and other products from the salts of such metals, or from other substances containing them, which consist in subjecting a solution of such salt or other substance to electrolysis in electrolytic apparatus, the cathode pole of which is composed more or less of a flowing or moving surface or body of mercury, substantially as hereinbefore described.

Second—In electrolytic apparatus for separating alkaline and earthy metals, and other products from the salts of such metals, or from other substances containing them, the method of employing mercury at the cathode pole of such apparatus, which consists in causing the mercury to flow or move over, on, or with the surface of the cathode pole, substantially as hereinbefore described.

Third—In electrolytic apparatus for separating alkaline and earthy metals, and other products from the salts of such metals or from other substances containing them, constructing the cathode pole with means for causing a thin stream or lamina of mercury to flow or move over, on, or with, the acting surface of the said cathode pole, substantially as hereinbefore described and illustrated in the drawings.

## Crow v. Whitechapel Board of Works.

The reserved judgment was delivered in this action on Friday last in the King's Bench, the Court comprising Justices Grantham, Kennedy and Darling. The case has been fully reported in *The Electrician*.

### JUDGMENT.

Mr. JUSTICE GRANTHAM, in the course of his judgment, said he thought the magistrate had come to a proper decision on the matter. The question was whether the London Building Act of 1894 revoked or altered by the construction of general words the Electric Lighting Acts of 1882 and 1888? Was the language of the former act where it directed that notice should be given to the district surveyor before commencing work inconsistent with the powers given to the appellants by the Electric Lighting Acts, 1882 and 1888, and the provisional order of 1892 for the supply of electricity to their district? In his lordship's judgment it was not. It was true the appellants had power given them to provide electricity for their district, and that they were obliged to lay the scheme they proposed to adopt, and the plans by which they proposed to give effect to it, before the Postmaster-General and the County Council, but neither one body nor the other was bound to see how the work was done. The necessity of the sanction of the Postmaster-General was for the purpose of enabling him to see that the interests of the Post Office were not prejudiced, and not in any way to provide for supervision of the work done. In the same way the notice to the London County Council as the

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superior municipal authority was desirable, if not necessary, in order that the Council might be cognisant of what was going to be done. Not one of these notices, however, had reference to any control of the way in which the work was to be done, or as to the compulsory suspension of the work during its construction, but sec. 145 of the London Building Act, 1894, required such a notice to be given to the district surveyor as would enable him to know when the work was to be commenced, and the details of the proposed work so that he could survey the work when commenced and see that the details were carried out in conformity with any bye-laws that might have been passed in reference to such buildings. He did not see how it could be said that it was inconsistent with the or contradictory to the general provisions of the Electric Lighting Acts, under which the appellants obtained their authority to provide the electricity for their district. For these reasons his judgment must be for the respondent.

Mr. Justice KENNEDY concurred and Mr. Justice GRANTHAM added that although Mr. Justice Darling did not see his way to agree with the judgment of the Court he was at the same time unwilling to differ.

The appeal was accordingly dismissed with costs.

## Brush Electrical Engineering Co. v. The Governor of Malta.

The matter of an arbitration between the Brush Company and the Governor of Malta was heard in the King's Bench by Justices Kennedy and Phillimore, on Friday last, as a special case.

Following the special case, it appeared that, differences having arisen between the Brush Company and the Governor of Malta in respect of claims made against the latter under a contract of March 22, 1895, the matter was referred to Mr. E. Manville, under the arbitration clause in the contract. The claimants undertook to execute certain works for the supply of electric current in Malta, and Sir William Preece acted as consulting engineer. From time to time certificates were given by him and payments made for work done. On November 20, 1897, the consulting engineer gave claimants two final certificates, the first certifying the sum due to claimants, being the final balance less one-fifth the total amount of the contract price deducted therefrom, and the second certifying that the whole of the works had been completed, and had worked satifactorily for six months from completion, the other obligations of the claimants had been duly performed, and that the above-mentioned one-fifth of the total amount of the contract price was then due to claimants. In ascertaining the amounts so certified the consulting engineer deducted from the total price of the work as determined by him, £450 as damages for two delays under the contract. The Governor of Malta had offered to pay the total amount certified by the engineer less £1,100 (in addition to the £450 already deducted) which he claimed to be entitled to set off as liquidated damages for delay. In June last year the parties appeared before the arbitrator, when the claimants proposed to give evidence in support of their claim for the total amount of the invoices sent by them to the engineer less certain deductions which they had allowed. In particular they proposed to give evidence to show that the engineer had not correctly estimated the value of additions and deductions in accordance with the contract. The respondent contended that such evidence was not admissible. On his part the respondent proposed to give evidence to show that he was entitled to deduct the £1,100 as liquidated damages for delay, as provided under the contract. The claimants contended that such evidence was not admissable. The questions of law for the opinion of the Court were:—

1. Whether the engineer's certificate was a condition precedent to the claimants' right to recover under the contract.
2. Whether the engineer's certificate was binding and conclusive between the parties with regard to the points raised in the statement.
3. Whether the engineer's certificate was binding and conclusive between the parties with regard to the amount due to the claimants apart from the question of damages for delay.

Mr. Carver, K.C., Mr. Llewelyn Davies and Mr. Trevor Bigham appeared for the Brush Company, and Mr. Pickford, K.C., and Mr. J. Eldon Bankes, K.C., for respondent, the arguments being of considerable duration.

The Court reserved judgment.

## London County Council v. Metropolitan Electric Suppy Co.

An appeal action was heard before Lords Justices Collins and Stirling yesterday in which the defendant company appealed from an order of Mr. Justice Farwell, made on April 25 (fully reported in our issue of April 26). It will be seen that the question raised in the appeal was the interpretation of a section of the London County Council (Improvements) Act (1899), under which the Sardinia-street electricity station premises, owned by the company, were requisitioned by the Council for the purposes of a new thoroughfare from Holborn to the Strand. On the question in dispute between the parties Mr. Justice Farwell gave judgment for the Council.

At the conclusion of the arguments,

Lord Justice COLLINS, in giving judgment, said that it was obvious that, in order to ascertain what sum was to be paid by the County Council, they must have a decision by competent persons on questions of fact. It was substantially agreed that the matter must go to an arbitrator as to some part of the matters in dispute, and it had been thought desirable to anticipate the arbitration by taking the opinion of the learned judge as to the construction of a point of law arising upon the section in question. The short point of law which the learned judge had to decide was whether as a matter of law the arbitrator was to be debarred from allowing and therefore calling upon the defendants to pay for anything more than for such engines which could fairly be graded up to 4,000kw. It seemed to him that if he were sitting as a judge bound to disengage the question of law from that of fact he should come to the conclusion that on the section in question the proper direction would be that the sum to be paid would be for such plant as would be required to generate for a reasonable period under all conditions such as might reasonably be anticipated an energy of not less than 4,000kw. Dealing simply with the matter as a judge directing a jury, he could not lay down as a matter of law that nothing more than four machines of a capacity of 1,000kw. would be required to accomplish that purpose, nor, on the other hand, could he lay down that anything more would be required. That would be for experts to determine, and if they said that four such engines were not competent in an ordinary commercial sense to carry out the obligation imposed upon the plaintiffs of continually supplying an output of 4,000kw., then the County Council must find the money and pay for anything more that was required. He thought the appeal should be allowed.

Lord Justice STIRLING concurred.

## Hawkes v. the Leyton Urban District Council.

This case came before the Court of Appeal, composed of Lords Justices Collins and Stirling, on Monday, on the appeal of defendant Council against an order of Mr. Justice Buckley, made on April 30, that a writ of sequestration should be issued against them for disobeying the injunction granted in April last year restraining defendants from carrying on their works in connection with electric lighting in such a way as to cause a nuisance by noise and vibration. On two occasions the operation of the injunction was suspended on undertakings given by the Council, on whose behalf it was stated they were erecting steam plant which would be no nuisance. Upon appeal this Court confirmed the order of the Court below, but limited the injunction to noise and vibration by the use of gas engines. The steam plant had since been brought into operation, and it was represented that the gas engines were now only worked for certain hours a day as auxiliary to the steam plant. Plaintiff contended that the Council had broken their undertaking and disobeyed the injunction, and applied for the writ of sequestration, which Mr. Justice Buckley granted on the ground that the defendants had deliberately and wilfully disobeyed the order of the Court. The case has been fully reported in *The Electrician*.

At the conclusion of the arguments of counsel, their Lordships held that there had been a clear breach of the injunction by the defendants, and the writ must go, but it could lie in the office for one week to enable the defendants to apply to Mr. Justice Buckley for any indulgence they might require.

## British Motor Traction Co (Ltd.) v. Sherrin.

This case came before Mr. Justice Kekewich in the Chancery Division on Wednesday to restrain defendant from infringing letters patent No. 16,072 of 1893, granted to Wilhelm Maybach for an invention of "Improvements in the method of producing the explosive mixture in hydro-carbon engines," of patent No. 19,734 of 1895, granted to Count Albert de Dion and Charles Bonton for an invention of "Improved means or apparatus for electrically igniting and governing petroleum and other like motors," and a patent, No. 13,671 of 1899, granted to the British Motor Co. and Chas. Jarratt for an invention of "Improvements in or relating to motor vehicles." The plaintiffs are registered owners of these patents, and complained that defendant had imported and sold in this country motor cars in infringement. Defendant did not deny the infringement, but disputed the validity of plaintiffs' patents on the grounds of want of novelty, no good subject matter, anticipation, &c.

Mr. Justice Kekewich, in the result, granted an injunction in respect of all three patents, and also a certificate of validity in respect of all of them.

## Birnbaum v. Simon, Berry & Co.—Trade Custom.

A case was heard in the Lord Mayor's Court (London), on Friday last, before the Recorder and a jury, in which the plaintiff, Mr. Isadore Birnbaum, telephone manufacturer, trading as the Berliner Telephone Co., sued defendants, a firm of dealers, to recover £14. 13s. 8d. for telephones supplied. Plaintiff said on Jan. 24 last he called upon the defendant Simon with sample telephone instruments, and, after inspecting, Simon ordered duplicate sets of the instruments to be sent to each of their branch establishments. There were seven instruments to each set. As a condition for further business to follow, he placed defendants on his best factors' terms of 20 per cent. There was no mention made at the time that the goods were to be sent on approval, or that they were to be sent on the terms of sale or return. He (plaintiff) had never sent out a single instrument on sale or return. The telephones were delivered on the same afternoon, together with ordinary invoices, and no exception was taken by defendants to the form of the invoice. He subsequently received a letter from defendants stating that for goods supplied, say in January, payment was made between March 4 and 10, and that if these terms did not agree with his (plaintiff's) the samples would be returned forthwith. On Feb. 26 the telephones were returned. Up to that moment it had never been suggested that the instruments had been supplied on sale or return.

Mr. V. HOLT, traveller for plaintiff, said he had been in the telephone trade seven or eight years, and had never heard of telephones being supplied on sale or return.

Mr. P. F. SIMON said plaintiff frequently called upon his firm for orders for telephones, but they had had no demand for them. On January 24 plaintiff called, and he told him that they did no business in telephones, but were open to do business in any line. If plaintiff cared to send triplicate samples to each of their respective branches he might do so. There was no mention as to terms, as it was not necessary. It was the custom with a great many manufacturers to send samples for them to submit to their branches to see if any business could be done. If, after the samples had been out six or eight months, no good result was proved, then the samples were returned, and they were credited for the value. That was the arrangement he understood was made in the present case. When goods were ordered by the firm the orders were generally entered into an



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order book. The goods now sued for were not entered in that book. Telephones were generally ordered in pairs, but the telephones sent by plaintiff were single instruments.

Mr. MOSSOPP (Messrs. W. Mossopp & Co.), for defendant, said his firm dealt in telephones. It was the custom in the trade to receive sample instruments which were returnable, particularly so in the case of single instruments, which could not be of any use except as a sample.

Mr. PLATO, electric bell and telephone manufacturer, said the custom according to his experience in dealing with wholesale houses was to return samples if the firm was not in a position to deal any further with them.

The RECORDER said defendants, in order to establish a custom, must prove an immemorial condition of things and a usage extending over a period of time which was reasonable. It was for the jury to say whether defendants had proved any such custom as they sought to make out. If defendants had proved a universal and reasonable custom which could be grafted on to the contract so as to justify them in not making any payment, then they were entitled to succeed in the action. If they had not succeeded in doing that, there must be a verdict for plaintiff.

The jury found for the plaintiff for the full amount claimed and costs.

### Re British Electrozone Corporation (Ltd).

Mr. Justice Wright, on Wednesday, allowed the petition recently presented for the winding-up of this company to be withdrawn.

## PARLIAMENTARY INTELLIGENCE.

(*Concluded from page 102.*)

### MOND GAS BILL.

On Friday last the Select Committee of the House of Commons of which Lord Welby is chairman further considered this bill.

Mr. ORFORD SMITH, town clerk of Birmingham, explained that though the company did not propose to supply in the City of Birmingham they did propose to cover districts such as Handsworth and Perry Bar, which were within the Corporation's area of supply for gas purposes. The Corporation viewed the proposals as essentially in the nature of an experiment and therefore held that they should not be extended over so large an area as 135 sq. miles. It was very hard that the Corporation, having purchased the statutory rights to supply gas in the outside areas referred to, should have this competing scheme brought in until it had been proved that Mond gas could be distributed. Their streets had been broken up on a former occasion by a compressed air company who, after they had laid their mains, found themselves unable to supply. If the bill were passed it would be granting Mond gas virtually a monopoly, because there could not be a perpetual introduction of new schemes involving the laying of fresh pipes over the district. His chief objection to the gas was on the ground of competition with existing supply.

Mr. DUGALD CLERK said so far as he knew no scheme which attempted to distribute so weak a gas as Mond gas for power purposes could succeed in practice. Mond gas was suitable for use in works where there were skilled men in attendance, but not for general distribution over a large area; and from a commercial point of view the gas would not be advantageous, 2d. per 1,000ft. being much more than a manufacturer could afford to pay for it.

Mr. CORBET WOODALL, gas engineer, said Mond gas, though suitable for use in works was not suitable for distribution. He adversely criticised the estimates and pointed out that nothing was allowed for storage plant, which would certainly be required. With regard to the Northwich electric station, which is supplied with Mond gas from Messrs. Brunner, Mond & Co.'s works, he said, in that instance, the make of the gas being enormous, it appeared to him that the works might be regulated much more easily than the supply from a factory to a large area with a considerable body of consumers. If the company dispensed with gasholders they must have such enormous plant to deal with the output that the load factor would be very bad.

On Tuesday, Mr. WEDDERBURN addressed the Committee on behalf of the Corporation of Walsall, who supply gas within the Walsall district, and electricity within the borough. The chief trade of the town was the saddlery business, which did not require large power and for which Mond gas was absolutely unsuited. There were few large manufactories of any kind likely to take it. Counsel also emphasised the point that the Corporation strenuously opposed the bill on the ground that they wished to retain their present control of the streets. They had spent £50,000 on an electrical installation, which was just developing, and a question would arise as to how far the Committee, by passing the bill, would check that enterprise. They intended to supply electric current at 1¾d. per unit for power. Walsall was on the edge of the proposed area of the company, and therefore could easily be lopped off without detriment to the remainder.

Mr. ALEXANDER WYLLIE, electrical engineer to the Corporation of Walsall, said that at present the Corporation had about 13 miles of electric mains in the borough, part in connection with the tramway undertaking. At the generating station they had five generators and machinery of nearly 1,000 I.H.P. The generators were driven by steam. A discussion occurred with regard to the use of producer gas owing to the high price of coal last year, and in consequence he investigated the use of Mond gas by the Northwich Electric Company. Having made a careful comparison as to the economy resulting from the use of Mond gas and ordinary fuel, he came to the conclusion that no advantage would result to the Corporation from the use of Mond gas.

Do you know of any supply works of any substantial size that work by gas power?—Not of substantial size. Up to 300 H.P. or 400 H.P. producer gas may be used advantageously in an electricity station.

Are you familiar with the experiment tried at Leyton?—I know an experiment was tried, and I know they decided to add steam plant to their works. For some reason gas was not found satisfactory for the larger output.

Do you think there is any probability of steam engines being replaced by gas engines or an engine burning Mond gas?—Where large power is used, if steam engines are anything like economical, manufacturers would be very reluctant to replace them by gas engines.

What do you say comparing them with electric motors?—For the economical distribution of power in large works such as those referred to by the promoters, I am strongly of opinion that an electric distribution is the one that will prove most economical.

How would the cost of electric motors compare with the cost of Mond gas?—For very small powers electric motors are found most economical in our district. Most of the manufacturers are in a small way, being saddlery manufacturers or manufacturers of bits and buckles and so forth. At the end of 1899 we decided to adopt a moderately low rate for motors and have been fairly successful. We charge on the maximum demand system, the average coming out at something under 1¾d. per unit. That is found to be very economical for small powers, although we do supply works which require 20 H.P. He hoped to reduce the 1¾d. average when the tramway system used more current to improve the load factor. It would be unfortunate if competition prevented them from getting some of the larger consumers.

By Mr. WALLACE: The price at which you supply your motor power is 1¾d. per unit. That is equivalent to £47 per H.P. per annum working continuously?—Yes.

Have you calculated what Mond gas costs working continuously?—Certainly; and I am quite aware how unsafe such calculations are compared with the results of actual work.

How much does Mond gas work out to—£4. 7s. 7d.?—Yes; but for perfectly continuous work, which is unknown in practice.

Lord ROBERT CECIL, K.C., on behalf of the Borough of Smethwick, submitted that the establishment of the Mond gas scheme would considerably injure Smethwick, and that there was no public advantage arising from the scheme to justify that injury. Smethwick had many important works, but no one connected with any of its industries had been called to say he was desirous of taking this gas. Having regard to the large expense of distribution, rates and taxes, and other charges, which the company, if they supplied, would have to bear, but which, if manufacturers supplied themselves would be avoided, private manufacturers would be able to supply themselves, if they desired Mond gas, at a cheaper rate than a company from a central distributing station.

Mr. E. ELLINGTON, C.E., chief engineer to the London Hydraulic Power Co., said he had come to the conclusion that power supply alone in manufacturing centres could not be commercially successful. With regard to the bill, he thought large consumers of Mond gas could not be supplied for central stations at a sufficiently low rate to compete with the manufacturers themselves if they chose to produce the gas, and that the small consumers would not warrant the capital expenditure proposed.

Evidence was then given on behalf of the Oldbury District Council, and subsequently on the petition of the West Bromwich Corporation, who own electricity works just established under a provisional order of 1898, and whose supply would commence in a few days for both power and lighting purposes.

Yesterday, in support of the opposition of West Bromwich, Mr. W. O. Y. WEBBER, C.E., chief of the editorial staff of the *Journal of Gas Lighting*, examined by Mr. RAM, K.C., said he had had 30 years' experience in gas manufacture, and had studied the distribution and utilisation of gas for all purposes. In his opinion any competition with existing gas undertakings would be contrary to the whole practice of Parliament for the last 50 years, and such competition as was now threatened would be most outrageous. The company proposed to enter a district and sell nobody knew what, in a way which had never been tried, and for a price which seemed to be exceedingly doubtful. Every customer which the Mond Gas Company obtained he should regard as a customer lost to the gas undertakings. The introduction of the scheme would be a tremendous bar to expansion by the existing concerns, and he thought the local authorities and gas companies would be justified in reducing their price to any point in order to fight the competition. He saw no attractiveness in a proposal, speaking with regard to manufacturers, under which they would pay 2d. per 1,000 for gas which they could make themselves for ¾d. There would be very grave insecurity to the public if this gas were ever allowed to be supplied except under the most stringent penalty clauses enacting that the gas should be constantly supplied under pressure.

Is that owing to the fact that you fear a vacuum may be created in the street mains which would suck back air into the pipes?—Yes; without some such guarantee as that, if there were ever to be a negative pressure in these pipes the risk of a terrible gas main explosion would be very real.

Mr. RAM, for West Bromwich, submitted that the Committee were asked to deal with an experimental matter as to which they had no actual evidence of practical working in any other than Messrs. Brunner, Mond & Co.'s works; and that the cost of distribution would prevent all probability of its being supplied at a price at which consumers could take it with advantage. Even if it could be supplied at a cost which would make it worth the while of the manufacturer to take it, it would not do the work which he could now do with steam. Further, he pointed out that the promoters by taking power to supply producer gas, could supply any kind of such gas, besides the Mond, although it might be dangerous, and one which, if brought directly before the Committee, would not be sanctioned. He also objected to the scheme on the ground that to the extent to which it supplied power to small consumers, it would directly compete with West Bromwich gas.

Prof. VIVIAN B. LEWES, chief superintending gas examiner to the

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Corporation of the City of London, on behalf of several opposing gas companies, said his view was that Mond gas could be economically used in works where it was produced, but it did not lend itself to distribution at a distance. The great drawback to Mond gas was its low calorific power.

The Committee then adjourned till to-day (Friday).

## THE CALEDONIAN AND CLYDE VALLEY ELECTRIC POWER BILLS.

On Friday last the Committee of the House of Commons continued the consideration of the two competing bills promoted by the Caledonian and the Clyde Valley Power Companies, Sir James Woodhouse presiding.

Mr. G. STRAIN, C.E. (Messrs. Strain and Robertson), said his firm were, with Sir W. Preece and Major Cardew, engineers for the Clyde Valley scheme. He was chairman of John Watsons (Ltd.) and the Lanarkshire Steel Co. (Ltd.), both of which used electricity for power. He was representing their views when he said that they were in favour of the scheme and would be willing to abandon their own generating plant and take power from the Clyde Valley Co., as they believed the saving in expense would be great. It would, in his opinion, be disastrous for the boroughs within the area of the scheme to attempt to supply all the works as the original outlay would be so large, and to exclude those boroughs from the scheme would seriously hamper trade.

Mr. J. FULLARTON, of Paisley, said he was against Paisley going any further into electrical supply as the supply there set up was not a success. There was recently a plebiscite as to whether they should have the working of the tramways or not, and the veto of the public was against the Corporation by nearly two to one. They had spent £96,000 on their present electric installation, while the original estimate was only £3,500, and in witness's opinion the electric lighting supply would be better done by a private company.

Mr. J. CAMERON, convener of the Electricity committee of the borough of Greenock, said he was in favour of the Corporation being left to provide electric power within the borough. The people were, he believed, satisfied with the service given by the Corporation. Their present installation was certainly not sufficient to provide power to all the shipbuilding yards at Grennock and Port Glasgow, as to do that it would be necessary to expend more capital upon the generating station and the plant. Greenock was the first borough in Scotland to apply for a provisional order to supply electricity.

Mr. W. M. NELSON, electrical engineer to the Greenock Corporation, gave details of the capacity of the works.

Mr. C. F. PARKINSON, manager of the Paisley Corporation Electricity Works, said that Corporation last year supplied 193,000 units for public and 117,000 for private lighting at from 1½d. to 2½d. per unit, according to the quantity taken by the consumer. They had undertaken to supply the tramways with power at 1½d. per unit. £80,000 was spent on the original installation, and they were obtaining powers to borrow a further £25,000 for extensions. The Corporation suffered a loss of £4,000 on last years' working, including interest on sinking fund. They attributed their loss to the small number of consumers.

Mr. A. FISHER, convener of the Electric Lighting committee of the Paisley Town Council, considered the statement made that the Corporation was unable to carry out its undertaking with regard to the supply of electricity was wholly groundless.

Provost TEMPLETON, Ayr, said electrical tramways were in course of construction there, and power would be taken from the Corporation's mains. To meet the extra demand it would be necessary to expend a further £25,000 on extending the works. Up to last year £50,000 had been spent on the installation.

Provost WOOD, Partick, said the cost of the installation there was £50,000. When that Corporation began to supply electricity they did not dream of any other authority being allowed to come in. They did not wish to make a profit out of the supply but only to clear expenses.

Provost MACKAY, Kilmarnock, said his Council considered they were as well able to supply electric power as any company, and were unanimous in opposing the Caledonian Company's scheme.

Mr. W. A. BRYSON, consulting engineer to the Kilmarnock Corporation, said the cost of the new works would be £30,000. The installation would provide 600 H.P., and he had made preparations for putting down of more plant. In his opinion no company could supply energy better or more cheaply than the Corporation.

Evidence was then given on behalf of the Corporations of Gourock, Motherwell, Dumbarton and Port Glasgow against private companies being allowed to come in and supply power within these boroughs.

Sir CHARLES KENYON, M.P., said in his opinion the supply of electrical power would do much to develop the shipbuilding trade on the Clyde as well as the chief manufactories there, and he expressed a preference for the Clyde Valley area supply as compared with that of the Caledonian Company.

Bailie J. SHEARER (Messrs. John Shearer & Sons, shipbuilders, Glasgow) said his firm were about to erect a new shipbuilding yard of 1,500 H.P. to 2,000 H.P., and hoped to get electrical power from the Clyde Valley Company.

On behalf of the borough of Hamilton, Mr. MEACHAM, convener of the Electric committee, explained the difficulties the borough had had with regard to the carrying out of its provisional order obtained in 1898. It was now considering a large scheme both for power and light, and the order would be proceeded with as soon as it was sanctioned. He made that the ground for refusing power to a company to come into the borough.

Mr. R. W. HOGARTH, consulting electrical engineer for the Hamilton scheme, corroborated that evidence.

Mr. DAVID MARTIN, provost of Airdrie, explained the arrangement come to by the Airdrie Corporation with the Scottish House-to-House Electricity Co., by which that company was to supply current for power and light, and the Corporation was to have the right of purchase within a certain number of years. The appearance of one of these supply companies in the borough would impair the reversionary interest of the Corporation in the undertaking, and they opposed the bills.

Mr. CHARLES PRATT SPARKS, consulting electrical engineer to the Scottish House-to-House Company, explained to the Committee what the company proposed doing under the arrangement with Airdrie.

On behalf of several of the petitioning boroughs, Mr. ROBERT HAMMOND and Mr. E. MANVILLE gave evidence. The former claimed that the borough should have the right to carry on its work if prepared to undertake it, and Mr. Manville corroborated this view.

Yesterday, Mr. W. M. MORDEY expressed the view that no public advantage would accrue to Govan by the admission of one of these companies. On the contrary, he thought the people of Govan would suffer loss. Govan had been particularly enterprising in providing for its local electrical needs, and he thought that any investment of further capital would simply mean that there would be a greater expenditure in supplying the borough, and the public would ultimately have to pay a higher price for current. If the existing system was sufficient, or could be made sufficient, he thought it would best meet the local requirements. Owing to the excellence of arrangements and of the plant, the Council produced electricity at a very low cost, a cost, in fact, hardly reached by any of the large installations elsewhere.

This closed the evidence.

Mr. ERSKINE POLLOCK, K.C., addressed the Committee for the associated burghs of Motherwell, Paisley, Gourock, Greenock, Kilmarnock, Partick and Ayr, and for the burgh of Govan. He dealt with the main principle—the compulsory admission into the local areas of the promoters of these competing schemes, and recalled the legislation of last session. This, he said, consisted of three acts—the Durham, the Lancashire, and the South Wales Acts.

The CHAIRMAN said the situation seemed to be that Parliament had really set no precedent, but had left it to each Committee to consider, according to the special circumstances put before it, what should be done in order to meet the justice between parties. If these Acts of Parliament meant anything it was quite clear Parliament had not said that the smallest place should or should not be excluded from the area of supply of a power company; it had laid down no particular rule or principle by which any particular Committee was to be guided.

Mr. POLLOCK said it was idle to suppose that the boroughs of Scotland would rush into wilful and wanton expenditure, and if the commercial interests of the country were to be considered, it was evident that the boroughs should have the power to supply rather than private companies, because the former could, when they had paid off their borrowed money, supply current at a cheaper rate than a company, because the latter had their dividends to look to. The boroughs desired to preserve their independence.

Mr. FITZGERALD, K.C, and Mr. BLENNERHASSETT, having addressed the Committee, further consideration of these bills was adjourned until to-day (Friday).

## LONDON COUNTY COUNCIL TRAMWAYS, &c., BILL.

The Committee of the House of Commons, presided over by Mr. Seale Hayne, on Tuesday commenced the consideration of this bill.

Petitioners against the bill included the South Eastern and Chatham Railway Co., the London and South Western Railway Co., the Great Northern Railway Co., the Holborn local authority, and others.

Mr. FREEMAN, K.C., for the bill, said it was to enable the London County Council to make certain new tramways, to reconstruct and alter existing lines, to work the tramways by electricity, and to make certain street improvements. The Council at present owned about 60 or 70 miles of tramways, and were electrically working about 24 miles. They were about to equip a much larger portion. The difficulty had arisen that the tramways as originally constructed were made to serve the purposes of the particular companies owning them, with the result that there was often a gap between two tramways. Last year a bill similar to the present one was introduced to provide for the coupling up and uniting of various tramways and extending them, and for operating the tramways electrically. Evidence on that bill, which dealt with the north of the Thames, was taken as to the best system to be adopted for working tramways in London, with the result that in the thickly-populated parts the Council were precluded from using the overhead electric system. There still remained the south of the Thames. The tramways they were proceeding to deal with on the north side were few, but those on the south were more important, and included one from Wandsworth to Tooting, and another from Camberwell Green to Forest Hill, with a branch line to Nunhead and Peckham Rye. The petitioners against the bill made the usual objections, but it would be for the Committee to decide between the private inconvenience alleged and the public necessity.

Sir A. BINNIE, chief engineer to the London County Council, said it was proposed to construct a tramway about half-a-mile in length along the Holloway-road, as far as the Archway Tavern, to form a connection with the authorised Middlesex Light Railway, at a cost of £9,200. An extension of the existing line along the Farringdon-road would be made to Charterhouse-street, and would cost £6,700. These tramways would be worked by electricity, and with the exception of that in the Archway-road, which would be operated on the overhead trolley system so as to coincide with the Middlesex system, would be worked on the conduit system. In regard to the south of the Thames, a tramway was proposed, some 3 miles in length from North-street, Wandsworth to join with the existing tramway at High-street, Tooting. The cost would be £375,250. Another line would be made from Camberwell Green along Denmark-hill to Forest-hill at a point close to the railway station, length about 3½ miles, and the cost

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£265,400. The bill also provided for numerous small junction lines, and the doubling of several single lines. The estimated cost of the tramway portion of the bill was £444,920, and that of the whole scheme £1,012,000.

By Mr. MOON (for the County of London Electric Lighting Co.): Where footpaths were set back by the Council, and electric mains had in consequence to be replaced, it would be only reasonable that the Council should pay the cost.

Yesterday, Mr. J. W. BENN, chairman of the Highways committee of the London County Council, said the Council had already purchased 74 miles of tramways in London, and about 35 miles remained to be purchased, the greater portion of which would fall in before 1903, and the whole before 1910. The profit made by the Council on the tramways last year amounted to £70,000, but the estimate for the coming year was about £50,000, owing to increasing expenses. The road authorities benefited from this profit by a corresponding decrease in the county rate.

Mr. ALFRED BAKER, manager of tramways to the London County Council, also gave evidence.

The Committee then adjourned till to-day (Friday).

## LEEDS CORPORATION BILL.

The consideration of a bill, introduced by the Leeds Corporation, was considered by Lord Dartrey's Select Committee of the House of Lords, the proceedings being concluded yesterday. Amongst other matters the bill proposed to make tramways and tramway extensions in the borough. To the tramway portion of the bill there was no opposition. The tramway proposals included a double line 2 miles in length on the Leeds-Harrogate route, and six short extensions.

Mr. T. HEWSON, city engineer, said about £60,000 would be expended on these new branches, which would all be worked by electricity. In a short time the working of the whole of the tramways by electricity throughout the city would be completed. The inhabitants were clamouring for these extensions of the electric tramways, and he fully anticipated that the Corporation would come to Parliament in a year or two for further powers.

Certain modifications in the bill in connection with other matters having been sanctioned, the preamble of the bill was declared approved, and the measure reported to the House for third reading.

## ELECTRIC LIGHTING PROVISIONAL ORDERS (No. 1) BILL.

In the House of Commons yesterday (Thursday) this bill was read a second time without discussion, an arrangement having been come to between the promoters (the Marylebone Borough Council) and the opponents of the measure (the Metropolitan Electric Supply Co.), under which the opposition was withdrawn. [We understand that the opposition on the part of the Metropolitan Co. to the above bill was withdrawn in consequence of arrangements having been come to between the Company and the Marylebone Borough Council under which the latter agree to purchase so much of the undertaking of the Company as lies within the Marylebone area and also agree not to compete with the Company.—ED. *E.*].

Presumably the application of the Marylebone Electric Supply Co. will not now be proceeded with.

## ELECTRICITY IN MINING.

In the House of Commons on Thursday last Mr. RITCHIE stated, in reply to Mr. Markham, that only two fatal accidents from electric shock in mines had occurred during the last 16 months. The question of the use of electricity in mines was, however, being carefully watched by the Home Office and the inspectors.

## TELEPHONE ROYALTIES.

Replying to Mr. H. Heaton in the House of Commons on Monday, Mr. HANBURY said the amount received for royalties from the National Telephone Co. by the Post Office for the year ended March 31, 1900, was £129,854, and this was included in the amount of gross telegraph receipts.

## MUNICIPAL TRADING.

In reply to a question by Mr. B. Cohen, Mr. BALFOUR stated in the House of Commons on Monday that he would welcome the reappointment of the Committee on Municipal Trading.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The National Physical Laboratory committee propose shortly to consider the appointment of a superintendent of engineering department, one or two assistants in the physics department, an assistant in the physics department, and also a small number of junior assistants. Applications to Mr. R. T. Glazebrook, Old Deer Park, Richmond, Surrey, by May 24.

A railway telegraph inspector is required for service on the Government railways of the Federated Malay States to supervise the upkeep of the open telegraph lines, erect new lines, &c. Salary $150 per mensem. Further particulars will be found on page xxiii., and inquiries regarding the appointment must be made to the consulting engineers for the Crown Agents (Messrs. Gregory, Eyles and Waring), 2, Delahay-street, London, S.W. Applications have to be in to the Crown Agents for the Colonies, Downing-street, London, by May 18.

Walthamstow Urban District Council invite applications for the post of electrical engineer, to take entire charge of the Council's electric generating and distributing works. Salary £300 per annum. An advertisement gives further particulars, and applications must be delivered to Mr. E. J. Gowen, clerk to the Council, Town Hall, Walthamstow, by 5 p.m. May 24.

South Shields Corporation invite applications for the position of electrical engineer to their electricity undertaking. Further particulars are set out in an advertisement, and applications must be sent to the town clerk (Mr. J. Moore Hayton) by 10 a.m. May 22.

Battersea (London) Borough Council require an assistant electrical engineer. Applications to the town clerk (Mr. W. Marcus Wilkins), Municipal-buildings, Lavender Hill, S.W., by noon May 17. See advertisement.

The British Electric Traction Co. require an engineer capable of laying out and arranging electric tramway systems. Applications to chief executive electrical engineer, Domington House, Norfolk-street, London, W.C. See advertisement.

The Jandus Arc Lamp Co., Hartham Works, Hartham-road, Holloway, N., require an engineer to take charge of testing room and technical work. See advertisement.

A shift engineer is required for the Sculcoates-lane generating station, Hull. Applications to city electrical engineer (Mr. A. S. Barnard). See advertisement.

Bedford Corporation require a shift engineer at their electricity works. Applications to the chief engineer (Mr. W. J. Hope-Johnstone) by 17th inst. See advertisement.

Bradford Corporation require two good jointers for their electricity department. Applications to city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. See advertisement.

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**Accrington.**—The charge for electric current for lighting is now 5d. per unit for the first 90 hours per quarter of consumer's registered maximum demand and 3d. per unit for all current over this; for power 4d. per unit for the first 80 hours and 1½d. after.

**Alfreton.**—Owing to local opposition the Board of Trade have refused the Council's application for a provisional electric lighting order.

**Bath.**—The accounts of the electricity department for the year and a-quarter ended March 25, give the income from public lighting at £3,431 and private lighting £7,470, which, with meter rental, &c., made a total revenue of £11,408. The expenditure was £7,419, gross profit £3,988. Interest on loans absorbed £2,577 and sinking fund £2,404—deficit, £993.

**Batley.**—Sanction to a loan of £52,451 for electric tramway construction has been obtained by the Corporation.

**Birmingham.**—The official inspection of the Bristol-road electric tramway route takes place to-day.

**Blackpool.**—The new electric tramway round Marton will be ready for traffic by Whitsuntide.

**Brighton.**—Last week the Council had before them a report from the consulting engineer (Mr. A. Wright) on a communication from Councillor Robinson asking to be informed:

(1). The net cost per unit of generating the electricity sold at 7d. per unit.

(2). The net cost per unit of all electricity sold at 1d.

(3). How many units it was necessary for the Corporation to sell at 7d. before the units sold at 1d. became profitable.

(4). Whether any further extraordinary expenditure had been or would be incurred in change of voltage or inspecting cables and making improved joints beyond the amounts debited to the reserve account for year ended Dec. 31 last.

(5). Whether the mains, machinery, &c., appeared in the last balance-sheet at net original cost, or whether and what allowances for depreciation had been made thereon beyond the proportion paid to loans fund for extinction of stock.

(6). What was the proportion of the total cost shown in last balance-sheet for repairing and maintaining the mains supplied and laid during and prior to the year 1894?

Mr. Wright stated that Councillor Robinson's first three questions were evidently based on a misapprehension of the principles which determined the cost of supplying electricity, and they could not be answered directly. An analysis of last year's accounts of the Brighton electricity undertaking, on the lines laid down by the late Dr. J. Hopkinson and Prof. Kennedy, proved that the cost of producing all the electricity sold was 0·6d. per unit, and that the annual cost of keeping all the plant and mains in a proper state of readiness to supply it was £9. 13s. 4d. per kilowatt demanded. After explaining the principles of the maximum demand system, Mr. Wright stated that the fact that about 500 consumers did not use their proportion of plant and mains 365 hours last year resulted in a loss being made on these to the extent of £1,855, which, with the loss caused by the low meter rentals, had to be made up by debiting those units consumed after 365 hours' use of the lamps with nearly 0·4d. Nearly 2,215,000 units had to be sold at 1d. before the loss on the early-closing consumers and low meter rentals was recouped. The answer to the question (4)

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was that the change of voltage had been completed, and that the shifting of the position of cables necessitated by the tramway work was also nearly finished, but whether the cost of the first of these items would be debited to reserve or to capital, as had been done in every other municipal undertaking in Great Britain, depended on the Council's decision. In replying to query (6) Mr. Wright stated that £28 was spent last year in replacing cable laid prior to and during 1894, and £418 was incurred in having to make fresh house service joints on the cables laid prior to and during that year.

The borough accountant (Mr. Stevens) also submitted a report with reference to question (5). He stated that on the balance-sheet of the electric light undertaking the buildings, machinery, mains, &c., appeared among the assets at their original cost, with the exception that a sum of £4,496. 17s. 9d. had been written off by way of special depreciation in respect of accumulators, meters, and engineer's commission. It was not possible to lay down a hard-and-fast rule. On the general question of the advisability or otherwise of providing a depreciation fund in connection with electric light stations, there was no definitely recognised custom. Depreciation funds in connection with gasworks and waterworks were extremely rare, and Mr. Stevens further stated that in instances known to him where such funds existed, they had to bear the whole cost of all repairs, and thus merely effected in another method the same end as was accomplished by annually charging direct to revenue accounts the expense of repairs and renewals. While the 25 years' sinking fund might be justly held to be sufficient for all purposes, it might yet be advisable in some cases to make a more ample provision in respect of such of the assets as had become disused or practically non-existent.

**Bury.**—There was an increase of 22½ per cent. in electric current sold and 20 per cent. in the receipts of the electricity department for the quarter ended March 31 compared with the corresponding period of last year.

**Christiana (Norway).**—The City Council have decided to considerably enlarge the present steam generating station and to equip an accumulator room at an estimated cost of £40,000.

**Darwen.**—There was a loss of £886 on the electric lighting department and of £604 on the tramways department last year. At the Council meeting on Tuesday, the chairman of the Electric Lighting committee (Ald. Lightbown) said it was evident their electric tramways were to cost them more than they had been advised they would.

**Dublin.**—A memorial by ratepayers protesting against the proposed expenditure on the Pigeon House electric lighting scheme has been presented to the Local Government Board, the Irish Board of Works, the Board of Trade, and the Treasury.

**Dumfries.**—A report by Mr. Ritchie (Messrs. Carrick and Ritchie) as to the practicability of utilising the water power on the Cairn at the Glen has been remitted to a committee. Mr. Ritchie thinks that 500 H.P. could be obtained, and that, while the initial cost would be much the same as for a steam installation, the subsequent expenses would be much lower.

**Edinburgh.**—On Tuesday the Electric Light committee adjusted their estimates of expenditure and revenue for the year ending May 15, 1902. The expenditure is put at £44,465, compared with £45,485 for the present year, and an actual expenditure of £32,810 in 1899-1900. The receipts for next year are estimated at £95,960, against £88,685 for the current year, and an actual income of £63,659 during 1899-1900. The capital expenditure is estimated at £78,250. From April 18 to May 2 applications had been received for current equivalent to 3,714 8 c.p. lamps, whereof 1,296 were for motive power.

**Electricity Meters in Spain.**—Regulations affecting the selling and letting out on hire of electricity meters have been formulated and are published in the *Madrid Gazette* of April 27.

**Electro-Medical Apparatus.**—Messrs. Drake and Gorham have recently supplied and fixed at the Manchester and Salford Skin Hospital a special motor transformer and other apparatus for use with the "Finsen" lamp, which is producing remarkable results in the cure of skin diseases. The lamp is similar to one presented by the Queen to the London Hospital.

**Gateshead.**—The new electric tramways were opened for traffic on Wednesday.

**Glasgow.**—H.R.H. Princess Louise, Duchess of Fife, on Friday last, on the occasion of a private visit to the Glasgow Exhibition, started on its initial run the huge printing machine which has been installed for the proprietors of the *Glasgow Herald* by Messrs. Hoe & Co. The machine is one of a very special type required in the production of large quantities of papers, at a rapid rate, and, consequently, may be regarded as the highest type of printing machine, so far as its requirements for speed, regular running and accurate adjustment are concerned. This machine has been fitted with a very complete electric motor driving equipment by the British Electric Plant Co. on the "Reducer" (Spence's patent) system. The apparatus comprises a 50 B.H.P. motor, capable of developing a turning effort at starting equivalent to 100 H.P., which drives the machine direct through a flexible coupling. At full speed the motor runs about 400 revs. per min., while during the preparation of the printing cylinders, "making ready," and leading in the paper to the cylinders from the reels, a speed not exceeding $\frac{1}{25}$th of this (16 revs.) is demanded. This requirement of a dead-slow speed is one of the most exacting in this class of machinery, and is met by the employment of a motor-generator transformer (the reducer) whose function is to reduce the pressure of supply from 500 volts, in this case, to a lower pressure corresponding to that of the slow speed. The transformer has a capacity of about 13 H.P., and at slow speed enables the press motor to turn with an effort equivalent to 100 H.P. at its normal full speed. The controller is of special design, and by motion of a hand-wheel all the necessary movements for starting, regulating and stopping the machine are performed. A reversing switch is provided to enable the motor to move the machine backwards when required. Owing to the high velocity and to the great mass of machinery in motion, the inertia at full speed is very large, and facilities for the prompt slowing of the machine are therefore of the greatest importance. For this purpose an electromagnetic brake is provided, which comes into action automatically whenever the current fails or is switched off, and, to further complete the effectiveness of control, a number of push-buttons are fixed at different positions on the machine, pressure on any one of which opens the cutout and applies the brake. The electrical arrangements above indicated should make this particular exhibit a great attraction to newspaper printers visiting Glasgow.

**Hanley.**—The accounts of the electricity department for the past year show a gross profit of £3,630, insufficient to meet interest and sinking fund instalment, and the deficit (£641) has been put on the general district rate.

**Hexham.**—Messrs. Lacey, Clirehugh and Sillar have been instructed by the Council to prepare a report on a combined scheme for lighting and traction. The utilisation of water power is to be dealt with.

**Hornsey.**—At the last meeting of the District Council tenders for the supply and erection of electricity generating plant were let, and the consulting engineer (Mr. Robert Hammond) was instructed to proceed with the completion of his specification for plant with a view to obtaining tenders for pipe work, coal conveyors, &c.

**Ilkeston.**—The Council have arranged with the Derbyshire and Notts Electric Power Co. for the supply of electricity in bulk.

**Kearsley.**—The District Council have authorised Messrs. Lacey, Clirehugh and Sillar to prepare specifications for the complete electrical equipment of the tramways.

**King's Lynn.**—Instead of a general charge of 5d. per unit for electric current the Corporation have adopted the following scale:—For all current consumed from May 1 to August 31, 3d. per unit, and during the remaining eight months 5d; for each winter quarter, after 10 units per 8 c.p. lamp have been used, 3l.

**Kingston on-Thames.**—The Council have received sanction to a loan of £17,800 for electric lighting extensions.

**Liverpool.**—The Tramways committee have applied to the Board of Trade for sanction to borrow £319,000 for constructing tramways and works authorised by the Corporation Tramways Extensions Orders, 1898 and 1900.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Nuneaton and District Light Railways Order, 1901.

The Light Railways Commissioners have submitted to the Board of Trade for confirmation the County of Middlesex Light Railways Order. Objections by 24th inst.

The promoters of the Lizard Light Railway have applied for an amending order extending the time for acquiring land and constructing the line. It is also proposed to substitute electricity for steam. The Cornwall County Council support the amendments.

Nottingham City Council have decided to support a scheme for the construction of electric tramways from the city boundaries to Arnold, Hucknall Torkard, Carlton and Gedling, Kimberley and Eastwood, Beeston, Bramcote and Stapleford.

**London County Council.**—At Tuesday's meeting £5,160 was loaned to Stepney for electric lighting.

The Board of Trade has approved the plans for the reconstruction of specified tramways on the south side of the Thames for electric traction and, provisionally, the proposed system of traction at pressure not exceeding 500 volts. A special meeting of the Council is to be held on June 18 to consider the giving of notices to purchase certain parts of the system of the South London Tramways Co. and of the Woolwich and South-East London Tramways.

A report was submitted by the Highways committee on the inquiry into the question of the alterations of standard pressure under the Electric Lighting Acts recently made by Sir Courtenay Boyle. The committee thought the Council would consider the regulations satisfactory, as they carried out the principle which the Council had upheld and afforded reasonable protection to the consumer.

The estimates for the year 1901-2 from the Fire Brigade committee make provision for electric lighting at various stations and for an expenditure of £1,350 and £50 for electric bell work. £8,500 was provided for telephones (about 170) and fire alarms (about 750).

Under the Electric Lighting Acts the Highways committee estimated the expenditure to be £1,475. The actual expenditure last year was £1,074. Against that, fees for inspecting and testing electricity

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meters and electric light pressure would amount to £425. The actual receipts last year from this source were £479.

**Machinery Users' Association**—An interesting report is issued by this Association, to be presented at the annual general meeting to be held at the Westminster Palace Hotel on May 15 at 3 p.m. Typical instances are given of cases where the assessment of machinery has been based upon erratic lines by the assessment committees of local authorities, and a case of special interest is one at Northampton, where a machine used in the manufacture of boots has been assessed not only at a percentage of its full value but on the supposed value of certain patent rights.

**Malvern.**—The Council has at last committed itself on the electric lighting question. At Tuesday's meeting the joint electric lighting and refuse destructor scheme of the surveyor (Mr. Maybury), involving an expenditure of £17,000, was approved.

**Manchester.**—An inquiry into the application of the Corporation to borrow, among other sums, £810,110 for electricity supply was held on Tuesday.

The deputy town clerk (Mr. Hudson) asked the inspector (Mr. Boulnois) to treat the two applications in respect of electricity as one. He explained that the Corporation had agreed to supply districts outside their own area with electric current for lighting, and had thus accepted heavy obligations. They had also entered into agreements, in connection with the tramways scheme, to go beyond their own area, and when those lines were completed the Corporation would have in all 150 miles of single track. He asked that the repayment of the loan might be spread over 25 years. The amount authorised to be borrowed by the electricity department up to the end of March was £884,011, and the total amount expended at that date was £867,322. Dr. Bishop, chairman of the Electricity committee, said the demand for electric current had steadily grown, and they were practically unable to meet it, though the progress of the undertaking had been very considerable. The number of consumers had doubled in five years, and the number of lamps now connected could be doubled if the committee could accept applications. In March, 1897, the number of consumers was 1,581 and the equivalent number of 8 c.p. lamps connected was 144,028; in 1898 1,981 consumers and 182,138 lamps; in 1899 the figures were 2,570 and 244,615; in 1900 the numbers were 3,240 and 315,322; and in March last consumers numbered 3,800 and lamps 332,437. Acting on the advice of Prof. Kennedy the committee had for the present decided to cease connecting until their new generating station at Stuart-street, where it was ultimately intended to provide accommodation for plant of 60,000 H.P., was ready. For the present the committee only asked for about a quarter of that power, but the whole of the works were urgently required, and must be pressed forward to enable the Corporation to fulfil its obligations. Mr. John Phythian, deputy chairman of the committee, the consulting engineer (Prof. A. B. W. Kennedy), and the chief resident electrical engineer (Mr. G. F. Metzger) also gave evidence in support of the application. Prof. Kennedy said the Stuart-street site was conveniently situated, and there was plenty of room for extension. Mr. Metzger stated that it was intended to light all the main streets through which the electric cars passed by means of arc lamps at an estimated cost of £75,000 (£35 per lamp) including cable and other accessories.

There was no opposition.

The estimates of the Electricity committee were under consideration by the City Council on Wednesday when the chairman (Dr. Bishop) admitted that they were the most unfavourable the committee had yet had to submit. They were unable to anticipate anything but a loss for the next 12 months, and the reason was because there had been no attempt whatever to bring about an approximation between the income on the one hand and the capital expenditure on the other. During the past four years there had been a steady, continuous and heavy drop in the percentage of profit to capital. The percentage had dropped from 11·10 in 1896-7 to 6·41 in 1899-1900, something like 5 per cent. decrease. Notwithstanding this, the committee had during those years handed over to the city fund, in aid of the rates, sums of £10,000, £10,000, £12,000 and £10,000 respectively, while at the same time they had allowed the amount placed to reserve to drop from £7,965 in 1896-7 to £1,764 in 1899-1900. That fund ought to stand at £80,000 instead of £13,000. During the same period the capital expenditure had risen from £309,190 to £641,821. Their expenditure on mains had been out of all proportion to that on generating plant. Owing to the enormous capital expenditure that had been thrust upon them, it would probably be several years before the department again obtained a position that would enable them to hand over such sums to rates as they had handed over in recent years. The estimated expenditure for the next 12 months was a little under £400,000, or 46 per cent. Their estimated increase of income for the 12 months was something like £17,000, equal to 19 or 19½ per cent. Of the increase no less than £11,187 was estimated revenue from the Tramways committee, but current would be sold to the latter on such special terms that the profit to be derived from that source would prove infinitesimal. Therefore, that £11,187 would have to be eliminated from the estimate of profits for the next year, and this would leave an estimated increase of income of only £6,000 or £7,000. During the past 12 months they had spent £150,000 in laying mains, and the estimates for the ensuing year provided for an outlay of £125,000 in the same direction. They expected shortly to get more of the plant at the Bloom-street station at work, and some of the plant at the Stuart-street station during the year. There had been a most unwarrantable delay in the construction of the latter station, but it was extremely difficult to apportion the blame for what had occurred. There had been a lavish expenditure in the out-townships. He did not want to say that they should disregard the obligations which they had entered into, but he did say that it was an outrageous policy to rush mains 4 or 5 miles from the generating station, when it was impossible to keep up such a pressure as would satisfy customers in the districts concerned, and when, also, there were thousands of customers at their own doors eagerly waiting to be connected. They estimated that they would spend on the Bloom-street station £115,000 during the next year. Last year they only spent £29,000, although their estimate amounted to £93,000. This proved that there had been great delay in the construction of the station. At the Stuart street station they had estimated to spend £40,000 last year, but they had not spent a farthing. It was now estimated that they would require to spend over £100,000 during the next 12 months at this station and this would indicate the pressure under which the committee were at present working. Nor could he approve the past policy in regard to the Dickinson-street works. There they held a record for the quantity of current turned out, but at what a cost! The plant had been strained to the utmost, and all had been at work, so that there was nothing to fall back upon in the event of a breakdown. He moved the adoption of the report. Mr. Wainwright moved as an amendment that the committee be required to alter their estimates so as to provide for paying to the city funds a sum equal to a 1d. rate, as he thought the gas consumers ought not to be the only persons who were to bear extra burdens. Also, he thought Dr. Bishop might have said less about the committee's work in the past, because no matter what expert they got, if the financial department was imperfect they would be sure to flounder. After discussion Dr. Bishop said the wording of the amendment was such that he must oppose it. The amendment was defeated and the estimates adopted.

**Middlesbrough.**—The Electric Lighting committee recommend the Council to apply for sanction to borrow £34,000 for electric lighting extensions.

**Middleton.**—An inquiry has been held into the application for further borrowing by the Corporation of £12,442 to meet the expenditure necessary for additional plant for traction. Messrs. Lacey, Clirehugh and Sillar, the consulting engineers, supplied details of the scheme.

**Municipal Telephony.**—Portsmouth Telephone committee recommend the Council to accept tenders amounting to £19,000 in connection with their municipal telephone exchange scheme. The original estimate of the consulting engineer (Mr. A. R. Bennett) for the whole of the work was £26,580, but various items, estimated to cost £4,325, have not yet been tendered for, and £2,000 is to be set aside for contingencies, making a total of £25,325. A loan of £26,000 is to be applied for.

In a report to the Aberdeen Corporation Mr. A. R. Bennett, M.I.E.E., of Glasgow, recommends that application be made for a licence to establish a municipal telephone exchange.

**Nicolaieff (Russia).**—The local tramway company is seeking powers to convert the horse tramways into electric lines.

**Patent Litigation**—We are informed that the Jandus Arc Lamp Co. have, as a result of further experiments and investigations, decided to proceed with a test action against a rival manufacturing company. Messrs. Drake & Gorham inform us that Messrs. Crompton & Co., the General Electric Co. and Messrs. Johnson and Phillips have paid considerable sums down in commutation of royalties.

**Plymouth.**—A further expenditure of £10,000 on the extension of the electric tramways is contemplated.

**Portsmouth**—Sir Frederick Bramwell has issued his award in connection with the acquisition of the tramways by the Corporation. The price to be paid to the Provincial Tramways Co. has been fixed at £185,633.

**Reigate.**—Application has been made for sanction to borrow £5,000 additional for extensions of cables and mains.

**St. Pancras (London).**—The accounts of the Electricity committee for the year to Dec. 31 were submitted on Wednesday. The gross revenue amounted to £49,329, an increase of £4,449 compared with 1899. Additional revenue of £3,207 came from public lighting, and £1,242 from private lighting. The total units sold during the first half of the year were 1,056,613, the average price realised being 4·48d. per unit, and in the second half 1,239,773 units and 3·63d. The net profits amounted to £2,921, increased to £4,056 by the balance from 1899. £2,916 has been placed to reserve and the remainder carried forward. The committee express disappointment that the reductions in price have not produced a larger increase in business. The Council have decided to retain the charge of 6d. per unit for the first hour's maximum demand and to increase the rate for subsequent hours from 2d. to 3d. per unit.

**Shanklin (I. of W.).**—Electric lighting has scored a triumph here, the recent poll resulting as follows:—For electricity 236, for gas 216.

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**Shoreditch (London).**—It is estimated that the past year's trading of the electricity department will show a deficit of over £3,000. Coal shows an additional cost of £3,133. It has, therefore, been decided to increase the price from 4½d. to 5d. per unit, to alter the scale for large consumers from 2d.—4d. to a fixed charge of 4d., and to raise the scale for power from 1½d.—2d. to 2d. per unit for all consumers. The revised list comes into operation on July 1. The question of erecting new stores and workshops at the generating station has been referred back.

**Stoke Newington (London).**—A deputation of tradesmen in the High-street recently approached the Borough Council to request that an arrangement be made with the Hackney Council for the supply of electric current to premises on the west side of the street, pending an installation by the Stoke Newington Council. A committee is considering the matter and has been authorised to obtain expert advice on the whole question of electric lighting and dust destructor plant.

**Torquay.**—The report of the borough electrical engineer (Mr. P. Storey) on the electric tramway question is under consideration by a committee.

**Warrington.**—Acting upon the advice of their consulting engineers (Messrs. Preece and Cardew), the council have applied for a further loan of £15,000 for electric lighting extensions. It is proposed to provide an additional boiler, engine and dynamo, to increase the capacity of the electricity station to 600kw., at an estimated expenditure of £6,720, and extensions of mains with three new feeding points are to be made at an estimated cost of £6,500.

The Tramways committee on Tuesday presented a report from Messrs. Preece and Cardew on the construction, cost and system of traction of the proposed tramways from Sankey Bridge to Knutsford-road swing bridge over the ship canal at Latchford. The cost of carrying out the specified works would be as follows:—Permanent way, £27,000; poles, trolley-wires, &c., £6,000; cars, £6,340; total, £39,340. The annual cost of working is put at £7,725, and the probable revenue per car mile at 10·3d, which would meet all charges.

The report also deals with the relative merits and demerits of the overhead trolley, the conduit, the surface contact and the accumulator systems of traction. The overhead system is credited with much lower first cost, greater simplicity, less liability to derangement, greater facility for repair, and far less disturbance of streets during construction. Wherever the accumulator system had been tried it had been found to be excessively costly in working and maintenance, and to have other objections, such as the discharge of disagreeable acid fumes in the cars, the rapid corrosion of ironwork, the great increase of deadweight, loss of time in charging, &c. Advocates of the open conduit system admitted that where a single track line cost £5,300 per mile for an overhead trolley road the conduit construction would cost £11,000. In this estimate no allowance had been made for obstructions such as sewers and gas and water pipes, which had to be diverted, and that might vary from several hundred to several thousand pounds sterling per mile. During construction the roadway had to be entirely blocked for weeks, and the rails forming the side of the slot usually exposed a width of 6in. of iron, and was objectionable to horses and ponies, who shoes varied from 3½in. to 6in. in width. The open conduit was also more difficult to work satisfactorily than the trolley wire, because the mains, being hidden, were difficult to inspect. The draining of the conduit was an important matter, and the cost of cleaning varied in different localities, but was between £50 and £100 per mile of track. The greatest defect of surface-contact systems hitherto had been the risk of one of the studs remaining charged after the car had passed over it, involving great danger of a serious accident from a horse stepping on it.

The Council have finally decided to adopt the overhead system, and contracts have been let subject to the consent of the Board of Trade, who have already approved provisionally of the system of electric traction proposed to be adopted.

The petition against the South Lancashire Tramways Bill has been withdrawn, and the Council have declined to grant running powers from Stockton Heath to the centre of Warrington to the proposed Warrington and Runcorn Light Railway.

**Watford.**—The salary of the chief electrical engineer (Mr. W. H. F. Colebrook), has been increased to £350, with an increase of £50 at the end of the year. Application is to be made for sanction to borrow £31,000 for extensions to the electricity works.

**Wolverhampton.**—The Council on Monday accepted the offer (referred to in our last issue) of the Lorain Steel Co. to lay down an experimental length of tramway on the Brown surface-contact system.

Ald. C. T. Mander, chairman of the Tramways committee, stated that further information had been obtained with regard to both the Dolter and the Lorain systems, and the members thought the Lorain was the better of the two. The Lorain Company offer to lay down their system for £1,800 per mile single track, to lay down 1 mile of double track and furnish three cars if the Corporation agrees to give them a thorough test for at least 60 days, the Corporation at the expiration of 30 days, if the test is successful, to give notice for the equipment of the remaining portion of the track, the company guaranteeing the successful operation of the system and to reinstate the paving if unsuccessful. The borough electrical engineer (Mr. Shawfield), who had been asked to give his opinion on the system, stated that he was unprepared to recommend it until he had seen it in operation, though he was of opinion that the Lorain was better than any other surface-contact system, and he saw no objection to the Corporation accepting the company's offer, provided the guarantees were acceptable and the company would take up the track in case of failure. Ald. Mander said the Board of Trade had virtually agreed to the Corporation giving the system a trial. The expense of the proposed line would amount to £24,500 more than the overhead system, and the extra cost per annum for repayment of capital would be £1,155. He moved that facilities be afforded to the Lorain Company to lay down the line at their own risk and cost on the terms mentioned.

The resolution was carried by 23 to 14.

**Workhouse Lighting.**—Barnsley Council have petitioned the Local Government Board to refuse sanction to an application of the Barnsley Guardians to borrow money for an independent electricity generating plant for lighting the workhouse, as the Council can supply current at less cost than the Guardians, and that the proposed expenditure would consequently be a waste of public money.

**Worthing.**—The question of applying for a tramway provisional order will be discussed by the Council on June 4.

**Dinner.**—The second annual dinner of the Faradian Club will be held at St. Ermin's Hotel, Westminster, on May 17, at 8 p.m.

**Ibero-American Benevolent Society.**—The eleventh anniversary festival of this society was held at the Whitehall Rooms, Hotel Metropole, London, on Saturday, Sir Albert K. Rollit, M.P., presiding. The large company included the official representatives of Spain, and of the South and Central American States, and, as usual at the gatherings of this society, many prominent telegraph men were present. One of the seven tables was presided over by Mr. Ch. Gerhardi, manager of the Direct Spanish Telegraph Co. A subscription of between £500 and £600 was announced.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Long Eaton* District Council invite tenders for two steel Lancashire boilers, engines, dynamos, switchboard, and accessories. Specifications, &c., of the district engineer (Mr. F. Worrall), Council offices, Long Eaton, and tenders must be in by noon May 20. An advertisement contains further particulars.

*Hull* Electric Lighting committee invite tenders for 12 direct-current street arc lamps, erected complete with cast-iron posts and spare parts and accessories. An advertisement contains further particulars, and specifications may be obtained from the city treasurer. Tenders to chairman by noon May 23.

*Dublin* Lighting committee invite tenders for main and sub-station switchboards, transformers, arc lamps and arc lamp pillars. An advertisement contains further particulars, and specifications, &c., may be inspected at the office of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and at the office of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., after 13th inst., and may be obtained from the latter address. Tenders to secretary (Mr. Fred J. Allan), City Hall, Dublin, by 4 p.m., June 3.

*Dundee* Gas Commissioners invite tenders for supply and erection of steel steam piping, valves and accessories, at the Dudhope-crescent electricity station. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), and tenders to the clerk to the Commissioners (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by May 30. An advertisement contains further particulars.

*Exeter* City Council invite tenders for the equipment of their new electricity generating station, including boiler and engine-house plant, steam pipes, &c., main and exciter switchboards and connecting cables, recording and other instruments, steel-plate coal bunkers and coal conveyors, and feed and condensing water tanks. Further particulars are set out in an advertisement. Specifications, &c., of the city electrical engineer (Mr. H. D. Munro) after 14th inst. Tenders to town clerk (Mr. Geo. R. Shorto) by June 14.

*Kingstown* (Ireland) District Council invite tenders for boilers, pumps, steam and water pipes, tank, economiser, ironwork, &c.; engines, generators, balancer and booster; switchboards and instruments; battery of accumulators and accessories; cables, electricity meters, wiring electricity station, and arc and incandescent lamps and fittings. An advertisement gives further particulars. Specifications of the town clerk (Mr. John Donnelly), and may be inspected, but not obtained, at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Tenders to town clerk by noon, May 30.

*Stoke-upon-Trent* Guardians invite tenders for electric motors for driving new laundry machinery, and also for the wiring of the laundry buildings, nurses' home, and farm buildings. Specifications from the consulting engineer (Mr. G. R. Peers), 96, Deansgate, Manchester, and tenders to the clerk (Mr. C. Daniel) by 9 a.m. May 22. See advertisement.

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*Colne* Electrical committee invite tenders for boiler, mechanical stoker, superheater, &c., steam pipes, crane, ejector condenser, motor, centrifugal pump, and a 3kw. motor transformer. Tenders by May 20.

*Manchester* Corporation Tramways committee require tenders for steel girder tramway rails, fish plates, tie bars, bolts and nuts, and 5,000 steel tramway poles. Tenders to Chairman, 55, Piccadilly, Manchester, by 1 p.m., May 18.

*Tonbridge* District Council invite tenders for boiler and engine-house plant, condensing apparatus and pipe work, travelling crane, switchboard and instruments, accumulators, mains, meters, public arc and public incandescent lighting. Tenders to clerk by 4 p.m. May 30.

*Tonbridge* District Council invite tenders for erecting electricity station buildings and chimney shaft. Tenders by 4 p.m., 30th inst.

*Fulham* (London) Borough Council invite tenders for materials and goods required in connection with their electric lighting and dust destructor station for the period ending March 31, 1902. Tenders to Town Hall, Fulham, London, S.W., by 5 p.m. May 15.

*Bermondsey* (London) Borough Council invite tenders for wiring the electricity station and stables, Neckinger. Tenders to town clerk by noon May 21.

*Hendon* District Council invite tenders for wiring the new Council offices. Tenders to Mr. Henry Humphris, Public Offices, the Burroughs, Hendon, before 4 p.m. June 5.

*Battersea* (London) Borough Council invite schemes for wiring consumers' premises. Tenders to Mr. W. Marcus Wilkins, Municipal Buildings, Lavender-hill, S.W., by May 14.

*Rochdale* Corporation require two 412kw. steam dynamos. Tenders to town clerk by May 16.

*Rochdale* Corporation also invite tenders for rail bonds. Tenders by 23rd inst.

*Motherwell* Electric Light committee require cast-iron lamp columns, arc lamps, switches, fittings, &c. Tenders to town clerk by May 18.

*Ludlow* Corporation invite tenders for electricity generating plant. Tenders to town clerk by May 20.

*Bristol* Electrical committee invite tenders for alternating-current transformers. Tenders to city electrical engineer by noon May 12.

*Plymouth* Corporation invite tenders for overhead line construction. Tenders by 18th inst.

*Swansea* Corporation invite tenders for two-phase motor generators and switch gear. Tenders before noon May 15.

Clyde Navigation Trustees, *Glasgow*, require tenders for electrical stores. Tenders by noon of May 16.

*Newcastle-on-Tyne* Corporation invite tenders for 800 tons of tramway rails, fishplates, &c. Tenders by noon 18th inst.

A notice is issued in the *Madrid Gazette* of April 26, calling for tenders for the purchase of the plant belonging to the telephone service of the city of Cordoba, and for the continuation of the service for the unexpired term of the original contract, terminating May 14, 1908. The upset price for this tender has now been fixed at £2,013.

*Spanish Post and Telegraph Department* invite tenders until June 1 for the supply of 30,000 zinc cylinders for the telegraph service.

A concession for establishing and working for 20 years a telephone exchange at *Denia*, Spain, is open for tender up to 15th inst. Applications to the Director-General Posts and Telegraphs, 10, Corretas, Madrid.

*Brazilian* Government invite tenders until July 8 for the supply of electrical machinery for hoisting and transporting of locomotives at the Engenho de Dentro works.

## TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board received the following tenders for supply and fixing electric generating plant at Tooting Bec Asylum:—

| | | | |
|---|---|---|---|
| Lancashire Dynamo & Motor Co. (*accepted*) | £6,399 | G. H. Woods & Co. | £7,424 |
| Calvert and Taylor | 8,984 | Veritys Limited | 7,110 |
| T. Scott Anderson | 8,200 | Brush Co. | 7,060 |
| Rosling, Appleby and Fynn | 8,125 | British Schuckert Co. | 7,048 |
| R. Dawson & Co. | 7,929 | Cox-Walkers | 6,990 |
| Marshall and Woods | 7,890 | Morley Elec. Eng. Co. | 6,760 |
| Frank Suter & Co. | 7,757 | Crompton & Co. | 6,650 |
| Bilbie, Hobson & Co. | 7,650 | Geipel and Lange | 6,450 |
| Bergtheil and Young | 7,597 | Nalder Bros. and Thompson | Informal |

The consulting engineers' revised estimate for the work was £7,292.

Aberdeen Gas and Electric Lighting committee have accepted the following tenders for plant for the Dee village electricity works:—

| | |
|---|---|
| Babcock and Willcox (six boilers) | £10,175 |
| Geo. Jamieson (joiner's work) | 2,190 |
| W. Simpson (plumber's work) | 698 |
| James Scott and Son (plasterer's work) | 499 |
| Adam & Co. (slaters' work) | 355 |

Farnworth Electricity committee have accepted the tender of the British Insulated Wire Co. for the lighting of the main streets by arc lamps, to the specification of the consulting engineers, Messrs. Lacey, Clirehugh and Sillar.

Hornsey District Council have accepted the following tenders for plant for their electricity works:—

| | | | |
|---|---|---|---|
| Siemens Bros. & Co. (mains) | £25,986 | 5 | 0 |
| Mather and Platt (engine house plant) | 6,601 | 0 | 0 |
| Fraser and Fraser (boiler house plant) | 4,856 | 0 | 0 |
| *General Electric Co. (arc lamps, pillars and brackets, with incandescents in each post) | 3,166 | 16 | 3 |
| Electrical Power Storage Co. (accumulators) | 2,888 | 10 | 0 |
| Cowans Limited (switchboard and instruments) | 1,585 | 10 | 0 |
| British Thomson-Houston Co. (meters) | 1,470 | 15 | 0 |
| Cole, Marchent and Morley (condensing plant) | 1,296 | 0 | 0 |
| Couper, Schwarz & Co. (water cooling apparatus) | 385 | 0 | 0 |
| Easterbrook, Allcard & Co. (tools, &c., for work-shop equipment) | 324 | 1 | 2 |
| Carrick and Ritchie (overhead travelling crane) | 292 | 0 | 0 |

* Right is reserved to vary the number of lamps 50 per cent.

Cardiff Tramways committee recommend the acceptance of the following tenders for their electric tramway department:—

John Williams & Co. (poles, bases and refuge pillars).
John Preece (brackets).
Thornton and Co. (telephone boxes).
Bergtheil and Young (feeder and section pillars).
Back and Manson (trolley wires).
Fredk. Smith & Co. (span wires and guard wires).
R. W. Blackwell & Co. (insulators and line suspensions).

Dundee Corporation have accepted the tender of Messrs. Felten and Guilleaume (per W. F. Dennis & Co.) for the supply of copper bonds at £938.

Warrington Corporation have let the contract for the construction of the permanent way of their electric tramway system at £28,789 to Mr. J. A. Ewart, and the overhead equipment contract has been given to Messrs. R. W. Blackwell & Co. at £4,839. 19s.

Derby Town Council have accepted the tender of S. Z. de Ferranti (Ltd.) for switchboard extension at £404, that of Babcock and Wilcox for chain grain stokers at £230, and that of Messrs. Radford and Greaves for boiler seating, &c., at schedule prices.

Dublin Lighting committee recommend the acceptance of the tender of Messrs. John Spencer (Ltd.) for the supply of intake-piping, wells, sluice valves, &c., for the Pigeon House power station at £710.

The tender of Messrs. Witting Bros. has been accepted by the Middlesbrough Electric Lighting committee for the supply of additional plant for the electricity works at £3,561. About 50 tenders were received, that of Messrs. Witting Bros. being the lowest, the next being that of Messrs. Mavor and Coulson at £3,744. Messrs. Witting Bros. tendered for Kolben dynamos.

Kingston-on-Thames Town Council have accepted the tender of Messrs. F. and E. Davey for erecting a chimney shaft at the electricity works for £1,989.

Watford District Council have accepted the tender of Messrs. S. Z. de Ferranti (Ltd.) for switch-gear at £733 and for 12 junction boxes at £210.

Tenders for the supply and erection of electricity generating plant were accepted last week by the Sleaford Town Council.

## BUSINESS NOTICE.

Messrs. A. G. R. Hawkes, J. J. De Lacy and H. K. De Lacy (trading as Hawkes and De Lacy), electrical and general engineers, 58, Old Hall-street, Liverpool, have dissolved partnership. Debts by Messrs. J. J. and H. K. De Lacy, who continue as Lacy Bros.

## PETITIONS, BANKRUPTCIES, LIQUIDATIONS, &c.

G. F. Cook (trading as G. F. Cook & Co.), electrical engineer, lately trading at Charles-street, Bradford, has been adjudicated bankrupt.

The first meeting of creditors of A. W. B. Pearson, electrical contractor, &c., 81 and 82, Palmerston-buildings, London, E.C., was held at the London Bankruptcy Court on Monday. The debtor has carried on business since 1898. He is interested in various patents, including "Eborine"—a vulcanite substitute, a rotary engine pump, a patent switch and a dry cell. Debtor attributes his failure to bill transactions. The draft statement of affairs showed liabilities £10,216, assets £13,814, surplus £3,576. The assets mainly consist of debtor's interest in certain land in the Wassau district of West Africa (£7,000) and in property in Mexico (£5,000). A resolution was passed to administer the estate in bankruptcy, with a committee of inspection.

Mr. H. W. Freshwater, Brighton Chambers, Bristol, has been appointed trustee in the bankruptcy of G. I. Lloyd (formerly trading as G. I. Lloyd & Co.), electrical and mechanical engineer, Leicester.

A meeting of the shareholders of the Coventry Gas Fittings, Electrical and Engineering Co. was held at Coventry on Monday, when the scheme for the reconstruction of the company was adopted.

It has been resolved to wind-up the British Electric Works Co. (Ltd.) voluntarily, and Messrs. H. E. Abbott and W. C. Spencer, of Liverpool, are liquidators. A petition for the compulsory winding-up of the company is still pending.

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A meeting of the Electric Organ Co. (Ltd.) will be held at St. Stephen's-square, Norwich, on June 5, to receive an account of the winding-up.

**Sale by Auction.**—Messrs. Wheatley Kirk, Price & Co. make a preliminary announcement in an advertisement that they are instructed to sell by auction on the works premises early in June the whole of the heavy modern machine tools, &c., of Messrs. Smith, Beacock and Tannett, Victoria Foundry, Leeds. Catalogues are in preparation, and may be obtained shortly (price 6d.) on application to Mr. F. Riley, at the works, or of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Messrs. Horne & Co. have for sale by private contract a 100kw. 500 volt generating plant, of which some particulars will be found in an advertisement elsewhere. Further particulars can be obtained of the auctioneers, 8, Delahay-street, Westminster, and 85, Gresham-street, London, E.C.

**Legal Notice.**—In an advertisement elsewhere it is announced that a petition, which has been presented to the High Court, for confirming a special resolution altering the provisions of the memorandum of association of the China and Japan Telephone Co. (Ltd.), so as to extend the operations of the company. will be heard before Mr. Justice Byrne on 18th inst.

**Glasgow Exhibition.**—The official catalogue of this exhibition is now ready, and can be obtained from Mr. C. P. Watson, 33, Gordon-street, Glasgow. Price 1s.

**Customs Duties.**—Chatterton's Compound imported into the United States is now held to be dutiable at the rate of 35 per cent. ad val., under paragraph 450 of the tariff, and not as hitherto as a chemical compound under paragraph 3.

Jars for electric batteries imported into Spain separately have now to pay duty under the classification corresponding to the manufactured material of which they are constituted.

**The Motor Car Exhibition.**—We refer elsewhere to the exhibition of automobile vehicles at the Agricultural Hall, London, which closes to-morrow (Saturday). The exhibits generally show great advance in get-up and finish. At Mr. Oppermann's stand, besides a victoriette, a "runabout," to carry two persons and guaranteed for 25 to 30 miles on one charge of the battery, is a feature. The victoria shown by Mr. Oppermann has been approved by the Commissioner of Police for London, by the Prefect of the Seine, Paris, and by the Commissioners of Public Vehicles in Vienna, as fulfilling all the requirements of the regulations made regarding the vehicular traffic in the streets. The accumulator used in the Oppermann victoriette is manufactured by Mr. Oppermann and is called the "Flambeau." At the City and Suburban Electric Carriage Co's. stand vehicles are shown which have been supplied to Royalty and to Lord Rothschild and other members of the aristocracy who have taken to this mode of locomotion. This company issue a catalogue of electrical vehicles which is the most complete of the kind we have seen. The National Motor Carriage Syndicate's "Brighton" electric voiturette for two riders is fitted with Joel motors and Rosenthal accumulators, and it is claimed that this vehicle has journeyed from London to Brighton with only one charge of current. Besides the vehicles, numerous exhibits administer to the requirements of the motor car industry. In addition to the exhibits of the Doe Portable Electric Light and Power Syndicate and of Messrs. Peto and Radford (referred to on page 82), Le Carbone, at stand 47, have a good show of "Sans Pareil" dry cells for electric ignition, and of carbon brushes, rheostats and sparking pieces for motors and controlling gear. The Meyra Electric Co. also show dry cells for various uses, and Mr. H. W. van Raden shows woven-glass ignition accumulators, electric motor-car accumulators, motor controllers, measuring instruments and other electrical appliances for motor ignition, &c. The McLachlan Engineering Co. show a patent electric and petrol boat rudder motor suitable for either river or sea work, to be fitted on to existing boats without altering their construction. Stores and material for the growing motor vehicle industries are shown by Messrs. W. H. Willcox & Co., Messrs. Fleming, Birkby and Goodall, and Messrs. Stern Bros. The exhibition has been well patronised, and has proved both interesting and instructive.

**Electrical Trades Union.**—In reference to the proposed rules for wiremen and cable jointers recently issued by this union, we are informed by the general secretary that—

These rules have been adopted by nearly all the metropolitan borough councils and other bodies who have electrical undertakings. The majority of contractors in the district, while not disagreeing with the rules, will not sign them, but state that we have a perfect right to make what rules we like, and if we refuse to work for less than 9½d. per hour they must pay it. On May 2 a deputation of our members waited upon the committee of the London District Engineering Employers' Association, Mr. Alexander Siemens being in the chair. The various clauses were fully discussed, and the chairman stated that the association could not bind themselves to recognise the 53-hour week as asked, although the deputation pointed out that, being closely allied to the building trade, it was usual for wiremen to finish work at 12 midday on Saturdays. The committee approved of the clauses dealing with out-of-town expenses and overtime rates, and reserved one or two points for future consideration by the association.

**B.T.H. Plant.**—Pamphlet No. 94, issued by the British Thomson-Houston Co., treats of various types of transformers, of which several illustrations are given.

**Westinghouse Plant.**—Circular No. 1,046 of the British Westinghouse Co., deals with alternating-current fan motors for 50 and 100 volt circuits.

**Electric Driving.**—Electric plant has been put down at the extensive works of Palmer's Shipbuilding and Iron Co., Jarrow. All the tools and machinery in the engine works and shipyard are to be driven electrically, effecting a considerable saving and placing the Palmer Company in a more advantageous position for dealing with their large volume of work expeditiously and economically. The electrical part of the work has been carried out by Messrs. Clarke, Chapman & Co. and the British Westinghouse Co., and the plant, which is three-phase, supplies current at 440 volts. A large number of motors have been placed throughout the works to drive the tools in various sections of the shops and separate machines. In the power station there are two sets of plant, each having a generator of a normal output of 750kw., coupled direct to vertical triple expansion marine-type engines built by the Palmer Company.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 1 to 7, with the ports of destination:—

*Africa*—Alexandria, £145; Cape Town, £33; Durban, £476; East London, £64. *Australasia*—Adelaide, £74 (telegraph wire); Brisbane, £51 (telegraph cable); Hobart, £289 (including £279 telegraph cable); Launceston, £45; Melbourne, £3,608 (including £3,446 telegraph material); Perth, £480; Port Chalmers, £235; Sydney, £1,366; Townsville, £1,056; Wellington, £544. *Belgium*—Ostend, £50. *British Guiana*—Demerara, £44 (telegraph apparatus). *Canada*—Halifax, £20 (telegraph wire); Montreal, £24. *Denmark*—Copenhagen, £82 (telegraph wire). *Germany*—Hamburg, £203 (telegraph material). *Gibraltar*—£14. *Holland*—Amsterdam, £127; Rotterdam, £38. *Hong Kong*, £10. *India*—Bombay, £270 (including £88 telegraph wire). *Japan*—Kobe, £172; Nagasaki, £1,695; Tokio, £28; Yokohama, £300. *Malta*, £46. *North Atlantic*, 333 knots of telegraph cable. *Norway*—Christiania, £22 (telegraph cable). *Persia*—Bushire, £50 (telegraph material). *Russia*—Kure, £11,637 (telegraph cable); Odessa, £25. *Sweden*—Gothenburg, £14 (telegraph wire); Stockholm, £129 (telegraph wire). Total £23,463, against £30,798 in the corresponding week last year (May 2 to 8).

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during April was £86,629, against £130,076 in the preceding month and £58,714 in April last year. The total for the four months ended April 30 was £408,318, against £255,732 for the corresponding period last year.

# COMPANIES' MEETINGS AND REPORTS.

## Western Telegraph Co. (Ltd.).

The fifty-fifth ordinary general meeting of this Company was held on Wednesday, Mr. W. S. ANDREWS occupying the chair.

The SECRETARY (Mr. E. Steer Hodson) having read the notice calling the meeting,

The CHAIRMAN said: At our meeting in May last the Directors ventured to hazard the expectation that a considerable improvement was about to take place in the affairs of Brazil. Well, since then, as is pretty commonly known, the amelioration and the advancement of the affairs of the United States of Brazil have been marked and sustained. The measures of the Government and their wise policy of conciliation and appeasement have met with great success. The finances, the trade, the internal activity of the country, and all commercial movements are on the up grade. Gold payments are to be resumed, as agreed, and the balances in the Treasury—this is always a mark noting progress or retrogression—are satisfactory. The Budget shows a surplus for 1900. That is a pretty satisfactory summary as respects the Government and the country, but I think we are entitled to say with reference to the Western Company that we have contributed our mite, small though it may be, towards this general well-being and improvement by maintaining satisfactory international telegraphic communications. We all know that the telegraph nowadays plays a great part in trade and commerce, and we can tell from our traffic and its movement that it has played a great part, as we believe, in the present state of things in Brazil. Everything has gone on extremely satisfactorily, and the measures which we have taken have met with considerable success. What is the position as tending, after all, to bear out these remarks? because what you gentlemen want is not so much remarks and statements as solid facts. The income of the company for the half-year ended December 31, 1900, including dividends from our investments in other telegraph companies, amounted to £264,717, against £230,435 for the previous half-year. That shows an increase of £34,282 over that half-year. It has one satisfactory feature. I said, "including dividends from our investments in other telegraph companies," and a satisfactory feature is that £34,000 odd is an increase from traffic and not from our investments in other companies, as to which there is a difference of only £1,100 or £1,200. Compared with the receipts for the half-year ended December 31, 1899, there is a somewhat larger comparative increase, but that, of course, only tends to show that the march, as I have previously

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had to describe it to the shareholders, is steadily onwards, and has been now, I am pleased to say, for a considerable period with us. Then, with reference to the other side, the total expenses for the half-year amounted to £84,139, and for the previous half-year to £80,579, showing an increase of £3,560. The greater portion of that increase has been incurred in South America. There are six items of increase, I think, and 10 of decreases, the first involving about £5,000, and the last about £2,500. The London expenses are very slightly higher than in the previous half-year, and the increase under this head is principally due to two items—one for advertising, which only occurs in December, and the other for the monthly audit of the amalgamated companies for the full period. There are six increases here and five decreases, but not one of the increases is of much importance. The station expenses show a net increase of £2,532. This is mainly in salaries and wages, due principally to the rapid rise in the rate of exchange, for which we had to make certain temporary adjustments, and additional staff required, and the annual increment in the remuneration of the older members of the staff. In rent and taxes there is an increase of £753, owing to additional office accommodation being required at some of our stations, and this entailed an extra expense in furniture of £492. The decreases, on the other hand, amount under agencies to £708; travelling expenses, owing to fewer members of the staff coming home on leave, £390; repairs to buildings, £454; and stationery and printing, £587. There are other increases and decreases of a trifling character, but I need not bother you about them. At the last meeting I ventured to say that the expenses of shipping would be reduced this half-year as compared with last half-year, and it only shows how very unsafe it is for a man to forecast a thing when he does not know. As a fact, the expenditure comes out pretty much the same, for two reasons. One is that we have been disappointed in the delivery of the "Norseman," and therefore the substituted ship had to be kept on for the whole of the period; and in the next place we had the misfortune, in November last, to sustain an interruption of the Lisbon-Madeira No. 1 cable, and consequently we were obliged to engage an extra ship to endeavour to repair it. Owing to the bad weather she was unable to do so. She could not complete the work, and the expenses of that came in to swell what otherwise would have been an economy. The larger portion of these expenses appear in the half-year's accounts, while a small portion has gone over to this current period. The new cables laid last year have enabled us to give a greatly improved service, and have afforded us, or rather will afford us, the means of coping with an increased traffic. In continuation of the policy of extending our operations and providing more feeders to our system as far as is prudent, we have lately secured a financial interest in a telegraphic-telephonic line now in course of construction between Buenos Ayres and Rosario. The latter is a most important place, and it continues to increase in a most satisfactory manner. I have been asked to say a word about wireless telegraphy, but, of course, that is rather a moot subject to say much about, and I do not propose to go into it much. All I have to say is that, as regards our extensive circuits, we do not anticipate any difficulty whatever in connection with wireless telegraphy. It is a very commendable invention, and a most interesting one, and within certain limits it is calculated to do good service; but we do not think that any fear need be entertained beyond those limits. In fact, we are rather inclined to look on wireless telegraphy as becoming an ultimate feeder, because it enables messages to be conveyed to lightships, &c., and when they get to their termini they must go somewhere else, which is to the telegraph lines, and which, therefore, are likely to get the benefit of the business. I now move the adoption of the report and accounts, and would say that we shall have to make a proposal to you with respect to the widow of our late manager, Mr. Axworthy.

Mr. FREDERICK YOULE seconded the motion.

Mr. G. ENNIS expressed great regret at the loss which the Company had sustained by the death of Mr. Axworthy—a view which he was sure was shared in by all the proprietors. The position of the Company was now very satisfactory. The Directors were placing £100,000 to reserve, and no doubt many of the shareholders would like to dip into such a tempting morsel, but he felt that the Board were to be congratulated on the conservative disposition made by them of the available funds.

Mr. CHARLES WEBB inquired how much further the reserve fund was likely to be drawn upon for repairs to cables.

The CHAIRMAN said he could not state what the position would be. A good deal depended on the Company's prosperity. If they continued in the same prosperous way as at present, the Directors did not expect that it would be necessary to impinge very largely on the reserve fund, although they must take from it what assistance might be needed. The policy of the Board was, however, to keep the fund as stable as they possibly could, and the transfer to it that day of £100,000 was, of course, in pursuance of that object.

The motion was then carried unanimously.

The CHAIRMAN said their late manager, Mr. Axworthy, was connected with the Company from its inception. For a considerable period, when their affairs were not so flourishing as they now were, Mr. Axworthy worked at a somewhat inadequate salary, and he was therefore unable to make such provision as he would no doubt otherwise have made for his wife and children. He was an indefatigable and careful officer, and rendered considerable services to the Company. He moved—

"*That the Directors be authorised to pay the sum of £2,500 to Mrs. Sarah Rachael Axworthy, the widow of the late manager, in recognition of the valuable services rendered by him for many years.*"

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which was warmly supported by Mr. R. M. Cunningham, Mr. Ennis and Major Cotton.

The CHAIRMAN, in reply to Mr. Ennis, stated that the amount to be voted, together with what there was besides, was to be invested in the names of trustees for the benefit of Mrs. Axworthy and her children, and one of the Directors had been good enough to consent to become a trustee.

The resolution was carried unanimously.

A vote of thanks to the Chairman and Directors for their services in the past six months was carried unanimously.

The CHAIRMAN briefly acknowledged the compliment, and the proceedings terminated.

## Cuba Submarine Telegraph Co. (Ltd.).

The fifty-ninth ordinary general meeting was held on Wednesday, Mr. CHARLES W. PARISH presiding.

The SECRETARY (Mr. James Scott) having read the notice calling the meeting,

The CHAIRMAN said: The results shown in the revenue account are not by any means of that excellent character to which we have been accustomed. It is disappointing to see our traffic receipts falling off so seriously, but there is no doubt about it that the competition of new routes and the reduction of rates have naturally upset the unique position which we held for many years. We enjoyed a long period of exceptional prosperity, and now we shall have to work hard to meet the change of circumstances.

The revenue account ending last December shows that we earned from traffic £8,904, interest received £2,059, and transfer fees £7, giving a total of £10,970 as compared with the half-year ending December, 1899—traffic £12,008, interest received £2,181, transfer fees £6, giving a total of £14,195, or a falling off of £3,225 in the last half-year, which I need scarcely mention is a very serious amount. Our expenses in 1900 were £5,502, in 1899 £6,192—a saving of £690—which is satisfactory, and reduces the net falling off of income to £2,535. We carried forward £5,204, and adding our profits, of £10,971, we have £16,175 to deal with, and we have decided to propose a dividend of 4 per cent. per annum on the ordinary shares, in addition to the necessary 10 per cent. per annum on the preference.

You will have learnt with regret that we have not yet succeeded in collecting the claim of £8,174 from the Government of the United States for damage to our cables during the Spanish-American War, nor has the United States Government recognised our concessions or agreed to the subsidy being paid which is now overdue for four half-years, and amounts to £4,158. It is disappointing, but doubtless these kind of settlements do take a long time; our last communication from the Foreign Office refers to this unfortunate delay and connects it with the negotiations now proceeding between the United States Government and Cuba as to the future status and government of the island. We can only hope that when these are disposed of our demands may receive the attention and settlement for which our Foreign Office is so kindly working. At our last meeting I informed you that we had won, in the High Court of Justice, our lawsuit with the West India and Panama Company, and that they had given notice of appeal. This appeal was heard last March, before Lords Justice Rigby, Stirling and Vaughan Williams, who unanimously sustained the judgment of the lower Court. This is so far completely satisfactory, but the West India and Panama Company have intimated their intention to further appeal to the House of Lords, and where we expect the case may be heard before the end of the year or early next year, according to the inevitable delays of the law.

I now move the adoption of the report and accounts.

Mr. GEORGE KEITH seconded the motion.

Mr. H. EASTES asked whether the subsidies referred to were being paid to other companies, but not to the Cuba company?

The CHAIRMAN: Well, I may explain that our difficulties have arisen to a large extent from our own Government subsidising lines from Halifax to Bermuda, and from Bermuda to Jamaica. Our Government originally subsidised a line from Halifax to Bermuda, and in 1898 the line from Bermuda to Jamaica was laid. These subsidies amount to £16,000 odd. Our subsidy was originally from the Spanish Government for merely the coast lines—we had no subsidy for the other lines—and we hope when matters are settled as to the status of the island of Cuba we shall again receive our subsidy. Before the competing lines were subsidised by the British Government—and this will give you a better idea than anything else of our position—the rate to Jamaica was over 5s. for every word, and now it is only 3s. per word. That is the whole story.

Mr. G. LYDDON: There is an item of £8,000 for repairs which we claim from the Spanish Government.

The CHAIRMAN: That item of £8,000 represents the cost of repairing cables which were damaged by the Americans during the war. Our claim is against the Americans. We have paid that money out of our pockets, and we are trying to get it repaid.

Mr. HANNAY: Notwithstanding the soothing report the Chairman has given us I am of opinion that the affairs of the Company are in a grave and serious condition. I quite dread to see the next Stock Exchange quotation of Cuba Submarine ordinary shares after our meeting to-day. I should like to make a proposal to reduce the £10 ordinary shares to £5.

Mr. C. H. HOBBS: I think you should include the preference as well, and then you would not be single-handed.

Mr. HANNAY: The reserve fund is an accumulation due to the non-payment of money which was available for dividends. It was always competent for the Board to have used that money in the payment of dividends, and had they done so it would have come to the ordinary shareholders. The preference shareholders have had their pound of flesh, and so I consider the reserve as especially belonging to the ordinary shareholders; and, therefore, if the Directors come to the conclusion that they cannot reduce the shares from shares of £10 each to shares of £5 each, I submit that they should withdraw £80,000 from the reserve and distribute it as a 50 per cent. bonus to the ordinary shareholders, thus bringing about the same result.

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The CHAIRMAN: That is an extraordinary view to take. Our shares are now quoted £7 or £8, but their value is not so much based on what we are earning to-day as to the strong position we hold in consequence of having a good reserve fund. (Hear, hear.) If we were to squander our reserve our ordinary shares would be unsaleable. We have obligations to other companies, bear in mind. We have a working agreement with the West India and Panama, and also with the American company, and I assure you that it would be impossible to carry out what you have suggested.

The resolution was then carried unanimously.

A resolution approving the dividends and a vote of thanks to the chairman and directors, moved by Mr. G. Lyddon and seconded by Mr. Aronson, was unanimously carried, and the proceedings terminated.

## West Coast of America Telegraph Co. (Ltd.).

The fourth ordinary general meeting of the Company was held on Tuesday, under the presidency of Mr. J. DENISON-PENDER.

The SECRETARY (Mr. Frederick L. Robinson) having read the notice convening the meeting and the auditors' certificate,

The CHAIRMAN said: The receipts for 1900 were £30,888, compared with £28,347 in 1899, and £25,800 in 1898. There has, therefore, been an increase in the receipts between 1898 and 1900 from £25,800 to £30,800, which is satisfactory; and the increase in the receipts as between 1899 and 1900 was £2,540. On the other side the expenses in 1899 were £21,065, against £23,046 last year, or an increase of £1,981, against an increase in the receipts of £2,510. The causes of the advance in the expenses, as well, to a certain extent, of our increase in receipts, are the values of exchange. In 1900 the exchange varied from 15⅞d. to 17d., but in 1899 the fluctuation was much greater, exchange varying from 12¼d. to 16d. That, of course, has a good deal to do with us, because all our expenses have to be paid at a higher rate, though we get a higher value for the money remitted home. Reverting to the expenses. In 1900 we had six repairs. The most important of those was in connection with the Mollendo cable in May; the breakage there was caused by chemical action. The Arica cable, owing to landslips, required repairs to be effected in it in April and October. The Iquique cable was repaired in September; there the fault was apparently caused by a ship grounding over the cable, flattening it out, and the copper inside was broken. At Antofagasta, on account of the risky bottom, we had to cement the cables in and make them solid, so that they would not get washed about and chafed. There was a considerable increase last year, as you all know, in the price of coal, and as we had more repairs than usual, the latter cost more than they would have done in an ordinary year in consequence of the increased expense of working the ship. I think, however, that we may take it as satisfactory altogether that we have an increase in the receipts in the year under review as compared with the year 1899, and a considerable increase as compared with 1898. The Directors propose to deal with the balance of £8,097, which includes the amount brought forward from last year of £256, in the following way:—Debenture interest will take £6,000, and the interest on the income bonds will require £800, and we propose to wipe off the balance of the reconstruction expenses, £709, so that that item will not again appear in the accounts. This will leave us with £588 to carry forward, or double the amount carried forward last year. I think I have given you pretty well all the items that would interest you respecting the working during 1900. As regards 1901, I am glad to say that, so far, we have had no interruption, and we have nearly got through five months of the year. The traffic is maintained, and you will see in last year's accounts that we sent out cable to the value of £4,000, so that we are now in the position, if any breaks occur, of having an efficient stock of cable, which we have not had before, ready for any emergency. I now move the adoption of the report and accounts.

The resolution was carried unanimously, and a vote of thanks was given to the Chairman and Directors.

## Submarine Cables Trust.

The annual meeting of the certificate holders was held on Tuesday, under the presidency of Mr. J. DENISON-PENDER.

The SECRETARY (Mr. Sidney Collett) having read the notice convening the meeting,

The CHAIRMAN said: The revenue for the past year amounted to £24,901, against £24,789 the year before, or an increase of £112. After meeting the coupons due on October 15, 1900, and April 15 of this year, an amount of £3,487. 12s. is available for and has been transferred to the redemption fund. The Trustees have disposed of the allotment of the Eastern Extension Company's new shares, which resulted in a net profit of £2,623. 15s. These shares came to us in right of our holding of the old shares in the Eastern Extension Company; but the Trust, not having any money to invest, took the opportunity of selling them, and the result has been the profit I have mentioned. This £2,623. 15s., with the amount transferred from the revenue account, has enabled the Trustees to purchase 21 certificates, exclusive of the coupons of reversion, costing £2,511. 7s., and to draw for redemption at £120 per certificate a further 30 certificates. I now move the adoption of the report and accounts.

The resolution was carried unanimously, as was a further resolution approving the action of the Trustees in disposing of the allotment of Eastern Extension new shares.

Mr. LAMONT said they were this year redeeming so many certificates, and he presumed that there would be a larger number next year. This would go on at an accelerated rate, and he desired to know how the Trust would terminate.

The CHAIRMAN: That entirely depends on the funds we receive for dividends.

Mr. LAMONT pointed out that there would be a certain number of shares left in the end, and he wanted to know what was to become of them.

The CHAIRMAN: On every bond there is a coupon, and that coupon represents the interest the holder has in the Trust at the last. When all the certificates are paid off, what remains will be distributed among the holders of the coupons. When your bonds are drawn by the Trustees for payment you receive the £120, and we take the certificate, but you retain the coupon.

The retiring auditors were then re-appointed, and a vote of thanks to the Chairman and Trustees brought the meeting to a close.

## Great Northern Telegraph Co. (Ltd.)

At the recent general meeting at Copenhagen, the chairman and managing director (Commodore E. Suenson, D.R.N.), in rendering an account of the working during the year, stated that it was many years since their cables had suffered so little from interruptions as in 1900, which was fortunate, because never before had an uninterrupted service been so necessary as during the past year, particularly in the Far East. In Europe there had been 15 interruptions distributed over seven cables, whilst in the Far East there have been eight interruptions on four cables. The cable steamer "H. C. Örsted" had been occupied for 88 days on repairs of the European cables, and, although the "Store Nordiske" had been on active service for 123 days, only half of that time was occupied in cable repairs, the remainder having been spent in the laying of new cables in China. The route via Wladiwostock had not been able to take its proper share in the transmission of the extraordinarily heavy traffic with the Far East, as the line was frequently blocked with Government telegrams, necessitated chiefly by the mobilisation of the Russian army in Siberia, while Blagowestschensk, one of the most important stations on the line was in July attacked by Chinese insurgents. In November a cable crossing the river Amur was interrupted by drifting ice, which proved how necessary it was to get the Wladiwostock line duplicated. The shortest route (continues the report) would be across Mongolia by way of Taku-Peking-Kiachta, and such a line would make an excellent direct route between China and Europe, which the directors hoped shortly to see realised.

The question of a meteorological cable between Iceland, the Faroe Islands and the telegraph system of the world had made but little progress. The Diet at Stockholm had, however, on the proposal of the Government, voted an annual contribution to the projected cable of £400 for 20 years.

In recent years the various governments whose territories were connected by the company's cables had in turn renewed the concessions originally granted to them. In the past year they had obtained the extension until 1912 of the privileges granted in 1882 by the Imperial Japanese Government, instead of the mere landing permission, which authorised the laying of their first cables in Japanese waters 30 years ago.

The event which had been of paramount importance to the company had, however, been the military occupation of China. At the beginning of the troubles the insurgents destroyed the telegraph lines between Taku, Tientsin, and Peking, and cut all the lines which connected those three places with the general telegraph system. The allied forces were consequently without direct telegraphic communication with their Governments and with the rest of the world, the nearest telegraph station being Chefoo, from which place the Chinese Telegraph Administration endeavoured to maintain telegraphic communication with Shanghai, but this route was very slow, unreliable and exposed to interruption by the Boxers. In those circumstances the company, with the Eastern Extension Telegraph Co., took prompt action, and arranged with the Chinese Telegraph Administration to offer the Allied Governments to lay a submarine cable between Taku, Chefoo, and Shanghai, and also (to meet the special requirements of Great Britain, Russia, and Germany) to lay strategic branch cables between Chefoo and the ports occupied by these Powers at Weihaiwei, Port Arthur, and Tsingtau. These offers were readily accepted, and the work of laying the cables and establishing the stations was completed within a remarkably short time. The cables in the Gulf of Petchili (Taku-Chefoo, Port Arthur-Chefoo, and Weihaiwei-Chefoo) were opened for traffic on Aug. 22 and Sept. 3 and 5 respectively, whilst the laying of the cable between Chefoo and Shanghai was completed on Sept. 17. Chefoo and Tsingtau were connected by cable on Oct. 4, and in December another cable was laid from Tsingtau to Shanghai, partly by a German cable steamer and partly by the companies' steamers. Later on the neutral Shanghai-Chefoo-Taku connection had been extended to Peking by means of a land line, which is intended to be continued to the Russian frontier at Kiachta, thus duplicating the Wladiwostock line. The valuable services rendered by the companies in establishing this cable system, which connects the whole of the north of China with the telegraphic centre at Shanghai, have met with due appreciation all over the world. Thanks to these connections, the Allied Governments have remained in continual and rapid communication with their military forces in China, and, after the relief of Peking, with their gallant diplomatic representatives. Arrangements were immediately made by the two companies to enable the officers, soldiers, and officials attached to the military forces to communicate at reduced rates with their families. The new cables and the revenue from them do not, however, belong to either of the companies. The strategic cables are the property of the respective Governments for whom they have been laid, and the cable between Shanghai, Chefoo and Taku, although mortgaged to the two companies, belongs to the Chinese Telegraph Administration, and the companies get only a moderate interest on their capital expenditure. This capital will be gradually amortised by the Chinese Administration in 25 or 30 years, during which time the working and maintenance will be entirely in the hands of the two companies. The section between Shanghai and Chefoo had been already duplicated by the German Shanghai-Tsingtau-Chefoo cable, and the Taku-Chefoo section would shortly be duplicated by a second cable, which would be laid by the "Store Nordiske" in May.

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The splendid financial results of last year, exclusively due to the exceptionally large traffic in connection with events in China, enabled the directors to propose to pay an extra dividend of 10 per cent., making 15 per cent. for the year, and at the same time to increase the reserve and renewal fund by a considerable amount, and also to set aside an amount for a renewal fund for the cable steamers. The reserve and renewal fund had, however, been written down in a similar way as in 1899, on account of the decrease in the value of various investments. The year 1900 would no doubt mark the zenith of the company's prosperity, and they must be prepared for a decline perhaps more rapid than the rise. The war in South Africa and events in China had given a fresh impetus to the projects of different nations, especially Germany and France, for having their own national and independent means of communication, and those projects were taking a more and more definite shape. The laying of a British Pacific cable between Australia and Canada would no doubt stimulate similar American schemes in the Pacific. The state of China, the principal field for their enterprises in the Far East, was still very critical, and before it was settled their interests and legal position in that country might be seriously affected.

## Calcutta Electric Supply Corporation (Ltd.).

The annual meeting of this company was held on Wednesday, Col. A. J. FILGATE, R.E., presiding.

The CHAIRMAN said: During the year 10,000 new £5 shares were issued at a premium of 10s., the premium having been put to reserve. Their capital expenditure for the year was £37,419, bringing the total to Dec. 31 to £118,266. They were making progress with their Alipore station, and hoped to have current available in the whole of their added area in time for the hot weather of 1902. At the company's Emambagh-lane station they had two 60 H.P., two 180 H.P., and two 360 H.P. steam dynamos installed, and a third 360 H.P. machine would shortly be sent out. Two 1,100 H.P. Crompton-Belliss sets were on order and would be erected at the station, where increased accommodation for this plant had been provided. This would bring up their available power to 3,760 H.P. For their new Alipore station they had secured an excellent site, and had ordered two 60 H.P. and two 300 H.P. steam sets. They had already laid 17 miles of overhead cables and 9 miles of underground mains, and a further 6 miles of overhead and 1 mile of underground mains were on order. To meet the demand for electric fans 1,100 of these had been sent out by the company. The local tradesmen were taking up the supply of these fans on a considerable scale, and the company's local agents reported that 5,000 fans would be running by the end of the season. At the end of 1899 they had 115 houses connected to their system with an equivalent of 9,463 8 c.p. lamps, while at the end of 1900 there were 409 houses and 23,784 lamps. The total number of units sold during the year was 412,950, from which the gross revenue was £11,147 and the expenditure £5,742, leaving a net revenue of £5,395. The final dividend now recommended at the rate of 4 per cent. per annum would, with the interim, make the dividend for the year 3½ per cent.; £2,500 was to be placed to depreciation and £327 carried forward. The company had an excellent business but were dealing with an industry which required delicate machinery to be used in a climate where machinery deteriorated more rapidly than it did at home. They had, therefore, to make provision for contingencies which might arise through this deterioration. The company's agents had not yet been successful in obtaining definite proposals from the Calcutta municipality for lighting the streets, but had concluded an arrangement with the Port Commissioners for lighting the jetties and the Hooghley bridge, and further lighting contracts were being negotiated. The demand for private lighting steadily continued, and on April 12 they had 501 consumers connected to their mains, and their equivalent 8 c.p. lampage was 36,034. The number of units sold from Jan. 1 to April 12 was 178,790, compared with 74,671 for the corresponding period last year.

The report and accounts were adopted, and a vote of thanks to the managing agents in Calcutta (Messrs. Kilburn & Co.) and to the chairman was carried unanimously.

## Callender's Cable and Construction Co. (Ltd.).

The report of the directors for the year ended Dec. 31, shows a credit balance of £70,546. 14s., making, with £8,221. 13s. 4d. brought forward, £78,768. 7s. 4d. Interest on debentures had taken £4,050, preference dividend £7,500, appropriation for depreciation £7,246. 0s. 7d., machinery renewal fund £3,000, leaving £56,972. 6s. 9d., out of which it is proposed to pay a dividend on the ordinary shares at the rate of 10 per cent. per annum (tax free), or 10s., per share, whereof 5s. was paid on Nov. 1, absorbing £15,000, and a bonus of 5s. per share, requiring £7,500. £23,616. 7s. 6d. is placed to reserve, and £10,855. 19s. 3d. carried forward. The total payment on the ordinary shares is, therefore, as last year, 15 per cent. per annum. The reserve now amounts to £100,000, the whole of which is used in the business of the company.

The plant and premises have been maintained in a thorough state of efficiency, and the expenditure on repairs and renewals have been fully debited against the year's profits. A further considerable sum has been spent on new plant and tools during the year, the directors being satisfied that it is indispensable to adopt all the most improved machinery obtainable, as it is only through the excellent modern appliances at the factory that the company has been able to carry on its large business with such satisfactory results. It is contemplated to incur further expenditure during the course of the present year on similar improvements.

The amount of business transacted in 1900 was again in excess of that of all previous years, and the deliveries from the factory for the current year are still increasing, even when compared with 1900. Many large contracts are on hand, and the company is fully employed in every department. The offices hitherto occupied by the company having proved too small for the company's business, Hamilton House, Victoria Embankment, London, E.C., has been taken.

During the year 51 reservists were withdrawn from the company's service to join their regiments, and ample provision was made for their wives and families, the company contributing £810. 10s. 10d., whilst a further large amount was willingly provided by the staff and men on the various works.

The directors again acknowledge the loyalty and zeal with which the company's staff have worked, and recognise that the satisfactory position in which the company now stands is largely due to this unstinted service.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27⅛d. per oz. (May 9). Consols (2¾ per cent.) 93⅞—94 for money, 94—94⅛ for account; 2½ per cent. 94⅛—95 (May 9). Consols Pay Day, June 3; Stocks and Shares Continuation Days, May 13 and 29; Ticket Days, May 14 and 30; Pay Days, May 15 and 31; Mining Share Carry-over Days, May 11 and 28.

**AFRICAN DIRECT TELEGRAPH CO. (LTD.)**—A list of 106 debentures of £100 each, being the tenth drawing of 4 per cent. mortgage debenture bonds of this company, is set out in an advertisement elsewhere. These bonds are due for payment at Parr's Bank, Bartholomew-lane, London, E.C., at par on July 1.

**BRITISH ELECTRIC TRACTION CO. (LTD.)**—Mr. J. S. Raworth has been appointed a managing director of this company, with the title of "technical director."

**BRITISH INSULATED WIRE CO. (LTD.)**—The first batch of letters of allotment and regret in respect of the new debenture issue have been posted.

**MUNICIPAL ISSUE.**—The London County Council have this week made a further issue of £2,000,000 3 per cent. London County Consolidated Stock at 98 for, *inter alia*, electric tramways and loans to other local authorities.

**PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BUENOS AYRES (LTD.)**—This company is inviting applications for £400,000 4 per cent. first debentures of £100 each.

**SOUTH AMERICAN CABLE CO. (LTD.)**—Eighty-four £100 debentures have been drawn for payment at the National Bank of Scotland on June 30.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has ordered £100,000 5 per cent. second debenture stock of the *Edison and Swan United Electric Light Co. (Ltd.)* to be quoted in the official list in lieu of the provisional certificates now quoted. The committee has been asked to allow £2,062,970 ordinary stock, £393,515 4 per cent. preferred stock and £393,515 deferred stock of the *Central London Railway Co.* to be quoted in the official list in lieu of the shares now quoted.

**THAMES IRON WORKS, SHIPBUILDING AND ENGINEERING CO. (LTD.)**—During the week this company made an issue of £100,000 5 per cent. registered second mortgage debentures of £100 each at 97½.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | May 4 | 650 | + 54 | 48 | 31,774 | + 3,613 |
| *Birmingham Tramways. | „ 4 | 4,470 | + 157 | 17 | 70,875 | + 1,223 |
| *Blackburn Corporation.. | „ 4 | 490 | + 67 | 18 | 7,781 | + 779 |
| Blackpool Corporation... | „ 2 | 346 | + 65 | †5 | 2,259 | + 354 |
| Blackpool and Fleetwood | „ 4 | 360 | + 27 | 18 | 3,950 | − 302 |
| Bolton Corporation ..... | „ 5 | 1,393 | + 315 | 5 | 7,510 | + 1,747 |
| Bradford Corporation... | „ 5 | 930 | + 516 | 5 | 4,875 | + 2,606 |
| Brisbane Trams ..... | Mar. 20 | 2,125 | + 182 | 11 | 22,466 | + 2,357 |
| *Bristol Trams & Carriage | May 3 | 4,494 | +1,613 | 17 | 69,139 | +19,988 |
| *Buenos Ayres & Belgrano | Apl. 7 | 3,001 | + 419 | 14 | 39,242 | + 7,328 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | May 4 | 6,428 | ... | 18 | 111,023 | ... |
| City & South London Ry. | „ 5 | 1,855 | + 572 | 18 | 35,716 | +13,470 |
| Cork Elec. Trams ..... | „ 2 | 530 | + 121 | 17 | 6,521 | + 745 |
| Dover Corporation ..... | „ 4 | 199 | + 10 | 5 | 1,072 | + 98 |
| Dublin & Lucan Rly. ... | „ 4 | 114 | + 21 | 18 | 1,490 | + 122 |
| Dublin United ..... | „ 3 | 3,646 | + 224 | 18 | 48,033 | − 1,776 |
| Dublin Southern Dist.... | „ 3 | 854 | + 50 | 18 | 13,451 | |
| *Dundee Corporation ... | „ 1 | 602 | + 215 | ... | ... | ... |
| *Glasgow Corporation ... | „ 4 | 11,757 | +2,563 | 18 | 155,783 | + 4,932 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 4 | 785 | + 167 | 5 | 3,123 | + 767 |
| Hull Corporation ..... | „ 4 | 1,584 | + 499 | 44 | 64,605 | +33,434 |
| *Liverpool Corporation... | Apl. 27 | 9,224 | +1,870 | 17 | 137,278 | +19,462 |
| Liverpool Overhead Rly. | May 5 | 1,632 | + 199 | 18 | 27,551 | + 2,215 |
| Perth (W.A.) Elec. Trams | „ 3 | 874 | + 464 | 44 | 29,050 | ... |
| Portsmouth Corporation | „ 4 | 558 | − 226 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 5 | 3,538 | +1,390 | 18 | 53,993 | +19,615 |
| Southampton Corporat'n | „ 2 | 660 | + 292 | ... | ... | ... |

* Partly electrical. † Minus 3 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 30. | Price Wednesday, May 8. | Rate per Cent. Yielded. | Dividend Due. | Business Done During 8 Days Ending May 8. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ ⅝ | ⅜ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 75 | 70 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12 0 | Bournemouth and Poole Elec. Supply Ord. | 11½ 12½ | 11½ 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. | 7⅜ 8¼ | 7⅜ 8¼ | 3 12 9 | | 7⅞ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9 | 8½ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 7 7½ | 7½ 7⅝ | ... | ... | 7 5/16 | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 10 0 | February and August | 9 3/8 | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 5½ | 5' 5½ | 4 1 10 | ,, ,, | 6 3/8 | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5¾ 6¼ | 5¾ 6¼ | 4 8 0 | March | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ 9½ | 8½ 9½ | 4 4 3 | February and August | 9 1/2 | 8 7/8 |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 13 | 12 13 | 4 12 4 | January and July | 12 3/4 | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 122 127 | 3 19 8 | June and December | 1 4 | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 103 | 101 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 9 | 8 9 | 4 8 11 | ... | 8 1/2 | 8 3/8 |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 12 | 11 12 | 5 0 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 106 109 | 106 109 | 4 2 7 | ... | ... | ... |
| 10,300 | 5 | 3/0 | Folkestone Electricity Supply Co. Ordinary | 5 5½ | 5 5½ | 3 12 9 | ... | ... | ... |
| 11,000 | 5 | 4/3 | Hove Electric Lighting Ordinary | 7½ 8½ | 7½ 8½ | 2 15 5 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11 12 | 11 12 | 4 7 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ 7 | 6½ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 102 105 | 102 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Kngtbg. Co & Notting Hill Co. (J't. St'n.) 4% | 102 104 | 102 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ 1¾ | 1½ 1¾ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | 4⅜ | ... |
| £350,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 101 | 98 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 11½ 12½ | 12 13 | 4 12 4 | April and October | 12¾ | 13½ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 8½ 9½ | 11½ 12½ | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | 111 | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 99 | 96 99 | 3 11 5 | ... | 9 1/2 | ... |
| 6,452 | 10 | 8/0 | Notting Hill Electric Ordinary | 15½ 16½ | 15½ 16½ | 4 13 4 | March | 16 | 15¾ |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ 6½ | 5½ 6½ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅜ ⅝ | ⅜ ⅝ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd.. 5% 1st Mor. Deb. | 65 75 | 65 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 104 | 102 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 14 15 | 14 15 | 4 13 8 | February and August | 14½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | ,, ,, | 9¼ | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 101 | 98 101 | 3 9 4 | ... | 101 | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | — | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ 3½ | 2½ 3½ | ... | ... | 3 3/16 | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 13 | 12½ 13½ | 3 17 9 | March and September | 13 | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) xd | 3⅞ 4⅛ | 3⅞ 4⅛ | 4 17 0 | April and October | 4⅛ | 4 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 129 | 124 129 | 4 14 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 9 10 | 9 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 10) | 5% | Do. 5% Debentures | 96 101 | 96 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ 3⅛ | 2½ 3⅛ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4¼ 4¾ | 4¼ 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 101 | 99 101 | ... | ... | 99½ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ 23¾ | 23½ 23¾ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅝ 10¾ | 10⅝ 10¾ | 3 15 4 | ... | ... | ... |
| 100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 116 | 114 118 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6¾ 7¼ | 6¾ 7¼ | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 10 10⅝ | 9⅞ 10¼ | 4 17 7 | May and November | 17 1/16 | 9⅞ |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 93⅝ 100⅝ | 99⅝ 101⅞ | 4 9 3 | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 15 16 | 15 16 | 5 6 3 | ... | 15½ | 15⅜ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 13 | 12 13 | 4 12 4 | February and August | ... | ... |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 119 122 | 119 122 | 4 2 0 | ... | 191 | 119 3/4 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. x | 5½ 6½ | 5½ 5¾ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" xd | 5 5½ | 5 5½ | ... | ... | 5¼ | 5 1/16 |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 107 | 104 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 1 8 | ... | 98¼ | 9¾ |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) xd | 10⅛ 11⅛ | 10⅛ 11⅛ | 2 14 2 | ... | 10 15/16 | 10⅜ |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 101 104 | 103 104 | ... | ... | 103⅜ | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | 1 13/16 | ... |
| 19,980 | 10 | 2/6 | Central London Ordinary | 9½ 9⅝ | 9¼ 9⅝ | 2 16 5 | June and December | 9 1/16 | 9 1/16 |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 118 | 113 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ 5¾ | 5¼ 5¾ | 4 6 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 101 104 | 100 103 | 3 17 10 | ... | ... | ... |
| £855,000 | Stock | 1¼% | City and South London Railway Con. Ordinary | 50 53 | 51 53 | 2 7 4 | February and August | 53 | 51 |
| 47,500 | 10 | 2/0 1/2 | Do. Ordinary (Nos. 22,501 to 70,000) | 5 5½ | 5 5½ | 2 5 5 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 127 | 122 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 118 | 113 118 | 3 9 0 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 14 | 13 14 | 4 5 9 | ... | ... | ... |
| 50,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5¼ | 5¼ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ 5½ | 4½ 5½ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 22½ | 22 22⅛ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ 15½ | 15 15⅝ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 114 | 112 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | ... | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7 13/16 8 1/16 | 7 13/16 8 1/16 | 4 1 5 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 13½ | 13 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 17 2 | January and July | ... | ... |
| £328,744* | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts (fllypd) | 102 104 | 102 104 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1903) | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,600 | 5 | ... | New General Traction Ordinary | 3 3½ | 3¼ 3¾ | ... | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4¾ 5¼ | 4¾ 5¼ | 5 14 3 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 8/0 | Do. 5 per Cent. Preference | ... | ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 12 | 11 13 | 1 13 4 | | 11¾ | 1 11/16 |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 9 10 11 | February and August | ... | ... |
| £125,000 | Stock | 87/0 | Do. 4½ per Cent. Debenture Stock | 107 109 | 107 109 | 4 3 9 | ... | 108 | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 94 97 | 94 97 | 3 2 2 | June and December | 94½ | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 30. | Price Wednesday, May 8. | Rate per Cent. Yielded. | Dividend Due. | Business Done During 8 Days Ending May 8. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £98,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 5 | January and July | ... | ... |
| 26,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 65 65 | 65 65 | ... | ... | 66 | 65 |
| £6(4,720 | Stock | 15/0 | Anglo-American | 53 56 | 55 58 | 5 7 9 | Feb., May, Aug., Nov. | 55 | ... |
| £3,097,640 | Stock | 20/0 | Do. Preferred | 97 99 | 98 101 | 5 12 5 | " " | 99½ | 98 |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10½ 1 ½ | 11 11½ | 3 3 6 | " " | 11 7/16 | 10⅝ |
| 12,232,200 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741.029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 104 | 100 104 | 3 18 5 | " " | 101½ | 100½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ 8½ | 7½ 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 17 | 16 17 | 5 17 8 | " " | .. | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 6 7 | January and July | ... | ... |
| 69,710 | 20 | 3/0 | Direct United States Cable | 9⅜ 10⅛ | 10 10½ | 6 13 4 | Jan., Apr., July, Oct. | 1 ⅜ | 10 |
| £108,200 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 102 | 100 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,300) (red.) | 135 140 | 137 142 | 4 18 7 | Jan., Apr., July, Oct. | 140 | 135 |
| £1,226,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 94 | 91 94 | 3 14 6 | " " | 93½ | 92 |
| £1,422,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) xd | 111 115 | 110 114 | 3 10 2 | May and November | 113½ | 111 |
| 250,000 | 10 | 6/6 | Eastern Extension xd & bonus | 13½ 14 | 13½ 14 | 5 0 0 | Jan., Apr., July, Oct. | 13 7/8 | 13½ |
| 50,000 | 10 | 2 0 | Do.(Nos. 250,001 to 300,000) £8 pd. is'd at £3 pm, all pd xd | 13½ 14 | 13½ 14 | ... | ... | ... | ... |
| £230,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 114 | 111 116 | 3 9 3 | February and August | ... | ... |
| £200,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 102 | 99 102 | 3 18 3 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red. xd | 101% 104% | 99% 102⅞ | 3 14 5 | May and November | ... | ... |
| 180,237 | 10 | 2/6 | Globe Telegraph and Trust xd | 9⅞ 10½ | 9⅞ 10½ | 5 2 5 | Jan., Apr., July, Oct. | 1 ⅛ | 9 11/16 |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference xd | 14⅝ 15½ | 14⅝ 15½ | 3 13 8 | " " | 15 | 14⅞ |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen ex coupon 51 | 84 85 | 83 85 | 4 5 9 | January and July | 83½ | ... |
| £33,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos | 99 102 | 100 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [1 to 1,300) (red. | 44 48 | 45 49 | 5 2 0 | May and November | 47⅛ | 46½ |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 102 | 100 103 | 3 18 1 | June and December | ... | ... |
| 11,239 | 3 | 4/0 | Reuter's | 7⅛ 8⅛ | 7⅛ 8⅛ | 4 14 1 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 120 125 | 121 126 | 4 15 7 | " " | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 3 3 | 3 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 100 | 97 100 | 5 0 0 | March and September | ... | ... |
| 20,000 | ¾ | ... | West Coast of America | ½ ⅝ | ½ ⅝ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 102 | 100 103 | 3 18 1 | January and July | 100½ | ... |
| 98,211 | 10 | 6d. | West India and Panama | ⅝ ¾ | ⅝ ¾ | ... | May and November | ... | ... |
| 24,553 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 6 7 | 8 11 6 | " " | 6⅞ | 6½ |
| 4,688 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 14 4 | January and July | 105 | ... |
| 207,920 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 13½ 14½ | 13⅝ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | 13⅝ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 2 | ... | 103½ | 10 3/8 |
| | | | **TELEPHONES.** | | | | | | |
| £1,000 | £5 | 4/0 | Ohill Telephone (fully paid) | 3½ 7 | 5½ 6 | 5 0 0 | August | ... | ... |
| 324,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 3/6 4/6 | 2/6 3/3 | 8 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ ¼ | ⅛ ¼ | 5 0 0 | November | ⅛ | ... |
| 86,493 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | " " | ... | ... |
| 590,000 | 5 | 2 6 | National | 2½ 2⅝ | 2⅜ 2⅝ | 7 17 2 | February and August | 3⅛ | 2⅞ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 10 12 | 10 13 | 5 0 0 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 12 | 10 13 | 5 0 0 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 3½ 4½ | 4 4½ | 5 17 8 | " " | 4⅛ | 4 1/16 |
| £1060,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 87 90 | 87 91 | 3 8 8 | June and December | 88 | 86 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 8 | " " | ... | ... |
| 171,504 | 1 | 0/6 | Oriental | ⅝ 1⅛ | 1⅛ 1 1/16 | 5 9 9 | April and October | 1⅛ | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ 5 | 4½ 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ 5½ | 4½ 5½ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 106 | 103 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 8 0 0 | ... | ... | ... |
| 125,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | 1 1/16 1 3/16 | 1 1/16 1 3/16 | 7 7 8 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 11 | 10 11 | 6 16 4 | July and February | 10½ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6⅜ 6½ | 5⅜ 6½ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅜ 5 | 4½ 5 | 6 0 0 | ... | ... | ... |
| 90,000 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ 1⅝ | 1⅜ 1⅝ | 3 6 7 | September | 1 7/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2½ | 2 2½ | 5 6 8 | " | 2⅝ | 2 5/16 |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 103 | 4 7 6 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 14½ 15½ | 14½ 15½ | 4 16 9 | " " | 14⅞ | 1 5/16 |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | " " | 5⅞ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 113 | 109 113 | 3 19 10 | November and May | ... | ... |
| £450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | ⅞ 1⅛ | ⅞ 1⅛ | 7 2 3 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 98 | 95 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1⅛ | ¾ 1⅛ | 5 6 8 | ... | ... | ... |
| 64,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 64,000) | 3⅝ 4 | 3⅝ 4 | 5 12 7 | January and July | 3⅞ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 101 104 | 1 1 104 | 4 17 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£5 paid) | 1½ 2 | 1½ 1⅝ | 9 1 6 | February and August | 1 1/16 | 1⅛ |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 3 4 | 3 4 | 6 12 3 | " " | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 89 | 87 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts (all pd) | 94 98 | 94 98 | 5 2 0 | " " | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5 5⅛ | 5 5⅛ | 7 14 7 | Half-yearly | 5⅜ | 5⅛ |
| 13,363 | 5 | 1 6⅛ | Do. Cumulative Preference xd | 5⅜ 6 | 5⅜ 6 | ... | ... | ... | ... |
| £130,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 106 | 103 106 | 4 5 1 | ... | 105⅜ | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1⅜ 2⅛ | 1⅜ 2⅛ | 5 6 8 | January and July | 2 1/16 | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅛ 2⅝ | 2⅛ 2⅝ | 4 6 2 | July | 2 1/16 | 2⅛ |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 16 11 | January and July | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15 16 | 15⅜ 16⅜ | 6 1 3 | February and August | 15 15/16 | 15⅜ |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6 | 5½ 6 | 3 15 0 | " " | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 111 | 107 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 20⅜ 21⅜ | 4 13 0 | " " | 2 3/8 | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 33 40 | 38 40 | 5 4 6 | March and July | 3 3/8 | 33 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1900 | 101 104 | 101 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10⅜ 11⅜ | 5 12 6 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ 6 | 5⅜ 6 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 7/0 | Willans and Robinson Ordinary ex new | 10 11 | 10 11 | 5 9 1 | April and October | 10⅛ | 10⅜ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref ex new | 6⅜ 7 | 6⅜ 6⅝ | 4 8 11 | " " | 6⅝ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,200. [No. 4. Vol. XLVII.] FRIDAY, MAY 17, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 20c., or 70pf.


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## NOTES.

AT last someone has asked a question in the House of Commons pertinent to the telegraph service, the losses on the conduct of which now exceed half a million per annum. We are thankful even to Mr. HENNIKER HEATON for once in a way drawing attention to a subject of real practical importance. The figures he adduces are startling enough; but they are borne out, as the Chancellor of the Exchequer had to admit, by accounts submitted to Parliament every year, and passed over unheeded until now. Of course, Mr. HEATON'S suggestion that the business should be leased to a private company who could and would make it pay, is not to be taken seriously; but in this implied condemnation of the unbusinesslike manner in which the telegraph service is conducted by the Government, the member for Canterbury has good ground to go upon, and we rather fancy that now he has put his foot upon it he will not take it off in a hurry, Sir MICHAEL HICKS-BEACH'S explanation will satisfy nobody who cares to look back on the history of the service. True, Parliament has extorted some concessions "which do not produce any corresponding increase of revenue"; but many others were voluntary surrenders; and most of the rest could have been resisted if the true state of the telegraph revenue had been frankly dealt with. The truth seems to be that while every care is taken to keep up the revenue earnings of the Post Office unimpaired, the income of the telegraph branch of that great department is frittered away in concessions for which the Post Office takes all the credit and the telegraphs all the odium. Here is an interesting path of inquiry open to Mr. HENNIKER HEATON if he cares to pursue it.

Mr. VOYSEY'S annual report to the Streets Committee of the Corporation of London is a document that generally possesses interest in proportion to the untoward eventfulness of the previous year. Happy, it has been said, is the nation that has no history; and it is only in years when electric supply affairs in the City have involved contentiousness and bitter hostility that these reports of the City electrical engineer have partaken of a specially interesting character. If, therefore, the report for 1900, now in our hands, is somewhat milder and of less absorbing interest than formerly, the fact merely indicates the entry upon a calmer and more prosaic phase, in which businesslike activity has supplanted vigorous litigation. We may now hope for the "general consideration of the public lighting question," which Mr. VOYSEY thinks desirable, and immediate activity in the electric lighting of the side streets. We learn from the report that the Charing Cross and Strand Corporation have laid about 27 miles of mains in the City, and are constructing two substations—one at Ludgate-hill and the other at Fenchurch-street. With regard to the street arc lamps, it is satisfactory to note that the average time of extinction per lamp has fallen from 181 minutes in 1899 to only 54 minutes last year, a fact which speaks well for the improvements in arc lamp construction and management.

DOUBTLESS our readers have watched with interest the passage through the committee stage of the bill promoted by the South Staffordshire Mond Gas, Power and Heating Co. This bill has created a greater diversity of opposition than has any engineering measure for some time past—gas and electrical engineers, local authorities and statutory companies having joined forces in hostile array. Yet, if we are to believe all that has been said on the side of the promoters, there is no necessity for alarm on the part of those who fear competition; the Mond gas is such harmless stuff that neither the gas industry nor the electrical industry can be injured by it. Truly remarkable is this Mond gas. For, although it will keep furnaces at a roaring white heat, we are asked to believe that it cannot be made to incandesce the Welsbach mantle; and, although it will run gas engines and develop power far cheaper than a consumer can get it in any other way, we are to understand that by no sort of ingenuity can it be made to compete with the statutory electric supply undertakings either of local authority or of company. While, as for the

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bare suggestion that Mond gas can be intended to compete with ordinary lighting gas, perish the cruel suspicion, for are we not assured that Mond gas burns with the feeble non-luminous flame of methylated spirit?—from which we are supposed to understand that not by the greatest chemical skill in the entire civilised world can Mond gas be "enriched" into any sort of lighting gas. Nevertheless, for ourselves, we have our doubts on all these points. Yet not even all these doubts combined are so great as our doubt whether the Mond scheme can profitably supply the gas to consumers at 2d. per 1,000 cubic ft. So we may hope as well as doubt.

A special interest has always attached to the electrical equipment of the Baltimore tunnel of the B. and O. Railway. It was the earliest application of electric traction to a standard railway; and, though constructed as far back as May, 1895, it has set a pattern from which important recent electrical construction has been carried out with but trifling alteration. The electric locomotives, for example, which have been used for hauling heavy trains through the B. and O. tunnel, are reproduced very closely in the locomotives in the "Twopenny Tube." We shall never forget our first ride at express speed on one of the B. and O. locomotives, with the clear and cool air of the tunnel blowing in our face. It was an eloquent testimony to the cleanliness of electric traction even in a long and unventilated railway tunnel. But, admirable as was the general arrangement of the pioneer equipment, there were defects that it has been wisely decided to remove, now that recent developments in electric traction make improvement possible. The cumbersome and unsightly overhead supports for the conductor beyond the tunnel ends, and the unnecessarily complicated arrangements for collecting current from this ærial conductor, are to be abolished, and a form of surface third-rail system will take their place.

The new system, which is the invention of Mr. McLeod Murphy, of New York, differs from the ordinary continuous third-rail system in having the conductor rail subdivided into sections, each section being alive only when actually required for supplying power to a passing train. A report for 1900, from the British consul at Baltimore, gives the following particulars of the system, which is now in course of construction:—

The rails are charged in the following manner:—The motorman, opening the controller to the first notch, automatically communicates with the air tank carried on the locomotive as a storage reservoir for compressed air, which operates the brakes. This compressed air tank immediately gives the power to the air engines, which in turn operate an electric generator, which generates current sufficient to pick up a switch, which charges the third rail with current from the power-house. That instant the current passes from the switch to the third rail, to the shoe, to the electric generator which lifted the switch; that immediately and automatically becomes a motor, which, through the substitution of two valves in the air engine, also becomes a compressor, and charges the air tanks from which it originally got its motive power. Thus at no time during the operation of a car over this system is it possible to have a charged conductor or third rail except when the motorman has opened the controller. Hence, should a person even fall beneath a car, and the motorman quickly closes the controller, there would not be the slightest danger from injury by electricity. There is no possibility of the third rail in front or rear of the car, while the car is in motion, becoming charged. It lies on the ground as harmless, so far as electricity is concerned, as any car track on any system.

Another alteration which is being effected in connection with the reconstruction is the addition of a large storage battery, which will serve to equalise the load on the power station. Since that station was erected its duties have been greatly augmented by the addition of a town tramway load, and by a certain amount of electric lighting on the railway. These items contribute a comparatively steady load, whereas the main-line trains, being less frequent than the tramcars, and each taking a much greater amount of power, are more liable to give rise to unpleasant variations of load on the engines. The new battery will smooth matters for the power station, and, at the same time, will ensure a reserve of electrical energy for the main line in the event of the machinery being interrupted. The maximum power obtainable from the battery, it is stated, will be 1,200 h.p.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |

**East London Technical College.**—A special course of four lectures on electro-chemistry ("Theory of the Voltaic Cell and Polarisation") will be given by Prof. R. A. Lehfeldt, D.Sc., on Thursday evenings in June, at 8 p.m.

**Glasgow Section of the Institution of Electrical Engineers.**—The area of this local section, which has now been defined by the Council, takes in all places within a circle of 50 miles radius from Glasgow, but excluding Edinburgh.

**Obituary.**—We regret to record the death, at Bournemouth, on 7th inst., after a long illness, of Mr. Charles A. Crook. Mr. Crook, who was born in 1838, served on board the o.s. "Hawk" as chief engineer in 1868-9, and afterwards took up a shore appointment at Greenwich as engineer-superintendent to the Telegraph Construction and Maintenance Co., in whose service he remained for over 30 years. Mr. Crook was a member of the Telegraph Cable Lodge, and will be greatly missed by a wide circle of friends.

**Summer Meeting of the American Institute of Electrical Engineers.**—The meeting of the members of the American Institute of Electrical Engineers, and all electrical engineers who may find it convenient to attend, will begin in New York city on August 14th. Trips will be made on Thursday and Friday, and on Monday the works of the General Electric Co. at Schenectady will be visited. On Tuesday, the 20th, the general meeting will open at Buffalo, and the closing meeting will probably be held on the 24th. It is expected that local committees of the Institute will be appointed in some of the larger cities to co-operate with the Council committee for the purpose of facilitating the arrangements which visitors may desire to make for seeing places of interest.

**Works Management.**—The sixth and concluding lecture of the course on "Works Management" was delivered by Mr. A. H. Barker, before the Institution of Junior Engineers, on April 25th. The lecturer continued the consideration of the question of cost accounts, treating it with special reference to establishment expenses. The methods necessary to obtain accurate results were indicated, and possible sources of error pointed out. Specimens of the books required were illustrated. The principles of the determination of depreciation charges were discussed at some length, and the desirability was urged of reducing all costs to a common basis and plotting them in the form of curves, from which it would be possible to deduce a law according to which the costs would vary. The various matters involved in the process of estimating were then entered into, the important bearing upon it of a proper system of cost-keeping being dwelt upon. At the conclusion of the lecture a vote of thanks was accorded Mr. Barker, and it was announced that the six lectures would be published by the Institution at the earliest possible date.

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**Report of the Paris Exhibition Commissioners.**—The report of the Royal Commission on the Paris Exhibition contains a clear account of the reasons for the British exhibits securing a relatively small degree of success, and we give below an extract from the portion relating to the industrial section :—

Taken as a whole, it cannot be said that the British Industrial Section presented a fair reflection of the industry of the country seen at its best. With some notable exceptions, comparatively few of the highest class of British manufacturers took part in the exhibition. Many of them, when approached, pleaded that if they exhibited at all they would have to do so on a scale which would put them to great trouble and expense, while they had no inducement to seek to extend their connections, since their businesses are so large already that they can hardly execute their orders. The result was that some industries were represented by firms of minor importance, who have an object in advertising themselves and pushing to the front. Their displays were often creditable, but they could not be taken as representing the best productions of the country, nor did their exhibits compare as favourably as could be desired with those of other countries. This is partly owing to the somewhat different view of exhibitions taken by Your Majesty's Government and the Governments of other Powers. The latter appear to regard them as a valuable means of promoting their commercial interests. They spend large sums of money and assist and encourage their manufacturers in such a way that they are able to select the best examples in every department of industry, and to present them in the most attractive form. We, on the other hand, have to rely exclusively on the voluntary efforts of our manufacturers, and our exhibitors have to bear the whole of the expenses which participation in an exhibition involves. We are inclined to doubt whether British industry as a whole derives any benefit from exhibitions in which British exhibitors enter at such a manifest disadvantage. Our system has remained unchanged for half a century, but the conditions are no longer the same as when exhibitions had the charm of novelty. . . . Now exhibitions have become so common that manufacturers no longer take the same interest in them, and only exhibit if they see a distinct prospect of advantage to be gained by doing so. . . . We are of opinion that the voluntary system can no longer be relied upon to secure an adequate representation of British industry, and that in any future international exhibition in which it may be decided to take part it will be necessary to have recourse to the principle of selection, which has been largely adopted by foreign powers. This principle, which involves the payment of some of the expenses hitherto borne by exhibitors, would necessitate larger grants than it has been customary to give; but we think that, unless some approximation can be made to the expenditure of foreign powers, no good purpose would be served by entering into further competition with them.

A sum of £125,000 it will be remembered, was granted by Parliament for the use of the Commission, and of this a considerable portion had to be devoted to the erection of the Royal Pavilion in the Rue des Nations.

**Electrolytic Production of Phosphorus.**—The production of phosphorus by electrolytic means has been the subject of experiments by Dr. F. J. Machalske in his laboratory at Long Island City, N.Y, and it is stated by our contemporary, the *Electrical World* of New York, that such satisfactory results have been obtained from the process developed from these experiments that a company, called the Anglo-American Chemical Co., has been formed to produce yellow and red phosphorus on a commercial scale. The following details of the system have been supplied by the inventor:—The raw material consists of the ordinary phosphate rock used generally as a fertiliser. At present two electrical furnaces are installed. Each furnace has a chamber 12in. by 18in. in area with a carbon bottom and sides lined with calcined magnesia, the cover being composed of fireclay and red brick. Each furnace has an aperture on top for feeding the phosphate rock, and an aperture for inserting an electrode 8ft. long and 4in. in diameter. It is stated that five minutes after current is turned on a temperature of 7,000°F. is produced, which will reduce in 15min. 150lb. of phosphate rock. The phosphorous vapour set free is condensed under water and the residual slag allowed to run off. The operation is a continuous one. Current for the plant is furnished from the circuits of the New York and Queen's Electric and Power Co., of Long Island City. It is claimed that yellow phosphorus may be produced by this method at a rate of 7 cents per pound, the cost of electric power being 3 cents per horse-power-hour. Dr. Machalske claims to have separated by means of the electric furnaces a new metallic compound which has the appearance of silver, and is not affected by sulphuric or hydrochloric acid, though slightly attackable by concentrated nitric acid. The metal has a specific gravity of 10 02, and is a good conductor of electricity at common temperatures, but a non-conductor at temperatures at 100deg. and above. He also claims that in the course of his experiments he found that by means of an electrical furnace connected with a properly constructed condensing apparatus chlorides of carbon and especially carbon tetrachloride may be produced by treating in an electric furnace a mixture of common salt, carbon and sand.

**The Electric Power Station at the Pierrefitte Mine.**—Mr. E. Henry Davies recently read an interesting Paper before the Institution of Mining and Metallurgy describing the electrical installation which has been working the argentiferous lead and blende mines at Pierrefitte in the French Pyrenees since January, 1898. The total fall available was 26·13 metres, and the quantity of water 2,200 litres per second. Two Escher-Wyss turbines, directly coupled to dynamos made by Messrs. Schneider & Co., of Creusot, were installed, each of 420 H.P., one being always in reserve. The intake canal is 3 metres wide by 1 metre deep, widening to 3·5 metres near the sluice gates. The first 42 metres of canal ends in a flushing sluice placed at its side and kept always partly open to drain off débris; the next section of 70 metres is arched, and terminates at the intake chamber immediately above, being on an inclined iron grating and overflow weir, and at this point the canal widens to 10 metres to reduce speed of water to 0·175 metre per second. From end to end the total fall is 0·13 metres, giving a flow of 0·57 metres per second. The pipes are 1·2 metres in diameter, and have always 1·8 metres of water above the top. The length of pipe-line is 382 metres and the loss by friction in the canal pipe-line and sluices 1·63 metres, reducing the working head to 24·5 metres. Commencing with pipes 4mm. thick they were gradually increased to 8mm., double riveted joints being used for the lower half; they are made of mild steel in 3 metre lengths, with flanged joints, bolted tgether, the joints being made with tarred cord. The pipes are carried along the ridge of the roof of the station and then straight through to the turbines. A blast piece is fixed close to the intake chamber, and a chimney 16in. diameter is placed in the pipe-line close to the power station, the top being a little above the level of the water at the intake. The floor of the station is 5 metres above the river, and for this distance the water acts by suction; the outflow pipes pass through the floor and terminate in a square water chamber by means of which their ends are always 2ft. under water. Each dynamo has an output of 400 amperes and 750 volts when running at 425 revs, per min. This voltage was chosen to permit of interchange of current with Pierrefitte-Canterets electric railway which has a 3,000 H.P. station 2 miles higher up the river. Thus, at the beginning, current was hired from the Tramway Company to work five motors at about ½d. a Board of Trade unit. The centre of the line to the air compresser plant is 2½ miles and to the concentrating plant 1 mile. The line is bare copper wire in duplicate except when it crosses the tramline, when lead-covered cables drawn in 3in. gas pipe is used. There are in all eight motors, one 100 H.P. for compresser, one 30 H.P. crusher motor, five 28 H.P. motors for jiggers and vanners, and one 10 H.P. motor for the machine shop. The motors for crushers, &c., are fixed on slide rails mounted on large cell insulators; they are placed in small separate rooms and drive machinery through a transmission shaft, the speed of the motors being 950 revs. and the speed of the jigger and other shafts 80 revs. The total cost of the work was £8,000. It was carried out by Messrs. Estrade and Capron, of Toulouse, under the supervision of the author.

**The Electrical Conductivity of Air and Salt Vapours.**—A Paper by Dr. Harold A. Wilson, read before the Royal Society on March 28th, described experiments undertaken to obtain information on the variation of the conductivity of air and of salt vapours with change of temperature, and on the maximum current which a definite amount of salt in the form of vapour can carry. They are a continuation of the two researches on the same subject published in 1899. A current of air, containing a small amount of a salt solution in suspension in the form of spray, was passed through a platinum tube heated in a gas furnace; this tube served as one electrode, and the other was fixed along its axis. The temperature of the tube was measured by means of a platinum platinum-rhodium thermo-couple, and the amount of salt passing through the tube was estimated by collecting the spray in a

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glass-wool plug. The relation between the current and E.M.F. in air was found to depend very much on the direction of the current. When the outer electrode was negative, the current attained a saturation value with an E.M.F. of about 200 volts; but when the outer tube was positive it increased rapidly with the current, even with an E.M.F. of 800 volts, so that a much greater E.M.F. would be necessary to produce saturation, if in this case it can be produced at all. With salt vapours the relation between the current and E.M.F. was not much affected by reversing the current. The current was always greater when the outer tube was negative, the reverse being the case with air alone. At low temperatures the current attained a saturation value, but above 1,000°C. it was found to increase more nearly proportionally to the E.M.F. The variation of the current at constant E.M.F. with the temperature for air was found to be approximately capable of being represented by a formula of the type $C = A\theta^n$, where C is the current, $\theta$ the absolute temperature, and A and $n$ constants. The constant $n$ depends on the E.M.F. used. With 240 volts it was 17, and with 40 volts 18. The energy required to ionize 1 gramme molecular weight of air was estimated by supposing that the fraction of the gas dissociated into ions is proportional to the current at small E.M.F.s. The result for air is 60,000 calories between 1,000°C. and 1,300°C.—of the same order of magnitude as the energy set free when H and OH ions combine to form water in a solution. The relation between the current and temperature for salt vapours was found to be rather complicated. With potassium iodide and using an E.M.F. of 800 volts, the current had a maximum value of about $4{\cdot}5 \times 10^{-4}$ ampere near 900°C., and rose very rapidly again near 1,150deg., the value at this temperature being $3{\cdot}6 \times 10^{-4}$ ampere and at 1,200deg. and 1,800deg. $7 \times 10^{-4}$ ampere. At 100 volts the same sort of curve was obtained, and other salts gave like results. The energy required to ionize 1 gramme molecular weight of KI at about 300°C. was estimated to be 15,000 calories in the same way as was done for air. The maximum current carried by the salt vapour (at 1,300deg. with 800 volts) was found to be nearly equal to that required to electrolyse the same amount of salt in a solution. The author regards this fact as considerable evidence in favour of the view that the ions are of the same nature in the two cases.

Polyphase Working.—Dealing with motors, transformers and incidentally with rotatory converters, Mr. Eborall, in his third lecture at the Society of Arts, last Friday, repeated to a large extent some of the main points in his recent Institution Paper (*The Electrician*, Vol. XLVI., pp. 855, 906, 948 and 982). The synchronous motor, he said, was constructed on the same lines as a polyphase generator, and the rules already given from the design of the latter applied. Although a single-phase synchronous motor would not start itself, a polyphase synchronous motor could be made to do so by means of the eddy currents in the pole-shoes; but it took two or three times the full-load current to get the motor up to the speed of synchronism by this means. Thus, when synchronous motors of a large size were used it was desirable to run them up to speed with small induction motors, or in the case of motor generators to start up if possible with the continuous-current machine as a motor. Mr. Eborall then came to the V-curve of the synchronous motor. Running the motor at a constant load and speed, and varying the exciting current, a distinct minimum main current is obtained at a certain excitation. When over-excited a leading current is taken, when under-excited a lagging current. This property is of great value for polyphase motor plants, as by a judicious combination of induction motors which always cause the current to lag and over-excited synchronous motors, a power-factor approaching unity can be attained. This also was the main advantage of rotatory converters over asynchronous motor-generators, an advantage naturally shared by synchronous motor-generators. The synchronous motor afforded also a means of regulating the voltage of a combined light and power distributing plant, for by varying its excitation the voltage of the whole system could be increased or diminished. The lecturer then referred to the regulation of the continuous-current voltage of rotatory converters, which is, of course, independent of the field strength. A method of supplying this requisite means of regulation is to vary the impressed voltage on the slip-rings by connecting in circuit a choking-coil arrangement. This inductive regulator consists of a shunt and series winding, one of which is movable to vary the distance between them and consequently the inductance. The regulation can be done quite automatically, however, by compounding the field-magnets of the converter, and profiting by the properties of the V-curve. As the current increases the machine is over-excited, the leading current is increased, and, acting in the opposite direction to the lagging effect of the circuit, increases the voltage. Dealing at some length with the question of hunting, Mr. Eborall practically followed the Institution Paper already referred to, concluding with the recommendation to employ—in addition to the chief precautions of engines with even turning moment, suitable governor dash-pots and damping coils on the field poles—a choking coil in series with each lighting feeder to prevent the smaller pulsations from affecting the lamps. These pulsations may be so noticeable that they go right back and are even observable in the field circuit ammeter. For a discussion of the questions of star-connected versus mesh-connected transformers and single versus combined transformers, the reader may be again referred to our reprint of the Institution Paper. Mr. Eborall, after dealing with these questions, indicated some points to be observed in the design of the core-discs, and explained the cause of the increased drop of the pressure of the transformer with an inductive load, showing Mr. Kapp's diagram in this connection. A well-designed transformer, he stated, should have a 1½ per cent. drop on a non-inductive load and a 6 per cent. drop on an inductive load. In conclusion, Mr. Eborall compared the butt and lap joint in building up the magnetic circuits of transformers, and expressed his preference for the former, as, although its magnetic reluctance was greater, it had the advantage of enabling the yoke to be taken off and the coils easily removed for repair or replacement.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), May 17th.**

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

*7:30 p.m.* Ordinary Meeting in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-upon-Tyne.

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture IV., on "Polyphase Electric Working," by A. C. Eborall.

**SATURDAY, May 18th.**

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

*10 a.m.* Visit to the Works of Messrs. Elliott Bros., Lewisham.

**MONDAY, May 20th.**

INSTITUTION OF JUNIOR ENGINEERS.

*6 p.m.* Visit to the Works of the Renewable Electric Lamp Co., Brunswick-place, City-road, N.

**WEDNESDAY, May 22nd.**

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

*7:30 p.m.* Annual General Meeting at 28, Victoria-street, S.W. There will also be a Lecture on "High Tension Discharge Through Gases, including Cathode Rays," by J. W. Coales.

INSTITUTION OF ELECTRICAL ENGINEERS—BIRMINGHAM SECTION.

*7:30 p.m.* Ordinary Meeting in the Physical Theatre, the University, Birmingham, when a Discussion will take place on Mr. A. C. Eborall's Paper "Some Notes on Polyphase Sub-station Machinery," which was read at the previous meeting.

**THURSDAY, May 23rd.**

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS—DUBLIN SECTION.

*7:30 p.m.* Annual General Meeting at the Royal College of Science, Dublin. The following Paper will be read: "Note on the Arrangement of Accumulators in a Small Installation," by W. Tatlow.

**FRIDAY, May 24th.**

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. R. T. Glazebrook. Subject: "The Aims of the National Physical Laboratory."

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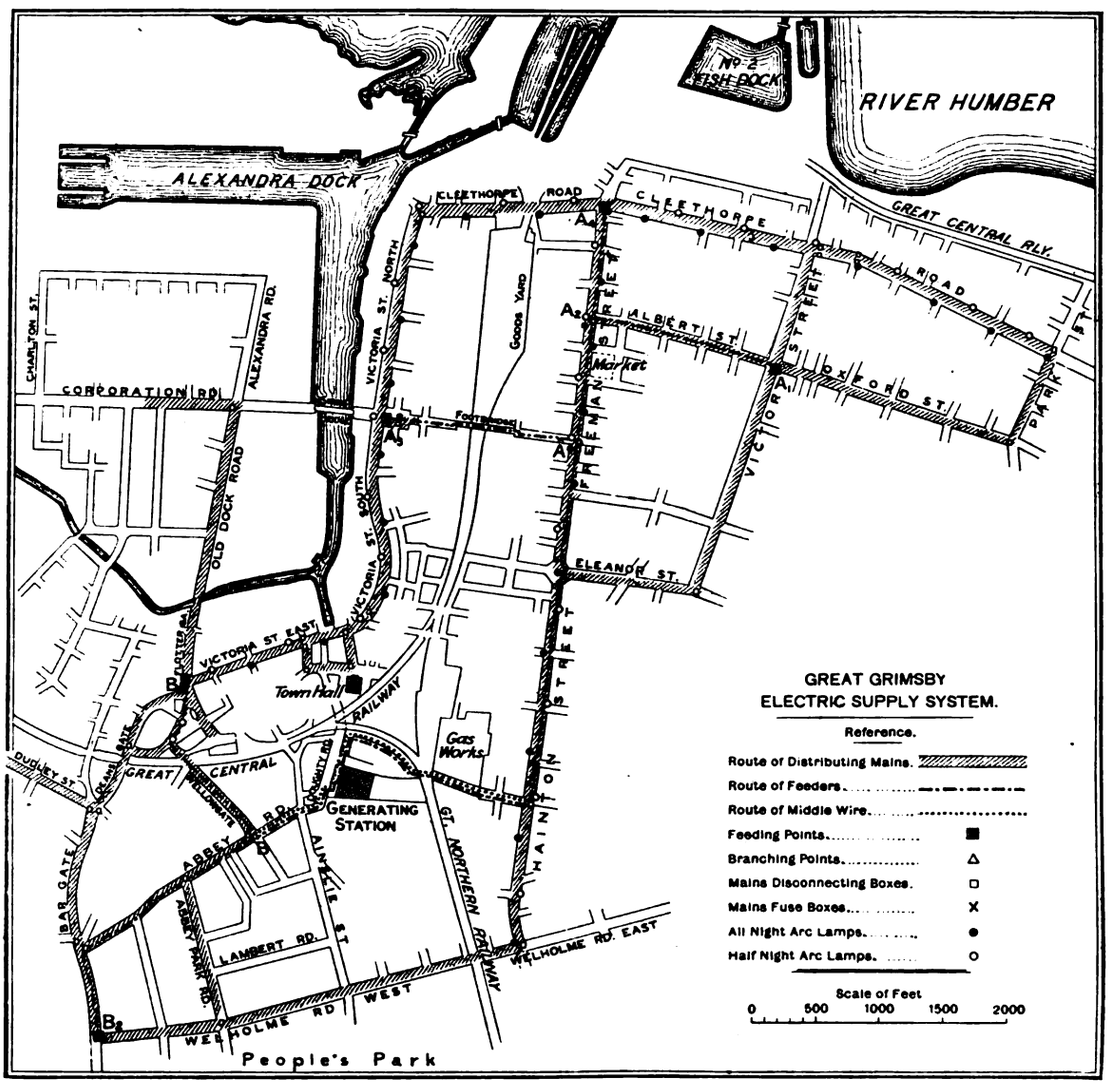
# GREAT GRIMSBY MUNICIPAL ELECTRICITY WORKS.

The Borough Council of Great Grimsby obtained a provisional order as far back as 1894 for lighting the town by electricity, but nothing was done till 1896, when the borough engineer drew up a report in which he estimated the total expenditure at £30,000. A sub-committee was appointed, which visited a number of stations; by January, 1898, the Public Lighting committee had endorsed the recommendation of the sub-committee that steps should be taken to provide a municipal electricity supply, and at the same time they engaged Prof. Kennedy as consulting engineer. The question of electric tramways had been under consideration for some time and now the sub-committee were authorised to meet the representatives of the local tramways company and endeavour to arrange terms, as the company's lease expired in about two years. In August the Lighting committee recommended the Council to proceed with the works, in accordance with Prof. Kennedy's scheme, at a cost of about £35,000; they also recommended that the tramway company's lease should be renewed for 21 years on condition that they worked the lines electrically, taking current from the Corporation. A necessary loan of £43,000 was applied for in April, 1899, and sanctioned by the Local Government Board by June. The tenders for plant and buildings, amounting to £31,000, were accepted by the Corporation in September, and the agreement with the tramway company approved. The work was then immediately put in hand, the foundation stone of the generating station being laid in October.

The station is conveniently situated on a waste piece of Corporation ground adjoining the Great Central Railway, from which a siding is taken for the conveyance of coal. Unfortunately, there is no running water, so a cooling tower has had to be erected for condensing purposes. The building is a well-built structure, with its fine block of offices in front, shown clearly in our illustration. It was built to the designs and specifications of Mr. Marshall Petree, and the work was carried out under the supervision of Mr. H. G. Whyatt, the present borough engineer. Ashton Hall buff bricks have been used for the construction, the engine-room being lined with white glazed bricks. The surface of the floor is composed of 3in. red and black tiles. Skylights run the whole length of engine and boiler-house. In the case of the former windows opening upwards are used for ventilating, in the latter the usual louvre boarding being employed. For the chimney shaft the ground had to be excavated to a depth of 11ft. 6in.; pine piles, 12in. square, were next driven in to a depth of 20ft.—12in. longitudinal sleepers were employed with 6in. plank decking bedded in solid cement. The shaft is octagonal, 180ft. high, tapering from 13ft. to 11ft. internal bore, with a fire-brick lining carried up 25ft.




GREAT GRIMSBY: MAP SHOWING ROUTE OF MAINS.

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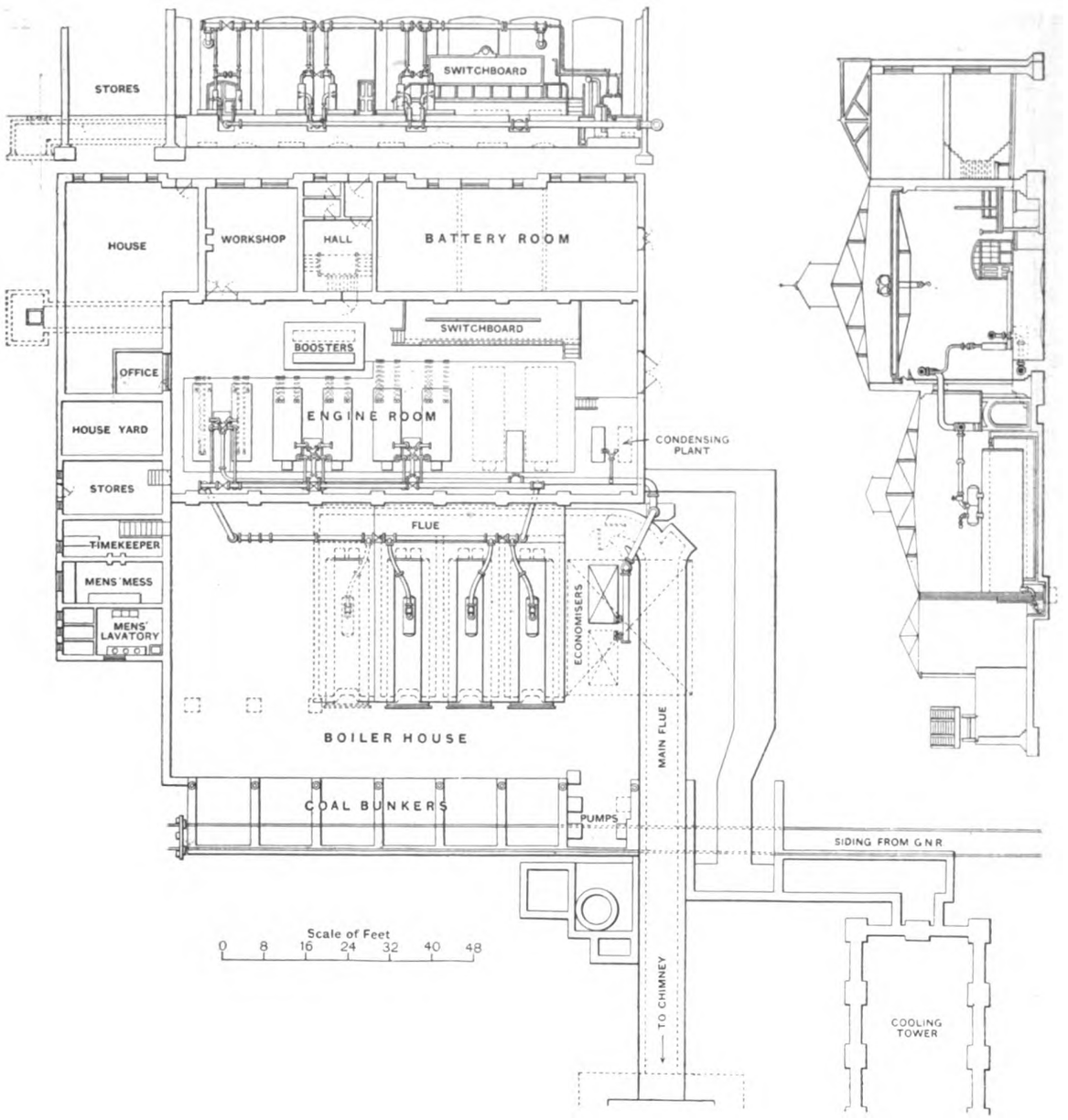
Three Lancashire boilers have so far been fixed, each boiler being 8ft. diameter and 28ft. long, fitted with two internal furnaces, 3ft. 3in. diameter; each flue is reduced to 2ft. 9in. at the back of the boiler, and is fitted with four cross tubes. Each boiler is also fitted with a steam drum, 2ft. diameter and 8ft. long, and is built for a working pressure of 160lb. to the square inch, though tested hydraulically for 20 min. with a pressure of 275lb. The steam piping is on the ring main principle, 8in. pipes being used, with 6in. branches to the boiler. The branch pipes to the engines are in duplicate, one pair of pipes serving two engines, the system generally now employed by Prof. Kennedy. The generating sets comprise three 150 H.P. steam dynamos, running at 550 revs. per min., and two 75 H.P. steam balancers, running at 550 revs. A fourth 150 H.P. set is now being fixed, and there is a 330 H.P. Belliss engine on order, coupled to a Westinghouse 200kw. unit. The larger dynamos are designed to have an output of 192 amperes at 480 volts when running at normal speed, but they are also capable of running steadily at any E.M.F. from 460 to 520 volts as shunt machines from no load to full load with a variation of speed not exceeding 5 per cent. from the normal, and they carry 20 per cent. over-load for a short time. These machines are also compound wound for working the system of tramways that is being introduced, the compound winding being so proportioned as to raise the voltage from 500 volts at no load to 550 volts at full load without adjustment of the shunt regulating resistance or alteration of the engine governor. A special rotary sectional double-switch, with two resistances, is fixed beneath the switchboard platform, worked by a lever on the platform. These resistances are connected one in series with the series field, the other as a shunt across its terminals. The series winding is connected between the equalising bar, which is connected to the negative terminal of the machines on the switchboard and the negative 'bus bar. The regulation of the compounding is five approximately equal steps, the resistances being so proportioned that the total resistance of the circuit between the equalising and negative bars remains constant for each machine. The lever for working the switches is arranged that it works through an angle of 180deg., and the switch can be locked in any position.

Each of the 75 I.H.P. engines is coupled to two dynamos, each machine having an output of 92 amperes at 240 volts and capable of running steadily with pressure varying from 230 to 260 volts.




GREAT GRIMSBY: PLAN AND SECTIONS OF GENERATING STATION.

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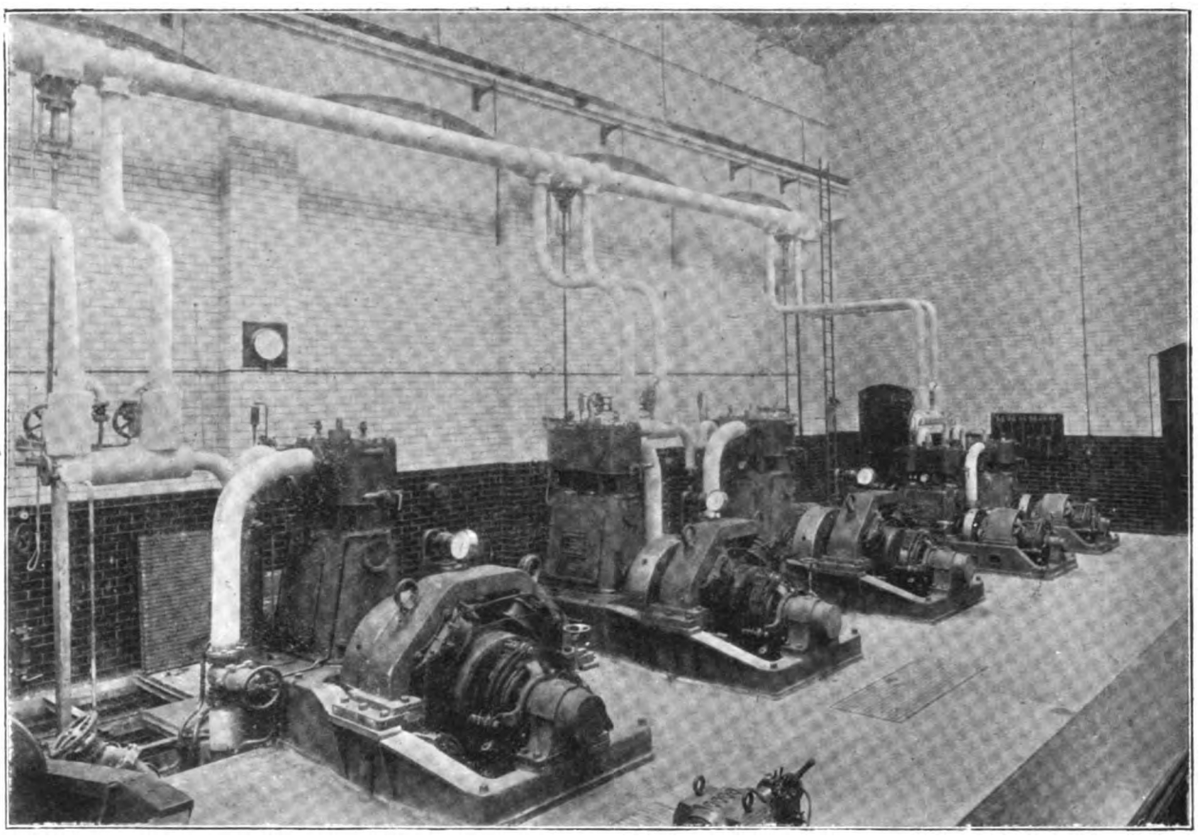
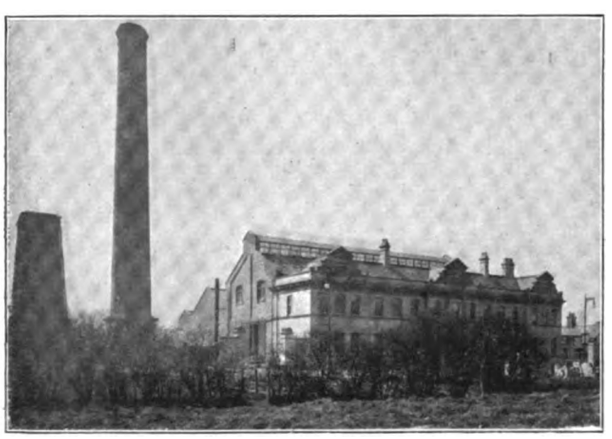
The main switchboard consists of eight dynamo and lighting panels and two traction feeder panels. They consist of enamelled slate slabs mounted to a steel framework, faced on the front and edges with polished teak moulding. The switchboard platform is placed several feet above the engine-room floor, and on the balustrade which surrounds this platform are placed the shunt regulating switches, which are of the slider pattern.



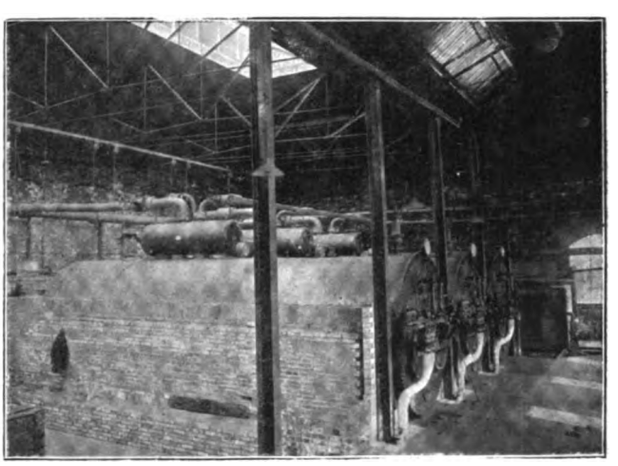
GREAT GRIMSBY: GENERAL VIEW OF ENGINE ROOM.

On the four panels at the right are mounted the dynamo and feeder instruments and the switch-gear, each dynamo circuit being fitted with a Ferguson-White patent double-pole automatic cutout, a Kelvin sector pattern ampere-gauge, an equalising switch, and the necessary plugging arrangements,



GREAT GRIMSBY: GENERAL VIEW OF POWER STATION.

so that any machine can be switched on to the lighting or traction systems, as well as the panels for plugging the dynamos and extension feeders on to the 'bus bars. An ebonite locking screen is provided to prevent the possibility of a mistake being made in the casing of the switching in of the dynamos to traction or lighting. The automatic cutouts are arranged to work as maximum or minimum by turning a small key, and it is impossible to keep the cutouts closed should an excess current be passing. Carbon breaks and asbestos screens are provided for dealing with the spark. Plug type switches are provided for the voltmeters, and as the centre distance of the plugs is different for the lighting and the traction instruments, a means is provided against the possibility of a mistake being made when switching in the dynamos. The voltmeters are of the Kelvin syphon recorder pattern. On this panel are also mounted the earth and middle wire ammeter, and in series with the former is a



GREAT GRIMSBY: INTERIOR OF BOILER HOUSE.

Kelvin earth recording ammeter. The next two panel are fitted with the instruments and switches for two lighting feeders and the balancing dynamos. The end panel is for controlling the boosters and batteries. In each booster circuit there is fitted a Kelvin edgewise pattern ampere-gauge, a booster reversing switch and the plugging bars, so that the

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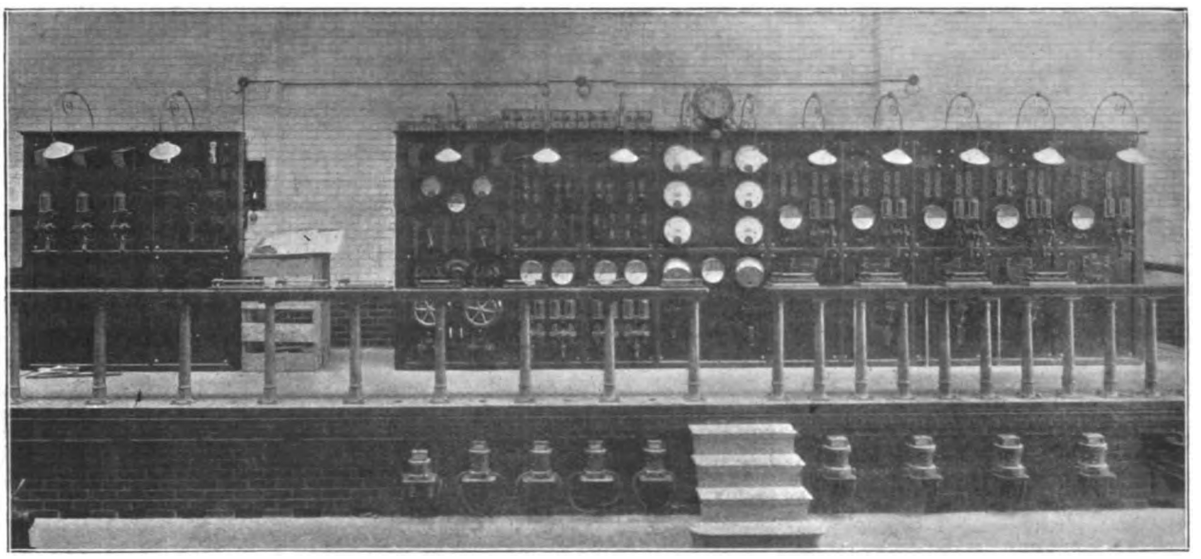
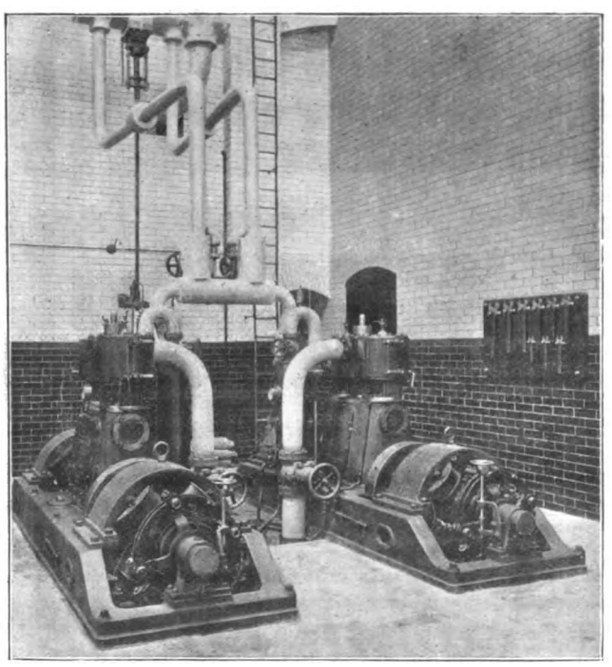
booster can be connected either to the main battery, the milking leads, or the meter testing leads. In each battery circuit is fitted a double-pole emergency switch, a Kelvin edge-wise ampere-gauge, and a 15-way battery switch, similar to that described in *The Electrician* (Vol. XLII., p. 297) as being fitted at Carlisle. The traction board is placed to the left and is mounted with instruments and switching gear for three feeders, and there is the usual Board of Trade panel.



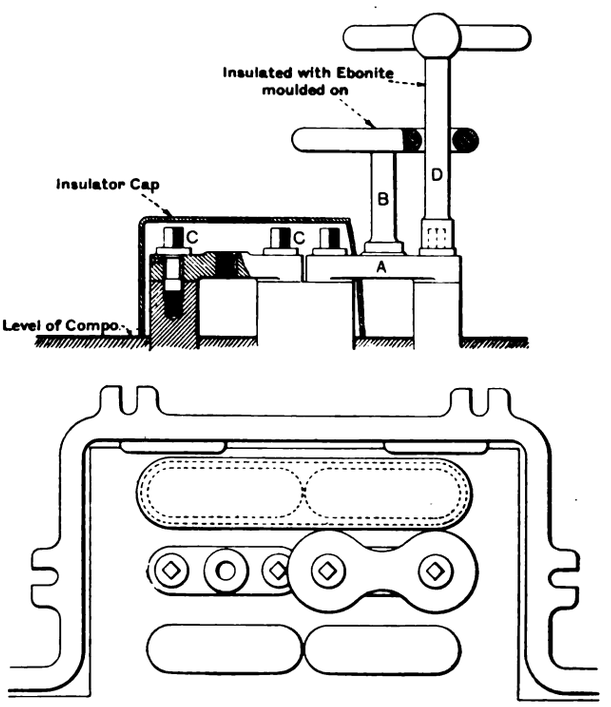
GREAT GRIMSBY: VIEW OF SWITCHBOARD.

The board is surmounted by an electrically-driven clock. There are double-pole fuses in the subways, and Chamberlain and Hookham meters, which are placed in front of the platform, in circuit with each dynamo.

The cables are of the British Insulated Wire Co.'s standard type laid on the solid system. Fuses are placed wherever the distributing circuits branch from the feeders and also at points in the distributors, pilot wires being taken back from positive and negative mains to lamps in the station, so that it is possible to tell immediately a fault develops on any section by the lamp failing. So far, two main feeders have been laid—one 0·75 sq. in. the other 0·35 sq. in.—the middle wire feeder being 0·10 sq. in. The distributing mains are 0·10, 0·10 and 0·06 sq. in. respectively. In series with the earth current recorder between the middle wire and the earth plate an automatic switch is placed. This switch opens when more than 10 amperes pass, and at the same time throws in a resistance of about 25 ohms between the middle wire and earth, and in parallel with this resistance is a lamp or bell alarm. By this means, even if a dead earth occur on one side of the network, no serious rise will take place in the pressure on the other side. Prof. Kennedy has introduced a novel form of disconnecting link box which has been largely used at Grimsby. The link A is removed by means of the lifting piece B, which is made of steel insulated with moulded ebonite, the steel screws C being first unloosened by a box-spanner similarly insulated. It will be seen from the drawing that, after the screws have been unloosened, there is no tendency for them to fall out, and they remain in position and are lifted with the link.



GREAT GRIMSBY: THE STEAM-DRIVEN BALANCERS.




GREAT GRIMSBY: DETAILS OF MAINS DISCONNECTING BOX.

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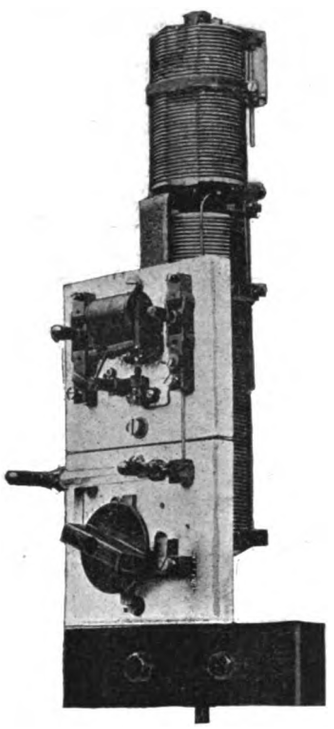
A battery of Tudor cells has been installed for day lighting load, and capable of giving 60 amperes for five hours, 90 amperes for three hours, or a maximum of 120 amperes for 30min. They are charged by two boosters driven by a single motor. The charging current is 60 amperes, and the boosters raise the station voltage 10 to 70 volts as desired when running at 1,000 revs. per min., or 90 volts with a 5 per cent. increase of speed.

Seventy-eight public arc lamps have, so far, been fixed, arranged 10 in series off the outers or five in series off the 230 volts. The Gilbert short type, with 12in. carbons, have been used. The post gear, of which we give an illustration, consists of a high-voltage switch and fuse, an automatic cut-out, two isolating switches and a compensating resistance. The cutout is of the trigger type, a small switch being released by the action of a shunt coil taking about 2½ watts, the adjustment being made by one screw. The makers claim that the lamps strike or retrace after any accident to within 15 per cent. of their normal condition and that they will stand a variation of voltage of 20 per cent. either way; they are fixed from brackets or posts, the latter being of very similar design to those erected in Edinburgh.



GREAT GRIMSBY: SWITCH GEAR IN ARC LAMP POSTS.

Two of Weir's direct-acting 6in. by 15in. feed pumps have been installed, each capable of discharging 2,200 gallons per hour against a pressure of 160lb. per square inch. As a stand-by a 6in. by 10in. differential feed pump of the bucket and plunger type has been fixed. A Green's economiser, with 144 tubes, has been erected in the main boiler flue, capable of raising 1,000 gallons per hour from 60°F. to 200°F., the scrapers being driven by a small engine in the usual manner.

The main exhaust pipe is 14in. diameter, and runs in a culvert under the engine-room. The exhaust can either be taken direct to atmosphere or through a surface condenser capable of dealing with 17,000lb. of steam per hour, giving a vacuum of 25in. of mercury.

The circulating water is obtained by a centrifugal pump from a well 6ft. diameter, the pump delivering 12,000 gallons per hour. For cooling, a Klein's tower has been erected. This is 66ft. high by 39ft. by 22ft. The inside is built to a height of 25ft. with cooling frames, the arrangement being such that the water is distributed at the top in thin uniform films, whilst the tiers are arranged so that the direction of flow is constantly changed and retarded.

The demand for current has already become large, and it is expected by Whitsuntide that the trams will be running, when the Corporation will supply current for them at the rate of 1½d. per unit for the first 360,000 units per year, 1⅜d. for the next 100,000 units, and 1¼d. afterwards.

The following are a list of the contractors and sub-contractors:—

| | |
|---|---|
| Hewins and Goodhand, Grimsby | Buildings. |
| Edwin Danks & Co. | Boilers. |
| Belliss and Morcom | Engines. |
| Mather and Platt | Dynamos, pipework and condenser plant. |
| Thomas Parker (Ltd.) | Booster. |
| Tudor Accumulator Co. | Accumulators. |
| Carrick and Ritchie | Traveller. |
| Kelvin and James White | Switchboard. |
| Crowther & Co.'s Electrical Industries | Lighting works. |
| J. Hopkinson & Co. | Engine valves. |
| Dewrance & Co. | Boiler fittings. |
| Washington Chemical Co. | Steam pipe lagging. |
| Smethwick Boiler Covering Co. | Boiler lagging. |
| E. Green & Son | Economiser. |
| Henry Watson & Sons | Water filter. |
| G. and J. Weir | Feed pumps. |
| Klein Engineering Co. | Cooling tower. |
| Gilbert Arc Lamp Co. | Arc lamps. |
| McKenzie Bros. | Arc lamp posts. |
| British Insulated Wire Co. | Mains. |
| Pilkington & Co. | Battery room floor. |

In conclusion, we must thank Prof. Kennedy, the consulting engineer, and Mr. W. A. Vignoles, the borough electrical engineer, for the information they have furnished us.

## THE KINGSLAND MECHANICAL SURFACE CONTACT SYSTEM OF TRACTION.

Last Friday a number of representatives of the technical Press had the opportunity of inspecting at Wolverhampton an experimental track equipped with the mechanical surface contact system on which Mr. Wm. Kingsland has been working for the last few years. The system differs from other surface contact systems now before the public in that the

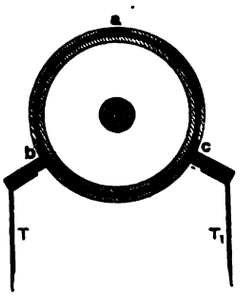



FIG. 1.—COMMUTATOR SWITCH.

studs are alternately made alive and dead by mechanical strikers on the car. These strikers operate tappet wheels, each of which has six teeth, the wheel being given a sixth of a turn every time it is struck. The wheel, spindle and bracket for fixing to the cast-iron case are clearly shown in Fig. 2, On a separate spindle but coupled by a universal joint are mounted the commutator switch and automatic stop, all of which are depicted in this illustration. The body of the commutator (see Fig. 1) is made of woodite, in which are imbedded three contact pieces, *a*, *b*, *c*, joined together by a metal ring. The brushes T, T′ are so placed that with alternate positions of the tappet wheel both will be in contact with the metal ring, or both will be insulated. The strikers on the car are arranged that the front contact is alive before the hind one is switched off, so that under ordinary conditions the circuit is not broken at this switch.

Fig. 5 shows a section of the roadway, giving the general features of construction. Fig. 3 is a sectional end view of the switch-box, rails and tappet wheel; and Fig. 4 is a half-sectional front view of the same. Referring to these two figures, R is one of the tram rails, and R′ is the outside or slot rail, forming, in conjunction with R, the slot S, which is ⅝in. in the experimental track. D is a cast-iron street box,

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about 1ft. 6in. deep, having a removable cover F, and containing the inner switch-box H, and the tappet wheel L, which latter is mounted on a bracket, B. The switch-box H is clamped down on a watertight joint J, by means of bolts and lugs. On unscrewing these latter the box H with all its contents can be lifted out of the outer box D for inspection or removal; and the bracket B and tappet wheel L can also be removed in a similar manner. Thus every part is perfectly accessible, and can be inspected or renewed in a few minutes. The spindle A, which carries the switch mechanism, passes through a watertight gland in the box H, and is coupled at E to the spindle C, which carries the tappet wheel. The main and branch conductors M, N pass through watertight glands into the bottom of the box D, and are connected by means of terminal pins and sockets with the contact brushes T, T′ of the commutator switch W. A plug is provided at the top of the switch-box to enable any water that may collect to be easily removed by a hand-pump.

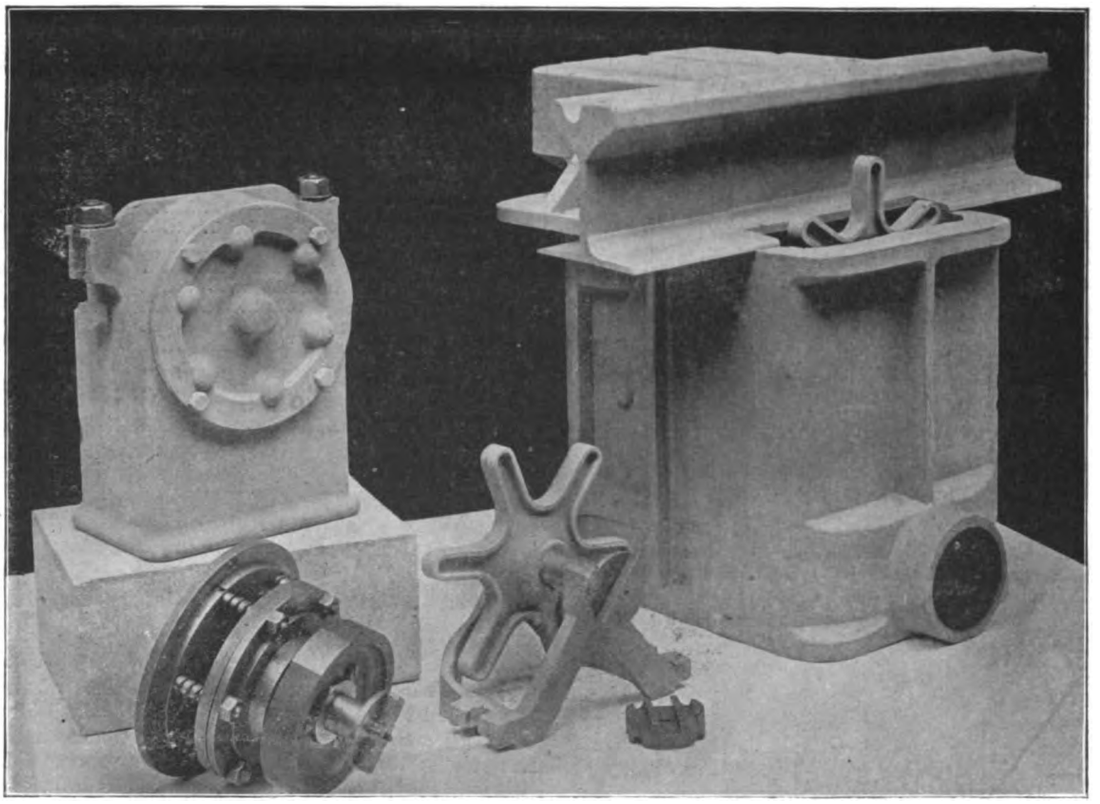

FIG. 2.—GENERAL VIEW OF STREET BOX AND APPARATUS.

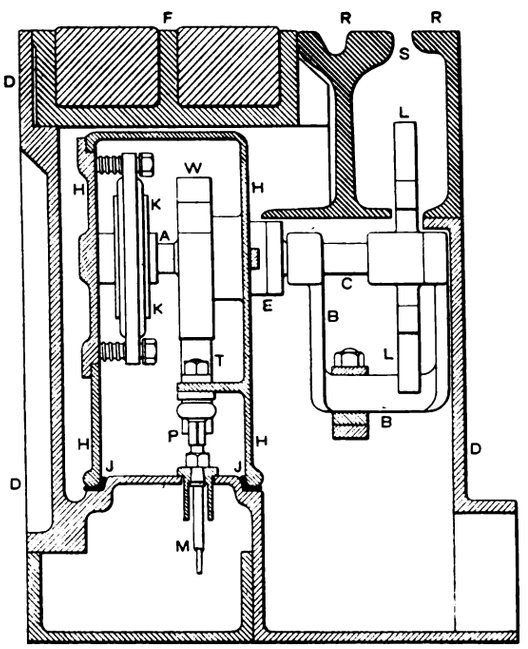


FIG. 3.—SECTIONAL END VIEW OF STREET BOX.

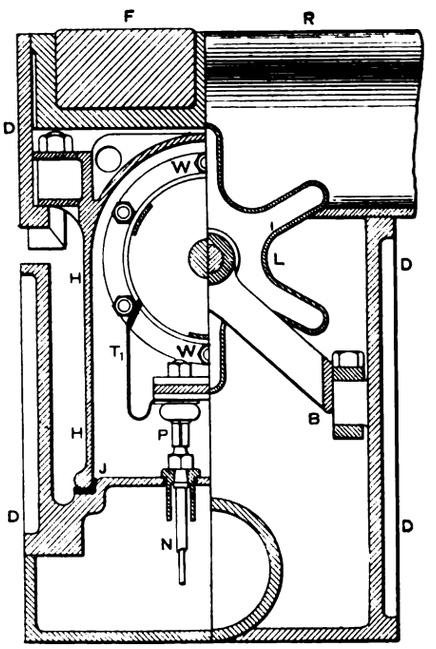


FIG. 4.—HALF-SECTIONAL END VIEW OF STREET BOX.

The principal difficulties to be overcome in a system of this description are the liability of the tappet wheel being carried too far and the shock of the blow deranging the mechanism. To prevent the former an automatic locking device has been

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used, and to obviate the latter an arrangement of springs has been called into requisition.

The locking device, of which we give a section, cross-section and development of one of the screw motions in Fig. 6, is much on the same principle as that generally used in the breech blocks of ordnance. To the tappet wheel A is keyed a wheel B, with segments of six screws cut on it. This wheel engages with a gun-metal ring C and imparts to it a rotary motion of $\frac{1}{6}$th of a revolution each time it is struck, the ring being provided with stops to prevent the spindle turning too far. The motion is combined with the movement of the parts C, D and E parallel to the spindle against the action of the springs F which return them to their normal position ready for the next stroke immediately the screw threads touch the stops. The ring C has likewise six left-handed broken threads cut on the outside to act when the tappet wheel is knocked in the opposite direction and engage with the ring D which is furnished with stops in the same way as the ring C. Lastly, the shock in transmitting from the rotary motion of the ring D to the lineal motion of the ring E is taken by the springs $G_1$ or $G_2$, depending on whether the tappet wheel is moving forward or backward. The movement can be more clearly traced in detail by considering the motion of one thread from the development plan as it moves from $P_1$ to $P_2$, when it will be seen that the ring C receives rotary motion to be taken up by the springs $G_1$, and a lineal motion to be taken by the springs F, the stop Q preventing the segment moving too far. To further prevent jar there is a powerful spring, attached to each of the car strikers, which hardly operates at slow speeds. The arrangement of conductors is shown in Fig. 7. R, R are the rails, $S^1$, $S^2$ are the studs, M is the main cable, and $C^1$, $C^2$ are the commutator switches. A system has also been got out for working the cars with one striker, which necessitates the use of two commutator switches on the same shaft in each box. To prevent the tappet wheel being wilfully turned, two contrivances have been patented. The first and simplest consists of a piece of angle iron fixed to the tramway rail over the tappet wheel, the strikers on the cars being curved not to foul the angle iron. The second consists of a vertical lever with two projecting pieces, which stand one on each side of the top vertical tooth of the tappet wheel. A projection on the striker moves the lever sideways away from the tappet wheel, the lever falling back into position after the striker has passed. The contact studs are solid fixtures connected by means of flexible conductors to enable them to be removed for inspection. The inventor claims that the first cost of a single line of track, including the electrical equipment of conductors, switches, and accessories, would be from £6,500 to £7,500 per mile, where the cost of the overhead trolley system would be from £5,000 to £6,000, and the conduit system from £10,000 to £12,000.

At Wolverhampton we saw about 200yds. of experimental track with one 60ft. curve. The contact studs were 18ft.

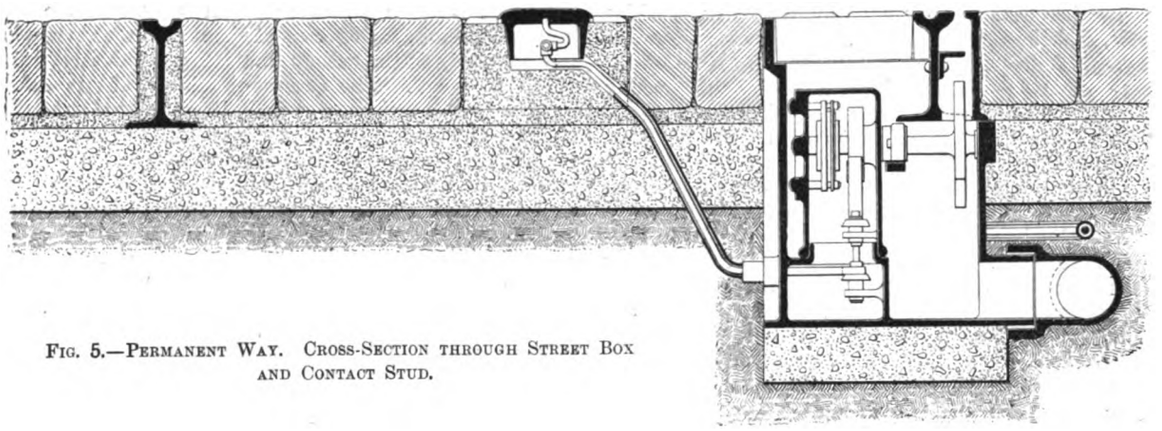

FIG. 5.—PERMANENT WAY. CROSS-SECTION THROUGH STREET BOX AND CONTACT STUD.

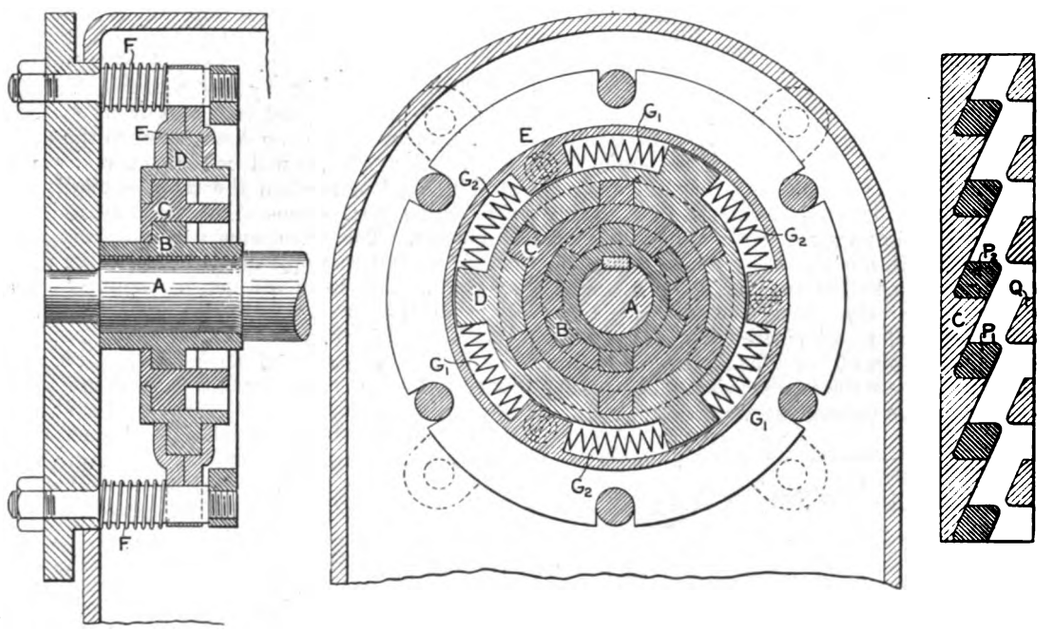


FIG. 6.—THE AUTOMATIC STOP.

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apart on the straight, the skate being 22ft. long, made of special section tube. The tappet wheels were of malleable cast-iron and the roadway had not been made up. We also had the chance of examining the various parts of the system, and we were shown a striker driven by a motor operating on a tappet wheel at a rate corresponding to a car speed of about 15 miles an hour.

It was evident, from inspecting the apparatus, that great care had been taken in getting out the details, and the designs are mechanically good. The worst feature noticeable at the trials was the noise, but this would to a certain extent be deadened on a made-up track; but it is difficult to say how much. We understand the inventor is now experimenting with raw-hide tappet wheels, and these, if successful, would lessen the noise considerably. It follows, from the noise, that in spite of the springs there must be considerable knock in the locking device, but we were informed that one which had been subject to many thousands of knocks had shown no signs of wear. It is a question for experience whether there is sufficient space between the tappet wheel and the box to allow for the proper drainage of the slush that would collect between the tram and guide rails, and the insertion of extra drains would add considerably to the expense. The insulation of one of the contact studs causes the current to be broken at a commutator switch, without any apparent damage however. The only apparent accident that could cause a stud to be left alive would be the derailment of the car, if the car were not replaced in same position as when it left the track. It is claimed for the system that it does not involve any departure from the present

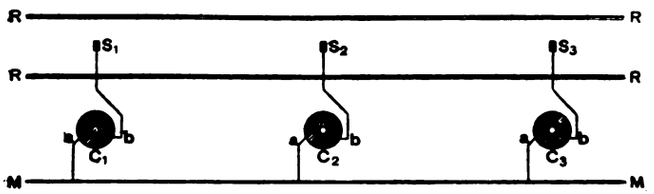


FIG. 7.—ARRANGEMENT OF CONDUCTORS WITH TWO STRIKERS ON CAR.

well-known methods of track construction, and that it may be applied to an existing track by setting up the outside rail to form the slot, with a minimum disturbance of the road-bed for inserting the street boxes.

There appears to be one point that has been overlooked, which is probably due to the track not having been filled up and which, we think, requires careful consideration. The leakage from the studs over which the car is passing is likely to be considerable when the roads are in a muddy condition, and the potential at some distance along the track may be a cause of danger to horses, not so much when the car is running at its normal speed as on starting and standing, when horses are likely to be close to the car. This danger would appear to be inherent to all surface contact systems, though it is possible a way out of the difficulty may be found by making the tie-bars between the rails heavier and extending them up to the surface of the permanent way.

## THE PARIS EXHIBITION.—XVIII.*

(BY OUR SPECIAL CORRESPONDENT.)

The telegraphic and telephonic apparatus at the Paris Exhibition has been so fully dealt with by Mr. Gavey in his recent Paper (*The Electrician*, Vol. XLVI., pp. 186 and 208) that little need be added. One notable feature of the telegraph and telephone section, however, which, owing to Mr. Gavey's own modesty, he failed to describe, was the British Post Office exhibit. In this was a collection of practically all the instruments and samples of the material used by this department, from the morning-test tangent galvanometer, with its seven shunts ($\frac{1}{5}$, $\frac{1}{10}$, $\frac{1}{20}$, $\frac{1}{40}$, $\frac{1}{80}$, $\frac{1}{100}$, and $\frac{1}{320}$), to the latest thing in Post-Office telephone exchanges. Among the smaller details not universally known was an insulator containing a fuse under a cap at the top and intended for places in which there are frequent crosses with overhead power lines. Another was a magneto bell with a mechanical indicator combined with it and actuated by the motion of the hammer. A "silence cabinet" for "counter telephones" was also shown, in which a stool is provided for the telephone user to sit on, a a contact in connection with the stool automatically ringing a bell at the counter when he leaves the cabinet. An exchange board, the first of this particular type which had been built, was exhibited, intended for small exchanges in which a multiple board is not required and a luminous signal board of the latest Western Electric pattern is not worth while installing. A permanent current of about 2 milliamperes holds up the armature of the calling indicator, this indicator having a 1,000 ohm coil. The action of taking off the subscriber's receiver stops this current and allows the indicator armature to drop, and the insertion of the answering plug by the operator sends a stronger current through the coil and restores the indicator. The substantial old 8-point jack, to which the Post Office has always shown considerable affection, is retained on these boards, but, in distinction to the former permanent-current exchange system of the Post Office, the subscribers have magneto sets with low resistance (100 ohm) bells having a single dome, instead of battery bells as formerly. Another feature of these boards is a combined speaking and ringing key, the back position of which, against the pressure of a spring speaks to the calling subscriber and rings the called subscriber; the middle position is "through," and the forward the speaking position. Visual shutter indicators are used for the clearing signal, being actuated as soon as the subscriber hangs up his receiver. The board shown at the exhibition was a 200-subscriber board, with three panels, the middle one of which was fitted for trunk lines.

It was disappointing that Mr. Gavey in his Paper had been unable to give more particulars of the Siemens and Halske 14,000 subscriber flat board. Although I was also unable to obtain a diagram of the connections, the following additional data may be of interest:—The 14,000 subscribers are all repeated on each multiple of the flat board in the usual manner, and there are 100 subscribers per operator's position, with 15 pairs of plugs and the combined indicator and answering jacks described by Mr. Gavey. Instead of opening in front, as the flat boards built by the National Telephone Co., the under side of the board is got at from one end for repairs, so that there need be no disturbance to the operators in such cases. This point, it will be remembered, was referred to by Sir William Preece when the relative merits of upright and flat boards were discussed at the Institution of Electrical Engineers. The wires were arranged very tidily under the board, leaving an ample passage-way in the middle for a man to enter. The jacks are set in strips of 20, arranged two deep on the strip, which measured 21mm. by 95mm., or 21mm. by 106mm. if the number strip be included, the jacks being thus at about 10mm. centres. The barrel of each jack fits into the board with a sort of spring catch, so that by employing a special tool any single jack can be pushed through to beneath the board and examined by itself. These boards, with series jacks and on the single-wire system, are in use in three of the Berlin telephone exchanges.

Of course, the "clou" of the telegraphic and telephonic exhibits was the Poulsen telegraphone, which has already been very fully described in *The Electrician* (see *The Electrician* of April 26, p. 5). It was unfortunate, however, that it was only a comparatively short time in operation there, so that many visiting the exhibition and desirous of testing the capabilities of the instrument were disappointed.

The Exposition Centenalle in the Electricity Palace was an interesting collection of books, manuscript and apparatus tracing the progress of electricity during the century. Among the manuscripts was the Paper (much corrected) read before the Académie Royale des Sciences by Ampère on Nov. 24, 1823, on Electrodynamic Phenomena. A forerunner of the Ruhmkorff coil was shown in the shape of a large coil with hand-wheel interrupter, constructed by the Maison Bréguet in 1842, and there was also a Clarke magneto dating

* Previous articles appeared in *The Electrician* of July 20 and 27; Aug. 3, 24 and 31; Sept. 14 and 28; Oct. 5, 12 and 26; Nov. 2, 16 and 30, 1900; Jan. 18, Feb. 1, April 12, and May 3, 1901.

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from 1834, and various electromagnet motors. The famous Pacinotti machine of 1860 was represented by a model, but the enormous built-up permanent magnet, made by Jamin in 1876 was there. The most interesting things in this collection were the first and second Gramme rings ever built, in the first of which the current was taken directly off the armature, the wire being bared for the purpose, and a number of models and actual machines showing the gradual evolution of the Gramme dynamo. A collection of early arc lamps was also interesting; it included the "Lampe Soleil," of which one has heard so much lately as the forerunner of the Nernst lamp. There were not so many early incandescent lamps, perhaps because this lamp did not interest French workers so much as the arc in its incipient stages. An interesting one, however, had been lent by M. de Lodyguine, and bore the date 1873; it consisted of a

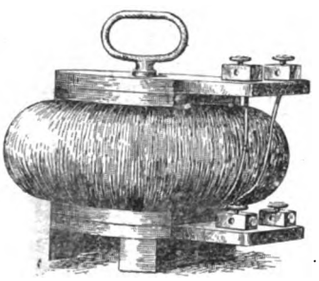

FIG. 116.—GANZ TRANSFORMER OF 1885.

carbon pencil supported by iron wires soldered into the ends of a glass cylinder. One of Mr. Swan's first lamps of 1880 was also exhibited, and one of the first Edison lamps made in France in 1883.

Two other historical collections were shown—one American, which was spoilt by the absence of a catalogue or any descriptive labels, and the other by Messrs. Ganz & Co. in the Hungarian section. In this the most interesting thing was a transformer built in 1885, and resembling in shape a gipsies' kettle (Fig. 116). It contains a ring of copper formed by the primary and secondary windings, surrounded with a closed magnetic circuit of iron wires in the form seen in the figure. The whole is held between two wooden discs carrying the terminals.

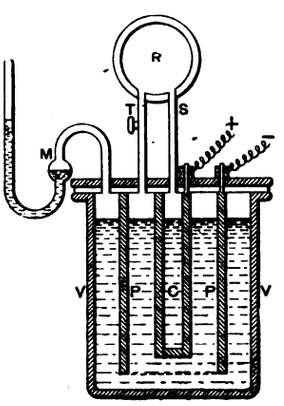


FIG. 117.—LABORATORY FORM OF COMMELIN-VIAU GAS BATTERY.

Electrochemical exhibits were distributed in various parts of the exhibition. Several types of storage cell were on view, claiming large capacities and small weights, and exhibiting grids of various degrees of architectural beauty. Two cells made according to patents of Messrs. Commelin and Viau had peculiar features. One is a gas accumulator based on the employment at the positive pole of oxygen and of a cadmium deposit at the negative pole. In the laboratory apparatus, shown diagrammatically in Fig. 117, the anode consists of a hollow carbon cylinder C, communicating by a tube S, with a reservoir R, this latter being connected to the outer cell V by a second tube with a tap T. The cathode is a cylinder of antimonious lead P, surrounding the carbon C, and the electrolyte is a solution of cadmium sulphate.

The apparatus is hermetically sealed, and the charging current produces a deposit of cadmium on the negative P, while oxygen is evolved at the carbon C. This oxygen accumulates in the upper part of the cell V, and passes through the tube T into the reservoir R, whence it is diffused by the tube S into the interior of the carbon C. When the pressure-gauge M indicates 1kg. pressure the cell is ready to furnish a discharge current. The tap T is closed, and on connecting the two poles through the circuit the pressure, which was equal in the cell V, the reservoir R, and the carbon C, begins to diminish in the cell V in consequence of the decomposition of the water by the cadmium, which is converted again into cadmium sulphate. The nascent hydrogen at the positive pole C combines with the oxygen in the pores of the carbon, and forms water. As the oxygen in C is under pressure, and the pressure in the outer cell V continually diminishes, the oxygen is continuously passing outwards through the pores of the carbon. The electromotive force of the battery is 1·5 volts, and the current is stated by the makers to be 0·25 to 0·30 amperes per square decimetre of cathode surface.

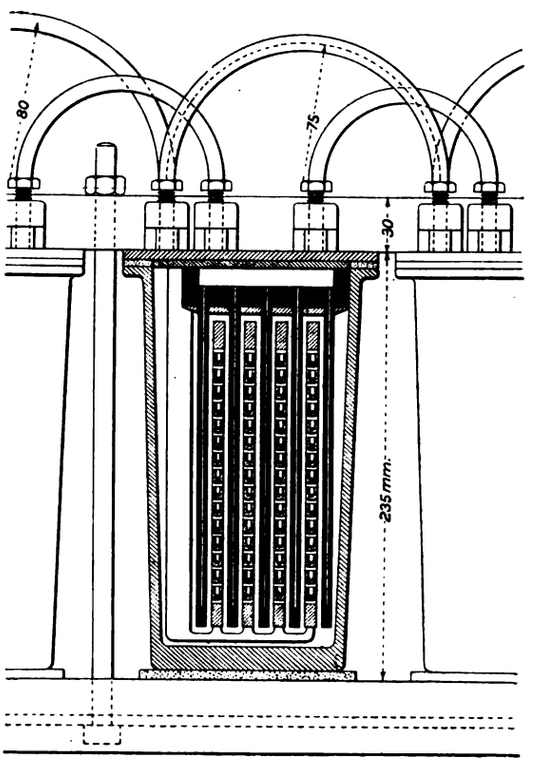


FIG. 118.—SECTION OF COMMELIN-VIAU GAS BATTERY

In the form of the battery intended for actual industrial use (Fig. 118), the hollow carbon cylinder is replaced by rows of small porous carbon tubes packed one against the other so as to form a plate, and these tubes terminate in a common chamber. The chambers of all the cells of a battery are in communication, and similarly the gases of all the cells V are in communication, so that one tap T suffices for all. The cathode is formed of celluloid troughs placed one above the other, along the bottom of each of which is a strip of lead, the ends of these strips being connected together by autogenous solder to form the negative plate. The cadmium deposits itself on these lead strips.

The second cell exhibited by this firm likewise makes use of the metal cadmium. The anode is made up of an ebonite grid (Fig. 119) on which is riveted a conducting frame of lead of the form shown in Fig. 120, and the insterstices of the grid are filled up with lead peroxide paste. The negative plate (Fig. 121) is a sheet of insulating material on the two sides of which are thin sheets of lead 0·2mm. thick, carrying sloping celluloid shelves 8mm. apart, as seen in the figure, the object of these being to support the cadmium deposited from a solution of sulphate of cadmium with which the cell is filled. Against these shelves is a perforated sheet of celluloid, so



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that the peroxide plate can be fixed flat against it. On charging, peroxide of lead is formed at the positive, and cadmium on the negative, sulphuric acid being set free in the liquid. On discharging the peroxide is reduced, the cadmium is attacked by the sulphuric acid, and the solution returns to its former state. When completely discharged, the inventors claim that there is no fear of the positive plate sulphating, as no sulphuric acid is left in the solution.

The E.M.F. of this cell is from 2·20 to 2·15 volts, and it is claimed that the capacity is as great as 30 ampere-hours per kilogramme of plate. This, it is said, may even be increased to 40 when a carbon plate 2mm. thick replaces the lead sheets and celluloid partition of the negative plate.

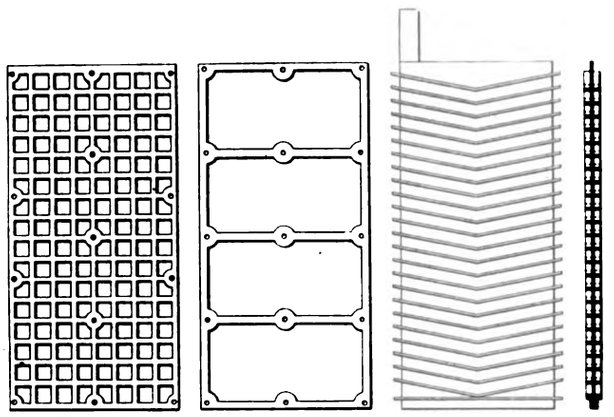

Fig. 119. Anode Grid. Fig. 120. Conducting Form for Anode. Fig. 121. Negative Plate.

Commelin-Viau Cadmium Cell.

Another storage battery of unusual construction was the Phœnix cell, in which the electrodes were lead rods, on which were threaded ebonite washers to hold the paste, and to act as separators. The Majert cell (see *The Electrician*, Vol. XLIV., p. 218), and the planing machine for increasing the surface of its plates was also on view.

English battery manufacturers were represented by the E.P.S. Co. and the Chloride Co., who both exhibited the various types of their cells. These are so well known as to require no further description. The E.P.S. Co. showed, in addition to batteries and accessories, an electrically-driven dog-cart, shown in Fig. 122.

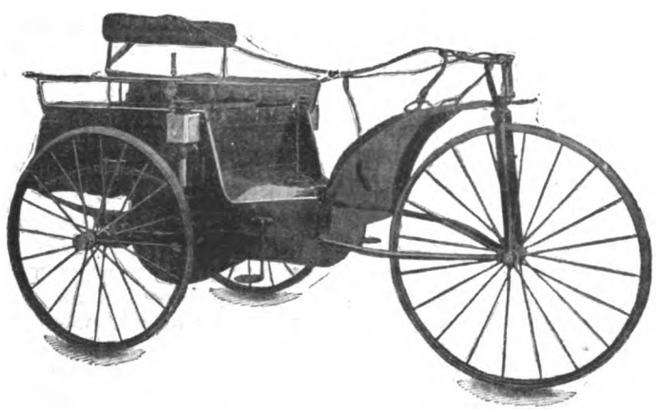

Fig. 122.—E.P.S. Dog-cart.

It is designed to carry two persons seated side by side, and is intended for a maximum speed of 12 miles an hour on the level, and to run, under average conditions 20 miles without recharging. Its weight is about 14½ cwt. exclusive of passengers. The two-pole motor is geared by means of an intermediate gear and a Renold chain to the driving axle, which is divided into two parts, united midway between the wheels by an ordinary bevel-wheel differential gear, to the case of which the sprocket wheel is attached. The steering wheel is mounted in a fork, and the backbone is pivoted on it by a joint having universal motion. Diagonal side braces are attached by joints to the lower extremities of the fork, and at their other ends to the front of the cart; these keep the fork in position, and permit of the wheel locking; they also cause the wheel when locked to be deflected from the perpendicular towards the side of the greater circle described, thus greatly adding to the stability when turning.

The steering wheel is guided by leather reins, running through eyes in a crossbar attached to the top of the fork. A bolt is provided, by which the wheel is kept in mid-position; this is released automatically when tension is applied to the reins. The switch gear consists of reversing and of a controlling switch, placed under the driver's seat; the former is manipulated by a vertical lever on his right hand, the latter has four positions: (1) off; (2) two parallels of 20 cells in series, in circuit with the motor; (3) 40 cells in series, in circuit with the motor; (4) 40 cells in series, in circuit with the motor, with a resistance in parallel with the magnets. The controlling switch is a roller, actuated by the driver sliding his seat forward when starting or accelerating the motion, and sliding it backwards when slackening the speed or cutting off the current. When the controlling switch is in the first position and the car is running, if the reversing switch be set to backwards, the motor is closed on itself in circuit with a resistance and generates current. In addition to this brake, there is a foot band-brake acting on a cast-iron drum on the motor axle.

The motor is carried by a frame, articulated at one end to the road axle-bearing cases, and at the other end slung by an elastic attachment to the under side of the footboard. In working, the distance between the motor and road axles is fixed, but it can be adjusted to compensate for wear in the chain. The driving wheels are 39in. diameter and the steering wheel 45in.; they are of steel throughout with solid rubber tyres. All three wheels are fitted with ball bearings. The sprocket wheel is 20⅓in. diameter; the chain is ¾in. pitch and has a breaking strain of over 5,000lb. About three-fourths of the weight is carried on ordinary elliptical carriage springs resting on the bearings of the driving axle, the rest of the weight is carried by the front wheel. The gauge is 4ft. 6in., and wheel base 5ft. 6in. All the working parts are boxed in, but easily accessible from above. The motor bearings receive continuous lubrication from an endless chain dipping into a reservoir of oil. The motor is series-wound, and has a slotted armature, drum wound with Eickemeyer coils, and carbon brushes are used. The magnet is two-pole, wound with a single coil of square wire. The commercial efficiency is about 80 per cent., with 80 volts and 10 amperes at 700 revs. per min., this output approximately corresponding to a speed of 8 miles an hour.

The accumulators are of the Faure-King type. There are four boxes, each containing ten cells, the total weight being about 5 cwt. Each cell consists of two half-plate negatives and one positive. The rated capacity is 40 ampere-hours at a discharge rate of 5 amperes, or about 28 ampere-hours at a discharge rate of 15 amperes. The accumulators are carried in the body of the car, and terminals are provided for charging them in place, for which current at 100 volts is required. When the volts drop to 74, the battery is completely discharged and then requires about seven hours to recharge.

The E.P.S. Co. has lately improved the design of its motor-cars in many respects, and is exhibiting a Victoria built on different lines at the Glasgow Exhibition.

## ELECTRICITY WORKS ACCOUNTS.

### Leith Municipal Electric Supply Works.

Although only dating from the beginning of last year, the Leith undertaking may fairly be said to be already highly successful. It is true that the concern had not in its operations last year become self-supporting and that as the net result of its working to December 31 last it had become indebted to the rates to the extent of £1,379, yet it is good work to have kept the deficit at no higher figure with an average total revenue from all sources of only 3·43d. per unit

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| | LEITH. | WINCHESTER. |
|---|---|---|
| *Undertaking Worked by* | Leith Corporation. | Winchester Electric Light and Power Co. (Ltd.) |
| *Date of Commencement of Supply* | January, 1899. | May, 1898. |
| *System of Supply* | 3-wire continuous-current. | 3-wire continuous-current. |
| *Chief Engineer* | J. Gray Scott. | H. N. Warburton. |

| YEAR ENDED | DEC. 31, **1899.** | DEC. 31, **1900.** | DEC. 31, **1899.** | DEC. 31, **1900.** |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 256,941 | 576,329 | 73,085 | 136,712 |
| ,, **SOLD (TOTAL)** | 235,985 | 511,765 | 56,707 | 113,267 |
| ,, sold to consumers | 107,591 | 293,119 | 56,707 | 113,267 |
| ,, sold for public lighting, &c. | 128,394 | 213,646 | nil | nil |
| ,, used on works | 10,956 | 13,500 | 6,979 | 8,764 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 17·3 | 25·6 | 6 05 | 10·1 |
| Maximum supply demanded | 235 kilowatts | 356 kilowatts | 89·2 kilowatts | 153·5 kilowatts |
| Number of public lamps | 105 arc | 110 arc | nil | nil |
| Number of consumers | 180 | 257 | 122 | 214 |
| Connections to mains in 8-c.p. lamps | 15,035 | 25,853 | 10,180 | 15,126 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 13,650 | 20,000 | 9,380 | 11,240 |
| **CAPACITY OF PLANT IN KILOWATTS** | 437 | 640 | 300 | 360 |
| **CAPITAL—** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** |
| **AUTHORISED (TOTAL)** | £35,000 / £80·1 | £65,000 / £102 | £45,000 / £150 | £45,000 / £125 |
| Share | — / — | — / — | 25,000 / 83·3 | 25,000 / 69·5 |
| Loan (including Debenture charges) | 35,000 / 80·1 | 65,000 / 102 | 20,000 / 66·7 | 20,000 / 55·5 |
| **RECEIVED (TOTAL)** | 35,000 / 80·1 | 44,000 / 68·8 | 24,175 / 80·6 | 32,375 / 90·0 |
| Share | — / — | — / — | 10,975 / 36·6 | 12,375 / 34·4 |
| Loan (including Debenture charges) | 35,000 / 80·1 | 44,000 / 68·8 | 13,200 / 44·0 | 20,000 / 55·5 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | nil / — | 21,000 / 32·8 | 20,825 / 69·4 | 12,665 / 35·2 |
| Share (unissued) | — / — | — / — | 13,865 / 46·2 | 12,665 / 35·2 |
| Share (uncalled) | — / — | — / — | 160 / 0·53 | — / — |
| Loan (including Debentures) | nil / — | 21,000 / 32·8 | 6,800 / 22·7 | — / — |
| **REPAID (TOTAL)** | 604 / 1·38 | 1,812 / 2·83 | — / — | — / — |
| **RESERVE OR SINKING FUND** | nil / — | nil / — | — / — | — / — |
| **DEPRECIATION FUND** | nil / — | nil / — | — / — | — / — |
| **EXPENDED (TOTAL)** | 36,833 / 84·3 | 44,042 / 68·8 | 30,474 / 102 | 34,095 / 94·7 |
| Lands and buildings | 9,397 / 21·5 | 9,693 / 15·1 | 3,351 / 11·2 | 3,351 / 9·31 |
| Plant | 14,762[a] / 33·8 | 15,950[c] / 24·9 | 15,807 / 52·7 | 17,279 / 48·0 |
| Mains | 10,625 / 24·3 | 16,346 / 25·5 | 10,490 / 35·0 | 12,837 / 35·7 |
| Miscellaneous | 2,050 / 4·69 | 2,055 / 3·21 | 826 / 2·75 | 627 / 1·74 |
| **BALANCE OF CAPITAL ACCOUNT** | −1,833[b] / −4·19 | −42[b] / −0·066 | −6,299[a] / −21·0 | −1,720[a] / −4·78 |
| **REVENUE—** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** |
| **TOTAL** | £3,371 / 3·429d. | £6,385 / 2·994d. | £1,218 / 5·155d. | £2,660 / 5·640d. |
| Revenue from supply | 1,939[d] / 1·973d. | 4,209[f] / 1·974d. | 1,156 / 4·890d. | 2,361 / 5·002d. |
| ,, meters, &c. | — / — | — / — | 62 / 0·265d. | 110 / 0·233d. |
| ,, public lighting | 1,425 / 1·449d. | 2,160 / 1·014d. | — / — | — / — |
| ,, sale of lamps, &c. | — / — | — / — | — / — | 188 / 0·399d. |
| ,, miscellaneous sources | 7 / 0·007d. | 16 / 0·008d. | — / — | — / — |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £2,348 / 2·389d. | £4,744 / 2·224d. | £659 / 2·789d. | £1,172 / 2·484d. |
| **WORKS COSTS** | 1,590 / 1·617d. | 3,446 / 1·616d. | 530 / 2·243d. | 897 / 1·901d. |
| *Generation of electricity* | *1,273* / *1·294d.* | *2,883* / *1·352d.* | *509* / *2·154d.* | *889* / *1·884d.* |
| Fuel (including cartage, &c.) | 587 / 0·597d. | 1,795 / 0·842d. | 283 / 1·220d. | 565 / 1·197d. |
| Oil, waste, water, stores | 35 / 0·036d. | 93 / 0·044d. | 17 / 0·072d. | 37 / 0·078d. |
| Wages at station | 607 / 0·617d. | 742 / 0·348d. | 202 / 0 855d. | 268 / 0·568d. |
| Repairs and maintenance at station | 44 / 0·045d. | 252 / 0·118d. | 1 / 0·004d. | 19 / 0·040d. |
| *Distribution of electricity* | *13* / *0·013d.* | *33* / *0·015d.* | *21* / *0·089d.* | *8* / *0·017d.* |
| Wages, &c. | 8 / 0·008d. | 17 / 0·008d. | 20 / 0·085d. | 8 / 0·017d. |
| Repairs, renewals of mains, &c. | 5 / 0·005d. | 16 / 0·008d. | 1 / 0·004d. | |
| *Public lighting* | *304* / *0·309d.* | *530* / *0·249d.* | — / — | — / — |
| Attendance | 148 / 0·151d. | 261 / 0·122d. | — / — | — / — |
| Renewals | 156[h] / 0·159d. | 269[i] / 0·126d. | — / — | — / — |
| **MANAGEMENT AND PROPERTY CHARGES** | 758 / 0·771d. | 1,297 / 0·609d. | 130 / 0·550d. | 276 / 0·585d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *26* / *0·026d.* | *443* / *0·208d.* | *68* / *0 288d.* | *91* / *0·193d.* |
| *Management* | *732* / *0·745d.* | *854* / *0·401d.* | *62* / *0·262d.* | *185* / *0·392d.* |
| Salaries | 477 / 0·485d. | 569 / 0·267d. | 36 / 0·152d. | 116 / 0·246d. |
| Stationery, &c. | 85 / 0·086d. | 74 / 0·035d. | 8 / 0·034d. | 15 / 0·032d. |
| Establishment charges | 91 / 0·093d. | 145 / 0·068d. | 5 / 0·021d. | 42 / 0·089d. |
| Law charges, &c. | 79[e] / 0·080d. | 66[g] / 0·031d. | 13[b] / 0·055d. | 12[f] / 0·025d. |
| **FINANCIAL RESULTS—** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** |
| **WORKING PROFIT FOR YEAR** | £1,022 / 3·58% | £1,641 / 4·06% | £422[c] / 1·66% | £1,488 / 4·61% |
| Sum carried to Depreciation Fund | — / — | — / — | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 604 / 2·12% | 1,208 / 2·99% | — / — | — / — |
| Net interest on loans (incl. Debenture charges) | 1,068 / 3·74% | 1,162 / 2·87% | 157 / 0·618% | 934 / 2·89% |
| **BALANCE FROM LAST ACCOUNT** | — / — | 350[j] / 0·866% | 40 / 0 158% | 121 / 0·375% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — / — | — / — | 324[d] / 1·28% | 477[g] / 1·48% |
| *Deficit* | *650* / *2·28%* | *379* / *0·938%* | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | 2½% / — | 3% / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 69·7% | 74·3% | 54·1% | 44·1% |
| Expenditure per kilowatt capacity | £5. 7s. 6d. | £7. 8s. 2d. | £2. 3s. 11d. | £3. 5s. 1d. |
| **REVENUE PER KILOWATT CAPACITY** | £7. 14s. 5d. | £9. 19s. 7d. | £4. 1s. 2d. | £7. 7s. 10d. |
| Expenditure per 8-c.p. lamp capacity | 3s. 5½d. | 4s. 9d. | 1s. 4¾d. | 2s. 1d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 4s. 11½d. | 6s. 4½d. | 2s. 7½d. | 4s. 8¾d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 4s. 5⅞d. | 4s. 11¼d. | 2s. 4¾d. | 3s. 6¼d. |
| Price charged for lighting, per unit | 6d. | 5d. | 7d., 4d. and 2d.[e] | 7d., 4d. and 2d.[e] |
| Price charged for power, per unit | 1⅞d. | 1⅞d. | 3d. | 4d. to 1½d.[e] |
| Price charged for public lighting | £20 per lamp per ann. | £20 per lamp per ann. | — | — |

**LEITH.**—REMARKS—*a* Inclusive of £745 on arc lamps and pillars and £2,090 on accumulators. *b* Over-expended. *c* Inclusive of £1,235 on arc lamps and pillars and £2,090 on accumulators. *d* Inclusive of £335 for motor power at 1¼d. per unit. *e* Insurance. *f* Includes £1,168 for motor power at 1¼d. per unit. *g* Insurance £44. *h* Carbons £111, repairs £45. *i* Carbons £186, repairs £84. *j* Being the balance of £1,000 received from the rates.

**WINCHESTER.**—REMARKS—*a* Over-expended. *b* £5 to insurance and £8 to auditing. *c* After deducting £137 "amount due to contractors under contract for maintenance." *d* Out of this is paid the dividend and £121 in reduction of preliminary expenses. *e* On maximum demand system. *f* Auditing. *g* After deducting £198 preliminary expenses written off.

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in the first year and 2·99d. in the second year, and with allocations in each year in respect of capital charges representing 5·86 per cent. on the total mean capital.

That it is justifiable to reduce the price for supply to so unusually low a point at the expense of the rates is, we think, at least doubtful, but, except in so far as the expansion of the business is due to the adoption of this course, this policy does not detract from the credit of the results attained looked at from a more purely engineering point of view.

The costs—especially the works costs—show excellent figures in both years. Relatively to the conditions of load, the first year's works costs are the better, since, with less than half the output and a much lower load factor, they have practically not been improved upon. Of course, the higher coal prices last year is one explanation of this fact. A material diminution was effected last year in the management charges which the great increase in the rents, rates and taxes failed to neutralise.

Naturally the undertaking is reaping the benefit of the very low tariff, the lamp connections increasing during last year 72 per cent. and the output by 117 per cent. The combined effect of substantial arc lighting and motor loads may be detected in the load factor, which was 11·5 per cent. in 1899 and 16·4 per cent. last year.

**Winchester Electric Light and Power Co. (Ltd.)**

Relatively to the character and magnitude of the load, the cost figures exhibited by the accounts of this station are most creditable, all the items of expenditure consistently sharing in the economical results achieved.

The load factor here remains unusually low, only rising to 8·43 per cent. last year. Fortunately the business is expanding rapidly, the lamp connections last year raising the total by nearly 49 per cent., while the year's output exceeded that of 1899 by 99·8 per cent. An increase of this sort coupled with a materially higher revenue per unit and lower costs naturally altered the aspect of the net revenue account, and we find the working profit in its relation to the mean capital nearly three times that of 1899. The interest charges were, however, also much higher, while the whole of the preliminary expenses (£198) were also written off out of the profits, leaving a balance of £477. The dividend of 3 per cent. which was paid absorbed £334 and £144 was carried forward.

The bulk of the increase shown in the total revenue per unit was obtained by the profits on hire purchase or "free-wiring" installations, which have been introduced in connection with the "shilling-in-the-slot" meter.

# PARLIAMENTARY INTELLIGENCE.

## DERBYSHIRE AND NOTTINGHAMSHIRE ELECTRIC POWER BILL.

This bill came before a Select Committee of the House of Commons presided over by Sir William H. Houldsworth, on May 6, and is a measure framed on similar lines to the Cleveland and Durham Bill, which came before the same Committee recently.

The petitioners against the bill were the Derby, Chesterfield and Mansfield Corporations, the Derbyshire County Council, the Derwent Valley Water Board, the Alfreton, Baslow and Bubnell, Belper, Eastwood, Heanor, Matlock, Matlock Bath, North Darley, Wirksworth, Worksop and Hucknall Torkard District Councils.

Mr. PEMBER, K.C., for the promoters, said the scheme embraced the whole of the counties of Nottingham and Derby, except an area south of the river Trent and except that part of the county of Derby which lay to the north-west of the boundary between the Unions of Bakewell and Chapel-en-le-Frith. The bill resembled very much the bill of 1898, which was promoted by a group of American speculators. The present bill was promoted by the great consumers in the district, and was framed very much on the lines of the South Wales Act of last year. The objects of the promoters were the usual objects—viz., to supply electricity principally for power purposes. The share capital of the company was to be £1,800,000, with £600,000 borrowing powers. Counsel gave a list of the more important local firms supporting the scheme. The list contained the names of some 400 firms, with a total capital of 20 millions. The district in which it was proposed to supply had an area of 1,570 sq. miles, the population was over 1,000,000, and there were 564 works, comprising collieries and factories, including 159 pits. There were a large number of local authorities in the district, but only three yet able to supply electric power, although 11 had legal powers to supply. The three authorities referred to could only supply 10 sq. miles, although their districts extended to 31 sq. miles. The eight other authorities had the legal power to supply electricity over an area of 97 sq. miles, so that there would still remain 1,473 sq. miles quite unprovided for. Some of the authorities the promoters had agreed with, and those were not opposing the bill. The promoting company proposed to erect four generating stations—at Colwick, Trowell, Newbold and Warsop. These sites were chosen mainly on account of their being near the railway and in the centre of a vast population; that at Warsop because of its proximity to the collieries which were opened and about to be opened there. The distribution of cheap power in the district would stop the exodus from the villages to the towns; and there were many small but decaying industries now carried on by hand which could be successfully carried on if economical electrical energy could be supplied. The promoters had been supported by 189 petitions from district and parish councils, chambers of commerce, public works, individuals and ratepayers. There were never more than 11 petitions against the bill. Counsel drew attention to the difference in the character of the opposition to the present bill as compared with that against the General Power Distributing Bill of 1898. Then all the villages were opposed to the scheme; now they were all practically in favour of it. Nottingham Corporation had arranged with the promoters. That Corporation had an electric installation, on which they had spent £178,000. Retford had come round to support the bill; Mansfield had also been agreed with; and Ilkeston, too, was to take current from the promoters. Dealing with the petition of Chesterfield, counsel said the Committee hardly required any argument against the monopoly of a town like Chesterfield, which had only powers to spend £25,000 on their electrical undertaking. Their rates were 7s. in the £; they had a bill before Parliament in which they proposed to spend £200,000 for more purely municipal purposes, and several ratepayers had objected to the Corporation embarking on a speculative scheme of electricity supply, and favoured that of the promoters to supply the Corporation in bulk. The Chesterfield Chamber of Commerce had petitioned in favour of the bill. Coming to the petition of the Corporation of Derby, counsel said that petition alleged that the Corporation had spent £120,000 on their electricity undertaking, and had laid 13 miles of mains. Well, 13 miles was not very much, and the Corporation did not say what proportion was supplied for power. They claimed to be able to supply electricity at a reasonable rate; but what was a reasonable rate? The promoters would be able to prove that they could supply at a lower rate, and he protested against the Corporation setting up a monopoly for the supply of electrical power. The promoters had the support of several manufacturers of Derby. Ilkeston had been settled with by means of an arbitration clause, the clause having a recurrent effect each time the promoters sought to supply a fresh portion of the district. In the case of the Derbyshire County Council they had failed to come to an agreement, but he could not see why they would not accept the clause agreed to between the promoters and the Nottingham County Council. Dealing with the opposition of the urban district councils, counsel said they asked for an absolute veto, but the promoters could not consent to that. Alfreton was seeking a provisional order, but he understood that it had been refused. That was the only district among the urban districts which had applied for its own supply. Referring to the petition of the Worksop Corporation counsel said the Corporation were only empowered to raise £15,700 for their electrical undertaking, and probably they could only supply electricity for lighting within the town of Worksop itself.

Mr. JAMES SWINBURNE said the proposed scheme was a very simple one. Steam engines would drive the dynamos at first, but probably gas would be used later. The area of supply was well situated from the point of view of fuel and water. Witness described in detail the proposed generating stations, all of which, he said, were well adapted for the purposes to which it was proposed to put them. The firms which had put down large installations of electrical plant would, in his view, never have gone to such great expense had schemes of the kind indicated in the bill been in existence. There would be no smoke at the stations, and no vibration at all at the sub-stations.

At this point Mr. F. N. KEEN, for the Corporation of Chesterfield, announced that the promoters had agreed with the Corporation of Chesterfield, and that opposition, as far as the preamble of the bill was concerned, would now be withdrawn. They, however, reserved their right to oppose on clauses.

Mr. RUSSELL: We give Chesterfield the same clause as we have given Mansfield.

Mr. SWINBURNE (continuing): He did not know that Derby had got a 3,000kw. scheme, but if it were so it would be getting on to what he should call "an economic scheme." He admitted it would be better to supply such power on the spot than to take it from 9 miles away. If Derby supplied motive power at 1½d. per unit that was very good.

The DUKE OF NEWCASTLE said he was the owner of very large estates in Nottingham, and was anxious to develop their resources. The production of the coal mines in the neighbourhood had grown very much in recent years—he believed it was now 5,000,000 tons. In 1896 he had granted the lease of 30,000 acres of his estate for coal to the Wigan Coal and Iron Co., and they were now actually working. He was anxious to secure the resulting products of his coal for his tenants. There were no large towns on his estates with the exception of Nottingham. Difficulty had been experienced in establishing factories in the district, but he thought that if electric power were available they would be able to establish these factories.

Mr. ARNOLD LUPTON, C.E., said that in his opinion the district was very suitable for the scheme proposed under the bill. He dealt with the sites of the proposed generating stations, and said each was favourably situated for the cheap production of electrical energy. It was intended to provide 60,000 E.H.P., allowing 10 per cent. extra for spare plant, mains, &c., and providing for a loss of 15 per cent. in transmission. Witness

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estimated the land, levelling, walling, roads, preliminary and parliamentary expense in connection with the scheme at £60,000, buildings of all kinds £216,000; engines, &c., £801,000; boilers, &c., £300,000; electric mains and some transformers £783,000; floating capital, engineering contingencies and reserve borrowing powers, £240,000—total, £2,400,000. He admitted that the Derby scale of charges to small consumers—1¼d. per unit—was a liberal one.

Mr. J. D. WILLIAMS here announced that Worksop had settled with the promoters, and consequently this opposition was at an end.

Mr. MAURICE DEASON, president of the Midland Institute of Mining Engineers, said he entirely approved of the objects of the bill. He was responsible for putting down plant at collieries and other places to the value of £80,000. That plant would never have been put down if the promoters' scheme had been in existence. He was going to use power from the company, but in cases where the plant had been already laid he would use power generated at the pits. He was thoroughly satisfied that this bill would be of great benefit to the district.

Mr. M. HY. MILLS, of Sherwood Hall, one of the promoters, said the promoters were all people largely interested in the district. The collieries interested represented an output of 10,000,000 tons of coal. He had no doubt that in the next 10 years there would be an increase in the output of coal of 5,000,000 or 6,000,000 tons between Nottingham and Derby. He described the disappointment felt in the district at the defeat of the General Power Distributing Co.'s Bill of 1898, and spoke of the collieries in the districts as constituting one of the richest coal-bearing areas in the kingdom. There was, among the colliery owners, a feeling that such a scheme as that before the Committee was absolutely necessary. Derby was not included in the bill of 1898, but Parliament and the country had become more enlightened since 1898. He was aware that Derby was borrowing large sums of money, and to save further borrowing they could take electric power from the promoters. It was in the interest of present and future consumers that Derby should come under the present scheme. The Derby consumers would require more electricity than he thought the Derby Corporation would be prepared to supply.

Mr. E. BAINBRIDGE, managing director of a number of undertakings in the district, said: at Mansfield Woodhouse it was proposed to lay down plant to raise a million tons of coal a year. It would pay colliery proprietors to sell their present electrical plant and take power from the company. If the present scheme were passed he thought some of the small manufacturers of Sheffield would avail themselves of the scheme by coming over the border into the area of supply. They would not only get cheap power but they would get lower rates.

Mr. HOOLEY, M.I.C.E., representing the Parliamentary Committee of the Nottinghamshire County Council, said the scheme of the bill would be of distinct advantage to the whole county.

Other evidence was given and counsel addressed the Committee for the various opposing bodies.

On May 8 the Committee met and agreed to the following addition to clause 44 of the bill:—"The company may charge for a supply of energy to authorised undertakers or persons supplied by them either by the actual amount of energy so supplied or by the electrical quantity contained in the supply or by such methods as may be agreed between the company and such undertakers or persons."

On the application of Mr. Frere, agent for the promoters, a clause framed on the Lancashire Bill, empowering the company to lay mains under railways and tramways without in every instance special application to the Board of Trade was allowed. A clause protecting the Nottinghamshire County Council was also incorporated in the Bill.

After consideration of further clauses, the Committee allowed the Bill to pass to the third reading.

## SOUTH LANCASHIRE TRAMWAYS BILL.

On May 9 the Select Committee of the House of Lords presided over by the Earl of Ducie considered a bill promoted by the South Lancashire Tramways Co. seeking further capital powers, and authorising the construction of further tramways.

Mr. BALFOUR BROWNE, K.C., for the bill, said it was a natural sequence of the company's act of last year. Additional capital of £150,000 was asked for in connection with the widening of certain roads, and the construction of about 6 miles of additional tramways—from Knowsley to Liverpool, from Newton to Warrington, and through Little Hulton Walkden and Worsley. The opponents to the bill were the Lancashire Electric Power Co., the Bury and District Joint Water Board, and the Corporation of Salford. The Electric Power Company was last year authorised to supply electric current to a district from the south of Lancashire up to the Ribble, but were shut out from some of the larger towns. Last year, when the present promoters were in Parliament, the local authorities said it would be a great deal better if the company, having electric mains all along the line of route of their tramways, would come under an obligation to light free of cost those roads, and to that the company had assented. Under last year's act the promoters were prohibited from supplying electric energy for other than the purposes of the act without the consent of the local authority. That left it doubtful whether the Tramway Company had power to supply electricity for lighting and other purposes. The company claimed that it did, but by the present bill it was intended to clear up any doubt on the point whether they could supply current to any local authority in their district. To that the Electric Power Company objected, and desired to establish a monopoly. They had, however, not yet even got a generating station, or what was more important, the money to make one. The local authorities would be the customers of the Tramway Company, as, under the bill, the company could only supply electricity to people who had got powers, and all the local authorities were in favour of the bill. He asked the Committee not to listen to the Electric Power Company.

Mr. SHAW, for the Electric Power Company, said the promoters were asking for a power bill not having the restrictions of one imposed upon them. The Electric Power Company were under all the liabilities and restrictions of power bills, and the present promoters sought to set up an unfair competition such as Parliament had never yet sanctioned.

The Committee decided that the preamble of the bill was so far proved, but required, as regards the lighting clauses, that the South Lancashire Tramways Co. should undertake to accept the same liabilities, restrictions and everything as the Lancashire Electric Power Co.

Mr. BALFOUR BROWNE said the complaint of the Bury and District Joint Water Board was that damage would be done to their pipes by electrolytic action. But the promoters, under the model clause of the Board of Trade, were bound to do what was necessary to protect the pipes from injury in this way, and he asked the Committee not to put them under any further obligation.

Mr. RAM, K.C., for the Salford Corporation, raised a similar objection.

The Committee, on Friday last, decided not to insert the clause, and passed the preamble of the bill.

## CALEDONIAN AND CLYDE VALLEY ELECTRIC POWER BILLS.

The House of Commons Committee over which Sir Wm. Woodhouse presides concluded on Friday the further consideration of the rival bills of the Caledonian and Clyde Valley Electric Power Companies.

Mr. FREEMAN, K.C., for the Clyde Valley Company, said this was not a case where a company was coming into a district simply to start a financial concern in the hope of its becoming a financial success. The undertaking was formed by persons who were large consumers in the district, not so much because of any profit they expected to derive, but on the ground that the supply was absolutely necessary for their works. They had, of course, the opposition of various burghs in the area to face; but he contended that the reservation of what the burghs called their freedom meant imposition of a servitude upon the industries in the district. There were, however, 10 burghs which were not opposing his bill, and therefore these might be considered as occupying a neutral, if not a favourable attitude. It would be hard on the traders within the burgh areas that such a bill as this should be rejected.

Mr. BALFOUR BROWNE, K.C., for the Caledonian Company, claimed that his scheme was well designed, could be carried out, and would do no injustice to anybody. The district the company were seeking to supply combined an area that was comparatively poor with one that was comparatively rich, and he believed that the whole intention of these great power bills had been that the promoters should take the lean with the fat. If the burghs could supply energy more cheaply than the companies then they could keep their customers in spite of the companies; but if the companies could supply more cheaply then the companies ought to get the custom. The Clyde Valley Company wanted to compete with the burghs but did not want to be competed with. His company took up a different attitude. While, of course, they would prefer to see their own bill passed and the other rejected, they were quite prepared to see both passed, so that there might be in the district a monopoly regulated by competition.

The CHAIRMAN said the Committee had arrived at a unanimous decision. With regard to the Caledonian Bill, they were of opinion that the preamble was not proved, but with regard to the Clyde Valley Bill, they were of opinion that the preamble was proved. But the Committee excised Port Glasgow, Govan, Partick, Paisley, and Hamilton, and wished certain provisions to be inserted for the protection of other local authorities.

Other conditions were named, and it was left to counsel to bring up amended words to give effect to what was required, their point being that the supply of power should be of such undoubted magnitude that the use of it for lighting purposes should be subordinate to that of ordinary power. The Committee gave no compulsory powers for transit of mains through Paisley, Partick, or Govan.

## BRIGHTON CORPORATION BILL.

One of the provisions of this bill, which came before a House of Commons Committee, presided over by Mr. Bill, raised the question of the supply by a local authority of electrical apparatus to consumers of electric current. The Corporation of Brighton already have power to supply electricity, and ask in the bill for power "to purchase, supply, sell and let for hire," but not to manufacture, "electric motors, cooking, heating, ventilating and other similar apparatus, and things incidental to and connected therewith," and also to "provide materials and do all work necessary and proper for the fixing, setting up, alteration, repair or renewal thereof."

Mr. FRERE, on behalf of the Corporation, said that such a clause was by no means a novelty, and there were good reasons why it should be inserted. There were many people who would use electricity for cooking, heating, &c., if they had the proper appliances, but who would not themselves incur the initial cost of purchase and installation. It was, therefore, desirable that the Corporation should have power to supply the appliances and so secure the custom of these consumers. Similar clauses were inserted last year in bills promoted by authorities in Southwark, Southport, Walsall, West Bromwich, Kingston, Morley, Coventry, Devonport, and Halifax.

The Brighton and District Ironmongers' Association petitioned against the provision, alleging that it would enable the Corporation to compete unfairly with private traders, and that, until the Parliamentary inquiry into the question of municipal trading had been completed, the Committee should not allow the question to be prejudged.

The Committee decided in favour of the Corporation's proposal, except with regard to wiring, and the power to wire houses was, therefore, struck out of the bill.

(*Parliamentary Intelligence is continued on page 145.*)

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

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## DR. BOSE'S THEORY OF RESPONSE IN LIVING AND NON-LIVING MATTER.

The lecture on "The Response of Inorganic Matter to Mechanical and Electrical Stimulus," which Dr. J. C. Bose delivered at the Royal Institution last Friday evening, affords a striking illustration of the far-reaching character of the long and elaborate series of researches which the lecturer has been carrying on during the past few years. Of the practical as well as scientific value of his researches in the "coherer" response of metallic matter to electromagnetic radiation the world of physical science has had more that one illustration; notably, for instance, in the great improvement Dr. Bose introduced into the coherer when he first commenced his researches, in the investigations on the quasi-optical properties of bodies exposed to Hertzian waves, in the quantitative measurement of the so-called "coherer" action of different substances, and in the discovery of a negative coherer-response and of an automatic or self-recovery in certain definite forms of his own coherers. All these researches have rendered invaluable assistance, both in the progress of scientific research into electromagnetic radiation and in the practical improvement of wireless telegraphy and other forms of ætheric signalling.

The latest researches, however, which served as the subject for last Friday's discourse, carry us further than the domain of theoretical and applied physics, into the regions of physiology and chemistry. They lead to the discovery of an universal action—which we hope will shortly be enunciated by Dr. Bose in terms of a general principle or law—underlying certain phenomena in both living and inorganic matter. If we take a piece of living muscle and pinch or twist it, or in any way subject it to stress, there is a contraction in the length and an increase in thickness, which may be accurately indicated by a diagram drawn by mechanism actuated by the muscle itself. The cessation of the stress is followed by recovery of the original condition of the muscle; and a subsequent similar stress produces an exactly similar diagram. When rapidly intermittent stresses occur, the diagram consists of a serrated curve, the cessation of the stress leading again to recovery. If the frequency of the stresses is increased, a point

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is reached at which the muscle exhibits persistent steady contraction until the stress ceases, this condition being known as tetanus. Extreme temperature produces a condition known as heat or cold rigour, the muscle giving no appreciable response to mechanical or electrical stimulus; and there is, for each particular species of muscle, a definite temperature at which a maximum of response arises from any given stimulus. When the condition of rigour is approached, not only is the response less vigorous, but the recovery is slower and more lethargic. Drugs exert a modifying influence upon the response; stimulants induce a more violent response and more prompt recovery; depressants diminish the activity; while poisons destroy the power of response altogether. Certain drugs act as stimulants when administered in one proportion and as depressants when administered in another proportion. When, moreover, instead of living muscle a piece of living nerve is investigated, a perfect parallelism in the character of the response and of the recovery is observed; but in the case of nerve the response takes the form of an electric current between the injured or excited portion of the nerve and the normal portion, instead of, as in muscle, a mechanical change of length. The effects of repeated mechanical or electric stimulus, of temperature, of stimulating and other drugs, &c., are perfectly similar to those produced in muscle; and curves corresponding in every characteristic with those for muscle are drawn when a galvanometric record of the response is made. Dr. Bose exhibited a large number of these diagrams, in which the characteristic responses to definite forms of stimuli were indicated. Physiologists are thoroughly acquainted with these nerve and muscle response-diagrams, the occurrence of which in connection with any given organic tissue is held by them to be a distinctive evidence of physical life in the tissue.

We pass now to the second subject, so to speak, in Dr. Bose's symphony—the response of matter that is inorganic, and, therefore, non-living. When a piece of wire is placed in a galvanometer circuit and one end of the wire is momentarily subjected to mechanical stimulus, as by twisting or tapping it, an electrical response takes place in the form of a current between the injured or stimulated end and the normal end of the wire. This response is indicated by a movement of the galvanometer needle, the amount of the deflection being definite in relation to the intensity of the mechanical stimulus. A convenient form of the apparatus for measuring and recording such responses consists in a vessel containing water into which two similar wires dip, one of the wires being fitted with a torsion head to allow of a measurable and graduated twist being applied to it. Experimenting with this apparatus included in the circuit of a galvanometer, Dr. Bose found that the response and recovery curves obtainable from it correspond in the closest possible degree with the physiological curves obtained from living nerve and muscle. It is scarcely necessary to re-state the entire series of operations by means of which characteristic curves may be obtained. Suffice it to say that repeated stimuli produce a series of response-curves which, on increasing the frequency of stimulus, merge into a true condition of tetanus; that changes of temperature produce, in extreme limits, a lethargy precisely analogous to rigour, and exhibit a condition in which the response is most marked at a definite temperature, depending on the nature of the wire; that certain drugs injected into and uniformly diffused through the liquid in the apparatus give rise to astonishing increase in the violence of the response—analogous, indeed, to alcoholic intoxication—while other drugs act as depressants, and still others as poisons. Again, there are certain drugs which act as stimulants when injected in a certain proportion and as depressants when administered in another proportion; while it is also found that the "killing" action of the poisons can be arrested by the timely injection of a fluid antidote. One of the most virulent of these poisons is corrosive sublimate, known as a powerful poison also in the organic world. The essential and most important fact in connection with these investigations is the extremely close agreement between all the diagrams obtainable from living tissue and those obtainable, in analogous conditions, from the inorganic substances experimented upon by Dr. Bose. So close is this agreement that expert physiologists are unable to distinguish between the two sets of curves. Carrying the matter still further, Dr. Bose has investigated the response of inorganic matter to light and other forms of electromagnetic radiation. He exhibited an artificial eye, the interior mechanism of which was such as to enable it to give an electrical response to radiation of every description, whether ordinary light, or Hertzian or Röntgen rays. We are not permitted as yet to disclose the exact nature of this interior mechanism, nor do we wish to do so until the proper time arrives, but we may say that we are perfectly satisfied as to its scientific adaptability to perform all that Dr. Bose claims for it. Like all the inventive work of its originator, it exhibits a marvellous delicacy and perfection of workmanship combined with a degree of simplicity in which few inventions can rival those of Dr. Bose. As to the mode of action of this eye, we believe that it involves an effect the discovery of which is originally due to Dr. Bose; it may be convenient to describe this as the "Bose effect" or as "Dr. Bose's molecular stress-strain effect in vision." The model is not a mechanism capable of merely imitating the phenomena of vision, it goes much deeper and acts in identically the same manner as the living eye acts when sending an impulse to the brain on being exposed to light. Dr. Bose's model eye, therefore, essentially embodies a physical theory of vision. Such a sensitive receiver of electromagnetic radiation, perfectly prompt as it also is in its self-recovery after stimulus, should serve to revolutionise existing methods of wireless telegraphy and ætheric signalling.

Returning once more to the actual researches, we may observe that a stupendous problem arises from their indications; the co-ordination between the response of living and that of inorganic matter is a riddle, in front of which neither physicists nor physiologists should rest until they have obtained the solution. There is a certain type of mind that shrinks from the bare suggestion of any co-ordination between living and inorganic matter; but to such it must be explained that the present inquiry no more unwarrantably encroaches on the sacred vestibule of the mystery of life than does the chemist when he investigates the phenomena of digestion, or the physiologist when he correlates waste of living tissue with the burning of fuel in a fire. The problem before us legitimately belongs to the domain of natural science, it relates exclusively to a series of phenomena governed by natural laws, whether in the world of living tissue or in the microcosm of metallic molecules. This problem demands adequate solution, and no one is so well qualified to solve it as is its originator. The scientific world is immensely indebted to Dr. Bose for the researches he has already completed and presented to it; researches which redound greatly to the credit of the Indian Empire, and, more especially, of the Presidency College of Calcutta, from which Dr. Bose is now on a visit to this country. The scientific world is also grateful to the India Office for having granted to Dr. Bose permission to remain in England in order to

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carry on these researches to the point at which they have now arrived. But the present point is not the final stage; much remains to be investigated, and a critical juncture has been arrived at which seems to show that Dr. Bose is on the eve of a scientific generalisation of widespread and deep-reaching application. Nor should the immense practical value of his work be overlooked. We trust, therefore, that no obstacle will be allowed to come in the way of his completing his work, and that he will be granted leave by the Government of India to remain in England and devote all his time and energies to the problem until he shall have succeeded in bringing it to a triumphant issue.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Influence of Pressure and Temperature on Dielectric Constants.*—Maxwell's theory, combined with the principle of the conservation of energy, may be employed for finding rules governing the relations between temperature and pressure on the one hand, and the dielectric and magnetic constants of a substance on the other hand. Such investigations serve to impart a physical significance to the rules of Clausius-Mossotti, Lorenz, Beer, and others, which are based upon molecular hypotheses. J. Koenigsberger has arrived at equations differing essentially from those found by Thomson, Drude, Duhem, and others, owing to the fact that he takes into account certain quantities of energy not considered by those authors, and which, he thinks, make a good deal of difference in the case of high dielectric and magnetic constants. The author shows that in solid and liquid bodies the change of a parameter in the electric field has a different effect from that which it would have outside the electric field (or the magnetic field in magnetic substances), and that when such substances are electrified, the phenomena of electrostriction, of Thomson's heating, &c., must be observed.

[J. Koenigsberger, *Ann. der Physik.*, No. 5, 1901.]

*Propagation of Polyphase Currents along Parallel Wires.*—W. B. Morton recently gave a method for finding approximately the speed of propagation and the attenuation of electric oscillations guided along certain arrangements of parallel wires. One of the cases worked out was that of an even number of similar wires arranged in a regular polygon, the wires passing through the corners of the polygon at right angles to its plane, and the currents at corresponding points of consecutive wires being opposite in phase. The same author has now extended the problem so as to include the more general case in which there is a constant phase-difference between consecutive wires, as in the ordinary three-phase transmission of power. If there are $n$ similar wires the phase difference must be a multiple of $2\pi/n$, and by taking different multiples different *modes* are obtained for each value of $n$. The number of modes is $\frac{1}{2}n$ if $n$ is even, and $\frac{1}{2}(n-1)$ if $n$ is odd. The analysis leads directly to the distance apart of the "equivalent pair of wires." Further, by comparison with Heaviside's well-known expression for the case of slow oscillations, the author deduces the effective capacity, resistance, and inductance of each of the leads. The second of these quantities comes out in agreement with Lord Rayleigh's formula, as was to be expected.

[W. B. Morton, *Phil. Mag.*, May, 1901.]

*Double Refraction of Electric Waves.*—Measurements of the refractive indices for electric waves of different kinds of wood have shown that their double refraction is always accompanied by a double absorption, the wood showing a different absorption of electric waves according to the angle between the grain and the plain of oscillation of the incident waves. G. Pierce, who carried out the experiments referred to, now examines the question as to whether, on Maxwell's theory, the double absorption by these media is sufficient to account for the double refraction, and whether both of these properties can be ascribed merely to differences of conductivity along and across the grain. With the data available a strict interdependence cannot be made out, but it is clear that heterogeneous conductivity plays an important part in the phenomenon of double refraction of electric waves. The absorption coefficient depends upon the direction of the electric force in the specimen. In that orientation of the electric force in which the absorption is greatest the velocity of propagation is smallest, and therefore the index of refraction is greatest. This agrees with experiment. When the wood is so oriented that its grain is parallel to the electric displacement, the index of refraction is greater than with the grain perpendicular, and so is the absorption.

[G. Pierce, *Phil. Mag.*, May, 1901.]

*Disruptive Discharge in Electrolytes.*—André Broca and Turchini have found, in experimenting with electric oscillations of a wave-length of some 400m., corresponding to a frequency of about one million per second, that the properties of the electrolyte placed in the discharge circuit were profoundly modified. Under favourable conditions very powerful disruptive discharges passed through highly conducting liquids, thus showing that for this order of frequency the electrolytes behave as dielectrics. This is a clear experimental explanation of the fact that the electrolytes in question are transparent to light, as they should be according to Maxwell's law. The authors employed a large induction coil fed by a current of 50 amperes at 110 volts, and 42 ~ per second. The capacity inserted was 12,500 electrostatic units. The sparks produced in acidulated water were extremely brilliant, and the electrodes wore away rapidly. Distilled water shows the phenomenon in great violence, and the sparks remain brilliant when sulphuric acid is gradually added, disappearing, however, when the concentration reaches 1 in 40. In copper sulphate brilliant effects are obtained, even in a 24 per cent. solution. The authors believe that at sufficiently high frequencies all transparent electrolytes behave as dielectrics.

[Broca and Turchini, *Comptes Rendus*, April 15, 1901.]

*Oscillating Sparks.*—An ordinary spark has a very irregular shape owing to the irregular distribution of the metallic vapour given off by the electrodes. Besides, the luminous track produced by the initial discharge is strongly marked. G. A. Hemsalech has, however, found that if a variable inductance is inserted in the circuit, then on increasing the inductance the shape of the spark becomes more and more regular, and the initial discharge recedes more and more into the background, so that eventually the discharge appears to consist entirely of incandescent vapour. The shape then taken by the spark is that of a sphere or ellipsoid, with its major axis along the discharge path. Copper and aluminium electrodes give very regular shapes, cadmium and lead irregular ones. In the case of iron, cobalt, zinc, cadmium, copper, aluminium and lead the brightness of the sparks diminishes on increasing the inductance, passes through a minimum, and then rises again. The author gives an interesting demonstration of the effect of introducing an iron core or cylinder in the induction coil. The oscillations are choked off, partly by magnetisation, partly by eddy currents.

[G. A. Hemsalech, *Comptes Rendus*, April 15, 1901.]

*Jaumann's Surface.*—If two electrodes, mounted in a vacuum tube about 2cm. apart, are both connected with the negative pole of an influence machine or an induction coil, and an influence machine or induction coil is made to produce a discharge in the circuit, a bright surface appears between the electrodes, and marks its traces on the walls of the tube by light-blue lines. When the leads are equal in length the surface appears midway between the electrodes, and when one of them is lengthened, the surface approaches the corresponding electrode. This phenomenon was first described by Jaumann and used by him to support his theory of longitudinal light. The experiments in question have been repeated by A. Korn, who has added an interesting new fact.

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The bright blue trace of the J-surface on the wall of the tube is not always straight. It is, in fact, generally speaking, wave-shaped, and the displacements of the surface are marked by a simultaneous progression or retrogression of the wave-line. Without entering into wide speculations, the author inclines to think that the oscillations are propagated into the electrode, and discharge is more vigorous from the more strongly oscillating electrode..

[A. KORN, *Ann. der Physik*, No. 5, 1901.]

## NOTES ON THE USE OF THE DIFFERENTIAL GALVANOMETER.*

BY C. W. S. CRAWLEY.

I do not wish to suggest that I am bringing forward anything new, but rather to say a few words in favour of an old but very effective instrument which has fallen into disuse, and to show a practical way of using it for modern work. In early days the differential galvanometer was used a great deal; when the bridge came into general use it was shelved, as the scope of the bridge was so much greater, and it sufficed for all the resistance measurements then required. Another reason why the differential galvanometer went out was, I think, this: People were used to the old pattern of differential galvanometer with pivoted needle, which was adjusted once for all and remained right. Then the reflecting galvanometer became universal, and the reflecting differential galvanometer when adjusted does not remain right for good, but must be very carefully levelled, and even then is seldom in perfect adjustment. Some year or two ago I wanted some low resistances adjusted which it was impossible to bridge, and so I looked into the potentiometer, which was better, but very troublesome, and this brought me to the differential galvanometer. For I always look on the differential galvanometer as a potentiometer; only, instead of balancing opposing E.M.F.s, one balances the M.M.F.s caused by them.

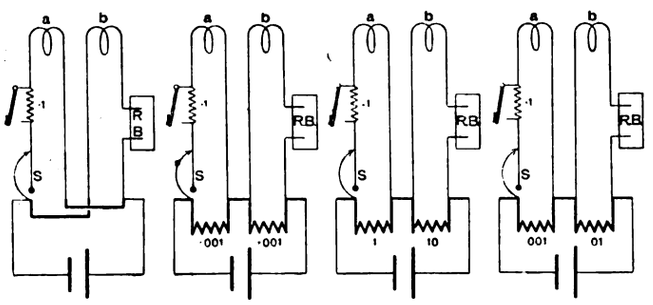


FIG. 1. FIG. 2. FIG. 3. FIG. 4.

Now, I knew by sad experience that to adjust a differential galvanometer was a very great nuisance, so I took the bull by the horns and did not adjust at all, but simply had the galvanometer coils wound double—*i.e.*, with twin wire, and set the instrument up as it was, without adjustment.

In Fig. 1, *a* and *b*, 100 ohms each, are the circuits of the differential galvanometer in parallel, opposed, joined to the battery. In the circuit of *a* is a 0·1 ohm resistance, which can be cut out by a key, and also a slide-wire resistance, S, of about 1·5 ohms. In circuit with *b* is enough resistance to about balance. This can be a resistance box. When joined, as shown, if *a* or *b* predominates and gives a deflection, sufficient resistance is added or subtracted by the slide wire till the spot roughly comes to zero. Now depress the 0·1 key; this disturbs the balance by 0·1 per cent. and causes a deflection of some hundreds of scale divisions. If we do not want to read closer than 0·01 we need not adjust the balance closer than, say, 10 scale divisions.

We now know that two equal and opposite E.M.F.s at the terminals of the two-coil circuits will balance, so that we can compare any two equal coils with great ease and great accuracy. For example, two 0·001 ohm coils, as in Fig. 2. If they are not alike there is a deflection. Pressing the 0·1 ohm key gives the deflection for 0·1 per cent. difference between them, which, with only 10 amperes through them, is about 400 scale divisions, so when working to 0·01 per cent. anything under, say, 10 scale divisions can be ignored (which is a great comfort when adjusting).

But we can go a great deal farther; we can join up on to the terminals of a 1 ohm and a 10 ohm standard coil, as in Fig. 3, and add resistance to *b* circuit till a balance is obtained. For all-round work an ordinary resistance-box will do, but if there is much 10 to 1 work to be done it is sometimes worth having a separate coil of 9 *b* ohms. It was in this ratio way that I used it first; I wanted a set of stretched copper wires, accurately adjusted, for copper conductivity work, of 1, ½, ¼, &c., down to $\frac{1}{1024}$ ohm. This would have been impracticable by bridge, and very inconvenient by potentiometer. But setting the differential galvanometer 2 to 1 it was quite easy, the first or 1 ohm coil being the most difficult, as it had to be done against an outside standard. And the checking is so simple; the galvanometer is set, say, 4 or 8 to 1, and every third or fourth wire compared in the same way.

At a pinch one can go a little further still; a coil differing considerably from the standard can be balanced by adding resistance to *b* coil and allowing for it, or setting to an odd ratio; but this is more troublesome.

Now, as to sensitiveness. With 0·1 volt at the terminals of coils short on to the galvanometer and a 10 second swing, we have a deflection of 450 scale divisions for a difference of 0·1 per cent., so that we can compare two $\frac{1}{1000}$ ohm resistances with only 10 amperes, and have a deflection of 4·5 scale divisions for 0·01 per cent.

As to limits of accuracy and sources of error, the galvanometer can be balanced far beyond anything required. Next the question of perfect contacts; they can certainly be counted on not to be more than $\frac{1}{1000}$th ohm if made rationally, or an error of 0·001 per cent. As to temperature, the galvanometer coils are copper, but being wound double remain always at the same temperature. Thermal contacts may occur at times, but are easily detected and eliminated by reversing the battery current. They are infrequent and small in effect.

For long and continuous testing, especially with a ratio, I like to have a rocking mercury switch which will do the check instantly. When working with ratios, temperature may cause an error; but if the galvanometer is placed so that its temperature remains constant, as shown by a thermometer, the error will not exceed 0·02 per cent. A check should be made at the end of the test.

In setting, it is, of course, necessary to allow for errors in the standards, if they would be within the limits required. It is easily done by deflection. There is only one inherent error to allow for. That is due to the resistance of the coil circuits of the galvanometer not being exactly the same when they are in balance. This, however, is but small. If the coils differ by *a* per cent. and they are *b* times the resistance of the coils under test, the error in the result is *a*/*b* per cent. *a* should be under 1, and *b* is generally at least 100, so that at the worst the error is 0·01 per cent., even when comparing 1 ohm coils or setting 1 to 10 ratio with 1 ohm to 10 ohm coils.*

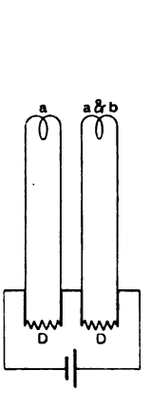


FIG. 5.

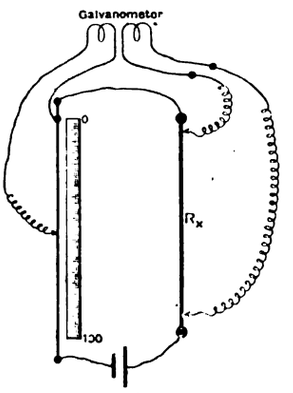


FIG. 6.

I designed a potentiometer some time ago to get rid of a slide-wire, and it is used a good deal now. There are two dials, one of about 16 ohms, divided into 150 equal parts, and the other, the whole of which is equal to one coil of the first dial, and divided into 100 parts, thus giving the equivalent of a slide-wire divided accurately into 15,000 parts, which is ample for practical work, and which cannot be damaged by its natural enemies—wear, pupils, or students. It can also be speedily checked, right through, against itself. Now, just think of the labour of adjusting the 150 contacts of about 0·1 each, and still worse the 100 contacts of about 0·001 each by potentiometer or other such means. But by differential galvano-

* Paper read before the Institution of Electrical Engineers, April 18.

* Let the two coil circuits be so adjusted by resistance that in parallel they give no deflection. Then equal E.M.F.s, at their terminals, always give none. Now join to the terminals of two equal coils, D, in series (Fig. 5). If the galvanometer circuits are of equal resistance there will be no deflection. But if they are not, but are *a* and *a*+*b* respectively, the E.M.F.s on them will be proportional to the joint resistances, and there will be a deflection due to the difference of E.M.F. on the two. The joint resistances are:—

$$R_1 = ad/(a+d) \text{ and } R_2 = (a+b)\,d/(a+b+d).$$

Let $b = a/p$ and $d = a/q$; substitute, and we get $R_2/R_1 = 1 + 1\,(p+q+pq)$; $p$ and $q$ are large—at least 100; so that error is practically $1\,pq$, *i.e.*, if the coils circuits differ by C per cent. the error in the result is C/P per cent., which is of the order of 0·01 at most, and can be easily allowed for in setting.

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meter it is perfectly simple; and the result can be easily checked, as pointed out before, by setting the galvanometer 2 or 3 or 10 to 1 instead of level.

Another use of the differential galvanometer method is shown diagrammatically in Fig. 6. It is a workshop method of measuring anything between 0·1 and 0·01, or even less. In the diagram there is a slide-wire of 0·1 total in series with the resistance under test and a battery. One coil of a differential galvanometer is applied to the ends of the resistance R by means of stabbers on cords; the other coil is joined to one end of the slide-wire and to the sliding contact, so that it takes the fall over more or less of the wire, the whole length of the wire being divided into 1,000 parts by a scale; each division (about 1mm.) is equal to 0·0001 ohm. The wire is about 0·1in. diameter, so wear does not come in. It works well with 5 A.

In conclusion, I do not suggest the differential galvanometer for ordinary accurate coil work; the Carey-Foster method is perfect for that, and I have never sanctioned any accurate coils between 1 and 10,000 being finally tested by any other method. But below 1 ohm it is invaluable, and it makes quite easy a good deal of special work which would not be practical commercially by any other method. For example, the conductivity of two copper bars can be compared with quite reasonable currents, say 10 amperes for bars 1in. square, which gives about four scale divisions for 0·1 per cent. with contact points 12in. apart.

### DISCUSSION.

Prof. R. T. GLAZEBROOK confessed that he had never used a differential galvanometer at all, although he had made various rough attempts. He was in Berlin about a year ago, and he gathered that at the Reichsanstalt they were using a differential galvanometer for resistance measurements in a somewhat similar kind of manner. It seemed that Mr. Crawley had solved the very difficult problem of adjusting and making standards of small resistance accurately, rapidly and easily, and he was very much to be congratulated.

Mr. A. P. TROTTER remarked that he had used the method shown by Mr. Crawley. Some time ago 1 ohm was the smallest measurement made in the Board of Trade laboratory, but with the use of the potentiometer method it was now very common to measure with considerable precision very much lower resistances. Some months ago there was sent to the Board of Trade a resistance of one ten-thousandth of an ohm to carry 10 amperes, which was intended for a laboratory in the United States, and it came out wonderfully well. Of course, the potentiometer method was used, but in putting a dozen amperes through a thing like that, the trouble was not so much to measure that dozen amperes as to make sure it was constant while the measurement was going on. In all potentiometer work, which had been recently introduced into the Board of Trade laboratory, they measured the current, switched over quickly to measure the resistance, and switched back again to see that the current had not altered. This was very difficult to do, and in the ordinary way necessitated repeated experiments to make quite sure that the current was steady. But Mr. Crawley had suggested to him the potentiometer method, with the result given above. They had a potentiometer fixed up, which, although not finished as regards the scale, &c., did all that Mr. Crawley said it would, and it had now been in use for some months. One of the latest measurements was 26·6 microhms (0·0000266 ohm).

Mr. ADDENBROOKE, in a communication, said that he had been supplied by Messrs. Nalder Bros. & Co. with an instrument on Mr. Crawley's system for measuring low resistances some time since, in connection with the method of measuring alternating currents electrostatically, on which he had been working, and he had been delighted with the ease and simplicity with which Mr. Crawley's system worked. In connection with this subject he alluded to a method described in *The Electrician* for Dec. 24, 1897, by Mr. R. H. Housman, and to which his attention had been drawn by Mr. J. Purrett (until lately of Messrs. Willans and Robinson), who had used it effectively. As a handy means of measuring or calibrating low resistances when only a Wheatstone bridge and a galvanometer were available, it seemed superior to the methods usually given in the text books.

Mr. C. W. S. CRAWLEY, briefly replying, thanked everybody for the kind way in which they had spoken of the Paper. He hardly liked to claim the method as his own, because it was invented by Heaviside in 1877. A reference to it was to be found in Mr. Swinburne's book.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Archives of the Röntgen Ray," for March, 1901. Edited by C. Mansell-Moullin and E. Payne. (London: Rebman, Ltd.) 4s.

Alphabetical Lists of American Patentees and Inventions for the Quarter ending December 31, 1900. (Washington: Government Printing Office.)

"Elektrische Verbrauchsmesser der Neuzeit," by Johannes Zacharias. (Halle-a-S.: Wilhelm Knapp.) 15m.

"Relazione Riassuntiva dell'ing Alessandro Panzarasa sul progetto della Città di Trento per la Costruzione di una Centrale Elettrica, Linee, Stazioni Trasformatrici, Condutture per le Ferrovie Elettriche Locali del Trentino e per la Città di Trento ed Altri Comuni." (Trento: Scotoni E. Vitti.)

"*Proceedings* of the Royal Society." No. 444, Vol. LXVIII. (London: Harrison & Sons). 2s.

## CORRESPONDENCE.

### ELECTRICITY IN BULK SCHEMES AND MUNICIPAL OPPOSITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As an outsider, unconnected with either the promoters of any electric power scheme or with the often antagonistic municipal corporations, might I suggest a clause for inclusion in these various bills which should go far towards pacifying opposition and which would entail hardship upon no one? It is this:—

That the power companies should be allowed to enter any districts at present supplied from municipal lighting stations, and to connect the premises of any person installing not less than (say) 20 B.H.P. in all; but as compensation for their loss of prospective consumers should annually pay to the municipal lighting committee an amount at the rate of ½d. per unit (or such lesser rate as the Board of Trade might direct) on all current supplied within their district, this amount to be treated by the lighting committee as general revenue, and not passed directly over to the relief of rates.

Much opposition to these schemes (other than that of the kind raised last year by the Hebburn and Felling District Councils against the Durham and Tyneside schemes, which is totally ridiculous) is quite understandable and to a large extent justifiable. Certain ratepayers are already taking electricity for lighting purposes, and have a perfectly reasonable expectation of very shortly getting prices reduced, as the growth of the municipal station lessens the cost of production, so that it is only to be expected that they should object to others supplying power in the neighbourhood and thereby preventing the natural growth of the station. If, however, the outside power company contribute to this suggested extent it would put the municipal station on quite as good a footing as if it had itself obtained these new customers, so that the interests of both those ratepayers that are at present connected to the municipal mains and also the general body of ratepayers (as owners of the station) would be amply protected. On the other side, any large would-be consumer of electricity could always obtain it from the municipal supply, if their charges were lower than the standard rate of the power company plus the special additional ½d., which would, of course, be directly put on to those customers situated in municipal supply areas, so that he would be, in any case, in no worse a position than if the power company had not got entry into that district; while the power company, for their part, could always leave severely alone any area in which they could not compete, with this adverse handicap, against the local supply, so that they, too, could never be more unfavourably placed than if that district were excluded from their bill, as without some such clause as this would most probably be the case.

This proposed charge of ½d. per unit is purely a random suggestion, as no attempt has been made to ascertain what amount of compensation the corporation might fairly be considered entitled to, but this surely does not err on the side of illiberality. It would, of course, be necessary that the Board of Trade or some other responsible body should have powers of adjusting this charge from time to time, as became necessary, and also of abolishing the charge in case the municipal committee were not using these compensation moneys in the reduction of the charges for electric light.

It is not for a moment supposed that all municipal opposition would be withdrawn by the inclusion of such a clause as this, but I think that Parliamentary Committees would know how to treat any opponents who by their antagonism must virtually admit that the power company would be in a position to supply electricity for power at a clear ½d. per unit less than themselves.

Doubtless many modifications of such a provision as this would be found necessary before anything really workable was obtained; but though somewhat crude, this is, nevertheless, offered as a *suggestion* towards a solution of a decidedly difficult problem.

In conclusion, Sir, I ask leave to subscribe myself,

"OUTSIDER."

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# PARLIAMENTARY INTELLIGENCE.

(*Concluded from page 139.*)

## MANCHESTER AND LIVERPOOL ELECTRIC EXPRESS RAILWAY.

A Committee of the House of Lords, presided over by Viscount Falkland, commenced the consideration of this bill on May 3. The measure is of a similar character to that which was introduced last year but failed to pass. It is for the construction of an electric railway between Liverpool and Manchester on the mono-rail system of Mr. F. B. Behr. The promoters anticipate that the cars will be able to attain a speed of 110 miles an hour, and to accomplish the journey from Liverpool to Manchester, or vice versa, in 20 minutes.

Mr. BALFOUR BROWNE, K.C., for the promotors, explained that the bill of last year was thrown out by a Commons Committee on the grounds that it had not been shown that the brake-power to be employed would be effective, and that the interests of the Salford Corporation and the Mersey Docks and Harbour Board had not been sufficiently safeguarded. The promoters proposed to run a service consisting of one carriage capable of conveying 60 persons every 10 minutes. There would be no stoppage between Liverpool and Manchester, and no goods traffic. The cars were to be fitted with two brakes, one to be the Westinghouse and the other an electric or magnetic brake. By applying the Westinghouse brake alone the car, when running at 110 miles an hour, could be stopped in 1,000 yards, and by applying also the electric brake the stoppage could be effected in 500 yards. The authorised capital of the company was £2,100,000.

Mr. F. B. BEHR, designer of the line, fully explained the character of the railway and of the cars by means of models. He said the railway would consist of an A-shaped structure, with one line at the apex and two on each side of the A. The carriage would sit on the top line like a pannier on a pony, and the centre of gravity would be below that line. On the side lines guiding wheels would run, and these would chiefly come into play when the carriage passed round a curve. It would be impossible to derail the car unless the line itself were broken, however sharp the curve. He considered that the line would be safer than any double line, and that not the slightest risk would be involved in running at the rate of 110 miles an hour. He constructed a mono-rail line at the Brussels Exhibition a few years ago, and, though it was only 3 miles long and was of an elliptical shape, with very sharp curves, the speed attained was over 80 miles an hour. According to his estimate, if the cars carried only eight persons on each journey, the company would pay working expenses, while, if they carried 20 in each car, they would pay 5 per cent. on their capital.

Cross-examined by Mr. LITTLER, K.C., for the Cheshire Lines Committee: It was true there was a classification of merchandise traffic included in the bill, but personally he should like to see that classification struck out; it had been put in by the parliamentary agents in the usual way. He denied that it would be possible, as the bill stood, for the promoters to turn the line into an ordinary electric railway if the mono-rail proved to be a failure. It would certainly be possible to carry goods by the mono-rail, though he personally had no intention of doing so. It was to be a pure passenger line. He was not aware that the Cheshire Lines Committee had spent £8,000,000 on their line between Manchester and Liverpool. The cost of construction of the new line was estimated this year at £13,500 per mile, though last year it was estimated at £18,000 per mile. The reason for the difference was that the price of steel had gone down since last year. He anticipated an enormous increase in the traffic between Liverpool and Manchester when the proposed new line was made and frequent trains were running at increased speed. He was not aware that, in consequence of the extended use of the telephone in recent years, the rate of increase in the number of passengers between the two cities had largely diminished. He had been experimenting with the mono-rail for about 15 years. There was a mono-rail in use in Russia and one in France, while there were about half a dozen in the colonies. The curves on the projected line would not imply any diminution of speed. No doubt additional pressure would be put on the guide wheels in passing round a curve, but those wheels were there for the purpose of taking such pressure. The pressure produced by a high wind had been taken into consideration. It was impossible for a carriage to leave the rails unless the rails were broken. He did not think that, in the event of derailment, the consequences would be more serious than those of derailment on an ordinary line, though the floor of the carriage would be 4ft. 6in. above the ground. The carriage would, of course, be buried in the ground. The electricity was to be conveyed, not by means of a rail, but by means of a cable. The weight of the motor would be 3½ tons. Asked what was the maximum power of the motors that could be usefully employed on the driving wheels without their slipping on the rails, Witness said that certainly more than 1,500 H.P. could be employed without causing slipping. The maximum horse-power developed by each motor at a speed of 110 miles per hour would be less than 400. He could not say that the weight of the carriages per passenger would be about four times that of the carriages on an ordinary railway, and about twice the weight per passenger on any electric railway system known. The advantages held out to the public by the scheme were increased speed, with perfect safety, and frequency of service. It would be impossible to make an intermediate branch, except at a station, and it would be fatal to the speed to stop the train anywhere between the termini. He denied that this would be an uncomfortable way of travelling. He had designed his carriages to accommodate 52, but it would be possible to have carriages holding 100. He did not think it would conduce to comfort to exceed 100 seats in one carriage. The cars were to run every 10 minutes. He believed it was more convenient to the public to have small trains at short intervals than to have long trains at long intervals.

Mr. R. ELLIOTT COWPER, C.E., expressed the view that the route selected by the promoters possessed greater advantages, and did less injury to private interests than any other route that could have been chosen. He put the cost of the works at £1,218,306, and of lands and buildings at £558,515. In his opinion, increased speed in this country could only be obtained by electric traction and the mono-rail. He thought that there would be none of the ordinary elements of danger in the proposed line. He quite agreed with Mr. Behr, that it did not much matter whether the line was ballasted or not, the conditions being so different from those prevailing on a two-rail line. The clearance between two cars passing in opposite directions was 1ft. 6in. If a platelayer were between the lines when two cars were passing he could easily take refuge underneath the A-shaped structure. The terminus would be quite as convenient for Salford as for Manchester.

Mr. J. M. DOBSON, C.E., said he considered it would not be practicable to tunnel through Salford, as suggested by the Corporation of that town. For all practical purposes the limit of speed had been reached on two-line railways, but by the introduction of the mono-rail system the speed could be very largely increased. The system of signalling proposed by the promoters would give the electrician in charge of the train a clear run of 7 miles in which to pull up. There would be no level crossings, no points, no shunting operations, and no goods trains on the line, so that the chief sources of danger on an ordinary railway would be non-existent. He did not consider that it would be necessary to use the brakes except at the termini and in the event of a breakdown. He regarded the mono-rail system as the proper one for a high express service.

Mr. W. SHELFORD, C.E., said the mono-rail system enabled very high speed to be attained with ordinary curves.

Mr. W. R. GALBRAITH, C.E., said he thought a speed of 110 miles an hour could be attained with safety.

Dr. E. HOPKINSON said he had no doubt whatever about the possibility of running the trains on the mono-rail line at the speed that was proposed. He calculated that a speed of 110 miles an hour could be attained in just over two minutes from starting, the distance covered in the meantime being just under 2 miles. During the time of acceleration he estimated that the maximum electrical power required would be about 1,500 H.P. It was quite possible to transmit that power from a central generating station. A rapid rate of retardation as well as a rapid rate of acceleration would be necessary. If 3ft. per second were applied as the rate of retardation the train would be brought to rest from a speed of 110 miles in considerably under 1 mile of distance and in 54 seconds of time. He thought this rate would be a proper rate to choose in ordinary working on approaching the terminus. It would be possible to apply a much greater rate of retardation if necessary. There were many instances on record of trains being suddenly pulled up at the rate of 8ft. or 9ft. per second. It was hardly conceivable that it would be necessary to do such a thing, and it would be very undesirable to pull up at that rate; still it was possible. There were three ways, all of which were feasible, by which the power from the motor armature shaft could be transferred to the car axle. One way was that Mr. Behr adopted in Brussels—to put the motor down below and drive by a chain from the motor-axle to the axle carrying the car. He had driven many cars by chains. In one case the speed of the chain was about 3,000ft. per minute, and the power about 30 H.P. He was referring to the first electric railway ever made in the United Kingdom, some 20 years ago, so that his recollection might not be quite accurate on these points. The line was the Bessbrook and Newry line in Ireland, and it was working at this moment entirely successfully and with advantage. He believed that it would be quite practicable to apply this system to the proposed new railway, though he did not say he considered it would be the best one for the purpose. Another way was by adopting the method used on every tramcar in the world—that of having a spur-wheel on the motor and another on the axle and gearing one up to the other. He had known a line in which gears had run up to 50 or 60 miles an hour very successfully. He thought that powers up to something like 80 H.P. or 100 H.P. had been transmitted by means of these gears, but he believed it was possible and practicable that such a power as 375 H.P. could be transmitted by them. Another plan would be to do away with gear altogether and to put the motor direct upon the axles. That was the plan adopted on the City and South London Railway, and it was both possible and practicable for the mono line. He was certain that any of the three ways he had mentioned would give mechanical success, and the choice between them would be a question of wear and tear. His own opinion at the present moment was in favour of the direct drive, but it would be necessary to make very careful calculations and to experiment before he could express a definitive view as to which was the best of the three modes. If the direct drive were adopted, he would put the motor on the axle, and would so dispense the weights in the car as to bring the centre of gravity 9in. to 12in. below the point of suspension. It was obvious that the car would have to be ballasted differently altogether from the way shown in Mr. Behr's diagrams, as weights would have to be put below to counteract the putting of the motor so high up. The weight of the motor would be about 2½ tons. It would be necessary to move four times 2½ tons if he moved each motor. The maximum horse-power each 2½ ton motor would have to exert would be about 375. The land scheduled in the bill for a generating station was at Warrington, and was in a favourable position for transmitting power in either direction. Here power would be generated at 10,000 or 15,000 volts. This would be reduced to 1,000 volts, an electromotive force which he had very little doubt the Board of Trade would approve as being a safe one to employ for distributing current along the whole length of the line. The current would be conveyed along the line by three conductors. Two of these might probably be placed on the sleepers, and be protected by continuous boards of wood. The other conductor might be on the permanent way. The car as it passed along would have a sliding contact to pick up the current from the conductors and convey it to the motors on the car.

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By Mr. HANS HAMILTON: Will 1,000 volts kill a man or a horse if they touch it?—It would kill a horse straight away. I believe there have been instances on record where men have been killed by 1,000 volts, but it is very rare.

Major P. CARDEW said he had investigated the scheme, and had no doubt that it was possible to propel a car of about 50 tons weight at the speed suggested by the promoters. The power would be generated in one power-house, and the three-phase current would be used at an alternation of 15 complete periods per second and a pressure of about 10,000 volts, though the pressure need not be so high as that. 10,000 volts would be sufficiently high for transmission to the distance required without undue loss. The number of transformers in sub-stations would depend on the limit of pressure insisted on. If the Board of Trade allowed the pressure which was now being worked on the Continent, or was just about to be put into practice, it would be a pressure of 3,000 volts. If they allowed the high pressure there would be fewer sub-stations required, and the whole equipment would be cheapened. The higher the pressure the more economical would be the working. With regard to the stopping of the cars, from full speed to half speed retardation would be derived from the motors by causing the motors to act as generators. From half speed to stop the retardation would have to be effected by a mechanical brake. During the time the motors were being used as brakes they would give out power to the line, and to that extent relieve the call on the generating station. The timing, which was a very exact thing with a railway on this sytem, would be so arranged that there would be a train going into Liverpool just on the point of retardation at the time a train started out, so that all the power given out by the motors would be at once taken into the other train without any call upon the generating station or the line conductors except for a very small distance. He estimated that the expenditure of energy would be 4·78 units per train mile, or, allowing for loss in the generating station, 5·6 units. The cost of that should not exceed a third of 1d. per unit for such load as would be obtained at the generating station. The traffic could be worked by five trains, and the total output would be 38·6 units per minute, or a mean load of 2,316kw., and the maximum load with this system of running should not exceed 3,000kw. He considered that 4 units of plant would be sufficient, each capable of giving 1,000kw. or 1,500kw. for a short time, if placed abreast. The motors should be what were recognised as induction motors, which had the property of maintaining a uniform speed. He saw no reason why a train of 50 tons should not be driven on the proposed line to run the distance between Manchester and Liverpool in, say, 20min., and he saw no reason to suppose that the train would not be under proper control. There was no reason why an electrical brake should not be adopted that would bring the train to a standstill within a reasonable distance.

By Mr. LITTLER (for the Cheshire Lines Committee): He had not considered the wind pressure that would be produced by two trains passing each other at 110 miles an hour 18in. apart, but agreed that it would be enormous.

Would it not be more than enough to break the glass of the carriages?—The glass would have to be made thick enough to withstand it. He was first consulted on the present proposal several months ago, but he had not had a design of the car submitted to him. He was asked merely to see how the electrical arrangements could be worked, and he gave it as his opinion that it would be possible to place the motors directly on the axles of the wheels. There were methods by which the electrical conductors could be so protected that no one could touch them. If the promoters were going to use the pressure that was allowed on the Continent, the wires would be entirely out of reach. His idea was that, with such a system of railway as proposed, there would be wires overhead which would take the current, and the rails would be only used for the portion of the current which could be kept at the potential of the earth, and which would not hurt anybody. If they could not use overhead wires they would have side conductors, which could be enclosed to whatever extent was desirable. The City and South London Railway and the Central London Railway used conductors which were not protected in any way. On the mono-rail line the conductors might be so far enclosed that it would be practically impossible for anyone, without doing it designedly, to get into contact with them. When he was at the Board of Trade he suggested, and the Department insisted, on a wooden guard being put along the conductors at the stations of the City and South London Railway so as to prevent the public touching the conductors.

By Mr. FREEMAN, K.C. (for Salford Corporation): There would be no danger whatever to the gas and water mains if the system of electric traction which he recommended were adopted.

Mons. E. GERARD, president of the Society of Electrical Engineers in Belgium, and chief engineer and inspector of State Railways in that country, stated that he acted as president of the Royal Commission appointed by the Belgian Government to examine the Behr high-speed railway at Brussels in 1897, and took part in the investigations attending the trial of that line. He satisfied himself that that scheme furnished a practical method of obtaining a high-speed railway. With respect to derailment he thought the mono railway much safer than an ordinary railway, especially where curves of a narraw radius were concerned. Given the necessary power, he thought that a railway on the electric mono-rail principle could attain a speed of 110 miles an hour with safety and comfort to the passengers. The Belgian Government had made many experiments as to the adaptability of electric traction to the State railways, and they had not adopted the mono-rail system.

Mons. A. DEGRAUX, engineer-in-chief and managing director of the traction and materials department of the Belgian State Railways, said he was Government Commissioner of the Brussels Exhibition of 1897, and Mr. Behr's mono-rail line came under his supervision. He satisfied himself as to its absolute safety, and the line was used by the public. In his view a line of a similar character could be constructed that would be capable of running at a high speed.

Mr. S. B. COTTRALL, manager of the Liverpool Overhead Railway, stated that he was a member of the local committee that was appointed to consider the mono railway scheme between Manchester and Liverpool, and he concurred in the finding of that committee in favour of the scheme. He had satisfied himself that by the system proposed derailment was practically impossible, and that there would be no difficulty in getting up a speed of 110 miles an hour. In his opinion there would be sufficient traffic to justify the construction of the line, and he thought that the signalling proposed would be all that was necessary. An emergency stoppage of a train on the line should be made in 18 seconds and within 500yds.

Sir WILLIAM PREECE, K.C.B., said he had carefully examined the plans of the railway, particularly with reference to the electrical portion of the scheme, and approved of them. The proposal to have a central generating station at Warrington met with his entire approval.

Sir F. BRAMWELL was of opinion that the proposed method of constructing the line was well adapted to secure a high speed with safety. The mono-rail line had the same advantage over a double railway as the bicycle had over the tricycle. By adopting the mono-rail the greatest obstacle to high speed would be removed. A train travelling at 110 miles an hour could be easily stopped in a short time. He knew of a train having been stopped in 17 seconds while travelling at the rate of 52 miles an hour.

Baron F. DE BEECKMAN said he travelled on the Brussels mono-rail line in 1897 at a speed of 78 miles an hour, and the movements of the train were similar to those of an ordinary railway. In going over the curves the train "canted" a little, but not more than an ordinary train would do. There had been no development of the mono-rail system in Brussels since then.

Sir W. BAILEY, mechanical engineer, Salford, said he was satisfied of the practicability and feasibility of the scheme, and was prepared to subscribe to the capital of the company if the bill passed.

Further evidence was given by local witnesses, and the promoters' case closed.

Ald. RUDMAN, Mayor of Salford, and Ald. PHILLIPS, Salford, did not recognise the utility of the new railway, and considered that Manchester and Liverpool were exceptionally well served by the existing railways.

Mr. CORBETT, borough engineer of Salford, produced an alternative scheme for the construction of a tunnel through Salford in lieu of the cutting proposed by the bill. In his opinion the chief danger of having the line worked at high speed would arise at each end of the journey. It was suggested on behalf of the promoters that full speed could be kept up till the trains were within 2 miles of the terminus, but it was very easy to imagine that if the slightest thing went wrong it would be impossible to pull up in time. The result would be that at the Manchester end, where the line was to be 22ft. above the street, the train would pitch right across Deansgate into the buildings opposite, while at the Liverpool end, where the line was to be 64ft. high, it would be precipitated into the Cathedral. His suggestion was that there should be a tunnel with a dead end of a quarter of a mile beyond the terminal station. He entered a protest against the assumption that the railway would be safer against bad packing of the sleepers than an ordinary railway, and said that it would be more dangerous. He did not believe that the scheme was a practicable one, but if it were carried out at all a tunnel ought to be made through the Salford portion of the route. He regarded the mechanical details of the invention as absurd, and held that the security which was claimed against derailment was an entire fallacy.

How do you explain that the passengers on the Brussels mono-rail line travelled without inconvenience or discomfort?—They made the journey expecting a violent sensation as on a switchback railway, and when they came out alive they were well satisfied.

Mr. W. MELVILLE, engineer-in-chief to the Glasgow South-Western Railway Co., said Salford's interests had been disregarded in the proposed construction of the new line. He thought the objection of Salford would disappear if the line were taken through a tunnel. Underground railways had been constructed under the main thoroughfares in Glasgow so as to avoid the expense of acquiring property. He saw no difficulty in carrying a tunnel through Salford.

By Mr. J. D. FITZGERALD: With a train going at 70 miles an hour in a tunnel there was no air pressure. He did not suggest anything with regard to a higher speed.

Sir DOUGLAS FOX, C.E., said he had come to the conclusion that in designing the proposed line no care had been taken to comply with the conditions mentioned by the Committee last year. In making a tunnel for such a railway as was proposed he did not think it fair to ask them to use a tunnel less than 30ft. in diameter; and even if two carriages were passing each other in the tunnel—an improbable circumstance—there would be double the air space round the carriages to that occupied by the carriages themselves. His estimate of the cost of making the works proposed by the promoters was £438,000 for construction alone. For the tunnel he suggested that the cost would not exceed £319,000. The promoters would thus save by adopting that tunnel.

On Monday last Mr. BALFOUR BROWNE said that, as it had been suggested that the promoters might possibly at some time or other abandon the mono-rail system and turn the line into an ordinary railway, he had been authorised to state that the promoters did not intend to use the line for any purpose but that of a mono-rail line, and they would be prepared to substitute "shall" for "may" in the bill. They were also willing to make it clear that no carriage should be run on the railway unless the centre of gravity was below the mono-rail, and that this must be proved to the satisfaction of the Board of Trade before any carriage was run at all.

Evidence was then called for the promoters to rebut that given for Salford Corporation in favour of the construction of a tunnel through Salford and Mr. Ackworth addressed the Committee on behalf of Salford.

On Tuesday, on behalf of the Cheshire Lines Co.,

Sir DOUGLAS FOX, consulting engineer to the Great Central Railway

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Co., complained that the proposed new line would "hug" the Cheshire Lines railway in such a way as to prevent expansion. The mono-rail system, he said, was a very complicated one, and nothing could have been devised that would be more awkward to maintain in proper running order. The Brussels experiment did not afford any ground for supposing that 110 miles an hour could be safely attained on this line, and he did not see how the scheme could succeed. He was interested in electric traction, but believed that the scheme would cause a set-back in the introduction of electric traction at high speed.

Mr. F. FOX, C.E., expressed the opinion that the mono-rail system, so far as it had been carried out, was impracticable. The Ballybunnion railway would, in his view, be a dangersous toy for anything like high speeds. He considered that that railway acted like a blight on the district in which it was laid, and that, at the earliest moment, it would be pulled up and made into an ordinary railway.

Mr. C. A. ROWLANDSON, chief engineer of the Great Central Railway Co., said he did not think the proposed line could be constructed with safety.

Mr. A. ROSS, chief engineer of the Great Northern Railway Co., took the view that the effect of the curves on the line would be fatal to very high speed.

Prof. SHORT stated that he had been sent by the United States Government to several international congresses on electricity in order that he might report on them. He was the builder of the first commercial road car used in New York, and he had since been providing electrical tramways and railways. Fully 60 per cent. of the electrical machinery used in this country was made from his designs. He had carefully examined the detailed drawings of the car it was proposed to use on the mono-rail line. Having regard to the high speed at which that car was to be run, he did not think it was to be built sufficiently substantial to stand the great vibration to which it would necessarily be subjected. He did not think it would be anything like strong enough for the work it would have to do. Nor could he agree with Mr. Behr and other witnesses that it would be practicable to stop the car within 500 yards when it was going at its highest speed. That would be practically impossible. Magnetic brakes had been tried on railways he had been practically associated with, but they had worn out so rapidly and given so much trouble that they had had to be abandoned. The brake appliances suggested for use by the promoters of this bill were not only inadequate but were on the lines of experiments which were abandoned because they proved to be impracticable.

On Wednesday Mr. STEPHEN SELLON, chief engineer of the British Electric Traction Co., said he considered the scheme both crude and impracticable, and agreed with other witnesses, that if it obtained Parliamentary sanction it would set back electric locomotion for years. He looked on the scheme as fanciful and doubtful, and as one that would be absolutely valueless for the purpose for which it was intended. In his opinion, the action of the car with a centrifugal force would be sufficient to turn the car over. No proper appreciation had, he thought, been shown of the expansion of the metal. In going round a curve at any speed the tendency of the car would be to fly off the rail. If the proposed railway took 500 per cent. more passengers than all the existing railways put together, it would only just pay its wage expenses.

Prof. A. A. C. WILSON said he had considered the proposals for driving the car by electricity, and thought that the resistance to motion was under estimated, and that this would involve a lower acceleration than was aimed at. This, however, would not materially affect the conditions of running, and so he was prepared to accept 1,500 H.P. as the maximum power of the motors on each car. He approved of the use of polyphase motors thinking that they were the only motors that could be used for such high speeds. The difficulty of space for the motors was not peculiar to Mr. Behr's system, but his system increased that difficulty. He could not put his motors where they should be—on the main driving axles—and so he had to stow them away on each side and drive up by some kind of transmission. He was thus limited both in space and in the power it was possible to transmit. There was not room under Mr. Behr's car for motors of the requisite power. There was space for motors of about 100 H P. each, he should think. Mr. Behr would require four motors each of 375 H.P. Witness had with him a drawing of one of the motors now being made for the Vattelina railway in Italy—a polyphase motor of about 370 H.P. at the given speed. It weighed 3½ tons by itself, or about 4 tons with attachments. That was not an excessive weight for a motor of that horse-power. It was rather below ordinary rating. According to the catalogue of polyphase motors made by the British Thomson-Houston Co. for motors of this output the weight would be over 4 tons.

Mr. LITTLER, K.C.: Are you, then, of opinion that motors of the requisite power must be placed on the axle?—Yes, that is the only possible way of getting them in, but then the centre of gravity is raised too high. High powers could only be transmitted at low speeds by any kind of toothed gearing or chain; at high speeds the teeth soon cut and went to pieces. The limit imposed by the difficulty of transmission was not the only fatal objection to placing the motors below the axle. The use of polyphase motors on railways was attended with a difficulty not found in direct-current motors. The clearance between the moving and fixed part had to be extremely small, so that side-thrust caused by transmission was detrimental. For such high speeds and powers direct connection was essential so as to avoid any chance of wearing on one side and contact between fixed and moving parts. Mr. Behr's system obliged him to put his motors where his passengers should be. This was a fatal objection, because it raised the centre of gravity so high. It had a further disadvantage in that it precluded him from the possibility of getting motors on more than one-third of his wheels. If he used all his wheels as drivers there would be no space left for the passengers. With regard to brake power, he did not think it would be possible to bring the train to a standstill in less than 1,944 yards of distance, and in exactly one minute of time. It was one of the great defects of Mr. Behr's system that the design of his car obliged him to take just twice the distance for stopping that would be necessary in a car of ordinary construction. With regard to safety in going round curves, with the centre of gravity where Mr. Behr said it was, his car would go round a 50-chain curve at 110 miles an hour as the utmost limit of safety. At Brussels the highest speed recorded on a curve of 25 chains was 83 miles an hour. One curve it was proposed to run round at 110 miles an hour on the new railway had a radius of 30 chains, but under the proposed conditions the car could not run safely round a curve sharper than 69 chains radius. As the line was laid out there were curves of 47, 44, 37, 35 and 30 chains, on any one of which the car would certainly come off at 110 miles an hour. If the limit of safety was not to be exceeded, the greatest speed at which it would be possible to run round the 30-chain curve was 85 miles an hour, taking Mr. Behr's own figures for the position of the centre of gravity. No doubt the Board of Trade would limit the speed to 80 or 85 miles an hour, and there was nothing in the bill to prevent the company running at the lower speed.

Mr. W. W. BEAUMONT, C.E., said a chain gear could only be employed at a low rate of speed. He considered the proposals made by Mr. Behr as to the arrangements of the car were quite impracticable.

Sir W. POLLITT, general manager of the Great Central Railway, objected to the proposed new line on the ground that it would interfere with existing railways, which already provided an adequate service.

The only remaining witnesses were Mr. Steel, general manager of the Great Northern Railway Co., and Mr. Aspinall, general manager of the Lancashire and Yorkshire Railway Co.

Yesterday Mr. Pope addressed the Committee on behalf of the Lancashire and Yorkshire and London and North Western Railway Companies, and Mr. Littler on behalf of the Cheshire Lines Committee.

Mr. Balfour Browne had not completed his reply for the promoters when the Committee adjourned till to-day (Friday).

## THE METROPOLITAN ELECTRIC SUPPLY BILL.

The Select Committee of the House of Commons presided over by Sir Henry Fletcher sat on Tuesday to consider the bill of the Metropolitan Electric Supply Co. (Ltd.) to confer further powers with respect to the supply of electrical energy and for other purposes.

Mr. BALFOUR BROWNE, K.C., for the bill, said that by an order of the Board of Trade, dated April 24, 1900, the Board consented to an "extra high pressure" supply being given by the company to their various distributing stations, subject to certain regulations and conditions, and to a condition that at least two separate and distinct trunk mains shall be laid to each distributing station, and that those mains should, where practicable, be laid by different routes. The present bill was merely to carry out that order. They required a second conduit of cables for high-pressure mains, and it was a condition of their getting it that they should find a different route to the south side of the towing path of the Regent's Canal. The conduit was required to carry electricity from the company's generating station at Willesden to the company's areas of supply, which were the Strand, Holborn, St. Giles's, Marylebone and Paddington. The conduits were underground. The chief opponents to the scheme were the Willesden District Council, who objected to the company having power to open up the streets, and the Borough Council of Paddington, who took a similar objection, and also objected to a piece of their district being added to the company's area of supply. A Select Committee, which had sat to consider the question of these electricity supply companies, had assented to one of the principles involved in the present bill, which was that an electric supply company might have power to erect a generating station outside their district of supply, and should have the necessary power for breaking up streets. Originally the company, in laying down their first conduit, had proposed to do it under the streets, but they had come to an agreement with the proprietors of the Regent's Canal, and have laid the mains under the towing path of the canal, which was private property. All power to go under the streets in the case of the first conduit was taken away. But now the position was altogether different; the Board of Trade insisting that the company should have a separate route altogether. So far as the Middlesex County Council were concerned they wanted protection, and if their demand was reasonable it would be acceeded to.

The CHAIRMAN: Why cannot you lay your second cable along the Regent's Canal?—The Board of Trade require us to have an alternative route, as one conduit might go wrong. It was desirable that there should be a second in the event of an accident on the canal. Besides there were physical difficulties in getting another conduit along the towing path of the canal.

Mr. J. CONACHER, general manager of the Metropolitan Company, said that to the end of last year the company had spent £262,286 on their works at Willesden. They were now spending about £85,000 on increasing the capacity of that station. Most of that money had been spent and the remainder would be expended during the year, and this would bring the expenditure to about £347,000. The additional trunk mains necessary if this bill were passed would cost £80,000. It had been estimated that their requirements for additional lamps each year during the next four years which would have to be provided for would be 30,000, but this year alone the number would probably reach 8,000. If that was continued till 1902 the total number of lamps estimated for 1910 would be reached in 1902. In view of this great development it had been thought necessary to increase the works at Willesden, though these had been laid down on a very large scale. Tenders had been invited in this country and abroad for the construction of larger machines for generating than those at present in use by the company. Under the Board of Trade regulations each main could only carry 1,000kw. of electricity. They were endeavouring to get the Board of Trade to extend the amount to 1,500kw. In the conduit under the towing path of the Regent's Canal they might have eight



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mains carrying 1,000kw. each. If they could bring about the change he referred to, they would have mains for 12,000kw., and that would not be more than they would want in 1904. If they did not get the change their main capacity would be exhausted in 1902. The new machines they were ordering would give them 30,000kw. a day. Witness pointed to the dangers of the canal-side conduits. Not long ago a man in charge of a barge had driven a marline-spike into the canal bank and got foul of the electric mains, and it had taken a considerable time to discover where the damage was, though at the works they knew that something was wrong. This occurred in the summer; if it had happened in the winter, when the mains were heavily charged, the interference might have been very serious, and probably the bargee would never have done the like again. Again, there might be an explosion on the canal similar to that which occurred on the Regent's Canal some years ago, and that would destroy the cables, and, unless there were an alternative route of supply, put the whole of their area in darkness. The petitioners objected to the breaking up of the streets, but the terms on which they did this work would put Willesden in no worse position than any other local authority. The only difference was that in Willesden they had power to break up streets without supplying electricity, whereas in other districts they did supply.

Mr. HARPER (for the Middlesex County Council) at this point said his Council had come to terms with the promoters.

By Mr. GREIG (for Willesden): The proposed new conduit should be taken through the streets, as that was the best route available. They had not chosen that route because they would not have to pay the local authority. That he could say honestly. They could not take their mains on the north side of the canal as it was covered with buildings, and there would be no space for the cables.

By Mr. ALLAN (for Paddington): The company proposed to take a new area in Paddington. They considered that by doing this they were conferring a great benefit on the district. They had not been asked to do it. The place was covered with artizans' dwellings, but they were hoping that there would be a demand for current there.

By the Committee: The rapid growth of the company's business had come upon them with surprise.

Mr. FRANK BAILEY, C.E., said that at the time the company's act was obtained to authorise the establishment of a generating station at Willesden he was engineer to the company, and the station was designed according to his plans, which were prepared at a time when they had not foreseen anything like the demand which was now made for electric power. In fact, it was considered that the conduit along the canal bank would carry them on for a very long period. When the bill of 1898 was deposited two routes were proposed—one through the roads and the other along the canal bank. These two routes were proposed as alternative routes. They only wanted one route, and not being sure which they would secure, they deposited plans for two routes. But having secured the canal route, they had withdrawn the road route. He could say positively that it was physically impossible to lay a second cable along the canal route. The only space there was occupied by their existing conduit. On the opposite side of the canal there was no towing path. The towing path route would be four or five times cheaper than the road route. He did not know of any other possible route than that they were now seeking. This was not the only case in London where a company carried its mains through a district without supplying it with electricity, or in which the generating station was outside the district of supply. The Central Electric Co. had taken power to supply districts from Hampstead, and to reach those districts they had to pass through Marylebone. The Charing Cross and Strand Company, in like manner, had power to run through areas which they did not supply.

By Mr. GREIG: Do you suggest that you require this extra high pressure in your mains?—Yes, for the transmission line, certainly.

Are you not using high pressure along your existing lines?—Yes; that was the original intention.

Have you had any accidents on the canal route, except in the case we have heard of, in which a man in charge of a barge put a marline-spike through your mains?—No. We have five mains along the canal route in the one conduit, but we only use four, one being a spare main. The company would like to put their mains above ground, but that the Board of Trade would not permit. They certainly would not allow the mains to be put overhead along the streets, and he very much doubted whether they would allow allow them to be put overhead along the canal bank. He was perfectly aware that it was done in America.

By Mr. ALLAN: Paddington would only require to be served by the proposed mains in the event of an accident at the Amberley-road generating station, whence they obtained their present supply.

By the Committee: Would it be possible for you to increase your mains along the canal bank?—We can lay another five cables there, making 10 in all, but that would only provide for a period of two or three years more. It would be cheaper to go along the canal route.

How much coal do you use at present?—We use 60,000 to 70,000 tons a year. We get it all by railway or canal at our Willesden station,

So that the roads are not cut up the cartage?—No. We do not bring a single cart along the road with coal.

By the CHAIRMAN: At what amount do you estimate the coal you will require in the future?—80,000 tons.

The CHAIRMAN: On the point of alternative route, what is the nature of the land on the south side of the canal? Have you considered whether there is any objection to laying your second line there?—There is the railway difficulty, but, besides that, there is a difficulty at Kensal Green, where there are gas works and houses. I repeat that the route is physically impossible.

Major P. CARDEW, R.E., said he had considered the scheme of the bill, and considered it desirable that the promoters should have the proposed alternative route. He pointed out the objection to having a generating station along the route of supply, involving, as it did, a large amount of objectionable traffic on the roads. A generating station outside London, in a large concern like this, was desirable. The view of the Board of Trade in regard to trunk mains was that if there were more than one they should be laid along different routes. This was considered desirable in order to prevent the possibility of some accidental stoppage affecting all the mains. The whole of a very large district in London was more or less dependent on Willesden, and a stoppage of the supply from Willesden would have a most serious effect. So long as there was only one route there was always a possibility of such a stoppage. As to overhead wires, no doubt they were dangerous, were very costly to maintain, and were always liable to interruption. In America they carried the cables overhead sometimes through open districts, and they used bare wire. In England that would not be permitted. The climate here is such that electricity would escape if you had bare wires. They had to depend upon insulating material, and that deteriorated in a year or two. Overhead wires for high-pressure electricity were not practicable.

This evidence completed the case for the bill.

Mr. GREIG complained that the Willesden Council had not been approached in the matter by the promoters before the bill was brought in, and that there had, therefore, been no investigation by any of their officials as to an alternative route. He maintained that the powers sought for opening up the streets in the Willesden district would interfere with their system of sewers, water pipes and tramway. Further, the Council were in possession of powers for the supply of electricity, and intended very shortly to put down mains along this very route.

The CHAIRMAN: Mr. Fitzgerald, for the company, offers to consider any alternative route which may be suggested by your Council.

Mr. FITZGERALD, K.C.: Yes, and it need not be decided now at all. Before we lay our line it is open to the Council to suggest an alternative route, and if they do suggest one the Board of Trade will consider and decide upon it.

Mr. ALLAN, for Paddington, objected to the district known as "Chelsea Detached," which was now a part of Paddington, being added to the promoters' district of supply, there being no special reason for it. The promoters said they proposed it to please the inhabitants, but the local authority (who only came into existence in November and had not yet had time to look round them) objected. They also objected to their streets being interfered with, though on this point they would accept Mr. Fitzgerald's offer on the subject of an alternative route.

Mr. FITZGERALD said he would withdraw that part of the bill dealing with "Chelsea Detached," and arrange the other matter by a special clause.

Mr. FITZGERALD (in reply to the Chairman) said that the promoters had their right-of-way on the canal bank in perpetuity.

The CHAIRMAN: The question is, if you get this alternative route, can you throw up your agreement with the Grand Junction Canal Co., and take away your line from there?

Mr. FITZGERALD: I have not had an opportunity of looking at the documents, but undoubtedly in the original agreement between the Metropolitan Company and the Canal Company there was a proviso to that effect. As far as I can tell you, I think the agreement is operative, and, therefore, as far as the Canal Company are concerned, it gives an easement in perpetuity, and they cannot bring it to an end; but after 1904 it is subject to a power on our part to bring it to an end by giving six calendar months' notice.

The CHAIRMAN, after a brief consultation with his colleagues, said: The Committee have very carefully considered this bill, and they consider the preamble is proved, but there is one provision which must be introduced in some form, and that is that the towing path route along the Grand Junction Canal is not to be abandoned without the consent of the Board of Trade, the Board having laid down very strongly that the two routes are necessary for this large work. And you are also subject to your agreement with Paddington; that clause is struck out.

## MOND GAS BILL.

On Friday last this bill was further considered by the Select Committee of the House of Commons of which Col. Welby is chairman.

Mr. HUGO YOUNG, K.C., for Handsworth District Council, objected to Mond gas on the ground that its utility had not been proved; that the possibility of distribution over a large area had not been established; and because it seemed evident that the suggested cheapness of the gas was an illusion, having regard to its chemical nature and the difficulties of its application to many forms of machinery. The particular objection Handsworth entertained with regard to the inclusion of their district in the area of supply was that that district was mainly residential and agricultural; that it contained very few factories or works; that there was no demand for the gas and no likelihood of any such demand. If the Committee passed the bill he asked them to exclude Handsworth from its operation, in the same way that that place was excluded from the area of supply of the Midland Electric Power Co.

Mr. HUTCHINSON, for Stourbridge District Council, also asked that his district should not be included in the bill. He alleged that the new gas would compete with the gas which the Council supplied for power, and that the Council would derive no benefits from the scheme commensurate with the injury and inconvenience which it would inflict upon them.

Mr. WM. GODDARD, clerk to the Stourbidge Council, said they owned the gas works, and had an electric lighting order. They were considering a scheme for the supply of electricity, and the works would probably be commenced in the present year. The proposals of the bill would very prejudicially interfere with the streets, and, having regard to the fact that anyone residing in the district would soon be able to use either gas or electricity, there was no need for the extension of the proposed powers of the bill into Sourbridge.

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Mr. LLOYD, for the Bilston Gas Co., asked the Committee to reject the bill because the proposal to establish a monopoly over a large district in regard to a patented commodity was unprecedented, and because the whole matter was so experimental, the Committee being asked to authorise the distribution at a cost which nobody knew or was capable of telling of an article of which no one had had any actual experience.

Mr. MOON, for the Wolverhampton Gas Co., 25 per cent. of whose supply was for heating and power, opposed the bill on the ground of competition. In point of principle in regard to Parliamentary legislation, the bill possessed a cardinal vice, because it enabled Dr. Mond to render it absolutely useless unless a certain condition in connection with the contribution of capital was performed within a certain time, and the result, if that power were exercised, would be that the company could no longer supply Mond gas. Either it was to the public advantage that Mond gas should be supplied or it was not. If it was not the bill ought not to pass, if it was it ought not to be in Dr. Mond's power to defeat the public interest.

Mr. PRITCHARD, for the Midland Electric Corporation for Power Distribution, did not think it necessary to call evidence. His company differed from many other electric companies because they obtained their powers, not by special Act of Parliament, as most of them did, but by provisional order. In order to obtain a provisional order the consent of the local authority had first to be obtained, and his company had obtained the consents of the local authority of every district they covered, which included an area greater than the area mentioned in the Mond Bill. Their works, which were nearly complete, were at Tipton. The company was spending some £300,000, and in a few months anticipated being able to supply cheap electric power throughout the district.

Mr. STATHAM, for the Dudley Gas Co., said there was every prospect that the scheme, if sanctioned, would be a huge financial fiasco, and he suggested that if the Committee did pass the bill they would thereby give the scheme prestige, which would cause people to readily invest money, every penny of which they might lose. He urged that Parliamentary powers, on principle, ought never to be granted to assist private enterprise to do what private enterprise could do without Parliamentary powers.

On Monday, Mr. BALFOUR BROWNE replied on the whole case for the promoters. He said in this case the Committee were asked to block what would be a very great improvement and benefit to the trade of the country by a very small number of local authorities and companies who had no argument but that of vested rights. He quoted the evidence at length to show the advantages of Mond gas for heating and engine purposes, and contended that it did not really compete with coal gas, and that in many respects it would be more useful than electricity. There was no doubt local manufacturers regarded the introduction of Mond gas as very important, and that it should not be postponed. With regard to competition with existing gas suppliers, it was admitted by the opponents that Mond gas would not compete as regarded the very small consumers. The very large consumers might be able to manufacture Mond gas, if they needed it, more cheaply than the company. It was only the consumers who came between these two classes that the company would supply, and, therefore, there would practically be no competition with the supply of coal gas. It was said that it would be useless to offer Mond gas because the cost of distribution was nearly equal to the cost of manufacture. But that argument was applicable to electricity, the cost of generating which was 0·66d., while the cost of distribution was 0·65d. Yet everybody said electricity could be distributed over an immense area at a profit, and Parliament had passed a number of electrical power distribution bills covering enormous districts. With regard to the application of particular areas to be excluded from the bill he pointed out that it would be difficult to get capital for half or three-quarters of a scheme. The great value of a large area was that it provided a diversity factor, and it was for that reason that all the power companies had sought powers in respect of large areas. The opposition of the local authorities was really due to fear of competition—which could not, however, take place. But if it could, would it not be a good thing? If the company could supply at a cheaper rate than the local authority, would the Committee allow the local authority to stand between them merely because the local authority had been allowed by Parliament to supply private consumers with gas? If the local authority could supply more cheaply than the Mond Company the manufacturer would not take from the Mond Company, but if the Mond Company could supply more cheaply than the local authority, why should not the manufacturer have Mond gas? Sir James Kitson's Committee advised that it was to the public advantage to facilitate measures which might ensure a general supply of electrical power to consumers. If that was true of electricity which, continuously worked, cost £47, against £4. 7s. in the case of Mond gas, it was equally true of Mond gas. He denied the allegation that this bill would set a fictitious value upon certain patents. At present no one could set up Mond plant in this district without the consent of Dr. Mond; it would be exactly the same in the future. He suggested that Dr. Mond's remuneration of £75,000 in shares would not be by any means excessive; his real remuneration would not be in the money he derived from this district, but from the demonstration in it of the value of Mond gas for power and heat purposes. One point raised was that by some means the bill, by the use of the word "exclusive" would override sec. 22 of the Patent Act, which gave the Board of Trade certain powers with regard to issuing a compulsory licence. No power in the bill would override that section, but if any of his friends were nervous about that he would insert a clause making the matter perfectly clear. It had also been pointed out that there was no obligation on the company to commence or finish their works. He agreed that that was fair criticism, and to meet it he proposed to insert a clause, similar to the one in the Lancashire Electric Power Bill, to the effect that if within two years the company had not began, and, within four years, made substantial progress with their works, their powers should cease. Another objection was, that if the agreement between Dr. Mond and the company were annulled, the company could go on supplying not Mond gas (because, of course, that depended on the agreement), but some other producer gas. He hoped the Committee would not think the promoters were trying to perpetrate a fraud upon Parliament—such a thing never entered their heads. Their whole object was to supply Mond gas, and he was perfectly willing to make it clear that the only gas the company could supply was Mond gas or any modification or improvement of Mond gas. Further, if objection were taken to the use of the word "exclusive" in the agreement (in which Dr. Mond agreed to grant an exclusive licence to the company to supply in the area), it could be left out, and instead Dr. Mond would bind himself not to grant licences inside the district on more favourable terms than to anyone outside, the company to be protected by a provision that Dr. Mond should not grant any other licence inside the district for distributing or selling Mond gas. It was contended that the practical utility of Mond gas was not proved because it had not been adopted more widely in 20 years. But look at electricity. Electricity had been before the public since 1882, when Parliament passed the first electric lighting act, but no one thought of a power bill before last session. Everybody was convinced of the necessity of cheap fuel, and witnesses on both sides said the fuel of the future would be a gaseous fuel, and some stated that Mond producer gas was the best at present known, and the only one which would comply with the non-poisonous regulations of the Home Office. Who stood in the way of manufacturers in the district who said they wanted it? The boroughs—not in the public interest, but as traders in gas—and some gas companies, who thought that they would be injured. But they were cutting their own throats. Surely, if it was non-competitive (and he had tried to show that it was) and it was wanted by the consumers, the local authorities ought to refrain from objecting in order to further trade. Mond gas was an important development, and if the Committee stopped it they would injure manufacturers and wound the nation. He asked the Committee to pass the preamble.

The CHAIRMAN said: The Committee find the preamble of the bill to be proved, subject to these conditions: In addition to those points which have been promised by counsel for the promoters (1) any new development of gas permitted by the bill must be certificated by the Board of Trade; (2) the shares to be allotted to Dr. Mond, the patentee, to rank as follows:—£40,000 to rank for dividend with the other shares, £35,000 to rank for dividend after the holders of the other shares had received 5 per cent. per annum dividend.

A number of counsel, including representatives of Handsworth, West Bromwich, Oldbury, and Smethwick, Dudley, Birmingham and Walsall intimated their intention to take no further part in the proceedings in the House of Commons, but to reserve their opposition for the House of Lords

## LONDON ELECTRIC UNDERGROUND RAILWAYS.

The Joint Committee of the two Houses of Parliament appointed to inquire into the various electric underground railway schemes now before Parliament commenced their inquiries on Tuesday, May 7th, under the presidency of Lord Windsor. The Committee decided, at a preliminary meeting, to deal with that part of the reference only which concerned the routes of the proposed lines, with a view to ascertaining the extent to which they met the public requirements.

Mr. FITZGERALD, K.C., for the London County Council, suggested that the questions involved should be treated as a whole, and that the Committee should reserve their decision until hearing the entire evidence.

The CHAIRMAN thought it would be for the general convenience that if the London County Council had any objections on public grounds to any particular line they should state them at an early period.

Mr. LITTLER, K.C., opened the case of the Brompton and Piccadilly Railway, from Brompton-road, by Hyde Park-corner to Piccadilly-circus. This railway (said counsel) would accommodate the whole of that long district with an electric railway, starting with a junction of the District Railway at Earl's Court, so that the electric railway became, as it were, a Piccadilly extension of the District Railway. The present proposal was to extend the proposed electric railway from Piccadilly to Museum-street, there to join with the Central London Railway, thereby obtaining a route to the Bank and North and East London.

Sir JAMES SZLUMPER, engineer of the scheme, said the generating station at Lots-road, against the Thames, was an ideal station for the purpose. The line would be practically connected with all the underground electric railways running from south to north, and with the Central London running from east to west, at the same time coupling up connection with the south-west and north-east, between which at present there was no means of communication except by omnibus. The proposed Piccadilly and City Railway, however, would block for all time the traffic from the south-west to the north-east. The schemes were incompatible. The Piccadilly and City route occupied practically the same route as the present District Railway. His objection to it was that it would block the construction of the proposed extension of the Brompton and Piccadilly line without meeting any public want.

Mr. BALFOUR BROWNE, K.C., argued, on behalf of the Piccadilly and City line, that the Brompton scheme was not a bona fide attempt to give facilities to the public.

The CHAIRMAN subsequently said the Committee were only desirous of considering how the proposed lines provided for the traffic, or whether, looking to future extension, some modification of the proposed lines might be required. Questions of detail would be left for the private committees before which the bills would go.

Mr. H. JONES, town clerk of Holborn, said his Council considered the proposed extension was by an undesirable route. Had the abandoned Islington route been carried out it might have justified this scheme. The proposed line went nowhere and finished nowhere as regarded the direction of traffic.



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The Committee, without coming to any decision, proceeded to take the Charing Cross, Hammersmith, and District Electric Railway Bill, the proposed route of which is by Hammersmith-road, Kensington-road, Knightsbridge, Green Park, and Pall Mall, connecting with the proposed Piccadilly and City line.

Mr. A. J. LAWSON, C.E., gave evidence in support of the scheme.

The District Railway Co. objected as the line would interfere with their traffic.

On Friday last the Committee resumed their deliberations, and Sir COURTENAY BOYLE was asked if he had anything to report with reference to Lord Rayleigh's Committee on the subject of vibration. Sir Courtenay handed in a memorandum from the Committee in which the Committee recorded its opinion that vibration was felt in many houses above the Central London Railway. Self-recording instruments showed that vibration arose from the large proportion of weight of locomotives not borne on springs and from want of rigidity in the rails. With a new type of locomotive which had been ordered from America, the Central London Company proposed to make new experiments, and efforts were being made to overcome the difficulties which had hitherto prevented the use of stiffer rails. Upon the results of further experiments the Committee would be able to give a more definite opinion as to what should be done on the Central London Railway to reduce vibration and what features should be introduced in new lines. The Committee considered that under proper conditions vibration could be prevented, but reserved definite recommendations until acquainted with the results of pending experiments. At the request of the Parliamentary Committee, Sir C. Boyle promised to ascertain the views of the Board of Trade on the following questions:—General control of these underground railways, workmen's trains, through fares, and the congestion of lines at central points, such as the Mansion House.

Mr. CRIPPS, Parliamentary agent to the London County Council, said the Council did not consider the present schemes were calculated to promote the best interests of the public.

The CHAIRMAN pointed out that the Committee would be unable, by the terms of reference, to enter into any ideal scheme except in so far as it concerned the particular schemes before them.

Sir DOUGLAS FOX, C.E., was called in reference to the Piccadilly and City route, and expressed the view that junctions on a three-minute service were likely to impede the regularity of the service. The Brompton to Holborn route was a most important one for London traffic, and if it were considered that the original proposal for an "end-on" junction ought to be modified, he suggested an interchange station at Piccadilly in place of a continuing junction.

Sir J. SZLUMPER drew attention to the great depth of the sewer which it was proposed to divert in the operations for the Brompton and Piccadilly line as being a rather serious undertaking, and if that difficulty were got over there remained the obstacle of the clause protecting St. James' Hall. The Brompton and Piccadilly railway promoters objected to their through route being interfered with as was suggested.

Mr. J. S. FORBES, chairman of the Metropolitan District Company, spoke against the proposed Charing Cross and Hammersmith line.

At this stage the Committee adjourned till May 14.

## PAISLEY CORPORATION TRAMWAYS.

A Parliamentary Commission, under the Scotch Private Legislation Procedure Bill, at Glasgow, on May 3, commenced the consideration of the order for the Paisley Corporation Tramways.

Mr. SALVESEN, K.C., for Paisley Corporation, said the scheme involved the construction of only a single line of tramway. There were existing tramways in Paisley, which were constructed under a provisional order of 1884, and the Corporation had power to acquire the lines at the expiration of 10 years, and every seven years thereafter on certain terms. The Corporation did not avail themselves of the first option, but the time for exercising the second one would mature in December, 1902. But they had made an agreement with the owners, under which they were entitled to acquire the lines immediately. The object of the present scheme was to secure a through connection with Glasgow. Glasgow Corporation had obtained powers to construct a tramway to the eastern boundary of Paisley. That tramway was to be worked by electricity, and in order to get a through connection with the centre of Paisley, the Paisley Corporation had now made an agreement which was sought to be confirmed by provisional order. Under this agreement with Glasgow (dated March 29, 1901), Paisley Corporation were guaranteed the financial success of the undertaking, because Glasgow had agreed to pay them 5½ per cent. upon the whole cost of construction, and in addition to pay them sums towards the maintenance and repair of the line and streets through which the tramway passed.

The CHAIRMAN (the Earl of Camperdown) said that it struck him as rather peculiar that Glasgow was apparently to run cars and Paisley was to maintain them.

Mr. SALVESEN: At Glasgow's expense; because Glasgow contributes towards the maintenance and repair of the line for 25 years. The reason for this was that Paisley had regard to the future, and the probability of other companies being allowed to run over that line. Glasgow guaranteed them 5½ per cent. in any event, but if other companies used the line, then Glasgow said, You must contribute to this 5½ per cent., according to the amount of use you make of this line. But so far as Paisley was concerned, it was in the fortunate position that it was entirely guaranteed by Glasgow, and secured a through service of cars to Paisley from Glasgow. The estimated cost of the scheme was £29,000, but borrowing powers were taken for £50,000, as it was still unknown what amount they would have to be paid for the existing horse tramways. The most important petition in opposition was one by the promoters of the Paisley District Tramways Order, 1901 - a competing scheme. That scheme was a very large one, and it was proposed to work 18 miles of lines by electricity. The promoters proposed to invade Paisley without the consent of the Corporation, and against their desire to have a tramway there for themselves. He contended that this was contrary to the 1870 Act. Mr. Murphy, the chief promoter of the opposing scheme, could not obtain a connection with Glasgow until he made terms with Glasgow Corporation, who refused to treat with any promoter of a private company. Glasgow was willing to act with the Corporation of Paisley, but absolutely declined to enter into any arrangement with a private promoter. The result would be, if Mr. Murphy got his scheme in its entirety and the Paisley Corporation did not get theirs, that the Glasgow tramways would run to the boundary of Paisley, and there would then be a hiatus. Paisley Corporation considered they were really carrying out the terms of the agreement made by Mr. Murphy last year. Glasgow Corporation objected to Mr. Murphy because, as a matter of policy, they did not wish to have any agreements with a private enterprise. The objection of the petition of certain ratepayers was not to the merits of the scheme, but to the additional burden which it was assumed would be imposed by the borrowing of £50,000. These objections to that small scheme were entirely unsubstantial, the success of which was guaranteed. The only other petitioners were the railway companies, who were not represented.

Evidence in support of the order was given by members of the Corporation and others.

Councillor W. PATON, convener of the Glasgow Tramways committee, held that a system of through cars between Glasgow and Paisley would be to the mutual advantage of both Corporations. But the Corporation would never think of acting in conjunction with Mr. Murphy or any other private individual. If the Corporation agreed to work with Mr. Murphy on that matter it would form a good reason why Mr. Murphy should seek to get powers to run over the Glasgow tramway system. It would be creating a precedent.

The CHAIRMAN intimated that the Commissioners had decided to reserve their judgment on the first bill until they had heard the second one—that of the Paisley District Tramways Order, 1901, as they regarded the bills as to a very large extent competing bills.

Mr. JOHN YOUNG, general manager of the Glasgow Corporation Tramways, said that Glasgow intended to complete their tramway system up to the eastern boundary of Paisley. They had already made the line up to the Half-way House, which was the boundary of Glasgow. In his view the agreement which had been entered into between the Glasgow and Paisley Corporations was one which would be of distinct advantage to both communities. If the provisional order were not passed what would happen would be their cars would stop at the eastern boundary of Paisley, and that would spoil the service for everyone concerned.

By the CHAIRMAN: Do you think you would be justified in doing that simply because the person holding the order was not Paisley Corporation? —I think so.

On what ground?—Because there is another way of doing it, and you do not require to deal with a private company at all.

That is not an answer to the question. You say you think you would be justified in causing this public inconvenience. What are your grounds of justification?—Glasgow has hitherto dealt with the local authorities in the neighbourhood, and I think it is quite obvious that the aim of Glasgow, Paisley, and all the Corporations is identical—to give the best possible service at the cheapest possible rates. If they make any money they improve the service with the money. A company, on the other hand, has as its object the making of the most money they can or of selling the concession at the highest price they can get.

But what is your justification. Give me the reason that would justify your action?—Glasgow is quite willing to join hands with Paisley, but is not willing to be mixed up with any private company. That may not justify us in causing a public inconvenience, but it is created in some other way than by Glasgow.

Do you consider your determination a sufficient justification for causing what is a public inconvenience?—Under these circumstances, yes.

Some local evidence closed the case for the promoters.

Mr. R. SCOTT BROWN, for objectors in Paisley, said the objectors were prepared to support Mr. Murphy's bill, and had it been the only order before the Commission they would have contented themselves with coming forward as witnesses in support of that bill. A plebiscite has been taken by Paisley, and it was generally understood that the question was settled by the plebiscite, which went against the Corporation taking up any tramway venture. Considerable surprise and dissatisfaction was felt when the Paisley Corporation imposed one condition after another, until Mr. Murphy's bill was so mutilated that it was thrown out of Parliament.

Mr. J. HELLYERS said a petition in favour of Mr. Murphy's project was signed by 13,800 ratepayers in Paisley.

Mr. WM. MURPHY said he represented the promoters of a system of tramways to supply the whole of Paisley, running from Johnstone on the one side and Renfrew on the other. At first the Paisley Corporation did not discourage him, but subsequently he found the Corporation were continually making new proposals to him, and at one stage he had instructed his agent to discontinue negotiations. Ultimately he came to terms with the Corporation, and the agreement was reduced to writing, but notwithstanding the agreement the Corporation proposed new terms, and a supplementary agreement had to be made. He was bound to accept the terms made by the Corporation, though he considered them unfair. The success of his scheme depended upon its working as a whole. He was willing that Glasgow should supply the electric power for his scheme, because it could do it cheaper. His only objection to the Paisley Corporation scheme was that they sought to construct a tramway which he also sought to construct.

Mr. A. SMITH said he believed in Mr. Murphy's scheme. He understood Mr. Murphy would be willing to take power from the electric station at Paisley, and that would mean a revenue to the town of £7,000 per

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annum, which would be a great blessing. In his opinion, a comprehensive scheme, such as Mr. Murphy suggested, would be more in the interests of Paisley than the smaller scheme to connect Glasgow to Paisley.

## PAISLEY DISTRICT TRAMWAYS ORDER, 1901.

The Committee then proceeded to consider this order.

Mr. H. JOHNSTONE, K.C., said Mr. Murphy's scheme was a Paisley and district scheme, with interests and a large population other than those in Paisley. It was incorrect to speak of the schemes as competing. The dominating purpose of the Corporation line was not to serve Paisley, but to tack Paisley on to Glasgow.

The CHAIRMAN asked whether the case for Paisley was not that, supposing their limited scheme granted, and that Mr. Murphy's scheme disappeared, they would be able to find other parties who would carry out the general scheme on equally convenient and equally economical terms.

Mr. SALVESEN : That is the contention of Paisley.

Mr. JOHNSTONE said that, as the result of the manner in which Paisley Corporation dealt with the matter last year, the House of Commons rejected Mr. Murphy's bill, not because the preamble had not been proved, but because of the conditions attached, which in their opinion made the bill unworkable. Mr. Murphy's proposal had large and influential support. With regard to the proposal of Glasgow Corporation, he did not think that under that act Glasgow would have power to work the line.

The Commission at this point decided that Glasgow had no *locus standi* as objectors to Mr. Murphy's bill, and evidence in favour of the scheme was then given. After this evidence had been given,

Mr. Salvesen, for Paisley Corporation, and Mr. Johnston, for the promoters of the Paisley District Tramways Order, addressed the Committee.

The CHAIRMAN then said the Commissioners had decided to recommend that the Paisley Corporation Tramways Order be refused, and that Mr. Murphy's bill might proceed. The Commissioners intended to require that a guarantee be given for the completion of the tramway scheme. Counsel for Mr. Murphy had stated that Mr. Murphy was prepared to give a guarantee, and it must be an effectual one. Clause 28, the purchase clause, was one of the most important in the order, and the Commissioners would be prepared to listen to any settlement that might be made to them as to the alterations that should be made in that clause.

## BLACKPOOL TRAMWAYS EXTENSIONS.

The Select Committee of the House of Commons presided over by Mr. Bill on Tuesday and Wednesday considered the Omnibus Bill of the Corporation of Blackpool, seeking powers to make extensions of the Corporation's tramway system. The tramways portion of the measure was opposed by the Blackpool, St. Anne's, and Lytham Tramways Co. and others.

Mr. FREEMAN, K.C., said the tramway service was owned and worked by the Corporation on the overhead system. Two small pieces of line were, however, leased by the Corporation—one to the Blackpool and Fleetwood Tramway Co., the other to the Blackpool, St. Anne's, and Lytham Co. The number of passengers carried on the Corporation tramways had been steadily increasing during the last five years, and was in 1900 4,828,021. The experience of the Corporation had been that the tramways certainly paid although they went nowhere in particular ; and for the reason that people were exceedingly fond of going by a quick and cheap service right into the country for an excursion, and also that the presence of a tramway led to the development of a district and caused houses to spring up along the route. More houses had been built in Fleetwood in one year since the electric tramways had been introduced than in several previous years put together, and new colonies had sprung up along the tramway route where artisans were able to find cheaply rented houses. There had been prophesies that the Corporation's tramways extension scheme would end in bankruptcy, but as a matter of fact the tramways had been a great success. Among other things the bill proposed a continuance of the existing tramway from Waterloo-drive, along Middle-lane to the borough boundary on the road towards Lytham, and this proposal was opposed by the Blackpool and Lytham Tramways Co. on the ground that the new line, although running considerably further inland, would be parallel to their tramway and was intended to compete with the portion of the line leased to them by the Corporation. The total length of the tramway extensions would be 11¼ miles, and the cost of construction £55,000, for street improvements £35,000, and for the diversion of the Spen Dyke £5,000, or a total cost per mile of between £8,000 and £9,000. The Corporation of Blackpool, in addition to their other undertakings, supplied nearly 1,000 consumers with electric energy, and had laid down 80 miles of electric mains, and had sold in the year ended March 31 last over 1,000,000 units, exclusive of the current supplied to the Corporation tramways.

Mr. L. SLATTERY, manager of the Blackpool and Lytham Company, gave evidence for his company's petition. They last year obtained Parliamentary powers to substitute electric for horse traction and to double their line. If the proposed line were constructed it would divert the traffic from his company's line, as there would be only a difference at the narrowest point of half a mile between the two lines. The Corporation tramway would be on the old Lytham-road, which was the more direct route.

Mr. J. PELL (contractor and engineer), a director of the tramway company, said as to the competition to be feared from the proposed line, what was wanted was that his company should have further running powers granted to them by the Corporation.

The Committee decided, by a majority, to pass the preamble of the bill so far as it related to tramways.

## LONDON TELEPHONES.

In the House of Commons last evening Mr. BANBURY asked whether the Postmaster-General would press forward the work of laying the telephone wires, which had now been going on for nearly a year ; and would also give instructions that all pipes and materials should be unloaded at night.

Mr. A. CHAMBERLAIN : The Postmaster-General asks me to say that everything is being done to press forward the work of laying the telephone wires in London, and that most of the main lines have already been completed. He understood that the unloading of pipes and materials was being done early in the morning.

## THE FINANCES OF THE TELEGRAPHIC SERVICE.

In the House of Commons on Friday last Mr. H. HEATON asked the Chancellor of the Exchequer if the loss on the telegraph service amounted during 1900 to £587,452, or, excluding £130,000 received from the National Telephone Co. as royalty upon their licence, the loss exceeded £700,000, although the total receipts did not reach £4,000,000 sterling ; and whether, since the telegraphs were taken over by the Government in 1870, the total loss to the country had exceeded £8,300,000 ; and, further, whether, in view of these facts he was prepared to lease the telegraphs to a private company, or take any other steps to meet the difficulty. Had he any official information to give the House showing the cause of the increasing loss, now approaching three-quarters of a million per annum on the working of the telegraph system of the country.

The CHANCELLOR OF THE EXCHEQUER said the figures set out by the hon. member seemed to be approximately accurate. The £587,452 mentioned was made up of two items—£288,602 excess expenditure over receipts and £298,850 interest on capital raised for the telegraph service under the powers of the various Telegraph Acts. He considered the main reason for the loss was that the public and their representatives in the House of Commons preferred to get a return on the large capital expenditure involved in the form of facilities for telegraphic communication rather than in the form of revenue, and that an effective way of checking the increasing deficiency in the account would be to discourage to some extent the demands for concessions and extensions which do not and cannot produce any corresponding increase in revenue.

## PATENT LEGISLATION.

In the House of Commons on Tuesday, Mr. LEWIS asked the First Lord of the Treasury whether the Government proposed to introduce legislation to carry out the recommendations of the committee appointed by the Board of Trade to inquire into the working of the Patents Acts.

Mr. A. J. BALFOUR said as the report as a whole contained recommendations of considerable importance which had not yet been fully considered, there was no prospect of being able to give effect to them by legislation this session. If time permitted it would be satisfactory to deal with the point which had formed the subject of international agreement and that connected with compulsory licences, and with that object a bill would be prepared.

# LEGAL INTELLIGENCE.

## British Aluminium Co. (Ltd.).

The Judicial Committee of the Privy Council (composed of Lords Macnaghten, Davey, Robertson, Lindley, and Sir Ford North) on Wednesday and yesterday heard an application for the extension of the term of Henderson's patent, No. 7,426, of 1887, for an invention of an improved process for the preparation of aluminium by electrolysis.

In this case letters patent were granted to Arthur Chas. Henderson, patent agent, London, communicated to him by Paul Louis Toussaint Héroult, of Paris. This petition for prolongation was presented by the British Aluminium Co. (Ltd.), as the assignees of the said letters patent, who claimed that the invention at the date of the letters patent was new and one of very great value and merit, and alleged that, prior to the date of the granting of the patent, aluminium had never been produced on a large industrial scale, but only for laboratory purposes, in which it was necessary to use costly materials, and the cost was so great that the aluminium could not be used to any substantial extent in the arts and manufactures. Prior to applying for the letters patent, the subject of this Petition (Héroult) had spent large sums of money in experimenting on the various then known processes for the manufacture of aluminium, which experiments ultimately led to the invention for which the patent was granted. The invention related to the production of aluminium by an electrolytic process, which consisted in decomposing alumina (or oxide of aluminium) in solution in a bath of molten cryolite by means of an electric current. The current passed through the bath by the medium of an electrode in contact with the crucible of agglomerated carbon containing the cryolite and another electrode also made of agglomerated carbon which dips into the bath. The electric current passing through the bath causes the decomposition of the alumina and the oxygen passes to the anode and causes combustion there, while aluminium precipitates on the bottom of the crucible forming the cathode in the metallic form. The cryolite (which was used merely as a flux) was not affected, and consequently always remains, but the low resistance of the bath which it formed enabled the process to be carried on with a current of low tension, thus greatly diminishing the amount of energy required and consequently the cost of the process. As the production of the metal proceeded a fresh supply of alumina was from time to time added to the bath to replace that previously decomposed, and the process could thus be carried on continuously. This continuity in the production of the metal was a matter of the greatest importance, and

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enabled the manufacture to be carried on upon a thoroughly commercial scale. The petitioners claimed that the invention was of the greatest public utility and by reducing the cost of production had in fact rendered aluminium a metal which could be largely used in all classes of manufacture, the price being reduced from 55s. to 1s. 3d. per pound. The The petitioners were incorporated on May 7, 1894, and prior to that date there were no works in the realm for the production of aluminium on a large scale, and therefore they had created a new and important industry of great benefit to British trade, and had erected mills at Milton, Staffordshire, and at Greenock, on the Clyde, and were in a position to put aluminium on the market at a profit, but they had not been able yet to pay a dividend and had not been adequately remunerated for their outlay, nor had the original inventor. The petitioners therefore prayed His Majesty to extend the patent a further term of 14 years.

The petition was opposed by the Pittsburg Reduction Co. of America and by Arthur Dennis, trading as Dennis & Co., of No. 11, Billiter-street, London, engineer and dealer in aluminium and other wires, on the ground that the invention was neither new nor useful, and was never likely to be useful to the public, and, moreover, that the inventor had been adequately remunerated, having received over £10,000 besides a share in the profits of the Swiss Company, which was paying a dividend of 6 per cent.; that the petitioners, who were the assignees of the purchaser of the invention, had made large profits from the manufacture of a monopoly, and had been adequately remunerated, and if they had not yet paid dividends it was owing to the inflation of the capital of the company, and as the French and Belgian patent for this invention expired in April of this year, it would be impossible, if the petition was granted, for manufacturers in Great Britain and Ireland to compete with foreign manufacturers upon any fair terms. Consequently, if the letters patent were valid, the extension of the term would operate to the injury of the commercial and industrial interests of Great Britain and Ireland in an important and growing branch of manufacture.

Mr. Fletcher Moulton, K.C., Mr. R. Wallace, K.C., and Mr. Graham appeared in support of the petition; Mr. Cripps, K.C., and Mr. Walter for the Pittsburgh Reduction Co., and Mr. Waggett for Dennis & Co.; the Attorney-General and Mr. H. Sutton watched the case for the Crown.

Their Lordships having intimated early in the argument that they did not desire to go into evidence unless necessary at any length, counsel on behalf the respective parties addressed the committee.

Lord MACNAGHTEN asked if the petitioners desired to call evidence on the two or three principal points raised, and the petitioners thereupon called their secretary, who gave some formal evidence as to accounts and other matters relative to the financial condition of the company.

Lord KELVIN was then called and gave evidence to support the petitioners' contention that the invention could only be profitable if carried out on a large scale in fully equipped factories, and that having regard to the heavy expenses incurred by the petitioners and the probable future financial value of the invention, the returns so far had yielded profits greatly below the figure which the petitioners as the assignees of the patent for Great Britain, might reasonably claim to receive.

Mr. FLETCHER MOULTON, in replying for the petitioners, said the opponents to the petition alleged that if the invention had not paid at present the inventor or his assigns here, that was due to the delay in starting manufacture under the patent on a business principle by the petitioners themselves. It was true that the patent had been granted in 1887, and that it was not used for profit earning really by the petitioners until 1894. But that apparent delay was fully accounted for by the circumstances which he proceeded to explain to the committee at considerable length.

Yesterday the petitioners also called Prof. Dewar and other witnesses, and at the conclusion of their evidence,

Mr. CRIPPS, K.C., addressed the committee on behalf of the opponents, but called no evidence.

Mr. R. WALLACE, K.C., having replied,

Lord MACNAGHTEN said the committee were of opinion that the petition should be dismissed, but with one set of costs. They, therefore, would advise His Majesty not to grant a prolongation of the term of the patent to the petitioners, and would give their reasons for their decision to His Majesty in Council.

## Atkins and Applegarth v. Castner-Kellner Alkali Co. (Ltd.).

The hearing of this case (reported fully in *The Electrician* of May 3 and 10) was continued before Mr. Justice Buckley on Friday last, when

Mr. FLETCHER MOULTON (continuing his argument on behalf of the defendants) said that both Figs. 1 and 5 of plaintiffs' specification (see our issue May 10, page 107) were impracticable, and neither of them would do what the patentees said they would. Plaintiffs had a somewhat curious defence to Fig. 5. They said that figure was only a diagram.

His LORDSHIP said that their point was that what was in the specification explained and described what was in the picture.

Mr. MOULTON replied that Fig. 5 was very much like the drawings they used to make at school to explain mathematics. He would now come to the two claims in the plaintiffs' specification for the purpose of interpretation. First, there must be a compound cathode. Next, there must be an isolation of the mercury as a film during the time it was acted upon; and, thirdly, there must be intensity of action during that period. There were three things which were not to be found there at all: no pouring in and out for the removal of the mercury; there was no flux or re-flux acting upon the mercury; and there was nothing about low charging.

His LORDSHIP: The poorness of the mercury?

Mr. MOULTON: The poorness of the mercury. No, nothing whatever. After Nolf there came the discovery of the method of disgorging by means of an electric current. In the tapping movement used by the defendants, whether it was done quickly or slowly, defendants borrowed nothing whatever from the plaintiffs. Counsel further submitted that defendants had not borrowed anything from the plaintiffs. The plaintiffs had not got the pouring in and out and the low charging, and his case was that there had been no infringement at all.

Mr. TERRELL replied on the whole case on behalf of the plaintiffs. His lordship reserved judgment.

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The following judgment was delivered yesterday (Thursday):—

**JUDGMENT.**

His LORDSHIP said that the patent to which this action related was No. 20,768 of 1890, granted to the plaintiffs for improved means and apparatus for separating alkaline and earthy metals and other products from the salts of such metals or from other substances containing them. The questions which he had to determine were, first, whether these letters patent were valid, and, secondly, if they were valid, whether the defendants had infringed them. The question of validity sub-divides itself into questions of anticipation and utility. The process with which I have to deal is one in which a solution of sodium chloride in water is subjected to an electric current while in contact with mercury, with the result that the sodium in solution is precipitated into the mercury and forms an amalgam, while the chlorine is thrown off in the form of gas. At the date of the plaintiffs' patent it was well known that when such a solution was subjected to electrolysis it was split up, the chlorine being liberated at the anode pole while the metal was liberated at the cathode pole of the cell in which the decomposition took place. And it was also well known that if the cathode was composed of mercury sodium was driven into the mercury so as to form an amalgam. Further, it was known that, by treating the sodium amalgam with water (although this was to some extent in question between the parties)—by further subjecting the amalgam in water to electricity—the sodium might be separated from the amalgam in the form of caustic. At the date of the plaintiffs' patent there existed patents of three persons, which were pleaded by the defendants as anticipations. First, those of a man named Nolf in 1882 and 1883. His process, shortly stated, was to use as a cathode a layer of mercury 1cm. in thickness lying at the bottom of the apparatus, and pass from carbon anodes a current of electricity through a salt solution so as to drive the sodium into and amalgamate it with the mercury, and periodically to remove the sodium amalgam by opening the cock of a small tube at the bottom of the apparatus. He knew that it was necessary to remove the amalgam before it had become charged with too much sodium, and told them so to remove it. It was a process of electrolysis with a mercury cathode of 1cm. in thickness, with periodic removal of the mercury when charged, and not too highly charged, with amalgam. The next was that of Petri, in 1886. His object was to obtain ferricyanide of potassium by electrolysis with a mercury cathode. The material point as regarded this patent was that the flow was to be or might be not intermittent, as in Nolf, but continuous. The third was a patent of Donkin, of 1883. His object was to obtain amalgam of sodium and quicksilver, for the purpose of using it in the amalgamation of gold and other ores. He used an electrolytic cell of some non-conducting material, with a layer of quicksilver on the bottom as a cathode. Above was a separated solution of chloride of sodium and a carbon anode, and by electrolysis he caused the sodium to be absorbed by the mercury cathode. He described how, by making cells and fixing pipes on the sides of the cell below the upper surface of the quicksilver, he could directly connect the main body of it to the quicksilver in an amalgamator, and cause a circulation of the quicksilver to and from the cell and the amalgamating device by means of a suitable pump. In this state of knowledge the plaintiffs' patent was granted in 1890; and their specification set out the knowledge which they admitted to have existed at the time, and went on on to say that therefore it had not been found possible, by which they meant, as appeared by what followed, industrially or commercially possible, to apply the electrolytic process to the purpose of separating metals from their salts, because, as they said (but he thought erroneously) counter electromotive force had been set up at the cathode by the metal and hydrogen to such an extent that the electromotive force required to effect the decomposition and deposit the metal in opposition to the electromotive force had been out of proportion to the industrial result obtained. This statement of the reason for the impossibility or difficulty which they alleged heretofore to have existed, was, he was satisfied, erroneous. The counter electromotive force was not the difficulty. It was constant, or nearly constant, being 3·2 of a volt at starting the process, and increasing by no more than 0·02 of a volt for every additional one-tenth of 1 per cent. of sodium forced into the mercury. But the fact that the patentees misconceived and mis-stated the theory did not, he thought, invalidate their patent. Their theory might be wrong, but if their process and apparatus were right their patent might be supported, notwithstanding their faulty theory. He passed on then to consider what, upon the true construction of their specification, was the invention which they claimed to have made. At the outset it was necessary to determine with exactness the meaning in which these patentees used the word "cathode." By derivation cathode meant simply "way out," but in the language of electricians it had come with strictness to mean the first or earliest point of the way out with which the electricity got access to the way out. According to this strict definition the cathode would be a point or a superficies, but electricians did not always use the word, and he was satisfied that these patentees did not use the word in the strict sense. What they meant by their cathode was not the superficies of the mercury or any superficies, nor was it the mercury apart from anything else. It was in their language a body of definite thickness and of composite character, composed partly of mercury and partly of a metal chamber or band supporting the mercury, or over which the mercury flowed. To show that this was so he referred to a few places in the specification. There they spoke of the mercury flowing over the surface of the cathode, which might or might not be itself amalgamated with mercury. They also spoke of the amalgamation as moving while still

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forming "a part of the cathode" and of the metal being removed continuously from the surface of the cathode. Then they spoke of retarding the descent of the mercury over the surface of the cathode. Other like passages might be referred to. That upon which the mercury was to be supported was always to be metal. The cathode in this patent was always either metal or mercury supported by metal. With a cathode, therefore, such as he had described, the patentees' object was, as stated in the specification, to provide means and apparatus for obtaining "on a practical scale" the metals without requiring "so great an amount of power" as would be required by the use of ordinary electrolytic apparatus. The emphatic words here were "on a practical scale" and without requiring "so great an amount of power." The object was to get on a practical scale that which they admitted could already be obtained on a scale not practical, and to obtain that was a saving of power. The essential points were a practical scale and economy, and if the patentees did not achieve these two results in a new way or in fact, it appeared to him that their patent failed. Shortly stated then, what was the process which they indicated. The process was one by which with the use of such apparatus as they pointed out, the mercury whilst exposed to electrolytic action was to flow continuously. He could not find that they said that the process required that it should flow rapidly or that the flow should be of such speed throughout the electrolytic chamber when it had attained a definite richness. Beyond the fact that the mercury was to flow at an undefined rate, there was nothing to indicate that it was to leave the cell while the percentage of sodium was still very small or of any defined amount. He could find only that it was to flow, and that it was to flow over metal. The patentees did not rely upon stirring or mixing with a view to homogeneity. Their point was continuous movement of the mercury cathode with a view, not to mixing, but to the removal from the electrolytic cell. And upon the question of rapidity of flow, he found that, so far from the patentees emphasising the necessity of speed, they indicated on page 4 of their specification means which were to be or might be taken for the purpose of retardation. Then, for instance, at page 5, line 4, they told them that to retard the descent of the mercury, the cathode might be made with horizontal corrugations, as shown in Fig. 4, and that by this means the time of descent might be considerably prolonged. Again, at page 5, line 13, they told them that, in place of keeping Fig. 1 in a vertical position, you might incline it at any desired angle. This would, of course, diminish the effective force of gravity and produce some retardation. There was another consideration which pointed in the same direction. The plaintiffs provided for a porous partition whose function was to prevent caustic, whose formation they contemplated in the cathode side of the partition, from reaching the anode. From this it was plain that they did not contemplate that the flow should be so rapid as that caustic should not have had time to form before the flowing mercury and amalgam left the cell. The conclusion he drew was that the patentees did not know and left the public to find out whether speed was advantageous or injurious for the process which they described. They summed up the matter at page 5, line 35, by saying that any arrangements of apparatus which would allow of the use of a flowing or moving mercurial cathode might be employed. Their claims then were—first, for the improved means which consisted of using electrolysis in an apparatus the cathode pole of which was composed more or less of flowing or moving mercury or body of mercury substantially as described. Secondly, the method of employing mercury at the cathode pole, which consisted in causing the mercury to flow or move over, on, or with the surface of the cathode pole substantially as described. Thirdly, constructing the cathode pole with means for causing a thin stream of mercury to flow over, on, or with the acting surface of the cathode pole substantially as described and illustrated in the drawings. His lordship thought that this was a claim for a process by which the patentees asserted that they would on a practical scale and with greater economy obtain the desired metals if flowing mercury was employed as the surface of a cathode, but he did not find that they knew or described the rate of discharge of the flowing mercury from the electrolytic cell which was necessary for success, either by indicating the speed at which it was to be caused to flow, or by indicating at what point of richness of the amalgam the flowing cathode must be made to leave the cell. Pausing, then, he asked himself what in the process described was new to anything which Nolf, Petri, and Donkin had done? They had all by electrolysis formed amalgam of sodium and mercury, and they had all removed it from the cell in which it was obtained. Nolf removed it intermittently, Petri removed it continuously, Donkin removed it either intermittently or continuously. He did not say which. The plaintiffs removed it continuously, but they did not say with what speed of continuity. He failed to find in the process which the plaintiffs claimed any new invention which was not found in the process previously described. He passed next to the question of utility. On this point he did not forget that which he learned in the Welsbach Company *v.* the New Incandescent Company, and there endeavoured to express; but the utility he had to investigate was not necessarily commercial utility or competitive utility, but utility for the purpose of the patent law. As regarded this patent, the essential utility consisted, in his judgment, of two things: First, that the patentees, adopting a known process, undertook to show the public how to effect on a practical scale that which could be effected before, but not on a practical scale; and secondly, that the way they indicated should be one which effected an economy of power. Did the patentees show how to effect the object on a practical scale? Their object was to separate sodium and sodium hydrate from sodium. They left it in doubt whether sodium or caustic was their principal product. It was plain that they intended to get sodium amalgam, and they expected to get caustic. But he would assume that they wanted to get the latter as well as the former, and not merely to get the former with a view to subsequently obtaining the latter from it. Did they obtain one or both on a practical scale, or to an extent greater than was attainable by methods previously described? The answer was in the negative. The efficiency of the plaintiffs' apparatus was about 50 per cent., and of this about one-half consisted of caustic, but caustic so mixed with brine as to be commercially of little or no value. The process of Donkin had an efficiency of about 90 per cent. It was plain that the patentees expected to get caustic in their electrolyte, for the very object of the porous partition was to prevent the caustic reaching the anode and from doing mischief. The plaintiffs' process, in his judgment, was not useful as indicating anything by which caustic could be obtained with greater efficiency than by previous methods. The next point was: Did the patentees effect what they claimed—viz., a saving of electric power? He did not consider that question could be answered in the affirmative, and on these grounds he thought the plaintiffs failed as regarded utility. Lastly, on the question as to infringement, his lordship having described the apparatus used by the defendants, said that, assuming in the plaintiffs' favour that a patent for a continuous flow in one direction of mercury over a metal base was valid, the defendants did not adopt a continuous flow in one direction; they did not adopt a compound cathode of which some part was a metal base, but theirs was an apparatus of which it was the essence that the cathode should be mercury only and that the base should be of a non-conducting material. In his judgment there was no infringement, and for these reasons he thought the plaintiffs' action failed, and he accordingly dismissed it, with costs.

## Hawkes v. Leyton Urban District Council.

This case came before Mr. Justice Buckley in the Chancery Division on Tuesday, when an application was made by the Council for modification of the order for sequestration recently granted (see *The Electrician*, May 3 and 10).

Mr. H. TERRELL, K.C., for the Council, said the order had been discussed at a special meeting of the Council, at which all but four of the members were present, and a resolution was unanimously passed instructing the clerk to make this application for the purpose of telling the Court that the Council were not aware until the motion for sequestration was made that there had been any breach of the order or undertaking; that it was their intention to strictly obey the order, and their desire to apologise to the Court for their disobedience. He now asked that the writ of sequestration be discharged upon the Council undertaking not to use the gas engines except in the case of emergency.

Mr. ASTBURY, K.C., for the plaintiff, left the matter in the hands of the Court.

Mr. Justice BUCKLEY said he desired to know exactly what defendants intended to do in respect of increasing their existing steam plant, and for that purpose would direct the motion to stand over for a month and suspend the writ of sequestration for that period. By consent he would make an order that defendants were not to work the gas engines at all, but would give them liberty to apply to be relieved of that order in case of any emergency making it necessary to work the gas engines.

## Middlesbrough Corporation v. Imperial Tramways Co. (Ltd.).

This action was heard before Mr. Justice Wright in the King's Bench Division on May 9. It was brought to obtain an injunction restraining defendants from causing a nuisance by watering their tramway lines to such an extent as to make the roads slippery, muddy, and dangerous to passengers, bicycles, and other traffic.

Mr. MANISTY, K.C., for the Corporation, said the action was brought by the Attorney-General at the relation of the Corporation of Middlesbrough against the Imperial Tramways Co., who have a right to run tramways through the borough of Middlesbrough and to use electricity for motive power. The injunction sought was to restrain defendants from pouring water on to their lines in such quantities as to cause the highway to be in a wet and dangerous condition in respect of its use by the public, and for damages. The method of watering the lines adopted by the defendants was by means of a large movable tank of water attached to the rear of a car, the water running from the tank on to the rails through two iron spouts about an inch in diameter. In that way the rails were flooded by the water flowing over the paved margin of the rails, and the slippery surface produced made the roadway dangerous to traffic and a nuisance to pedestrians. The electric trams began to run in 1898, and in the following March, in consequence of complaints, the Corporation gave defendants notice to cease watering and abate the nuisance. The nuisance, however, continued for some time, although the diameter of the pipes was reduced. Defendants had promised to submit a special car or tank to the Corporation for approval, but had failed to do so. The nuisance was considerably abated in 1900. Defendants contended that the use of water was essential to the proper and safe working of the lines by electricity. Plaintiffs, on the contrary, urged that the lines could be cleared of the mud without the use of water, and by the use of brakes or appliances attached to the cars. The excessive watering had caused subsidences to the road surface and consequent damage, which the Corporation had had to make good.

His LORDSHIP said it was evident the nuisance had ceased some months before the date of the action, and he wished to know what the object of the Corporation was.

Mr. CARRINGTON, for the defendants, said there had never been any nuisance at all.

After evidence had been given on behalf of the Corporation by leading officials, including Mr. Geo. Anderson, inspector of nuisances at Middlesborough; Mr. C. T. Johnson, borough engineer and surveyor, Thornaby; Mr. George Bainbridge, Town Clerk, Middlesbrough,

Mr. C. A. BAKER, consulting electrical engineer, said, in his opinion, water was not the proper thing to use to cleanse the rails of electric tram lines, as it led to a loss of electricity. The best way of cleansing the lines was by hand tools.

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Mr. CARRINGTON submitted there was no cause of action existing when the action was brought, and that there was never any nuisance. One reason why defendant company was compelled to use water was the abominable state of the roads in Middlesbrough, which caused dust and grit to get into the lines. As to the amount of water used, one tankful watered 2 miles. They reduced the size of the pipe to ¾in. last year, and that had been used ever since, and there had been no complaints. The system of watering the lines complained of was in use in Plymouth, Bolton, Leeds and other places, including London. In Bristol they used a pipe ¾in. in diameter. In none of these towns had there been any complaint of nuisance.

Mr. J. Clifton Robinson (managing director and engineer to the defendant company), Major P. Cardew, Mr. Cosmo W. Gordon (manager of the Dublin Electric Tramway Co.), Mr. H. Mayer (surveyor to Hammersmith Council), Mr. Everson (manager of the Plymouth Corporation Tramways), Mr. Wareham (general manager of the Leeds City Tramways) and others gave evidence for the defence, the professional witnesses asserting that it was absolutely necessary to use water for the safe working and cleansing of the lines.

His LORDSHIP said that by the admission of the plaintiffs the nuisance ceased early in December, 1899, and the action was not commenced until February, 1900, no communications having passed between the parties in the meantime. No damage had been proved. In his opinion the action failed, and must be dismissed with costs.

### South London Electric Supply Corporation v. Perrin.

In the King's Bench, last week, the Lord Chief Justice and Mr. Justice Lawrence heard an appeal from the decision of the stipendiary sitting at the Lambeth Police Court, convicting the appellant company of an offence under sec. 24 subsec. (b) of the Public Health Act, 1891. It seemed that ten several complaints were preferred by the respondent against the appellants charging them that at their electricity generating station a chimney (not being the chimney of a private dwelling-house) sent forth black smoke in such quantity as to be a nuisance. The matters complained of took place in November, 1900. At the hearing before the magistrate it was proved that black smoke did issue from the chimney, which was 180ft. high, on the days mentioned, and the magistrate convicted the appellants, and imposed the maximum penalty of £10 for each offence.

Mr. CRIPPS, K.C. (for the appellants) contended that the conviction was wrong because no one had been called to say that the black smoke was a nuisance to himself. The mere issuing of the black smoke was not sufficient; it must be shown in addition that it was a nuisance to someone.

Their lordships, however, summarily dismissed the appeal, with costs.

### Turner Bros. v. Hodges and Todd.

In the Lord Mayor's Court (London) last week Messrs. Turner Bros., London, sued defendants for £17. 12s. 6d. due upon a bill of exchange given in payment for certain steel magnets supplied. Defendants admitted the bill had been given, but pleaded that the consideration had failed, and that the goods supplied were useless, as after storage for some time they practically lost their magnetism.

The COMMON SERJEANT, who tried the action with a jury, said that unless the jury were satisfied that the absolute uselessness of the magnets had been proved their verdict must be for plaintiffs.

The jury found that defendants had failed to prove their case.

Judgment was therefore entered for plaintiffs for £17. 12s 6d., and also on the counterclaim set up by defendants for the cancellation of the bill of exchange.

### Daimler Motor Co. v. British Motor Traction Co. (Ltd.).

In the Chancery Division on Friday, Saturday and Monday, Mr. Justice Buckley heard an action seeking to restrain defendant company from registering a new company under the title of "The Daimler Wagon Co. (Ltd.)." The plaintiff company urged that the Daimler Motor Co. was known throughout the motor car world as the Daimler Co., and its manufactures as "Daimler" goods, and any new company introducing the word "Daimler" would cause confusion to arise, considerable damage to the plaintiff company, and would receive a commercial advantage from the use of the name for which no consideration had been received by the plaintiff company. The evidence all turned upon the question of the name by which the plaintiff company was generally known and referred to in motor car circles.

Mr. CRITCHLEY, a director of the plaintiff company and managing director of the British Electric Traction Co., said persons sending orders to the Daimler Motor Co. (plaintiffs in this action) use a variety of expressions all containing the word "Daimler," and any other company starting in the automobile business with this well-known name would have a great advantage.

A mass of evidence of a similar nature was given on behalf of plaintiffs.

For the defence it was contended that the plaintiffs had shown no title to the exclusive use of the word "Daimler." They were only licensees of the Daimler patents, and not exclusive licensees, while the defendant company were owners of the Daimler patents.

Mr. Justice BUCKLEY said defendants being the owners of certain patents, with the exception of the licence granted to the plaintiffs, were minded in January of this year to exercise their rights and were proposing to register a company under the name of the "Daimler Wagon Co. (Ltd.)." It was shown by the correspondence between the parties that defendants were not unwilling to withdraw the exact form of name, and it was not until the plaintiffs claimed an undertaking that no name with the word "Daimler" in it should be used that they declined to withdraw the name. He was satisfied that no *malæ fides* existed on the part of the defendants. The word "Daimler" was used by all persons manufacturing under the Daimler patent. The word conveyed the meaning of a system, and in his opinion did not necessarily convey the plaintiffs' goods. Plaintiffs did not necessarily call their cars Daimlers at all. They called them by various names. It appeared to him that the word "Daimler" had not become so associated with the plaintiff company that its use by anyone else would be calculated to deceive. The result, therefore, was that what the plaintiffs were, in fact, endeavouring to get was a monopoly of the word "Daimler" in their name. That, as non-exclusive licensees, they were not entitled to do. Plaintiffs had failed to make out that the name of the proposed new company would be calculated to deceive. Whether it did or not depended on how the company carried on business when it was formed. The action failed, and must be dismissed with costs.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Walthamstow Urban District Council invite applications for the post of electrical engineer, to take entire charge of the Council's electric generating and distributing works. Salary £300 per annum. An advertisement gives further particulars, and applications must be delivered to Mr. E. J. Gowen, clerk to the Council, Town Hall, Walthamstow, by 5 p.m. May 24.

Applications are invited for the position of lecturer in electrotechnics at University College, Liverpool. Particulars from the registrar, and applications by May 31.

Maidstone Borough Council require a resident electrical engineer. Applications to the town clerk (Mr. Herbert Monckton) by May 30. See advertisement.

An engineering teacher, with knowledge of elementary physics, will be required at the Merchant Venturers' Technical College, Bristol, in September. Particulars from the registrar. See advertisement.

A railway telegraph inspector is required for service on the Government railways of the Federated Malay States. Salary $150 per mensem. Applications to Crown Agents for the Colonies, Downing-street, London, by May 18.

South Shields Corporation require an electrical engineer for their electricity undertaking. Applications to town clerk by May 22.

Battersea (London) Borough Council require an assistant electrical engineer. Applications to town clerk by May 17.

Mr. W. H. Cooke has been appointed resident electrical engineer at Luton.

**Ashford.**—The Council have, on the recommendation of the Lighting committee, instructed Mr. Thos. Hesketh, of Folkestone, to advise the Council in connection with the carrying out of their electric lighting provisional order.

**Birmingham.**—The accounts of the Electric Supply committee show that during the year ended March 31 (the first complete year's work by the Corporation) there were 3,040,822 units of electric current sold and the total receipts were £55,810. 4s. 2d., compared with 2,357,506 units and £45,247. 7s. 6d. in 1900, increases of 28·9 and 23·3 per cent. respectively. The gross profit was £15,352. 18s. 7d., but had only the usual charges in connection with the generation of electricity and maintenance been debited against it there would have remained £27,233. 10s. 4d. to meet interest and sinking fund charges, which amount to £21,838. 17s 9d. The cost of altering and improving a portion of the feeder mains and of changing over sections of the department's system from 110 to 220 volts has, however, been charged to revenue. The lamp and motor additions during the year amounted to the equivalent of 23,710 8 c.p. lamps, bringing the total to 156,586, an increase of 17·8 per cent. The total number of motors now connected is 260, equal to about 710 H.P. The re-laying of the older mains in the centre of the city has been completed. The committee report that any large extension of the area of supply will necessitate the erection of new stations.

The Bristol-road electric tramway was opened for traffic on Monday.

**Boulogne and District.**—The extensive system of electric tramways now fully established in this district is very popular, and is found most servicable by traders and residents of the districts of Wimereux, St. Martin, Outreaux, Portel and other points. The steep gradients over which some of the cars travel are easily negotiated, and the regular service is much appreciated. The districts served by the tramways are growing at a very rapid rate, and places like Wimereux, Wimille and Portel are likely to become in the near future considerable residential centres. Already building operations are being carried on on a large scale, and the tiny hamlet of Wimereux, where the first wireless telegraph operations between this country and France were conducted two years ago, will shortly possess a huge hotel and will become a fashionable bathing resort, for which purpose it is admirably adapted. The electric tramway company having purchased a short section of a light railway line running into Portel is enabled to run its service right into the town.

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**Calcutta.**—Reference was made in the remarks of the chairman, of the Calcutta Electric Supply Corporation, in our issue of May 10, to the large trade now developing in connection with the supply of electric ventilating fans. These fans are hired out at a charge of 4 rupees (5s.) per month per fan.

**Canterbury.**—In the report of the town clerk (Mr. H. Fielding) upon the second year's working of the electricity undertaking it is stated that on March 31 there were 259 consumers connected, compared with 195 in 1900. There are 12 arc and 268 incandescent lamps used for public lighting. The gross profit was £1,885. 14s. 9d. against £1,913. 2s. 7d. last year. Coal has been responsible for an increased expenditure of £350. After payment of interest (£882. 8s. 6d) and sinking fund instalment (£989. 15s. 10d.) there was a net profit of £13. 10s. 5d., against £406 last year.

**Cape Railways.**—A Cape Town telegram to the *Daily Mail* states that Mr. Elliott, manager of the Cape Government railways, is retiring, and has been appointed a special railway commissioner to inquire into and decide upon the best system for electrically lighting the carriages on the Cape railways, on the relative methods of the different mechanical appliances for working single lines of railway and on the best forms of signals and interlocking gear. Mr. Elliott's powers are said to include authority to order material for the construction of light railways sanctioned by the Cape Parliament last session, and to purchase locomotives and rolling stock. Mr. Elliott was to have left Cape Town on Wednesday.

**Commercial Company's New Cable.**—There has just been completed the laying of a new submarine telegraph cable from Waterville to Weston-super-Mare for the Commercial Cable Co. The new cable is about 335 miles long, and forms a triplicate route for this branch of the Commercial Company's traffic. The cable was made and laid by the India Rubber Co., whose s.s. "Silvertown" carried out the work. On behalf of the Commercial Company, the testing operations, &c., were under the supervision of Mr. A. Dearlove (of Messrs. Clark, Forde and Taylor).

**Companies to be Struck off Register.**—The *London Gazette* of May 10 contains a notice that the following companies will be struck off the register of joint-stock companies if cause is not shown to the contrary in three months:—

Davy Improved Arc Lamp Syndicate. [Mr. W. J. Davy informs us he has no connection with this syndicate.]
District Electrict Supply Co.
Electrical Industries.
Electric Light Railways.
Electro-Metallurgical Co.
Folkestone District Electric Railway Co.
Great Yarmouth and District Tramways Co.
Hamilton, Motherwell, and Wishaw Light Railways Co.
Interchangeable Flash Sign Syndicate.
Rochester, Chatham, Gillingham, and District Light Railways Co.

**Darlington.**—The Imperial Tramways Co. have accepted the offer of the Council to purchase their tramway undertaking in the borough for £7,500. The lines are to be converted to electric traction.

**Deptford (London).**—The Borough Council has decided to refer to a committee the question whether the Council shall take steps to establish electricity supply within the borough.

**Dublin.**—A long and useless discussion on electric lighting matters took place at the Council meeting on Monday, when Mr. Irwin moved a report of the Lighting committee recommending the acceptance of the tender of John Spencer (Ltd.) for the supply of intake piping, screens, wells, sluice valves, &c., for the Pigeon House Fort station at £170. The committee also sought permission to incur a slight further expenditure, in view of a future extension of the scheme. The proposal was to provide at the present moment for the inevitable extension to Clontarf by the provision of an additional intake pipe, well, and accessories, at an extra cost of £333. This larger plant could be laid at present with scarcely any extra cost. The committee urged, in favour of this proposal, that unless they incurred this expenditure now a considerable future expenditure would be involved. The proposal raised a storm of opposition and miscellaneous discussion, but the committee's report was, in the end, adopted.

**Durban.**—An interesting pamphlet on the subject of "Electric Motive Power for Industrial Purposes" has recently been prepared by the borough electrical engineer of Durban (Natal) (Mr. John Roberts, A.I.E.E.), and has been published by order of the Durban Corporation. Mr. Roberts's object is to give the Durban public an idea of the uses to which electric driving can be applied, and he has effected his purpose very creditably by the provision of a well-got-up pamphlet, containing information which the householder and the general lay mind can readily absorb. A number of illustrations elucidate the text.

**Eccles.**—The Corporation have decided to carry out extensions of their electricity works in order to generate current for working the tramways. The Council have declined the offer of the Trafford Power and Light Supply (Ltd.) to supply current for traction.

**Exhibition.**—Particulars are given in an advertisement of an electrical exhibition to be held at the Town Hall, Stratford, under the auspices of the Corporation of West Ham, from Monday, May 20, to Saturday, May 25, when numerous electrical exhibits will be displayed, showing the latest applications of electricity to lighting, heating, cooking, and for driving domestic and other machinery.

**Factory Act Prosecution.**—At Thames (London) Police Court, on Tuesday, the Electrical Power Storage Company were summoned for failing to carry out certain special rules applying to electric accumulator works by not seeing that the rubber gloves used by their workmen were constantly inspected and renewed when defective. The company were also summoned for failing to limewash the pasting shop and other parts of the factory within the stipulated period of 14 months. The company admitted the facts, and said they were quite unaware of the state of affairs until the visit of the inspector. Regarding the supply of gloves it could not truly be said that this supply was defective, for in March 20 pairs of gloves were issued to 25 men, and in April 18 pairs were issued to 18 men. The inspector (Mr. C. Hoare) said these gloves would only last in use a fortnight. The magistrate (Mr. Mead) imposed a penalty of £4. 10s. and £1. 6s. costs on the first summons, and £4 and 4s. costs on the second.

**Farnham.**—The Council have instructed Messrs. Preece and Cardew to report upon electric lighting, and more particularly as to establishing municipal works.

**Gijon (Spain).**—Considerable activity is displayed in industrial circles throughout the district of Corunna. Amongst the plant about to be required by a local company, "Gijon Industrial," which has been established here with a capital of £190,000 (6,000,000 pesetas), are electric motors and lighting plants, plant for light railways, steam engines and boilers, oils and lubricants, and machine tools. The objects of the company are to establish large industrial works and mills in this part of Spain.

"Credito Industrial Gijones" is a company established in 1899, with a capital of £400,000 (15,000,000 pesetas), to construct a line of railway 60 miles in extent. It is about to require generating plant for electric lighting and electrolytic installations. The company has purchased the Gijon Gas and Electric Lighting Works, and also the Gijon tramways, which are about to be converted from horse to electric lines. A light railway is also to be constructed, connecting up the coal and iron districts with the port. Amongst the company's latest acquisitions are the rights for manufacturing soda by the Hargreaves-Bird process.

A number of other new industrial undertakings have recently been, and are on the eve of being, established in this district, for which considerable quantities of engineering and electrical plant and apparatus are likely to be required. Amongst these may be mentioned the "Algodonera de Gijon" and the "Compañia Gijonesa de Hilados y Tajidos." The following firms at Gijon are general dealers in machinery, apparatus and metal work of all kinds:—Messrs. Sheldon, Gerdtzen and Morgan, Senores Cifuentos, Stoldtz & Co., Messrs. Hulton & Co., and Mr. C. Jensen.

**Glasgow.**—The Electricity committee recommend the adoption of the following scale of charges for the year 1901-1902:—

*Lighting.*—(1.) Shops, warehouses, offices and other premises, except those specified under heads 2, 3 and 4, to be charged on the maximum demand system, at 6d. per unit for the first hour's use, and for all current consumed over this quantity 1d. per unit for 250 volt supplies, 1½d. for 200 volt supplies, and 2d. for 100 volt supplies.

(2.) Domestic consumers, a uniform charge of 3½d. per unit for 250 volt supplies, and 4d. for 200 and 100 volt supplies.

(3.) Theatres, halls and other places of entertainment, a uniform charge of 3½d. per unit.

(4.) Churches, a uniform charge of 3d. per unit.

*Motive-power.*—A uniform charge of 1½d. per unit for 250 and 500 volt supplies, and 2d. for 200 volt supplies.

No alteration is to be made in the rates charged for current supplied under existing special agreements, or for public street lamps.

**Ilfracombe.**—The agreement for the transfer of the Council's electric lighting order to Edmundsons' Electricity Corporation has been sealed.

**Islington (London).**—Various extensions of the electric lighting mains, estimated to cost about £5,500, were authorised by the Borough Council last week.

**Jassy (Roumania).**—Considerable extensions to the existing electric generating station in this town are about to be carried out to meet increasing demands for current. The existing plant supplies 10,300 8 c.p. incandescents and 190 arcs.

**Kensington (London).**—The Borough Council on Wednesday considered a report by the sub-committee on street lighting. It was stated that the lighting engineer had submitted plans and estimates for lighting some of the main thoroughfares by electricity, after consideration of which the committee had inspected the lighting at a number of places, and had come to the conclusion that, as regards side streets, Kensington was not behind the places visited. With regard to arc lighting the committee considered that lamps erected about 60yds. apart on each side of the road alternately, on

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posts 20ft. high, fitted with swan necks, so that the lamps hung a few feet over the roadway, were most suitable. They had further considered as to the advisability of submitting a large scheme for improving the general lighting of the whole borough, or a progressive scheme for lighting some of the principal thoroughfares; and having regard to the great and rapid improvements now being made in public lighting, were of opinion that electric lighting was preferable. With this view, they suggested further and more extended experiments with arc lighting in certain main roads, and for extending the use of incandescent gas lighting in other thoroughfares. The Council decided to further consider the lighting of a number of additional streets with electric arc lamps at a cost of £3,900.

**Leicester.**—A lengthy report has been prepared by Mr. E. Manville (Messrs. Kincaid, Waller and Manville) on—

(1) The relative advantages of underground conduit systems, surface contact systems, and overhead trolley system; and (2) the relative advantages of an independent power station, a power station in connection with the existing Corporation gas and electric light works at Aylestone, and a combination of the various dust destructor installations existing in the borough with electric generating stations, supplemented by coal-fired boilers. The Council are recommended to adopt the overhead system for their tramways, and the report also advises the erection of a separate power station. The Tramway committee have had Mr. Manville's report under consideration, and the Council are recommended to adopt the scheme, and to appoint Mr. Manville consulting tramway engineer.

**Light Railways.**—An inquiry was recently held at Northwich into the application to construct a light (electric) railway between Warrington, Northwich and Stretton. Mr. Wedderburn, K.C., stated that the application was for a line of railway, mainly single track, which would commence at Warrington and run through Stockton Heath, Stretton, Antrobus, Framley, Great Budworth, Marston, Wincham and Northwich. From thence it would proceed north to Winnington, Barnton and Whitley, and back to Stretton. Warrington and Northwich are only 8 miles apart, but there exists very inadequate means of inter-communication. The total length of the line was 21 miles, and the estimated cost £120,000. Major P. Cardew said that, speaking generally, he could recommend the scheme. He agreed with the engineer's estimate of the cost. The commissioners decided to recommend the granting of an order subject to certain conditions as to the widening of the roads on route. Mr. R. H. Scotter is engineer to the scheme.

The Bury and Diss and Bath and District Light Railway orders have been submitted to the Board of Trade for confirmation. Objections by June 7.

**Lowestoft.**—On April 26 the equivalent of 5,608 8 c.p. lamps, representing 103 customers, were connected to the electric light mains. Extensions in four additional thoroughfares have been authorised.

**Luton.**—The maximum charge for electric current has been fixed at 6d., and the minimum at 3d. per unit. The National Electric Wiring Co. has been asked to submit terms for wiring premises on the easy payment system.

**Manchester.**—Col. von Donop, R.E., and Mr. A. P. Trotter are about to inspect the permanent way and electrical equipment of the new electric tramway routes.

**Midsomer Norton.**—A report by Mr. A. H. Preece on electric lighting is now before the Council, who have appointed a committee to confer with the Radstock Council as to a joint scheme.

**Municipal Telephony.**—Swansea Corporation on Wednesday decided to appoint a committee to consider the question of applying for a licence to establish a municipal telephone exchange.

**New Malden.**—A proposal by Mr. F. J. Warden-Stevens in regard to obtaining electric lighting powers is under the consideration of the Council.

**Newport.**—The site of the proposed tramway power station has been settled. On Tuesday the Electricity and Tramways committee repeated their prior recommendation in favour of Corporation-road, and that tenders amounting to £55,056 for the equipment of the new station be accepted. An animated debate ended in the recommendations being adopted.

**Northfleet.**—Messrs. Preece and Cardew have been retained to advise the Council as to entering into an arrngement with the Gravesend Council for the erection of electricity works for supplying both districts.

**Oxford.**—The Governing Body of Christ Church have decided to carry out the electric lighting scheme prepared by Mr. Morgan Williams, and the contract has been placed with Messrs. Hill, Upton & Co.

**Pietermaritzburg (Natal).**—Considerable extensions of the electricity supply works, involving an expenditure of £200,000, are under the consideration of the Council.

**Portsmouth.**—The Electric Lighting committee report a deficit of about £1,000 on the past year's working. There has been a profit during the past few years, and this year's loss is attributed to heavy expenditure on coal.

**Presentation.**—At Coventry, Mr. Gilbert S. Ram, who recently resigned the position of engineer and manager of the electricity works, was presented last week by the principal officials of the Corporation with a watch. The presentation was made by the town clerk (Mr. L. Beard), who described Mr. Ram as an able officer, a pleasant colleague and a good fellow, and heartily wished him success in his career. Mr. Ram, in reply, expressed his regret at leaving Coventry, where he had received much kindness.

**Preston.**—On the advice of their consulting engineer, Mr. E. M. Lacey (Messrs. Lacey, Clinehugh, and Sillar), the Council have decided to adopt the overhead trolley system for their tramways, and to alter the gauge of the existing lines from 4ft. to 4ft. 8½in.

**Self-Propelled Lorry for Military Purposes.**—With a view to obtaining the best self-propelled lorry for military purposes the Secretary of State for War offers three prizes—first £500, second £250, third £100—for the three self-propelled lorries which shall be adjudged, after a series of trials carried out by the War Office Committee on Mechanical Transport, to be best suited to military requirements. The trials will begin on Wednesday, Dec. 4, and will extend over a considerable period, so that the vehicles may be thoroughly tested. A general scheme will be drawn up and issued as soon as possible to all intending competitors, but the committee reserve full powers to carry out any additional tests they may deem necessary, whether included in the general programme or not. Intending competitors must send in their names to the Secretary, Mechanical Transport Committee, War Office, Horse Guards, Whitehall, not later than Sept. 1. No vehicle will be admitted to the trials unless a fully-dimensioned set of drawings and a specification, giving complete details of the lorry and trailer exactly as submitted for trial, together with a statement of the purchase price of the lorry and trailer, have been lodged before Dec. 4. All designs and specifications lodged will be considered confidential. The drawings, &c., of the vehicles that may be purchased will be retained for the purposes of the Government, but without prejudice to patent rights, while those of vehicles not purchased will be returned to competitors. Certain firms have already been asked to send in designs, and some have communicated with the committee. It has, however, now been decided to institute an open competition. Further particulars are set out in circular Gen. No. 5 862, in which is also set out a "Statement of Requirements." This circular can be obtained of the secretary of the committee as above. Some of the requirements are severe, as is shown by the following:—

1. The lorry to be capable of being used on rough roads, and to a limited extent across country. To be able to go wherever a country cart can go, and to be capable of being driven through an opening 7ft. 6in. wide.

2. Net load to be 5 tons, of which 3 tons must be carried on the lorry itself and 2 tons on a trailer; these weights are exclusive of fuel and water, all of which must be carried on the lorry.

6. The lorry, carrying its full net load of 3 tons, and drawing a trailer loaded with 2 tons, to be capable (*a*) of a speed of 8 miles per hour on fairly level roads in fair condition, (*b*) of a mean speed of at least 5 miles per hour on average roads up and down hill, (*c*) of taking its full load without assistance on an average road, up a slope of 1 in 8.

12. The lorry to be able to run for 48 hours without overhaul or cleaning.

**Sheffield.**—Electric lighting has superseded gas at the Corn Exchange Market. There are 15 W. J. Davy enclosed arc lamps suspended from the roof, 13ft. from the floor. Current was switched on for the first time on Friday last.

**Shrewsbury.**—The chairman of the Lighting committee (Mr. T. P. Deakin) informed the Council on Tuesday that the demand for electric current had increased 76 per cent. in 12 months, and in two years the profits had been £2,200. New plant was being laid down, and the committee recommended the Council to sanction a further loan of £16,526 for additional cables to meet the increasing demand for current. The recommendation was agreed to.

**Solo (Java).**—A company has been formed to establish electricity supply for both private and public lighting in this town.

**Suicide.**—On Friday last the City of London Coroner (Mr. S. F. Langham) held an inquest on the body of Mr. A. W. B. Pearson, described as an inventor and electrical engineer, who committed suicide at the Manchester Hotel, London, on 7th inst. The evidence showed that a warrant had been issued for the arrest of the deceased on a charge of forging and uttering a bill of exchange, and this and other pecuniary troubles drove him to the desperate deed. There were many sad feature in the case, and the jury gave a verdict of suicide during temporary insanity.

**Swindon.**—The Corporation on Tuesday considered the report of Col. Yorke, Board of Trade inspector, with regard to the routes for the proposed electric trams, and it was decided to accept the recommendations contained in the report. The plans of the buildings for the electricity station have been approved, and tenders for the erection of these buildings are to be at once advertised for.

**Sydney (N.S.W.)**—The City Council, having acquired a site for their proposed electricity works, have resolved to proceed with the electric lighting scheme prepared by Major P. Cardew, of Messrs. Preece and Cardew.

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**Telephones in Russia.**—We recently referred to the concession obtained in November last by a Swedish company for the construction and operation of telephone services in Moscow and Warsaw for a period of 18 years. The subscription at Warsaw has, we understand, been fixed at £7. 10s., and in Moscow at £8. 7s. per annum.

**Theft.**—At the West Ham (London) Police Court on Saturday, a cable jointer named Ives was charged with stealing 60lb. of lead and 11lb. of copper, value £1. 15s., from the West Ham Corporation. Prisoner was in the employ of the Corporation, and the lengths of cable wire and lead left over at each job he should have handed into the stores. He was seen to go into a marine store dealer's at Plaistow with a bag containing the stolen property. In his defence prisoner said the copper and lead did not belong to the Corporation; it had been left by the British Insulated Wire Co, who had finished their contract and had gone away. Mr. Bullock, mains superintendent, said whatever was left by the B.I.W. Co. was bought by the Corporation. Sentence: Two months' hard labour.

**Tonbridge.**—An inquiry was held last week into the application of the Council to borrow £20,400 for electricity works. The Council's consulting engineer (Mr. Robert Hammond) supplied technical details. Mr. L. W. Bradley, surveyor to the Council, and Mr. Hewlett, assistant on the staff of Mr. Hammond, gave evidence as to the site for the proposed works and the demand for electric current. After some evidence in opposition had been taken, the inquiry was adjourned until to-day (Friday).

**Trieste.**—The signal success of the electric tramways at Trieste, where all horse tramways have been abolished and the lines converted to electric traction on the overhead system is causing the municipality to seriously consider the extension of the lines to the suburbs, and it is proposed to cut tunnels through some of the steep hills in the neighbourhood and so shorten the long journeys now necessitated to reach comparatively near points.

**Vibration Committee's Report.**—In the proceedings on Friday last before the Joint Committee of the two Houses of Parliament presided over by Lord Windsor, Sir Courtenay Boyle placed before the Committee the heads of an interim report of Lord Rayleigh's committee on the subject of vibration on the tube railways. This interim report is set out in Sir Courtenay Boyle's evidence, given on page 150.

**Vivero (Spain).**—A system of public electric lighting has been successfully installed by the municipality of this town. The plant is water driven from the falls of the neighbouring river Landrove. On this river there are a number of other falls available in excellent positions for industrial uses. The mining industry shows great activity in this district.

**West Hartlepool.**—The electricity mains are to be extended to Seaton Carew at an estimated cost of £3,500.

**Whitehaven.**—The chairman of the Finance committee (Ald. Dees) announced last week that the expenses of the electric lighting department had increased largely over the estimates. The expenditure on repairs, owing to the unfortunate breakdown of engines, dynamos and mains had reached £457 more than had been estimated. The total deficiency for the year was £754. He foreshadowed an increase in the charges for current to private consumers, as the present price (3d. per unit) would well permit of an increase.

**Willesden.**—The guardians have appointed Mr. Morgan Williams, M.Inst.C.E., consulting engineer to the new Willesden Infirmary.

**Woolwich (London).**—The Borough Council have offered the Woolwich District Electric Light Co. £80,000 for their undertaking, works and powers, the Council to take the profits of the undertaking as from Dec. 31, 1900, and to control the company's capital expenditure from that date, paying the company in return 4 per cent. interest on £80,000 from that date until the completion of the purchase, which is to take place at the earliest possible date. The offer is made subject to the Council obtaining all necessary powers and consents and the necessary loan. The directors of the company recommend the shareholders to accept the offer.

A special meeting of the Council will be held on June 6 to decide as to approaching the Blackheath and Greenwich District Electric Lighting Co. with a view to the Council purchasing that portion of the company's undertaking and works as is within the parish of Eltham.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Hull* Electric Lighting committee invite tenders for 12 direct-current street arc lamps, erected complete with cast-iron posts and spare parts and accessories. An advertisement contains further particulars, and specifications may be obtained from the city treasurer. Tenders to Chairman by noon May 23.

*Salford* Corporation invite tenders for the supply and delivery of additional steel poles and cast-iron bases. Specification from the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, London, S.W., and 78, King-street, Manchester (from the latter office only ofter Tuesday next). Tenders to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by 3 p.m., June 3. See advertisement.

*Manchester* Tramways committee invite tenders for special (permanent way) track work, cross-over tracks, &c. Specifications may be obtained from the general manager (Mr. J. M. McElroy), 55, Piccadilly, Manchester. Tenders to chairman by 1 p.m. of 25th inst. See advertisement.

*Sunderland* Corporation invite tenders for the supply of steel plate, coal bunkers and overhead gantry. An advertisement contains additional particulars, and specifications may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street. Tenders (addressed to chairman) must be delivered to town clerk (Mr. Fras. M. Bowey), by noon of 31st inst.

*Ipswich* Corporation invite tenders for the supply, delivery, and erection of dry-back marine type boilers of dimensions and fittings as set out in an advertisement. Specifications, &c., can be had from the town clerk (Mr. Will Bantoft), Town Hall, Ipswich, and can be seen at, but not obtained from, the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders must reach Mr. Bantoft by 10 a.m. June 8.

*Rochdale* Corporation invite tenders for the supply and delivery of six specimen electric tramcars. The general conditions, specifications, &c., may be seen at the offices of Messrs. Lacey, Clirehugh and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, London (obtainable from the latter office only). Further particulars will be found in an advertisement, and tenders must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, not later than June 7.

*Dublin* Lighting committee invite tenders for motors and motor generators, accumulators, meters and works wiring. An advertisement contains further particulars, and specifications, &c., may be inspected at the office of the city engineer (Mr. Spencer Harty), City Hall, Dublin, and at the office of the consulting engineer (Mr. Robert Hammond), 61, Victoria-street, London, S.W., and may be obtained from the latter address. Tenders to secretary (Mr. Fred. J. Allan), City Hall, Dublin, by 4 p.m., June 3.

*Dundee* Gas Commissioners invite tenders for supply and erection of steel steam piping, valves and accessories, at the Dudhope-crescent electricity station. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), and tenders to the clerk to the Commissioners (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by May 30. An advertisement contains further particulars.

*Glasgow* Corporation invite tenders for the supply of electricity meters. Specifications from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, Glasgow, and tenders to the town clerk (Sir J. D. Marwick), by June 10. See advertisement.

*Edinburgh* Corporation invite tenders for the electric lighting installation, &c., of the first portion of the Colinton Mains Fever Hospital. Specifications from the resident electrical engineer (Mr. F. A. Newington), Dewar-place, and tenders to the town clerk (Mr. Thomas Hunter, W.S.), by 11 a.m. June 12. See advertisement.

*Worksop* District Council invite tenders for 150 electricity meters. An advertisement contains further particulars, and tenders must be sent in to the clerk (Mr. George H. Featherston) by May 29.

*Exeter* City Council invite tenders for the equipment of their new electricity generating station, including boiler and engine-house plant, steam pipes, &c., main and exciter switchboards and connecting cables, recording and other instruments, steel-plate coal bunkers and coal conveyors, and feed and condensing water tanks. Tenders to town clerk (Mr. Geo. R. Shorto) by June 14.

*Kingstown* (Ireland) District Council invite tenders for boilers, pumps, steam and water pipes, tank, economiser, ironwork, &c.; engines, generators, balancer and booster; switchboards and instruments; battery of accumulators and accessories; cables, electricity meters, wiring electricity station, and arc and incandescent lamps and fittings. Tenders to town clerk by noon, May 30.

*Stoke-upon-Trent* Guardians invite tenders for electric motors for driving new laundry machinery, and also for wiring the laundry buildings, nurses' home, and farm buildings. Tenders to clerk by 9 a.m. May 22.

*Tonbridge* District Council invite tenders for boiler and engine-house plant, condensing apparatus and pipe work, travelling crane, switchboard and instruments, accumulators, mains, meters, public arc and public incandescent lighting. Tenders to clerk by 4 p.m. May 30.

*Todmorden* District Council invite tenders for the erection and maintenance of telephonic communication between the Fielden joint hospital, the workhouse, and the Council offices, and the house of the receiving officer. Tenders by 21st inst.

*Waterford* Electric Lighting committee are prepared to receive proposals as to the electric lighting of the borough. An advertise-

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ment contains some particulars, and additional information may be obtained from the borough surveyor, Mr. M. J. Fleming.

*Bermondsey* (London) Borough Council invite tenders for wiring the electricity station and stables, Neckinger. Tenders to town clerk by noon May 21.

*Hendon* District Council invite tenders for wiring the new Council offices. Tenders to Mr. Henry Humphris, Public Offices, the Burroughs, Hendon, before 4 p.m. June 5.

*Long Eaton* District Council invite tenders for two steel Lancashire boilers, engines, dynamos, switchboard, and accessories. Tenders by noon May 20.

*Worcestershire* Standing Joint committee invite tenders for wiring the judges' lodgings. Tenders to county surveyor by 31st inst.

*French* Ministry of Posts and Telegraphs invite tenders for the supply of 10 lots of magnetic calls and four lots of telephone cable. Tenders to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, Paris, by 23rd inst.

## TENDERS RECEIVED AND ACCEPTED.

Cardiff Corporation have adopted the recommendation of their Tramways committee to accept the tenders, set out in our last issue, for overhead line materials. For the insulators and line suspensions section there were nine tenders received, that of Messrs. R. W. Blackwell & Co. being accepted. For section 4 (trolley and other wire) 12 tenders were submitted, the contract for span and guard wires being obtained by Messrs. Frederick Smith & Co., and Messrs. Back and Manson secured the contract for trolley wires. 12 tenders were sent in for feeder and section pillars, &c., in section 3, and this contract was split between Messrs. Bergtheil and Young, who got the order for feeder and section pillars, and Messrs. Thornton and Crebbin for telephone boxes. The contract for section 2 (brackets) was given to Mr. John Priest out of 16 tenders submitted. In section 1 (poles, bases, refuge pillars, &c.) the order was given to Messrs. J. Williams & Sons, who quoted for poles by Messrs. J. Russell & Co., of Wednesbury. In this case there were 20 tenders.

Sunderland Corporation have accepted the following tenders:—

*For Hylton-road Station.*—Bertram Thomas, for switchboard; Chatteris Engineering Works Co., for travelling crane; Tudor Accumulator Co., for battery; Wearmouth Foundry Co., for main steam and other piping, &c.

*Annual Contracts.*—St. Helens Cable Co., for indiarubber-covered cables; Doulton & Co., for stoneware casings; Watson, Gow & Co., for C. I. piping, &c., and box frames and covers; Isdale and Farrow, for W. I. piping, &c.

*For Dunning-street Station.*—Clayton & Co., for additional panels to tramways switchboard.

Barrow-in-Furness Town Council have accepted the tender of the British Insulated Wire Co. for the supply and delivery of paper-insulated lead-covered cables at about £2,742, and also for cast-iron pipes, manholes, bolts, nuts, and washers, at £500. Tenders of Messrs. Doulton & Co. for earthenware troughing and pipes, at £592; of the Albion Clay Co. for earthenware conduits, at £178; and of Messrs. Mavor and Coulson for a 25kw. balancing transformer and switchboard, at £583, have also been accepted.

Ashton-under-Lyne Corporation have placed the order for two 250 H.P. direct-current generating units with Messrs. Siemens Bros. & Co. at £3,260. Belliss engines are to be supplied. About 50 tenders were received.

Beckenham District Council have accepted the tender of the British Insulated Wire Co. for additional machiney for the electricity works, at £13,693. The boilers and pipe work will be supplied by Babcock and Wilcox, the steam alternator by Johnson and Phillips, and the cables by the B.I.W. Co.

Burnley Town Council have accepted the tender of the Oldham Boiler Works Co. for two Lancashire boilers, with fittings, at £700, and that of the Tudor Accumulator Co. for a storage battery of 260 cells at £2,380.

Burnley Council have also accepted the following tenders for their electric tramways department:—

| | | | |
|---|---|---|---|
| British Insulated Wire Co. (overhead equipment). | £10,201 | 0 | 0 |
| Do. Do. (cables) ..... | 7,725 | 16 | 4 |
| R. W. Blackwell & Co. (rail bonds) ..... | 778 | 4 | 9 |

Bradford Corporation have accepted the tender of the British Insulated Wire Co. for the supply and delivery of lead-covered and armoured cable for electric lighting mains extensions for £2,562, and that of the Phœnix Dynamo Mfg. Co. for a motor balancer and booster, switch gear, &c., for £1,403. 18s., and for a 100kw. motor-generator for £883. 10s.

Newton Electrical Works (Ltd.), Taunton, have received an order for three complete sets of direct-coupled Taunton dynamos and Belliss engines for the Royal Masonic Institution for Boys, Bushey, Herts.

Eastbourne Town Council have accepted the tender of Mr. J. Every for constructing six transformer chambers at £554. 6s. 6d.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A summary statement of affairs in the failure of G. W. de Tunzelmann is issued, showing the amount of liabilities to 49 unsecured creditors to be £4,767. 0s. 3d., to four partly-secured creditors £4,430. Total liabilities, £9,197. 0s. 3d.; assets absolutely nil. The "observations" furnished by the O.R. (Mr. E. Leadam Hough) give some particulars of debtor's connection with the Electrical and General Engineering College and Experimental Works at Penywern-road, Earl's Court, London, from 1893 to 1899, and the sale in the latter year of the business to a limited company, with a nominal capital of £15,000, of which about £1,500 was subscribed. In March, 1897, another company was promoted, with a nominal capital of £40,000, of which about £3,500 was subscribed. Debtor acted as director and consulting engineer to the company. Debtor attributed his insolvency mainly to losses and expenses incurred in connection with the Electric Welding Co., which debtor promoted in 1897, and to the transfer of the Electrical and General Engineering College and Works to the company first mentioned in the "observations." Through the Electric Welding Co. he lost £6,550 by depreciation in the value of his vendor shares, £300 on other shares in the company, and a further £300 through supplying the company with apparatus. The bankrupt's public examination took place on Wednesday. The O.R. is trustee of the "estate."

John Murdoch, electrician, 188, Glasgow-street, Ardrossan, will be examined in the Sheriff Court House, County-buildings, Kilmarnock, on 22nd inst.

Claims against J. E. Bunce, electrical fittings manager, 16, Elmfield-terrace, Halifax, must be in by 28th inst. Mr. E. E. Deane, Trinity House-lane, Hull, is trustee.

In the bankruptcy of G. F. Cook (trading as F. Cook & Co.), electrical engineer, lately trading at Charles-street, Bradford, the first meeting of creditors will take place at 31, Manor-row, Bradford, on 21st, and the public examination on 22nd inst.

Claims against the "Commercial Telegraph Syndicate (Ltd.)" must be sent to the liquidator (Mr. C. Quennell), 7, Angel-court, Throgmorton-street, London, E.C., by June 30.

A resolution has been passed and confirmed to wind up voluntarily the Kerbey Bowen Electric Syndicate (Ltd.) and to appoint Mr. Walter Roden, 72, Coleman-street, London, E.C., as liquidator.

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**Sale by Auction.**—Messrs. Wheatley Kirk, Price & Co. announce that they are instructed by the sole surviving executor of the well-known firm of Smith, Beacock and Tannett, Victoria Foundry, Leeds, to sell by public auction, piecemeal, at an early date, the entire contents of the works. Some particulars of the tools and plant are given in an advertisement, and catalogues, now in preparation, may be obtained shortly (price 6d. each) on application to Mr. F. Riley, c/o Messrs. Smith, Beacock and Tannett, or of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

**Plant for Sale.**—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and Albert-square, Manchester, have electric lighting plant for disposal, some particulars of which are set out in an advertisement.

**Westinghouse Plant.**—Circular No. 1,047, on "Standard Railway Switchboards," has been issued by the British Westinghouse Co. A seven-panel board is shown.

**General Electric Co.**—The literature for the week of the General Electric Co. includes a list of "Geeko" telephones (with showcard, 20in. by 30in., of the most up-to-date design), a circular dealing with electric tramway fittings, and particulars of the company's exhibits and loan apparatus for the exhibition to be held under the auspices of the West Ham Corporation at the Town Hall, Stratford, next week. In the telephone catalogue are illustrated instruments which are well known to the trade, and which have been christened with popular names in order that the uninitiated may become acquainted with the specialities which this company have to offer. Several well made instruments, offered at low prices, are illustrated. The tramway fittings include a swivel trolley head manufactured by the company under Wood's patents of 1897 and "1899" (!) This head includes a self-oiling arrangement which is claimed to enable the spindle to run for six weeks without attention. For five years this head has been adopted on many of the largest tramway systems without a single accident having occurred with it. Frogs, crossings, movable points, and trolley standards for cars with and without top seats are also shown. This company have also now ready a descriptive catalogue of electric fire alarms and fire brigade calls illustrating the apparatus which has recently been adopted by the Walthamstow and Tottenham District Councils. The apparatus listed includes street posts, wall boxes, pocket telephones, thermostats, &c.

**New Traction Cell.**—Mr. J. T. Niblett sends us particulars of a new form of traction cell which he has recently devised and will shortly place on the market. The metallic conductor used is of small dimensions and light weight. It forms the backbone of a frame wherein the active material is contained, and is so arranged that all those parts immersed in the electrolyte and not covered by the active material are insulated. By this arrangement all the lead salts are brought under direct electrolytic action, and uniformity of formation is ensured, both in the initial processes and in the charging and discharging operations, and greater efficiency obtained. The

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material employed in both positive and negative plates is a compound of lead salts produced electrolytically, and is of a conductive nature. When set and properly seasoned the material is of a stonelike nature, while the necessary porosity is obtained. Cells made by the new process can be formed very rapidly, and the amount of energy consumed in the formation is said to be only about one-half that required by the ordinary grid or pasted type of cell. The expansion on the positive and contraction on the negative plates during formation is much reduced, and the elements do not tend to bend, buckle, or shed their active material, either during formation or in subsequent charging and discharging. An electromotive force of from 2·2 to 2·3 volts per cell is found to be sufficient to effectually re-charge. So far plates varying from 0·1in. to 0·75in. thick have been tested, and give uniform and equally good results. Mr. Niblett furnishes the following particulars of a cell constructed for motor car work :—

Positive plates, 4 ; negative plates, 5 ; gross weight of conductors in plates, 3lb. 10oz. ; of positive active material, 8lb. ; of negative active material, 6lb. 7oz. ; of complete cell, including containing vessel and electrolyte, 24lb. 9oz. ; normal discharge rates, 16 amps. ; current density of positive surface at normal discharge, 1 amp. for 7 sq. in. ; capacity, 160 amp. hours ; capacity per lb. of complete cell, 5·55 amp. hours. These results were obtained with a fall of potential down to 1·75 volts per cell, but under ordinary conditions the electromotive force may be safely run down to 1·7 volts without injury to the elements or loss of efficiency. At half rates of discharge the capacity per lb. of cell was found to be 7·5 amp. hours.

**Manufacturers' List**—A well-arranged catalogue of electrical apparatus manufactured by Messrs. Dorman and Smith, Ordsal Works, Salford, and London, is just issued. Seventy large quarto pages are devoted to the illustration and description of a large variety of goods manufactured by this firm, and the full-page plates include views of traction, lighting and power switchboards. Much of the apparatus of which particulars are given is made from patented designs. On page 55 is given a useful sheet of electric light fittings to scale.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 8 to 14, with the ports of destination :—

*Africa*—Alexandria, £179 ; Cape Town, £878 (including £768 telegraph material) ; Chinde, £52 ; Durban, £3,004 (including £295 telegraph wire) ; East London, £55. *Argentina*—Buenos Ayres, £2,637 (including £1,546 telegraph material). *Australasia*—Adelaide, £47 ; Auckland, £120 ; Melbourne, £1,430 (including £704 telegraph material) ; Perth, £43 ; Sydney, £460 (including £42 telegraph wire). *Austria*—Fiume, £307 ; Trieste, £1,928 (telegraph cable). *Belgium*—Ghent, £13 ; Ostend, £116. *Burma*—Rangoon, £234. *China*—Shanghai, £493. *Gibraltar*—£75. *Holland*—Amsterdam, £180 ; Rotterdam, £60 (telegraph material). *Hong Kong*—£3,450 (including £120 telegraph material). *India*—Calcutta, £1,875 ; Madras, £120. *Japan*—Yokohama, £1,228. *Mauritius*—£60. *Norway*—Christiania, £45. *Russia*—Libau, £32 ; St. Petersburg, £520 (telegraph material). *Straits Settlements*—Penang, £9 ; Singapore, £217. Total £19,873, against £10,622 in the corresponding week last year (May 9 to 15).

# COMPANIES' MEETINGS AND REPORTS.

## Callender's Cable and Construction Co. (Ltd.).

The fifth annual general meeting of this company was held yesterday, Mr. HENRY DRAKE presiding.

The SECRETARY (Mr. H. L. Manning) having read the notice convening the meeting,

The CHAIRMAN said : Gentlemen, the balance-sheet now presented is, I think, as satisfactory as possible, and shows a very satisfactory year's trading. The credit balance exceeds £70,500, and with the amount brought forward from 1899 totals £78,768. On the other side of the account you will observe that there has been a sum of £21,000 for enlargement of works and additional plant. This is an expenditure we cannot help. We must have all the most modern plant of every kind, and I am afraid there will be further expenditure on this account this year, but we hope the sum will not be so large. The item for cable drums shows an increase of £3,300. I like to see this item, because, if it has increased, then a larger amount of business has been done for which the drums are used. The expenditure on contracts in course of execution shows an increase of nearly £40,000, and this is, I think, satisfactory. Shares in other companies stand for £9,600, against £7,500 last year. This is also an item necessary in a company like ours. In the profit and loss account, the profit on the manufacturing account is £100,000, against £64,000. Of course, the expenses have increased, but in a lesser ratio. After paying preference interest we have a net profit, including the amount brought forward, of £56,972, against £33,000 last year. This we propose to deal with by paying the same dividend as last year, 10 per cent., and the same bonus, making 15 per cent. We propose to place to reserve £23,616 and to carry forward £10,855. The amount to reserve is a large one, but with the business we are doing—and I think this year the business will be still larger—it is necessary to have a large reserve as, with increasing competition, the tendency is to make prices closer and profits smaller. I now move that the report and accounts be adopted.

Major W. M. MACKENZIE seconded, and the motion was carried unanimously.

A SHAREHOLDER pointed out that the reserve now equalled two-thirds of the paid-up capital of the company, and suggested that the time had come when some arrangement should be made to limit this reserve, and for the directors to deal with the surplus by issuing it as paid-up shares to the present shareholders.

The CHAIRMAN thought it best to await the result of the present year's trading before interfering with the present reserve. He proposed, and Lieut.-Col. G. A. ELLIOTT seconded, that the dividends be paid as set out in the accounts, and this was carried.

Mr. T. O. CALLENDER then dealt with the present year's working of the company. The prospects, he said, for the present year were excellent. They had a large amount of work in hand, and had done more work up to date than even in the prosperous year 1900 for the same period. It was necessary, however, to be prepared for the competition which would undoubtedly come. Their prosperity was aggressive, and he felt sure some competition, and probably keen competition, would have to be met. Most of the more important municipalities, however, had some consideration for good work, and know that they are better served by a company which had been working some 20 years than by new companies. Their works and factories were in excellent condition, and they are right up-to-date and fitted with all the latest improvements in labour-saving machinery. He could not conclude his remarks without calling attention to the valuable services of their permanent staff, who by their united efforts in the interests of the company were largely responsible for its success.

The re-election of Mr. Henry Drake as director, the re-appointment of the auditors, and a hearty vote of thanks to the chairman and directors terminated the proceedings.

## West India and Panama Telegraph Co. (Ltd.).

The accounts for the half-year to Dec. 31 show the revenue to have been £24,300. 0s. 1d., against £22,643. 14s. 7d. for the corresponding half-year of 1899, expenses £20,962. 14s. 1d., against £21,432. 13s. 3d., balance £3,337. 6s. The directors again express regret that, owing to the very small and disappointing telegraphic business of the West Indies, which the reduced rates have so far failed to augment, the result of the half-year's working is so discouraging. To the small balance of £3,337. 6s. there is added £2,379. 19s. 5d. interest on investments, and £953. 11s. 11d. brought forward, making £6,670. 17s. 4d. This is insufficient to meet the cumulative dividends on the first and second preference shares for the half-year, amounting to £11,769. 12s.

The Court of Appeal has given judgment against the company in the action brought against it by the Cuba Submarine Telegraph Co. In these circumstances, and as there is no longer any appreciable increase over cost in the value of the investments, the directors are of opinion that the most prudent course in the interests of shareholders of all classes is not to pay dividends from the reserve funds, as was done during the last two half years, but to carry forward the balance of £6,670. 17s. 4d. to next account.

Renewed efforts have been made to bring to the notice of the Colonial Secretary and the colonies the company's financial position and its urgent need of Imperial and Colonial assistance, but thus far without result. The directors are considering what steps can be taken to increase the revenue of the company.

The company's second repairing steamer, "Duchess of Marlborough," which has been lying up in London for a considerable period, has recently been sold. This will effect a small saving in future expenses.

## Kidderminster and District Electric Lighting and Traction Co. (Ltd.).

The directors' report for the year 1900 states that the total capital expenditure to Dec. 31, on account of buildings and plant for electric lighting was £14,287. 3s. The gross receipts, including the sum receivable from the Kidderminster and Stourport Electric Tramway Co. for dividend, were £1,778. 10s. 3d., which, added to £1,145. 19s. 4d. brought forward, makes £2,924. 9s. 7d. After deducting expenses (£767. 4s. 2d.), there remains a net profit of £2,157. 5s. 5d., and the directors propose to pay the dividend on the cumulative preference shares (absorbing £1,449. 2s. 2d.) and to carry forward £708. 3s. 3d.

The balance-sheet and profit and loss account of the Kidderminster and Stourport Electric Tramway Co. accompanies this report, and shows that the net profits for the year in respect of the tramways amounted to £2,108. 14s. 10d., which, added to £92. 14s. 11d. brought forward, makes £2,201. 9s. 9d. available. A dividend of 5s. 6d. per share on 5,720 shares absorbs £1,573, depreciation fund £500, and £128. 9s. 9d. is carried forward.

The public supply of electric energy for lighting and power was begun on Aug. 22, 1900, and from the commencement there has been an active demand for light, the number of lamps connected to the mains being equivalent to 5,760 8 c.p., and further applications are on hand. Electric motors for driving machinery have been successfully installed, and the company has now more applications for power than the present plant can supply. New generating machinery is on order and nearly ready for delivery, which will increase the available power by 600kw., equal to 800 H.P.

Mr. E. Garcke and Mr. C. Shirreff Hilton having resigned their seats on the board, the vacancies have been filled by the appointment of Mr. R. P. Sellon and Mr. George Stevens. Mr. D. F. Sugrue has been appointed a director of the company.

## Bastian Meter Co. (Ltd.).

The report of the directors for the 12 months to Feb. 28 states that the small profit earned could have been considerably increased, but that it was considered advisable to replace, free of cost, certain defective meters

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sold by the company in previous years. In this way customers have been retained, and the value of the goodwill preserved. The principle and construction of the Bastian meter received the official approval of the Board of Trade on July 27, 1900, and the constant substantial repeat orders received show that the instruments are considered by engineers to be serviceable and efficient. One municipality has over 500 Bastian meters in use, with satisfactory results, and the directors now feel complete confidence that the present construction of the meter is good, mechanically and electrically, while the design admits of economical and methodical manufacture.

The present arrangement with the British Electric Meter Co. (Ltd.) for the sale and distribution of the meters is not so satisfactory as was anticipated, and the directors have now succeeded in obtaining the option to cancel the agreement by the repayment of £2,500, plus £500, which may be regarded as interest for the period of three years from January, 1898. At a recent meeting with some of the largest shareholders it was decided to recommend this option be exercised.

Subject to the approval of the preference shareholders it is proposed to create 6 per cent. first mortgage debentures to the value of £6,000. £5,000 will be immediately offered for subscription amongst the shareholders to provide funds for the option and further working capital. It has been suggested that all the vendors should be asked to surrender a proportion of the shares they hold in the company sufficient to expunge the item to the debit of profit and loss in the balance sheet, and the directors have again relinquished their fees for the period under review.

**BULAWAYO WATERWORKS CO. (LTD.)**—At the recent meeting the chairman (Sir John C. Willoughby, Bart.) said that the electric lighting plant, which had been running for upwards of two years, had given great satisfaction. Early in 1899 an order was placed for doubling their plant to bring it up to a capacity of 7,000 8 c.p. lamps. Owing to the war this extra plant had been detained at Port Elizabeth, and had only reached Bulawayo in December last. It was now being erected, and they would soon be in a position to supply double the number of lamps. With the increased production the cost of generation per unit would be materially decreased. They expected soon to obtain coal either from the Tuli or Wankie coalfields, and this should effect a reduction of 50 per cent. on the present cost of wood fuel. The laying of mains throughout both the town and the suburban township, owing to the great area involved, had been a heavy cost, but he understood they need not anticipate further heavy outlay on capital account.

**CORK TRAMWAYS AND LIGHTING CO. (LTD.)**—The directors' report states that the receipts for 1900 amounted to £32,856. 4s. 4d., and the expenses to £21,488. 4s. 10d. After taking into account £1,753. 8s. 7d. from 1899, there was a balance of £13,126. 8s. 1d. Debenture interest absorbed £2,328. 16s. 10d., and after allowing for bad debts (£47. 4s. 7d.) and proportion of preliminary expenses (£333. 19s. 10d.) £10,416. 6s. 10d. remains. £3,500 was paid for the half-yearly preference dividends, and the directors now recommend that £2,000 be put to depreciation, £3,500 to a 5 per cent. dividend on ordinary shares, £165. 16s. to 10 per cent. reserved to the board, and £1,250. 10s. 10d. forward. The traffic receipts show an increase of £1,774, and the receipts from lighting £4,178, compared with 1899. In consequence of the increased demand for current for lighting, additional cables, at a cost of about £18,000, have been laid. The public are lamps erected in Cork and Queenstown have proved a great success, but from a financial point of view this branch of the undertaking is unsatisfactory, as considerable loss is incurred owing to the exceptionally low rate charged to the Corporation. The extension from Ballintemple to Blackrock was opened for traffic last month, and to meet the increased service five additional motor cars have been ordered. Owing to pressure of business Mr. E. Garcke has retired from the board.

**NEW GENERAL TRACTION CO. (LTD.)**—The gross profits for the past year were £41,037. 7s. 11d., after deducting £10,739. 17s. for general expenses, salaries, directors' fees, and interest, and £1,388. 16s 9d. expended on new business not proceeded with. After adding £37,030 15s. 2d. from last year, there is £78,118. 3s. 1d. available for distribution. The dividend on the 6 per cent. preference capital has been paid, and the directors propose that the balance (£63,118. 3s. 1d.) shall be dealt with by transferring £7,000 to reserve against goodwill, £132 8s. 10d. to meet difference of present market value of Consols purchased and lodged as caution money and the price at which they stand in the company's books; and £10,000 to general reserve. From the balance (£45,935. 14s. 3d.) a distribution of 4 per cent. on the ordinary share capital is recommended, leaving £41,135. 14s. 3d. to be carried forward. The most important undertakings belonging to the company are the Douglas (Isle of Man) Southern Electric Tramways, the Coventry and the Norwich Tramways, and about 20 miles of line in the near neighbourhood of Philadelphia, U.S.A. The Douglas and Coventry Tramways have been working some time, and are yielding revenue to this company, and during the past year the Norwich lines have been finished and opened, and are yielding satisfactory returns. At Philadelphia the company has 9 miles working, and it is expected that the entire 20 miles will be finished and in operation by July next, little further capital expenditure being required to complete the system, which it is confidently anticipated will prove a valuable asset to the company. To meet this expenditure and cover the amount of outstanding loans the directors propose to at once issue £200,000 5 per cent. redeemable debentures. The Parliamentary powers for tramways at Airdrie (N.B.) obtained last summer have been disposed of.

**SOUTH AFRICAN LIGHTING ASSOCIATION (LTD.)**—The profit for 1900 including balance from 1899, and after payment of interest on debentures and income tax, is £11,259. The directors have placed £2,000 to reserve, and recommend a final distribution of 6 per cent., tax free, making 10 per cent. for the year. The carry forward is £3,259.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BLACKPOOL ELECTRIC TRAMWAYS (SOUTH) (LTD.)**—Registered April 29, capital £250,000 in £10 shares, to carry on the business of the construction, maintenance, and working of tramways, light railways, electrical and other motors, and their accessories and appurtenances, to manufacture and deal in vehicles, &c., and to generate and supply electricity.

**ELECTRICAL PRODUCTIONS (LTD.)**—Registered May 6, capital £3,000 in £1 shares, to carry on business of manufacturers of and dealers in wires and cables, electricians, electrical, mechanical and general engineers &c. The subscribers are R. T. Smith, J. D. F. Andrews, A. B. Andrews, W. Tozer, F. Walker, E. W. Spears, and G. E. Winter (electrician).

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27⅞d. per oz. (May 16). Consols (2¾ per cent.) 94 1/16—94 1/16 for money, 94 1/16—94 1/16 for account; 2½ per cent. 94½—95 (May 16). Consols Pay Day, June 3; Stocks and Shares Continuation Days, May 29 and June 12; Ticket Days, May 30 and June 13; Pay Days, May 31 and June 14; Mining Share Carry-over Days, May 28 and June 11.

**ALDERLY AND WILMSLOW ELECTRIC LIGHT CO. (LTD.)**—At the meeting last week the directors' report stated that the prospects of this company had considerably improved. The income was about double that of the preceding year, with only a slight increase in the working expenses. The equivalent number of 8 c.p. lamps connected was 3,045. Negotiations were still pending with regard to the supply of current to Wilmslow. The Council of the latter district hold a provisional order.

**REUTER'S TELEGRAM CO. (LTD.)**—The directors report that the amount available for distribution for the year to Dec. 31, including £309. 8s. 7d. brought forward, amounts to £8,437. 18s. An interim dividend of 2½ per cent. was paid in October, and the directors now declare a further 2½ per cent., making 5 per cent. for the year (tax free), absorbing £5,259. 7s.; £3,000 is put to reserve, and £178. 11s. is carried forward.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has ordered the further issue of 2,200 ordinary £10 fully paid shares (Nos. 10,001 to 12,200) of the *Notting Hill Electric Lighting Co. (Ltd.)* to be quoted in the official list. The committee has also been asked to appoint a special settling day in £100,000 5 per cent. registered second mortgage debentures of £100 of the *Thames Iron Works Shipbuilding and Engineering Co. (Ltd.)*, and to allow the same, together with the further issue of 6,400 non-accumulative 5 per cent. £10 preference shares of the *British Columbia Electric Co. (Ltd.)*, the further issue of £103,919 3½ per cent. preference stock of the *Eastern Telegraph Co (Ltd.)*, and 125,000 ordinary £1 fully-paid shares (Nos. 1 to 125,000) of the *Aron Electricity Meter (Ltd.)* to be quoted in the official list. The latter is a renewed special application.

**WILLANS AND ROBINSON (LTD.)**—The registers of debenture stockholders and of transfers are closed from May 17 to 31 inclusive.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways. | May 11 | 4,402 | + 108 | 18 | 75,277 | + 1,337 |
| *Blackburn Corporation.. | „ 10 | 530 | + 84 | 19 | 8,312 | + 851 |
| Blackpool Corporation... | „ 9 | 357 | + 72 | 16 | 2,617 | + 426 |
| Blackpool and Fleetwood | „ 11 | 335 | + 3 | 19 | 4,285 | − 299 |
| Bolton Corporation ..... | „ 12 | 1,425 | + 391 | 6 | 8,935 | + 2,137 |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ..... | Mar. 27 | 1,974 | + 249 | 12 | 24,440 | + 2,606 |
| *Bristol Trams & Carriage | May 10 | 4,305 | + 1,456 | 18 | 73,445 | + 21,444 |
| *Buenos Ayres & Belgrano | Apl. 14 | 2,969 | + 468 | 15 | 42,211 | + 7,786 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | May 11 | 6,514 | ... | 19 | 117,537 | ... |
| City & South London Ry. | „ 12 | 2,015 | + 635 | 19 | 37,731 | + 14,105 |
| Cork Elec. Trams ..... | „ 9 | 514 | + 94 | 18 | 7,035 | + 839 |
| Dover Corporation ..... | „ 11 | 197 | + 19 | 6 | 1,269 | + 117 |
| Dublin & Lucan Rly. .. | „ 11 | 96 | − 9 | 19 | 1,586 | + 113 |
| Dublin United ..... | „ 10 | 3,523 | + 71 | 19 | 51,556 | − 1,807 |
| Dublin Southern Dist... | „ 10 | 779 | − 43 | 19 | 14,230 | |
| *Dundee Corporation ... | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation ... | „ 11 | 10,691 | + 1,508 | 19 | 167,474 | + 6,440 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 11 | 853 | + 250 | 6 | 3,976 | + 1,017 |
| Hull Corporation..... | „ 11 | 1,597 | + 447 | 45 | 66,202 | + 33,882 |
| Liverpool Corporation... | „ 4 | 8,964 | + 1,499 | 18 | 146,242 | + 20,961 |
| *Liverpool Overhead Rly. | „ 12 | 1,616 | + 200 | 19 | 29,167 | + 2,415 |
| Perth (W.A.) Elec. Trams | „ 10 | 805 | + 411 | 45 | 29,855 | ... |
| Portsmouth Corporation | „ 11 | 493 | − 234 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 12 | 3,503 | + 1,406 | 19 | 57,496 | + 21,021 |
| Southampton Corporat'n | „ 9 | 659 | + 292 | ... | ... | ... |

* Partly electrical. †Minus 3 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 8. | Price Wednesday, May 15. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending May 15. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ ⅝ | ⅜ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) .. | 70 75 | 70 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. ..... | 11½ 12½ | 11½ 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. ..... | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ..... | 101 104 | 101 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord ..... ... | 7⅜ 8½ | 7⅜ 8½ | 3 12 9 | | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 8½ 9 | 8½ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) .....xd | 7½ 7¾ | 7 7⅛ | 2 6 8 | ... | 7½ | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp.... | 9 10 | 9 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... | 5 5½ | 5 5½ | 4 1 10 | ,, ,, | 5 7/16 | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary ..... | 5½ 6½ | 5½ 6½ | 4 8 0 | March ..... | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) ..... | 109 112 | 109 112 | 4 0 4 | June and December... | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. ..... | 8½ 9½ | 8½ 9½ | 4 4 3 | February and August | 8⅝ | 8⅝ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. ..... | 12 13 | 12 13 | 4 12 4 | January and July..... | .. | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ..... | 122 127 | 122 1.7 | 3 19 8 | June and December ... | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) ..... | 101 103 | 101 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary..... ... | 8 9 | 8 9 | 4 8 11 | ... | 11½ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference..... | 11 12 | 11 12 | 5 0 0 | March and September | 11⅝ | 1 13/16 |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ..... ..... | 106 109 | 105 108 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary ... ..... | 5 5½ | 5 5½ | 3 12 9 | ... | 5½ | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary ..... | 7½ 8½ | 7½ 8½ | 2 15 5 | ... | 7⅞ | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary..... .. . | 11 12 | 11 12 | 4 7 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. ..... | 6½ 7 | 6½ 7 | 4 2 7 | January and July..... | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)..... [Deb. Stk. (red.) | 102 105 | 101 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 104 | 102 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary ..... | 1½ 1⅝ | 1½ 1⅝ | ... | ... | 1⅝ | 1½ |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference ..... | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ... . | 98 101 | 98 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) ..... | 12 13 | 12⅜ 13⅛ | 4 8 11 | April and October..... | 13⅜ | 1 2/16 |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) ..... ... ..... | 11⅜ 12⅛ | 12 13 | ... | ... | 12⅞ | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage ... | 110 113 | 110 113 | 3 19 8 | June and December | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) ... | 96 99 | 96 99 | 3 11 5 | ... | 93 | ... |
| 8,652 | 10 | 8/0 | Notting Hill Electric Ordinary..... ... | 15⅛ 16⅛ | 15⅛ 16⅛ | 4 13 4 | March ..... ..... | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary ..... | 5⅝ 6⅝ | 5⅝ 6⅝ | 3 16 11 | ,, ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric ..... | ⅜ ½ | ⅜ ½ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.... | 65 75 | 65 75 | ... | January and July..... | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 104 | 102 104 | 4 6 2 | April and October... | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary ..... | 14 15 | 14 15 | 4 13 8 | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 8½ 9½ | 8½ 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.)..... | 98 101 | 98 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ..... | 80 90 | 80 90 | 4 10 11 | — | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 103,518 | 5 | 5/6 | Westminster Electric Supply Ordinary ..... | 12½ 13½ | 12 13 | 4 0 9 | March and September | 12¾ | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... ..... | 3⅞ 4⅛ | 3⅞ 4⅛ | 4 17 0 | April and October..... | 4⅛ | 4 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock ..... | 124 129 | 124 129 | 4 14 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary ..... ... | 9 10 | 8 10 | 2 0 0 | ... | 8⅞ | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference ..... | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £59,900 | 100 | 5% | Do. 5% Debentures ..... | 98 101 | 96 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) ..... | 92 97 | 92 97 | 4 13 9 | ... | ... | ... |
| 15,0 0 | 10 | 9,0 | Blackpool and Fleetwood Tramways ..... ..... | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. ..... ..... | 4½ 4¾ | 4½ 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. ... ..... | 99 101 | 99 101 | ... | ... | 99½ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary ..... | 23⅛ 23⅞ | 23⅛ 23¾ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) ..... | 10⅜ 10⅝ | 10⅜ 10⅝ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... | 114 118 | 114 118 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary ..... | 6⅞ 7⅛ | 6⅞ 7 | .. | ... | ... | ... |
| 13,600 | 10 | £/0 | Do. 5% Preference .....xd | 9⅞ 10⅛ | 9⅞ 10 | 5 0 0 | May and November | 11 1/8 | 9⅞ |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs.... ..... | 99⅝ 101⅞ | 99⅝ 101⅞ | 4 9 3 | ... | 10 1/4 | .. |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. ..... ..... | 15 16 | 14½ 15½ | 5 9 8 | ... | 15 | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref.... ..... | 12 13 | 12 13 | 4 12 4 | February and August | 12⅝ | 1 1/4 |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... . | 119 122 | 119 122 | 4 2 0 | ... | 1 21/4 | 1 1/4 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary ..... . | 1⅛ 1⅜ | 1⅛ 1⅜ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. ..... | 5¼ 5½ | 5¼ 5½ | 5 4 4 | ... | 5 5/8 | ... |
| 27,500 | 5 | 2/6 | Do. "B" ..... | 5 5½ | 5 5½ | ... | ... | 5 1/16 | 5¼ |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures ..... | 104 107 | 104 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) .. | 96 99 | 96 99 | 5 1 8 | ... | 98½ | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) ..... . | 10⅛ 11⅛ | 10⅛ 11⅛ | 2 14 2 | ... | 10⅜ | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) ..... | 102 104 | 101 104 | ... | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares..... | 1⅜ 1⅞ | 1⅜ 1⅝ | ... | ... | ... | ... |
| 19:,980 | 10 | 2/6 | Central London Ordinary ..... ..... | 9¼ 9⅝ | 9¼ 1) | 2 15 0 | June and December | 9½ | 9⅜ |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs ... .. ..... ... | 113 118 | 113 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5¼ 5½ | 5 5¼ | 4 11 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. ..... | 100 103 | 101 103 | 3 17 10 | ... | ... | ... |
| £855,000 | Stock | 1½% | City and South London Railway Con. Ordinary .. | 51 53 | 52 54 | 2 7 0 | February and August | ... | ... |
| 47,500 | 10 | 2 0,9 | Do. Ordinary (Nos. 22,501 to 70,000) ..... .. | 5 5¼ | 5 5¼ | 2 5 5 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) .. | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) ..... ..... | 122 127 | 122 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... xd | 113 118 | 111 116 | 3 9 2 | May and November .. | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary ..... | 13 14 | 13 14 | 4 5 9 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference ..... ..... | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 8½% | Do. 3½ per Cent. Mort. Debs. (red.) ..... . | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5¼ | 5¼ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4¼ ⅛ | 4¼ 5¼ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary... ..... | 22 24⅜ | 22 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference..... .. . | 15 16⅛ | 14½ 17½ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... ..... ..... | 112 114 | 112 114 | 3 18 11 | January and July..... | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. .. | ... .. | ... .. | ... | May and November .. | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary ..... ... | 7 15/16 8 1/16 | 7 15/16 8 1/16 | 4 1 5 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference .. ..... | 13 13¼ | 13 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... ..... | 102 104 | 103 105 | 3 17 2 | January and July..... | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts (fllypd) | 102 104 | 102 104 | ... | ... | 104 | 103½ |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1903) .. | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) ..... ..... | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary ..... ..... | 3½ 3¾ | 3½ 3¾ | ... | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference ...xd | 4⅛ 5⅛ | 4⅜ 5 | 6 0 0 | May ..... ... ... | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord..... | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | £/0 | Do. 5 per Cent. Preference ..... ..... | ... | ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary ..... ..... . | 11 12 | 11 12 | 1 13 4 | ... | ... | ... |
| 20,000 | 10 | o/o | Do. 5 per Cent. Cumulative Preference ..... | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... ..xd | 107 109 | 105 107 | 4 4 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) ..... ..... ..... | ... | ... | ... | April and October..... | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) ..... | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (3)% paid) ..... | ... | ... | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary..... ..... ..... | 94 97 | 94 97 | 3 2 2 | June and December | ... | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 8. | Price Wednesday, May 15. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending May 15. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 5 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,700 | 100 | 8% | Do. 8 per Cent. Debentures | 75 85 | 81 71 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 55 58 | 73 76 | 5 11 9 | Feb., May, Aug., Nov. | 74 | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 101 | 97 99 | 6 1 2 | " " | 99½ | 97½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 11 11½ | 10 10½ | 2 7 7 | " " | 11 | 10⅞ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,020 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 5 | " " | 101½ | 100½ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary xd | 7½ 8½ | 7 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. xd | 16 17 | 15 16 | 6 5 0 | " " | 15½ | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 6 7 | January and July | ... | ... |
| £6,710 | 20 | 2/0 | Direct United States Cable | 10 10½ | 17 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10⅜ | 10⅛ |
| £102,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 137 142 | 139 144 | 4 17 7 | Jan., Apr., July, Oct. | 141 | 139 |
| £1,826,898 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 94 | 91 91 | 3 14 6 | " " | 94 | 91½ |
| £1,452,200 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 114 | 110 114 | 3 11 2 | May and November | 111½ | 111 |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ 14 | 13½ 14 | 5 0 0 | Jan., Apr., July, Oct. | 14 | 13½ |
| £220,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 116 | 111 116 | 3 9 3 | February and August | 111½ | ... |
| £200,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 102 | 99 102 | 3 18 3 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% 102% | 99% 102% | 3 18 5 | May and November | ... | ... |
| 120,227 | 10 | 2/6 | Globe Telegraph and Trust | 9½ 10½ | 9½ 10 | 5 5 0 | Jan., Apr., July, Oct. | 9⅝ | 9½ |
| 120,042 | 10 | 2/0 | Do. 8 per Cent. Preference | 14½ 15½ | 14½ 15½ | 3 19 8 | " " | 15½ | 14½ |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen | 83 85 | 83 85 | 4 5 9 | January and July | ... | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (w thn Nos. | 100 103 | 100 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 37.6 | Indo-European xd [1 to 1,200) (red.) | 45 49 | 43 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 1 | June and December | ... | ... |
| 11,239 | 8 | 4/0 | Reuter's | 7½ 8½ | 7½ 8½ | 4 14 1 | April and October | ... | ... |
| 3,333 | £100 Certs. | 9% | Submarine Cables Trust | 121 126 | 124 129 | 4 13 5 | " " | 124 | ... |
| 15,000 | 10/0 | ... | West African Telegraph | 2 3 | 2 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 100 | 98 101 | 4 19 7 | March and September | 99½ | 96½ |
| 20,068 | 2½ | ... | West Coast of America | ½ ⅝ | ½ ⅝ | ... | ... | ... | ... |
| £160,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 103 103 | 100 103 | 3 18 1 | January and July | ... | ... |
| 66,321 | 10 | 6d. | West India and Panama | ⅝ ¾ | ⅝ ¾ | ... | May and November | ... | ... |
| 54,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 6 7 | 8 11 6 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 14 4 | January and July | ... | ... |
| 207,980 | 10 | 2/0 | Western Telegraph (late Brazil'n Submarine) | 13½ 14½ | 13½ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 13⅝ | 13½ |
| £70,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| £248,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 2 | " " | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3½ 4 | 3½ 4 | 5 0 0 | August | 3½ | ... |
| 224,880 | 10 | 2% | Consolidated Telephone Con. and Manfg. | 2/6 3/3 | 2/3 2/9 | 10 13 2 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¾ 1 | ¾ 1 | 5 0 0 | November | ¾ | ... |
| 68,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | " " | ¾ | ... |
| 800,000 | 5 | 2 6 | National | 3½ 3¾ | 3⅜ 3½ | 7 11 9 | February and August | 3⅝ | 3½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 10 13 | 10 12 | 5 0 0 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 12 | 10 12 | 5 0 0 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4 4½ | 4½ 4⅝ | 5 14 3 | " " | 4½ | 4⅜ |
| $1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 87 90 | 87 90 | 3 8 8 | June and December | 89 | 8 ⅞ |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 8 | " " | ... | ... |
| 171,504 | 1 | 0 2½ | Oriental xd | 1⅛ 1⅛ | ¾ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ 5 | 4½ 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ 5½ | 4½ 5½ | 4 15 3 | June and December | ... | ... |
| £179,947 | teck | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 106 | 103 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 8 0 0 | ... | ... | ... |
| 128,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | ⅛ ⅜ | ⅛ ⅜ | 7 7 8 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 11 | 10 11 | 6 16 4 | July and February | 10½ | 10⅜ |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5⅜ 6½ | 5⅜ 6½ | 4 16 0 | January and July | 6 | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference x l | 4½ 5 | 4½ 4¾ | 6 6 4 | ... | ... | ... |
| 90,000 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ 1⅝ | 1⅜ 1⅝ | 3 5 7 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2½ | 2 2½ | 5 6 8 | " | 2⅛ | 2 |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 103 | 4 7 5 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 14½ 15½ | 14½ 15½ | 4 16 9 | " " | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | " " | 5⅞ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 113 | 109 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/0½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1½ | ¾ 1½ | 7 2 3 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 96 98 | 95 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1½ | ¾ 1½ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3½ 4 | 3½ 4 | 5 12 7 | January and July | 3¾ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 101 104 | 101 104 | 4 17 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1½ 1¾ | 1 1½ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 3 4 | 2½ 3½ | 7 11 6 | " " | 3¾ | ... |
| £344,022 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 89 | 87 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 98 | 94 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5 5½ | 5 5½ | 7 14 7 | Half-yearly | 5¾ | ... |
| 13,303 | 5 | 1 6½ | Do. Cumulative Preference | 5½ 6 | 5½ 6 | ... | ... | 5½ | ... |
| £110,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 106 | 103 106 | 4 5 1 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1⅝ 2⅛ | 1⅝ 2⅛ | 5 6 8 | January and July | 1⅞ | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅝ 3⅛ | 2⅝ 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 16 11 | January and July | 102⅝ | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15½ 16½ | 15½ 16½ | 6 1 3 | February and August | 16⅛ | 15⅝ |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 6 | 5⅛ 6 | 3 15 0 | " " | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 111 | 107 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21½ 21½ | 21 22 | 4 13 0 | " " | 21⅜ | 21⅛ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 38 40 | 35 39 | 5 7 8 | March and July | 37½ | 37 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1900 | 101 104 | 102 105 | 3 16 10 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11½ | 5 12 6 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5⅝ 6 | 4 3 4 | ... | 5⅝ | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 1 | April and October | 10⅝ | 10⅜ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 6¾ | 6½ 6¾ | 4 8 11 | " " | 6⅝ | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,201. [No. 5. Vol. XLVII.] FRIDAY, MAY 24, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 15 cents, or 20c., or 70pf.


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## NOTES.

EVIDENCE in connection with a number of projected electric railways in London came before the Joint Committee of both Houses of Parliament during the past week, and is reported in our columns. We thoroughly sympathise with the desire of the Central London Railway Co. to be permitted to loop the ends of their line, so as to permit of an interchange between the up and down tracks without the necessity for shunting and disengaging the locomotive. It may reasonably be expected that power to effect this change will not be withheld. Owing to the scheme of the Great Eastern Railway Co. for an underground station beneath their Liverpool-street station, modification of the Central London Railway extension scheme has been rendered necessary, and it is now proposed to connect the two projected underground stations at Liverpool-street by means of a subway. Some interesting evidence was given by Mr. C. F. JENKIN in favour of the metallic return system used by Messrs. Siemens Bros. & Co. on the "experimental" section of the Metropolitan District railway; but the effect of this evidence upon the Joint Committee is better regarded as a matter for future history than for present prophecy.

A MELANCHOLY interest attaches to the recent report of the Board of Trade and the Light Railway Commissioners under the Light Railways Act, inasmuch as it is the last of these documents to bear the signature of Sir COURTENAY BOYLE, whose sudden decease this week we announce in another column. Since the passing of this eminently useful measure in 1896 no less than 105 orders have been confirmed by Parliament, a large number of these relating to electrical undertakings. In the course of the past year 40 schemes were submitted for confirmation, and 13 were brought forward; 29 of these were actually confirmed by the end of the year, while of the remainder 10 have subsequently received confirmation. A matter of interest is the loans and grants which have been made under the provisions of the act, although we observe that in no instance has an electrical undertaking received this form of support. Three loans of from £5,000 to £10,000, and a free grant of £5,000, coupled with a loan of £3,000 without interest, have been conditionally agreed upon, while to two schemes not yet submitted for confirmation similar privileges have been extended.

Two patent cases of importance to the electro-chemical industries in this country came up for decision last week. The first was an application to the Privy Council by the British Aluminium Co. for an extension of the term of the English patent covering the Hérault process of manufacture of aluminium. At the close of the hearing of evidence and speeches by counsel, the Judicial Committee simply announced that the application would not be granted, and that, as usual, the full decision would be given at a later date. We are thus unable at present to say what consideration has weighed most heavily with them in leading them to this decision; but no doubt the fact that the foreign patents are about to expire, and that, therefore, if a prolongation were given here, this method of manufacture would be protected in England while open to all in foreign countries, would have some weight with the Committee. This consideration of undue restraint of trade is one which often proves fatal to such applications. The further argument also that the original inventor had received adequate compensation would also, if established, have a decided effect on any decision on petitions of this character.

THE other case was that of Atkins and Applegarth *v.* the Castner-Kellner Alkali Co. (Ltd.), which has been fully reported in our columns. It is curious to note that the parties concerned in this action were the same as those who fought the action on the Kellner patent three years ago, but with their positions interchanged; for while ATKINS and APPLEGARTH were nominally plaintiffs, the real plaintiffs were the Commercial Development Corporation, who hold an option of purchase of the patent sued on. Mr. Justice BUCKLEY, in

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a very lucid judgment, has declared that the Castner process is not an infringement of ATKINS and APPLEGARTH'S patent; and, further, that that patent is invalid on the ground of non-utility, as it aims at achieving cheaper production by the use of known processes, and does not succeed. In Mr. BERTRAM BLOUNT'S excellent treatise on "Practical Electro-Chemistry," recently published, it is stated that the Castner-Kellner Company's process of working is kept a secret; but, if this were ever the case, there can be very little now left secret after the minute examination to which the process was exposed during the hearing of the trial. The company has succeeded in getting an efficiency of 90 per cent. in working, largely owing to their arrangement for short-circuiting the amalgamated mercury and the water in the combining cell, thus hastening the process of disgorging of sodium into the water. No such arrangement had been used in practice before.

WHILE these two cases have been tried here, a case of still greater importance to the electrical industry in America has been heard in New York—viz., the action brought by the Westinghouse Co. against the Saranac Lake Electric Light Co., in which the validity of patents for the use of transformers, with their primary circuits connected in parallel on the mains, came in question. The patents sued on were those of RANKIN KENNEDY (No. 407,294, 1889) and STANLEY (No. 469,809, 1892), both being of later date than the Zipernowski-Deri patent. The first was held to be invalid on the ground of prior publication by the patentee himself, but STANLEY'S patent was upheld, on the ground that it shows how the winding of the transformer ought to be made in order to secure perfect self-regulation, a difficulty which no earlier patentee had solved. Practically all distribution by transformers in the United States will be seriously affected by this judgment, so that the ultimate issue in the Appeal Courts will be of the greatest importance, and will be anxiously awaited.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Bolama | May 20, 1901 |

**Royal Society.**—Among the Papers down for reading at the Royal Society yesterday was one by Mr. Shelford Bidwell, F.R.S., "On Negative After-Images and their Relation to certain other Visual Phenomena."

**New Council of the Institution of Electrical Engineers.**—No other nominations, in accordance with article 45 of the Articles of Association, having been sent in, the members nominated by the retiring council are duly elected for office for the session 1901-2. The list of these was published on page 48 of our issue of May 3rd.

**Progress in Laying the Government Telephone System in the City.**—The city engineer (Mr. D. J. Ross), in his recent report, mentions that so far 3½ miles of trench work had been finished in the carriageways and nearly 8 miles in the footways in connection with the new system of telephones which is being installed by the Postmaster-General.

**Electric Railway to Chamounix.**—An electric rack railway is now being constructed from Fayet St. Gervais, a station two hours by rail from Geneva, to Chamounix. The line is 20km. (12½ miles) long, and for 3·6km. (2¼ miles) the rack will be employed. The line, according to the United States Consul at Geneva, is expected to be in working order by June or July next.

**Institution of Electrical Engineers' Visit to Germany.**—The preliminary arrangements for the Institution visit are now almost complete, and the date of departure—namely, Saturday evening, June 22, remains unchanged. Circulars giving the completed programme will, we are informed, be issued immediately after Whitsuntide.

**Personal.**—The King of Denmark has recently conferred upon Mr. J. Denison-Pender, managing director of the Eastern Telegraph Co., the decoration of Knight Commander of the Order of the Dannebrog, and upon Mr. F. E. Hesse, manager and secretary of the Eastern Extension Telegraph Co., and Mr. W. Hibberdine, traffic accountant to the Eastern and Associated Companies, the decoration of Knights of that order.

**Obituary.**—We regret to announce the death of Mr. Arthur H. Roe, the borough electrical engineer of Bury St. Edmunds. He was for some time assistant engineer at Bradford, and he supervised the erection of the plant at Bury St. Edmunds. He died on Friday last, in his 29th year.——Admiral Sir John E. Commerell, who died on Tuesday last, assisted, while in command of the "Terrible," in laying the Atlantic cable in 1866, a service which was rewarded by a civil C.B.

**Pan-American Exhibition.**—The centre-piece of the exhibition is a tower 409ft. high and 80ft. square. At night the exterior is studded with 40,000 incandescent lamps, and a 80in. projector is placed at a height of 360ft. From a niche in the tower 70ft. high 13,000 gallons of water per minute are poured in the form of an immense screen. In the basin below are 68 large pillar jets, and under the water are 94 searchlights. The exhibition takes 5,000 H.P. from Niagara.

**Paris Exhibition Literature.**—The sixth part that has appeared of MM. Hospitalier and Montpellier's "L'Electricité à l'Exposition de 1900" (Paris: Vve. Ch. Dunod) is rendered the more interesting by the fact that it is devoted to exhibits which were not among the most prominent. The volume is devoted to "Electrothermie," and deals in a thorough manner with electric heating appliances and electric furnaces. It is written by MM. J. A. Montpellier, A. Bainville, and A. Brochet.

**Wireless Telegraphy.**—A deputation, introduced by Mr. Henniker Heaton and Sir John Leng, waited on Tuesday on the First Lord of the Admiralty, the Earl of Selborne. The deputation consisted of Mr. Marconi and the directors of the Marconi Wireless Telegraph Co. Mr. Marconi explained his syntonic system. "He had already worked out four separate tunes, and," says the *Dundee Advertiser*, "the number could be increased with an increase of electric energy." Lord Selborne put several questions as to the risk of interference if a number of different companies worked different systems.

The Beaver liner "Lake Champlain" has been fitted with Marconi apparatus. She started from the Mersey on Tuesday and it was intended to make a series of experiments whilst she was passing Holyhead, Crookhaven and the southern Irish ports.

**Cable Communications Committee.**—At last week's meeting of this Committee evidence was accepted from Mr. J. Henniker Heaton, M.P., and Lieut. Carlyon Bellairs, R.N. The Committee notify that if any person not yet communicated with desires to be heard by the Committee, he should apply to the secretary, Cable Communications Committee, Treasury, S.W. Every application must be accompanied by a memorandum stating the points upon which the witness proposes to give evidence. This Committee met on Wednesday, when evidence was given by Mr. R. Kaye Gray (of the India Rubber, Gutta Percha and Telegraph Works Co.).

**The Institution of Junior Engineers.**—On Monday evening the members of this Institution paid a visit to the works of the Renewable Electric Lamp Co. In addition to the renewing of old lamps by the introduction of a new filament, the company are manufacturers of incandescent lamps, the filament being prepared in a special way. In the renewal process the bulb is re-opened, the old filament is detached and a new one inserted, thus avoiding the waste of the bulb, the cap, the platinum, leading-in wires, &c. In the glass-blowing room, where the bulbs are expanded and the filaments inserted, both the Ediswan and the American methods were shown.

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**The British Fire Prevention Committee.**—A new testing station was opened by this committee, on Wednesday last, at Westbourne Lodge, 66, Porchester-road, Bayswater. The work carried out by this committee is of great value to electricians and others, in the determination of the fire-resisting properties of materials. It is satisfactory to notice that this work is progressing at a rate necessitating the opening of a new station. From the number of stations opened by this committee it has been suggested with malicious humour that possibly it is necessary to burn down an entire station in order to carry out each fire test, a suggestion that is reminiscent of Charles Lamb and his roast pig.

**A Feeder System for Express Traffic.**—A demonstration has just taken place on the Palatinate (Bavaria) railways of a means of communication between suburban localities and the stations at which the express train stops. The first two trial sections were between Ludwigshaven and Neustadt (30km.), and between Ludwigshaven and Worms (22km.). The system of traction in use is the storage battery method, there being four long coaches, each of which can travel separately or combined in a train, with trailer cars when necessary. The weight of each car, with a full complement of passengers, is 53 tons, of which 15 tons represents the weight of the storage batteries. The normal speed of the cars is 45km. per hour, and 24 journeys are accomplished daily over a distance of 440km. In addition to the above-mentioned lines, the cars are employed on other routes. It is understood that this feeder service, which has been found to work out at a less operating expense per car mile than if steam locomotives had been employed, has stimulated the traffic to and from the suburban stations.

**An Electrical Museum.**—The following circular has been issued to members by the Secretary of the Institution of Electrical Engineers :—

The Council has under consideration the formation of a museum containing objects or apparatus, not now in commercial use, possessing interest in connection with electrical science and its application.

Many members, no doubt, have in their possession apparatus or specimens of the types required, and there is considerable danger that, in the course of time they may become dispersed and entirely lost sight of, unless steps be taken to guard against such a contingency. Further, there is a tendency to destroy or otherwise dispose of obsolete apparatus for want of storage room.

To prevent the irretrievable loss to the profession of the many objects of historical interest that are still in existence, the Council invites members and their friends to co-operate either in the collection or in the tabulation of such apparatus as may be available. To facilitate this work two schedules are enclosed ; one (*a*) on which entries should be made of apparatus offered to the Institution ; and one (*b*) on which it is desirable that information should be given of collections which the owners still desire to retain, but which are of sufficient interest to justify their being tabulated and recorded in the archives of the Institution.

Extra copies of these schedules can be obtained on application.

The authorities at the South Kensington Museum have been good enough to promise to receive such of the objects as may appear to them to be of sufficient public interest as a loan collection from the Institution until the Institution is in a position to exhibit them in a home of its own.

It is particularly requested that objects offered to the Institution should not be forwarded until intimation is sent that the Council is in a position to receive them.

**Submarine Signalling.**—Further details of the method of submarine signalling described in *The Electrician* for April 26th, are given in a recent number of the *Electrical World*. The system is the invention of Mr. A. J. Mundy, of the Gray Telephone Co., and consists in having two bells placed at equal distances from the entrance of a harbour, which are rung by cable connection at precisely the same instant. The bells have different pitches, so it is possible to know on the ship by the sound first heard which direction to steer. The correct position for entering the harbour is when the two bells are heard simultaneously. The picking up of submarine sounds is equally effective. Messrs. Gray and Mundy experimented with a great variety of receivers operated pneumatically, electrically and mechanically. The simplest mode of hearing such submerged bell signals on board ship is to go below into the hold of the vessel, as close to the keel as possible, without any apparatus whatever, and simply listen. A common tin ear-trumpet, screwed on to the end of a piece of gas pipe, the mouth of the trumpet being sealed by a tin diaphragm, and submerged 6ft. under water, enables the observer, at the upper end of the pipe, to hear the submerged bell at a distance of 3 miles. For greater distances an electrical receiver has been devised by means of which the bell has been heard distinctly a distance of 12 miles. The submerged end of this receiver may be lowered over the side of the ship, or attached to it on either side of the bow, under the water line, like a pair of ears. The submerged portion of the receiver is connected by wires to a telephone receiver, which may be carried to any part of the ship. Prof. Gray, before his death, devised an improvement for the electrical receiver by means of which a large gong will be rung automatically on the ship whenever the submerged bell is rung. That is to say, the gong rings sympathetically, following the bell, stroke by stroke.

**Calcium Carbide as a Reducing Agent.**—In the issues of the *Zeitschrift für Electrochemie* for April 11th and 25th, Fr. v. Kügelgen gives the results obtained in a series of experiments relating to the use of calcium carbide as a reducing agent in metallurgy. The metals dealt with in these investigations were lead, bismuth, chromium, molybdenum, tungsten, manganese, nickel, sodium, potassium, aluminium and cerium. The reduction of the oxide or of the chloride to the metallic state was possible in most cases. The action of the carbide was greatest in the case of the chlorides, and in these instances, when the reduction was started, sufficient heat was generated to carry it forward without external heating. With the oxides this was not the case. Reductions made by using mixtures of the oxides and chlorides of the metals also gave very favourable results. It was found that carbides of the reduced metals were only formed in those cases in which the temperature of the reduction approached that required for carbide formation ; but metals more free from carbide could be obtained by the new method of reduction than by the old method with carbon, for the temperature in all cases was lower. As regards the presence of calcium in the reduced metal, it was found that this depended upon the excess of calcium carbide used in effecting the reduction, and that it could be reduced to a minimum by using only the amount of carbide demanded by theory. The new reducing agent is considered to be one that will be useful in laboratory work, since it can be used for blowpipe reductions and also in certain assays, as, for instance, that of tin by the Winkler method. Calcium carbide cannot, however, be used in this way with sulphide ores, as these demand a very high reducing temperature. As regards the use of calcium carbide for reducing purposes in metallurgical works, it is stated that under ordinary conditions 202kg. carbide should yield 1,000kg. (1 ton) copper, and other metals in equivalent proportions. At the present prices the economic reduction of copper ores by means of carbide is not feasible ; but the application of the method to the production of nickel and bismuth ought to prove remunerative. Modifications of the method may also yield good results, the addition of charcoal or of aluminium to the carbide being practicable where oxides are being dealt with of low or high refractoriness. The new reagent is, however, likely to find its widest field of application in the production of alloys, for by using a mixture of the oxide and chloride of the metals desired it is possible in one operation to produce alloys which are difficult to obtain by the ordinary methods of work.

**German Imperial Electrical Standards.**—The German Government has issued the following specification for the preparation of the silver cell in measuring the standard ampere. The ampere itself, it will be remembered, is the same as the British standard, viz., the current depositing 0·001118 grammes of silver per second from an aqueous solution of silver nitrate. The solution is to contain 20 to 40 parts by weight of pure nitrate of silver to 100 parts of distilled water free of chlorine, and it must not be employed after 3 grammes of silver per 100 cubic centimetres of the solution has been deposited electrolytically. The part of the anode within the liquid is to be of pure silver, and the cathode of platinum. If the silver deposited on the latter exceeds 0·1 gramme per square centimetre the silver must be removed. The current density is not to exceed $\frac{1}{3}$th ampere per square centimetre at the anode, and $\frac{1}{50}$th ampere per square centimetre



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at the cathode. Before weighing, the cathode has to be washed with distilled water free of chlorine until the rinsing water shows no cloudiness when a drop of hydrochloric acid is added to it; then it is to remain in distilled water at 70 to 90°C. for ten minutes, and again rinsed in distilled water. This last rinsing water must not show any cloudiness when treated cold with hydrochloric acid. The cathode is then dried in heat, and is kept in a dessicator until it is weighed, and after it has been cooled at least 10 minutes must elapse before the weighing. It addition to the volt, ampere and ohm, the names Ampere-sekunde (ampere-second) and Coulomb, Ampere-stunde (ampere-hour), Watt, Wattstunde (watt-hour), Farad and Henry, and the prefixes kilo, mega and meg, milli and micro are now legalised, as are also the general acceptance of the terms effective, mean, electrolytic, and maximum momentary value of alternating or variable currents, E.M.F.s, or pressures. The limits of error of electricity meters are also now fixed:

I. *Continuous-Current Meters.*—(*a*) Between the maximum load for which the meter is intended and $\frac{1}{10}$th maximum load, the error must not be greater than 0·6 per cent. of the maximum load plus 6 per cent. of the load the meter is carrying at the time, and at loads of $\frac{1}{20}$th full load an error of 2 per cent. of the full load is permissible. In the case of meters on lighting networks, however, these restrictions do not apply to power consumptions below 30 watts.

(*b*) When no electric power is being consumed the meter must not run forward or backward at a rate greater than that corresponding to $\frac{1}{2}$ per cent. of its full load.

II. *Alternating and Polyphase Meters.*—The same conditions apply as for continuous-current meters, with the exception that if there is a difference in phase between the pressure and current used, twice the tangent of the angle of lag is to be added to the percentage error determined under the rule I. (*a*) above, the angle of lag being taken as the angle whose cosine is the power-factor of the circuit.

**Polyphase Working.**—The last of Mr. Eborall's series of four lectures at the Society of Arts on Friday, May 17th, was chiefly devoted to the induction motor, but towards the close of his lecture the design of mains was briefly dealt with. First he considered the relative advantages of holes and slots in the stator stampings of induction motors. Holes are excellent mechanically, but are hard to wind, and they may be troublesome on account of the magnetic leakage over the bridge piece. The latter effect necessitates that the radial depth of this bridge should be diminished as much as possible, and that means that the core has to be machined, instead of the stampings being employed just as they are, as in the case of slotted armatures. As the chief disadvantages of the slot are the difficulty of stamping and its greater magnetic resistance, the balance of advantage is, in Mr. Eborall's opinion, in favour of this form of armature. Rotors, on the other hand, are usually hole-wound. The lecturer gave 5 H.P. as about the limiting size of motors with permanently short-circuited rotors, and sketched the methods of winding the latter. The arrangement of slip-rings and resistances for the larger sizes was not gone into at length. He once again emphasised the importance of reducing magnetic leakage, especially in induction motors. For this reason many slots per pole per phase must be employed in the stator, and this is also necessary to avoid a tendency to synchronism. The old practice of Gramme-wound stators was condemned on account of its inherent magnetic leakage. The following data were added as a guide in the design of induction motors:—Clearance (iron to iron) $\frac{1}{450}$th the diameter of the rotor. Flux densities: In air-gap 30,000 lines per square inch; in stator teeth, 60,000 lines per square inch; in rotor teeth, 80,000 per square inch. Current density in rotor wires, 1,100 to 1,500 amperes per square inch. Peripheral speed, 6,000ft. per second. Ampere-wires per foot in stator, 300 for sizes up to 5 H.P. and 450 up to 100 H.P. These data and the fundamental formula $E = 4{\cdot}4 \times \sim \times S \times N_p \times 10^{-8}$ (S and $N_p$ being the number of turns and the number of lines per pole) form the basis for the design of these machines. Owing to the small clearance, an essential point is that the case be a stiff mechanical job, this being a particular weakness in polyphase traction motors. The efficiencies of polyphase motors are, the lecturer said, a shade lower than continuous-current motors up to 100 H.P., but their weights are about the same. Mr. Eborall then showed the simple vector diagram connecting the various quantities in the case of an induction motor, just as he had done in a previous lecture for generators, and thus led up to the Heyland diagram. Before leaving the subject of motors he pointed to the importance of having the full rated pressure applied at the motor terminals, the torque being proportional to the square of the voltage. Much of the trouble with three-phase motors had been due, he thought, to the absence of this precaution, and to no defect inherent in the motor itself. In conclusion, he pointed out the difficulty of applying the Heyland diagram with accuracy to hole-wound motors on account of the impossibility of estimating accurately the magnetic leakage in these machines; but he thought that hole-wound armatures would soon be quite abandoned. Coming now to systems of transmission, the lecturer explained the three and four-wire transmission and distribution systems for two and three-phase. For long distance transmissions he thought there could be no doubt as to the superiority of three-phase with three-core cables. A point to be observed in the design of the latter was that the distance between the conductors and the sheath should be the same as that between the centres of the conductors. A device which was convenient in some cases of town lighting was to provide a fourth wire to the middle point of the transformers, in cases when these were star wound, to carry the outer-balanced current. The Postmaster-General not being present, Mr. Eborall suggested that an earth-connection each end might take the place of this fourth line. It was, he said, a mistake to say that it was easier to balance two-phase than three-phase; in fact, in three-wire two-phase systems (the use of which in this country he strongly condemned) there was an unbalanced inductive effect between the wires, with the result that a symmetrical two-phase current is not obtained, but two currents differing anything between 80deg. and 90deg. in phase. Another point in favour of three-phase systems for mixed lighting and power was the balancing effect of the motors and the polyphase transformers, and the latter were not used on two-phase systems. As to the question of earthing, on the Continent they did not earth anything, unless, perhaps, they connected the sheathing of the cable to the middle point of the dynamos or transformers. On overhead lines, the trouble was with the insulators and the inductance effect; with underground cables the chief disadvantages were the Board of Trade and the capacity effect. The leading currents caused by the latter were rather an advantage, compensating the lagging currents taken by the motors, but danger arose in the event of the circuit being suddenly broken, as by a cut-out acting, when the capacity effect might cause the voltage to rise enormously. This was provided for by devices similar to lightning protectors, of which the Siemens and Halske horn type was as simple and efficient as any. Prof. Perry, who had occupied the chair during all four lectures, then proposed a vote of thanks to Mr. Eborall in very eulogistic terms, and the vote was carried by acclamation.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), May 24th.**

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. R. T. Glazebrook. Subject: "The Aims of the National Physical Laboratory."

**THURSDAY, May 30th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Annual General Meeting at the Society of Arts. The announcement of the election of the new council will be made at this meeting.

**FRIDAY, May 31st.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On a Model which Imitates the Behaviour of Dielectrics," by Prof. J. A. Fleming, F.R.S., and A. W. Ashton. (2) "On the Resistance of Dielectrics and the Effect of an Alternating Electromotive Force on the Insulating Properties of Indiarubber," by A. W. Ashton. (3) "Note on the Electrification of Dielectrics by Mechanical Means," by A. W. Ashton.

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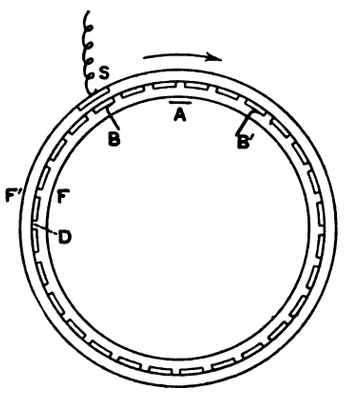
## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Open Currents.*—V. Crémieu has already shown that electric convection produces no magnetic field. It follows that "open currents" must exist, and he demonstrates their existence as follows:—On an ebonite disc D, 37cm. in diameter and 2·5mm. thick, 25 segments are gilt. The disc turns about a central axis between two fixed ebonite discs F and F'. The disc F' bears a tinfoil armature S twice as broad as the moving armatures. Two brushes, B, B', 60deg. apart, are in contact with the moving armatures. When S is charged, the armature in contact with B acquires an induced charge, which passes on to B', where it is discharged. If B and B' are connected there will be electric convection between them on the one hand and electric conduction on the other. At A is




placed one needle of an astatic system. If B and B' are joined through a galvanometer, the latter shows a deflection while A does not. If B and B' are joined through a coil placed near the lower needle of the astatic pair, a deflection of A is observed as soon as S is charged, and varying in direction with the sign of the charge. The current circulating in BB'B is therefore an open current.

[V. Crémieu, *Comptes Rendus*, May 6, 1901.]

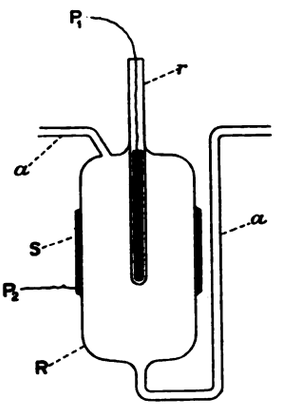
*Aluminium as an Electrode.*—A. Bartorelli has continued his researches on the electrode properties of aluminium, with special reference to their use as "valves" for rectifying alternate currents. The fact that the transition resistance of the electrode as an anode is inversely proportional to the sectional area of the electrode, shows that the resistance is confined to the contact surface between metal and liquid. The resistance decreases gradually as the density of the current increases, and this the author attributes to some transformation of the non-conducting layer which may be of either a physical or a chemical nature. As regards the question whether the one-sided resistance of an aluminium anode is due to true resistance or polarisation, the author believes that for small E.M.F.'s we have a true resistance effect, and for large E.M.F.'s a polarisation effect.

[A. Bartorelli, *Phys. Zeitschr.*, May 11, 1901].

*Longitudinal Thermo-Magnetic Effect.*—Let a circuit consist partly of bismuth and partly of other metals. Let the latter be traversed by a current of heat in a certain direction, and let it be immersed in a magnetic field whose lines of force are at right angles to the heat current. Then the E.M.F. of the circuit depends upon the strength of the magnetic field. This effect was discovered by Ettinghausen and Nernst in the year 1886. L. Lownds has devoted some work to discovering in what way the effect depends upon the strength of the magnetic field. He finds that when one junction is kept at a temperature of −120deg., the effect attains a maximum at a field intensity of 2,450 units and then decreases with increasing field, probably becoming negative at a certain strength. This is remarkable in the face of Yamaguchi's result that the transverse thermo-magnetic effect continues to increase with the field, even at the lowest temperatures attained. Both the longitudinal effect and the change of resistance may be represented by the same formula, except at low temperatures, where the longitudinal effect changes sign.

[L. Lownds, *Ann. der Physik*, No. 4, 1901.]

*Nitrogen and Tesla Currents.*—A strange phenomenon in connection with the behaviour of nitrogen when exposed to the influence of Tesla currents has been observed by H. Kauffmann and B. Hell. The apparatus used was of the kind shown in the diagram. A wide glass tube R, with inlets and outlets *aa*, has a narrow tube, *r*, along its axis, containing a column of mercury a few centimetres long. The mercury is joined to one electrode of a Tesla coil through $P_1$, and the external tin coating S is joined to the other pole by means of $P_2$. A portion of the coating S is removed in order to show the interior of the tube. On working the Tesla coil, a blue fluted light appears in the wide tube, accompanied by a green fluorescence of the glass walls. On stopping the current of nitrogen, the blue light gives way to pink sparks and pink light, and the green fluorescence also disappears. On making the gas stream again, the blue and green lights once more displace the red. The difference is not observed when the




nitrogen is purified over glowing copper, only the pink light being seen then. The green fluorescence appears to be generated wherever the blue rays impinge upon the glass, just as if these were cathode rays.

[Kauffmann and Hell, *Phys. Zeitschr.*, May 11, 1901.]

*Induction in an Open Circuit.*—J. Kœnigsberger reports the results of some experiments made to demonstrate, if possible, the existence of the displacement current induced in a circuit consisting partly or wholly of dielectric material when either the conducting or the non-conducting part of it is placed in a varying magnetic field. For the first case a solenoid of 2,040 turns of fine copper wire was brought between the poles of a strong electromagnet. One of the ends of the solenoid was put to earth, while the other was connected with one pair of quadrants of a Thomson electrometer. On exciting the magnet a deflection was observed corresponding to a potential integral of 4·7 volts. It appears that this induced potential is directly proportional to the field intensity, and to the number and sectional area of the coils. This gives, incidentally, a new means of measuring magnetic fields. The potential is independent of the capacity and resistance of the open circuit. The experiments in connection with the other alternative are of much greater difficulty. If in two paraffin rings the dielectric polarisation were to change rapidly in a tangential direction those rings would attract each other like two conducting circuits. The great mass necessary for a crucial test at present excludes an actual experiment, but results could be hoped for from an ordinary open circuit containing a small portion of dielectric immersed in a magnetic field. The author has not had an opportunity of making the test. The effect would be very small in any case. The author points out that if a vacuum is traversed by a displacement current, a finite amount of work must be performed, or otherwise no induction effect of finite electromagnetic energy can take place. The latter alternative is the more probable, since a ray of light in air is not influenced by a change of the magnetic field.

[J. Kœnigsberger, *Phys. Zeitschr.*, May 11, 1901.]

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## THE PARIS EXHIBITION.—XIX.*

(BY OUR SPECIAL CORRESPONDENT.)

The Rieder process of electric etching, described in *The Electrician*, Vol. XLIV., p. 404, was exhibited in operation. The apparatus, shown in Fig. 123, has undergone some slight modifications and improvements. Briefly, the process consists of applying a plaster mould of the object to be reproduced to the steel plate on which it is to be etched, the matrix being the cathode and the metal plate the anode. As the steel surface of the plate is gradually eaten away into the shape of the mould, the latter has to be removed frequently in order to wash away the unattacked constituents of the steel, and this gives rise to certain difficulties which have gradually been overcome. The plaster mould, fastened in a cast-iron frame, rests on a vertically-moving table, which is put into motion by an excentric. Above this is a frame, adjustable in its entire height, for the metal to be etched. A special contrivance is added to secure parallelism between the plates. Behind the table is a carriage with a revolving brush, also

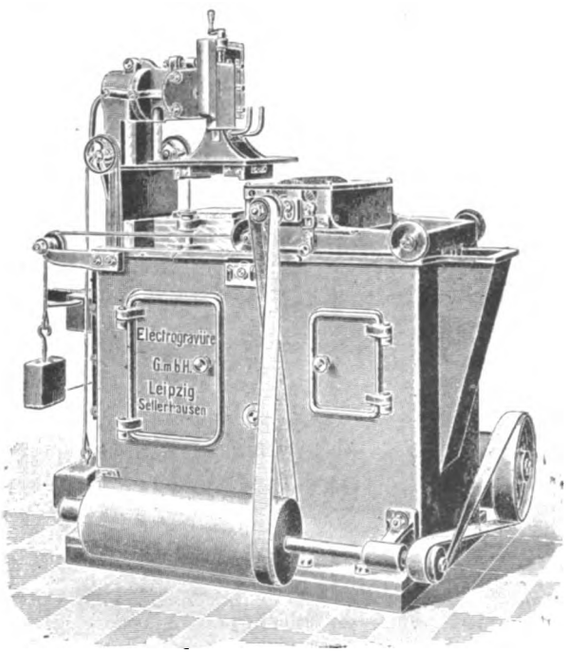


FIG. 123.—RIEDER ELECTROLYTIC ETCHING APPARATUS.

driven by an excentric, which passes between the mould and the steel, and brushing the latter. This brush is supplied with water from a perforated pipe, and besides this, a sponge roller passes over the mould, supplying fresh electrolyte to it and distributing the electrolyte which comes to the surface on the removal of the plate. Such a contrivance is necessary, as the electrolytic process in the porous mould does not take the same course as in a free electrolyte. The brush removes the chloride of iron, which in any ordinary cell would enter into solution, the iron being deposited on the cathode, chlorine freed, and the electrolyte renewed. To prevent the electrolyte from becoming alkaline continuous additions of hydrochloric acid are made, causing the fresh formation of chloride of ammonium on the upper surface of the mould.

The sequence of operations is as follows:—The mould is laid on the steel plate by means of the movable table, and this contact is accomplished elastically and without shock. The mould now remains for about 15sec. in contract with the plate, is withdrawn, and the cleaning process already described takes place. After the withdrawal of the cleaning carriage the mould is replaced, and the whole process is repeated.

A potential difference of from 12 to 15 volts is employed. The current varies, of course, with the extent of surface momentarily in contact, and with plates of 200mm. by 300mm., as those of the above machine, may rise to 50 amperes if the whole surface is being etched.

Among miscellaneous exhibits may be mentioned a small rotatory converter for reducing the pressure of supply mains for medical purposes or for charging small accumulators. This little machine, already alluded to in *The Electrician* on a previous occasion, is illustrated in Fig. 124, and several were running at M. Legros' exhibit. Its chief recommendation is its compactness and light weight—a machine with an output of 100 watts at 2 to 16 volts, and for a primary voltage of 100 volts weighing but 21 lbs. The efficiency is low—some 50 per cent.—but this is unimportant in view of the small amount of energy required altogether, and the great loss in the method frequently adopted of merely reducing the voltage of the mains by a rheostat. The price, however, is higher than it should be, taking into account that a low efficiency only is required, and there should be room for improvement in this direction, for the demand should be sufficient to enable a standardisation of the apparatus and manufacture in quantity. Originally the machine consisted of an ordinary shunt motor, with a shuttle-wound armature added for the generator winding. Now, however, the makers find it quite sufficient—and, of course, cheaper—to employ a single drum armature, one of whose coils is of thicker copper than the other, and is connected to the two-part low-pressure commutator. The speed of the motor is 2,400 revs. per min., and the current proves quite continuous enough to charge accumulators. For cautery the current would also be quite suitable, but the frequency must be too low for delicate direct local applications of continuous current.

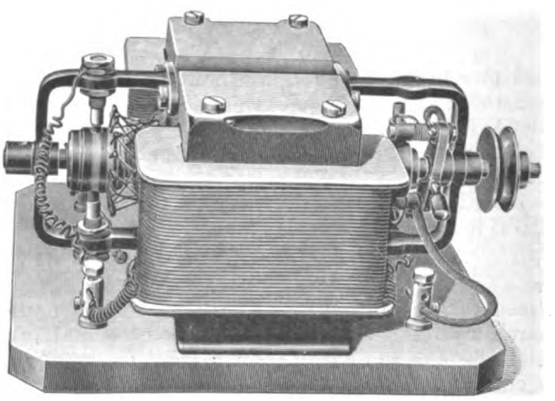

FIG. 124.—LEGROS-MEYNIER CONTINUOUS-CURRENT ROTATORY CONVERTER.

In concluding these notes a few words may be devoted to the Vincennes annexe of the exhibition. This part, owing to its distance—about 6 miles—from the main body of the exhibition, the extreme lateness at which it was completed, and the difficulty of reaching it until the opening of the Metropolitain line towards the end of July, was undoubtedly a failure. It was here that the greater part of the electric traction section had been banished to, but with one or two exceptions this important branch of the electrical industry was poorly represented. Among the novelties were the electrically-driven trolley-omnibus, which, although it appeared on the scene before the close of the exhibition, did not seem to be taken quite seriously as a possible profit-earning system of transport, a full sized model of the Elberfeld-Barmen single-rail system and car, and one of the enormous accumulator motor-car carriages which are employed on the Milan-Monza railway in Italy.

The latter are standard gauge carriages (Fig. 125) resting on two bogies, and designed to carry 90 passengers, 64 of whom are seated. Each bogie has one 75kw. motor. The battery is composed of 130 cells in series, which can be divided into two parallel sets if necessary, and it has a capacity of about 80 kilowatt hours. Each cell contains 11 Planté positive plates and 12 negatives of the Hagen make. The run from Milan to Monza is only 13km., and the cells are charged after four journeys. The cells are of ebonite, and in groups of five in wooden boxes. They are held in place by bolts sliding into

* Previous articles appeared in *The Electrician* of July 20 and 27; Aug. 3, 24 and 31; Sept. 14 and 28; Oct. 5, 12 and 26; Nov. 2, 16 and 30, 1900; Jan. 18, Feb. 1, April 12, May 3 and 17, 1901.

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ebonite sockets. The wooden boxes rest on iron trays, which facilitate their withdrawal, but the cells are charged in position from two charging terminals outside. Travelling at 60km. an hour, the normal discharge current is about 400 amperes, and the cells are intended for a maximum of about 500 amperes. The following additional data are interesting:—

| | | |
|---|---|---|
| Length from buffer to buffer | 18·50 | metres |
| „ of the car body | 17·80 | „ |
| Width „ „ | 2·85 | „ |
| Wheel base of each bogie | 2·63 | „ |
| Distance between centres of bogies | 14·63 | „ |
| Weight of the empty car without battery | 34 | tons. |
| „ of the battery | 20 | „ |
| „ of the electrical equipment | 4 | „ |
| „ of 90 passengers, say | 6 | „ |
| Total weight | 64 | tons. |

Electrical automobiles were in the minority at the exhibition. Such as were shown were chiefly of American and German manufacture, some of the former especially being of neat design. Accurate data as to the capabilities of the batteries in them and figures relating to absolute trials were difficult to obtain.

In the railway section, the system of electro-pneumatic signals exhibited by the Westinghouse Brake Co. attracted considerable attention. In this system the signals are worked by compressed air, the valves of the air-motors, however, being controlled by electromagnets and placed near the points to be moved, so that the connection to the signal box is merely by wires. The electromagnets have resistances of 130 ohms, and take about $\frac{1}{10}$ of an ampere. The various details and the interlocking arrangements were extremely ingenious, and the whole seemed to combine strength with a workmanlike finish that is not always apparent in electrical appliances for ordinary

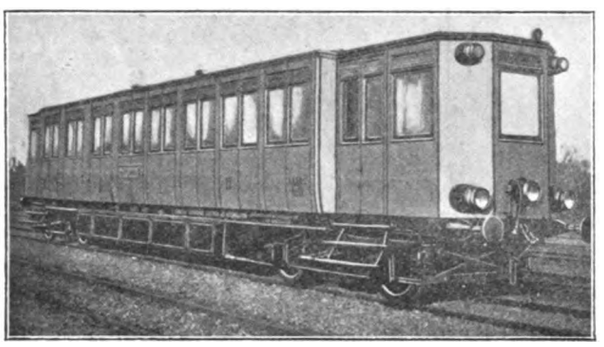

FIG. 125.—ACCUMULATOR MOTOR CAR USED ON MILAN-MONZA RAILWAY.

railway working. Although the system seems pre-eminently suitable for automatic signalling, and has been successfully applied to it, no exhibit of this was included.

At Vincennes a pavilion was also devoted to a kindred and rival industry—acetylene lighting, which, it appears, has made considerably more progress in France than in this country. One French firm has erected no less than five acetylene town-lighting plants, one of which, at Mouzon, has been in operation for three years, another at La Clayette for two years, and a third at La Courneuve for one year. The last-mentioned includes 14½km. of mains, the others being on a somewhat smaller scale.

In the course of this series of articles I have been unable to acknowledge separately and by name all the assistance given and courtesy shown to me by the representatives of the various firms exhibiting. To these I would now tender my best thanks, and also to many manufacturers who have supplied drawings and photographs for illustrating these articles.

**The Rowland System of Multiple Telegraphy.**—The Berlin correspondent of the *Standard* announces that the German telegraph administration has allowed a wire between Berlin and Hamburg to be used for experiments with the Rowland multiple telegraph system. This system, it will be remembered, was exhibited at the Paris Exhibition and was described in Mr. Gavey's recent Institution Paper.

## THE INFLUENCE OF A NON-INDUCTIVE RESISTANCE ON THE OSCILLATORY DISCHARGE OF A CONDENSER.

BY T. MIZUNO.

A discharge current from a condenser of the capacity C through a given inductive circuit having the resistance R and the coefficient of self-induction L is, as well known, given by the differential equation

$$\frac{d^2i}{dt^2}+\frac{R}{L}\frac{di}{dt}+\frac{i}{LC}=0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the value of the discharge current at any time $t$ is

$$i=\frac{Q}{LC\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}}e^{-\frac{R}{2L}t}\sin\left[\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}\cdot t\right], \quad (2)$$

where Q is the initial charge of the condenser, provided the inequality

$$R^2<4L/C \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

holds true.

Now, in my Paper, "Über den Einfluss eines Selbstinductionslosen Widerstandes auf die Oscillatorische Condensatorentladung,"* I have proved that if a non-inductive resistance

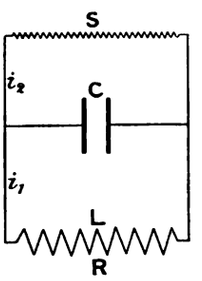


FIG. 1.

S be added in parallel to the circuit as shown in the annexed figure (Fig. 1), the differential equation for the current $i_1$ in the inductive circuit will become

$$\frac{d^2i_1}{dt^2}+\frac{R'}{L}\frac{di_1}{dt}+\frac{i_1}{LC'}=0, \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where

$$R'=R+\frac{L}{SC}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and

$$C'=C\frac{S}{R+S}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and consequently that so long as the inequality $R'^2<4L/C'$,

*i.e.*,

$$EC^2S^2+2LRCS>L^2, \quad . \quad . \quad . \quad . \quad (7)$$

where

$$E=\frac{4L}{C}-R^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

holds good, the discharge current in the inductive circuit will be still oscillatory, and its value will be given by the equation

$$i_1=\frac{Q'}{LC'\sqrt{\frac{1}{LC'}-\frac{R'^2}{4L^2}}}e^{-\frac{R'}{2L}t}\sin\left[\sqrt{\frac{1}{LC'}-\frac{R'^2}{4L^2}}\cdot t\right], \quad (9)$$

where

$$Q'=Q\frac{C'}{C}.$$

So far, the theory is given in the above cited paper, and the following forms a further extension of the theory.

Let us consider the period of electric oscillations of the inductive circuit shunted with the non-inductive resistance.

* T. Mizuno, *Ann. d. Phys*, 4, p. 811, 1901.

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The period, T, say, is evidently given by the following expression

$$T=\frac{2\pi}{\sqrt{\frac{1}{LC}-\frac{R'^2}{4L^2}}}=\frac{2\pi}{\sqrt{\frac{1}{L\frac{CS}{R+S}}-\frac{1}{4L^2}\left(R+\frac{L}{CS}\right)^2}} \quad (10)$$

Denoting the frequency of the oscillations by $n$, we have

$$n=\frac{1}{2\pi}\sqrt{\frac{1}{L\frac{CS}{R+S}}-\frac{1}{4L^2}\left(R+\frac{L}{CS}\right)^2}. \quad . \quad . \quad (11)$$

Squaring this, we get

$$n^2=\frac{1}{4\pi^2}\left\{\frac{R+S}{LCS}-\frac{1}{4L^2}\left(R^2+\frac{2RL}{CS}+\frac{L^2}{C^2S^2}\right)\right\}$$

$$=\frac{1}{16\pi^2}\left\{\frac{1}{L^2}\left(\frac{4L}{C}-R^2\right)+\frac{2R}{LCS}-\frac{1}{C^2S^2}\right\}. \quad (12)$$

This expression for the square of frequency is a function of the non-inductive resistance S. Differentiating (12) with respect to S, we obtain

$$\frac{dn^2}{dS}=\frac{1}{16\pi^2}\left\{-\frac{2R}{LCS^2}+\frac{2}{C^2S^3}\right\}=\frac{1}{8\pi^2C}\left(\frac{L-RCS}{LCS^3}\right). \quad (13)$$

Therefore, we see that

(i.) $dn^2/dS$ is positive when $S<L/CR$, . . (14)

(ii.) $dn^2/dS$ is negative when $S>L/CR$. . . (15)

Now the critical value of S at which the electric oscillations in the inductive circuit will just cease is given by the equation

$$EC^2S^2+2LRCS-L^2=0. \quad . \quad . \quad . \quad (16)$$

Solving for S we get

$$S=-\frac{RL}{EC}\pm\frac{\sqrt{R^2L^2+EL^2}}{EC}. \quad . \quad . \quad . \quad (17)$$

But S being the resistance, its value must be always positive, and therefore we must take the upper sign of the square roots. Hence, we have

$$S=\frac{\sqrt{R^2L^2+EL^2}-RL}{EC}=\frac{L}{EC}\left(\sqrt{R^2+E}-R\right)=S_{T=\infty}, \text{ say. (18).}$$

In the above, we have seen that when $S<L/CR$, the differential coefficient $dn^2/dS$ is positive. Hence, a question arises whether this limiting value of S, namely, L/CR, is greater or less than the critical value of S, *i.e.*, $S_{T=\infty}$ given by the equation (18). Now,

$$S_{T=\infty}<L/CR.$$

For, if this be the case, we must have

$$\frac{L}{EC}\left(\sqrt{R^2+E}-R\right)<\frac{L}{CR},$$

*i.e.*, $$R^2(R^2+E)<(R^2+E)^2,$$

*i.e.*, $$R^2<2R^2+E. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

This inequality is evidently true, because E is a positive quantity by the supposition. Therefore,

$$S_{T=\infty}<L/CR.$$

Again, differentiating the equation (13) once more with respect to S, we get

$$\frac{d^2n^2}{dS^2}=\frac{1}{8\pi^2C}\left(-\frac{3}{CS^4}+\frac{2R}{LS^3}\right)=\frac{1}{8\pi^2C}\left(\frac{2CRS-3L}{LCS^4}\right). \quad (20)$$

Equating the left-hand member of the equation (13) to zero, we obtain

$$L-RCS=0,$$

*i.e.*, $$S=L/RC. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

Putting this value of S in the equation (20), we find that

$$\frac{d^2n^2}{dS^2}=-\frac{C^2}{8\pi^2}\cdot\frac{R^4}{L^4}.$$

Hence, the value of S given by the above equation (21) makes $n^2$, and, consequently, the frequency $n$ a maximum, and these maximum values of $n^2$ and $n$ are respectively given by the following equations

$$n^2_{max.}=\frac{1}{16\pi^2}\left(\frac{E+R^2}{L^2}\right), \quad . \quad . \quad . \quad (22)$$

and

$$n_{max.}=\frac{1}{2\pi}\cdot\frac{\sqrt{E+R^2}}{2L}. \quad . \quad . \quad . \quad (23)$$

Now, it is very interesting to observe that the frequency $n_0$, say, of the inductive circuit in absence of the non-inductive resistance is

$$n_0=\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}=\frac{1}{2\pi}\cdot\frac{1}{2L}\sqrt{\frac{4L}{C}-R^2}=\frac{1}{2\pi}\cdot\frac{\sqrt{E}}{2L}. \quad (24)$$

Therefore, the ratio of the maximum frequency of the oscillations of the inductive circuit with, to the given frequency without, the non-inductive circuit is

$$\frac{n_{max.}}{n_0}=\frac{\sqrt{E+R^2}}{\sqrt{E}}=\sqrt{1+\frac{R^2}{E}}, \quad . \quad . \quad . \quad (25)$$

where

$$E=\frac{4L}{C}-R^2.$$

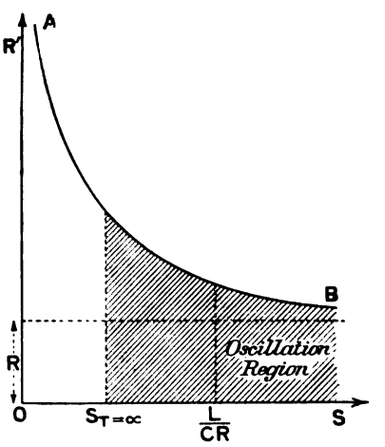


FIG. 2.

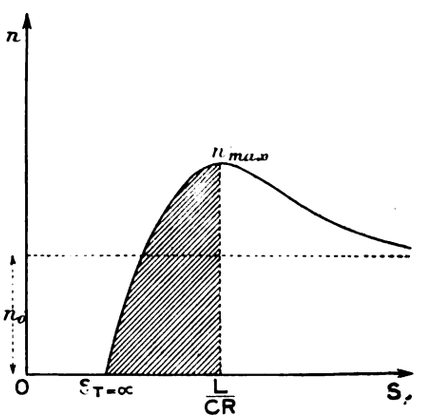


FIG. 3.

Next, let us consider the effective resistance of the inductive circuit. As we have already seen, the value of this resistance is

$$R'=R+\frac{L}{SC}.$$

Being considered as the function of the non-inductive resistance S, this effective resistance R' is represented by an equilateral hyperbola AB (Fig. 2). The resistance R' diminishes as S increases, and finally approaches asymptotically to the limiting value R, when S becomes infinite.

So long as the value of S remains greater than its critical value $S_{T=\infty}$, electric oscillations always takes place in the inductive circuit. In Fig. 2, the shaded portion indicates the oscillation region of S and R'.

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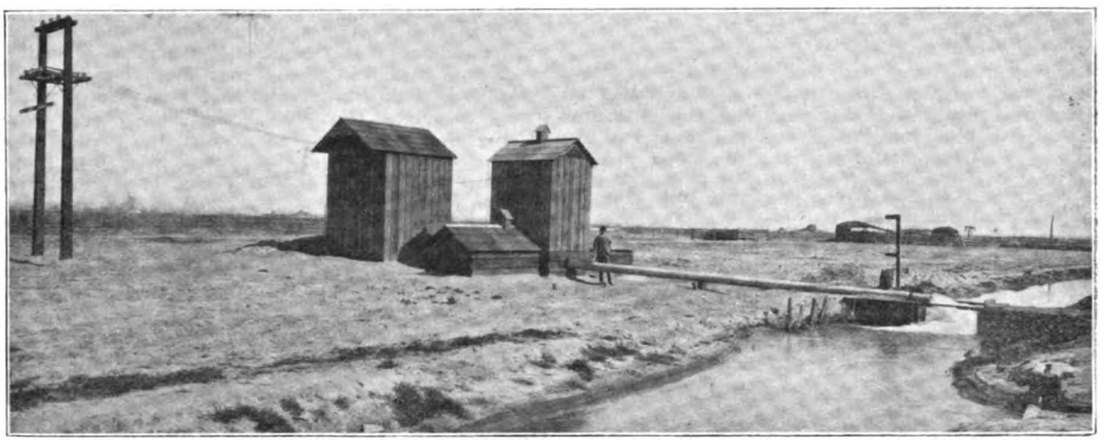
The damping of oscillations expressed by R′ naturally increases as S diminishes. Again, the frequency $n$ of oscillations, also given as a function of S by the equation (11), may be represented by a curve of the form as shown in Fig. 8. As S increases from $S_{T=\infty}$ up to L/CR, the frequency $n$ increases and attains the maximum value $n_{max}$.

With the further increase of S, $n$ diminishes and finally takes the value $n_0$ when S becomes infinite.

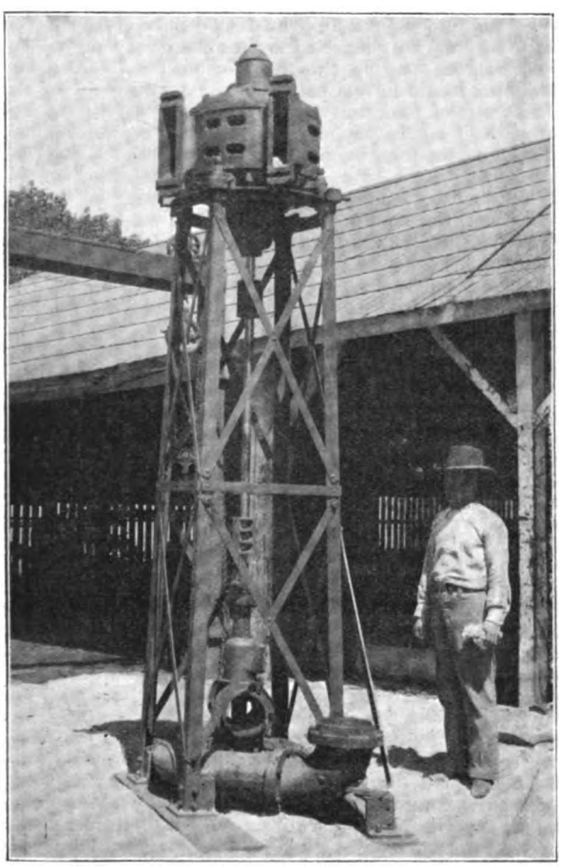
In the shaded region, we can therefore assign any required low value of frequency to the oscillating inductive circuit by properly choosing the value of the non-inductive resistance S.

## IRRIGATION PUMPING IN CALIFORNIA.

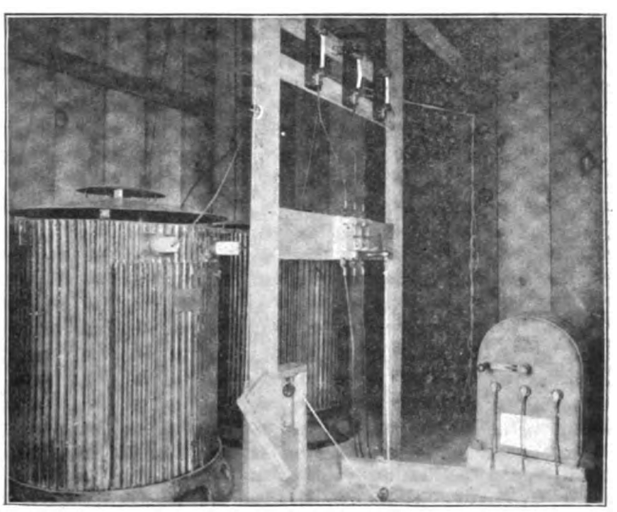
The *Electrical World* of New York for April 6 describes the electrical installation at Bakersfield, California, for irrigating a large tract of land in the Kern Valley, where there is no surface water for a large portion of the year, but a plentiful undercurrent, which can be reached by wells 60ft. deep. The power station is 13 miles off, and contains at present two 450kw. three-phase 500 volt General Electric Co.'s dynamos, driven by Knight waterwheels operating under a 200ft. head, whilst a third unit is now being installed. Each waterwheel has two governors: one acts in the ordinary way, the other consists of a dynamometer in the shaft between the waterwheel and the generator. As the load comes on the pull on the dynamometer increases, and the governor acts so that more water is turned on. The power is transmitted over two lines at 10,000 volts, and there are no fuses at the station. Each pumping station contains two step-down transformers, usually 15kw., reducing to 500 volts, and a 30 H.P. to 40 H.P. induction motor. Double-break switches are placed on the terminal poles, the moving part of the switch carrying a 36in. fuse of No. 28 copper wire, enclosed in a hard rubber tube. The switch is operated by ropes from the transformer house. The automatic arrangement on the motor-starting switch for cutting off the current is operated by the failure of the water pressure, and not by stoppage of the current in the ordinary way; this is to prevent the switch operating due to a momentary short circuit on the line. To enable the centrifugal pumps to be placed as near the water line as possible the vertical shaft type have been used, and the motors have been placed above the ground, and the pumps 10ft. to 20ft. under ground. The wheel of the pump is a solid casting with ports. The suction pipe enters at the top, and the runner is so close to the bottom of the pump and so close fitting in the chamber in which it runs (although it does not touch) that when the pump is running the suction and pressure act to entirely take the weight of the shaft, runner and armature, so that practically no weight comes on the thrust bearing. The thrust bearing is at the top of the shaft on the motor. The oiling devices for the bearings are ingenious. The motor has a hollow shaft, and as the oil runs through the bearing into a receptacle



One of the Pumping Stations.



Motor and Pump before Installation.



Interior of Transformer House.

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below the motor, it is picked up by a scoop on the shaft and forced by virtue of the speed of the scoop up through the shaft and into the bearing again. The iron frame work of the motor-pump combination is braced firmly by timbers in the pit, and the pumps run with practically no vibration.

It is found that a 30 H.P. motor will pump enough water to irrigate about 1 square mile of land. The average total lift of water from the well to the surface is about 25ft. The pumps raise from 3½ to 5 cubic ft. of water per second, depending on the lift. The discharge pipe is 10in. galvanised steel. In each pump pit is a small piston pump, which can be belted to the motor shaft for priming the centrifugal pump when it is necessary. In operation one man looks after 10 wells, and two other men attend to eight each. The pumps are run continuously, except when some of them have to be stopped on account of shortage of power. Each pump is visited by an attendant twice a day. A telephone circuit is run to each pump house on the transmission line poles. On account of the great number of instruments the telephones at the pumping stations are cut out by a double-pole knife switch (except when a man is at a pump house), to prevent having so many bells bridged across the line.

Besides the above, a rotary converter has been installed for working a tramway between Kern City and Bakersfield, and in addition to the local lighting and railway load the Power Development Company supplies current for pumping city water. This is done with centrifugal pumps, which pump directly from wells into the mains at 35lb. pressure, and lift water about 12ft. with the suction. There are four pumping stations of this kind for city water at the present time, and two more are to be put in.

At present the power load in pumping and other ranch uses is about full load for two 750kw. generators during the day, and some pumps have to be cut off in the evening to accommodate the lighting. The power-factor in the middle of the day, when the load is almost entirely induction motors, is said to be about 75 per cent.

## SYNTONIC WIRELESS TELEGRAPHY.*

BY GUGLIELMO MARCONI.

The very rapid advances which have been made in the art of telegraphy through space continue to attract much attention to this fascinating subject. What was stated yesterday to be impossible has now become possible, and what we regard as almost insurmountable difficulties may be removed in the immediate future. The number of experimenters working in this field has increased, as, many workers, who, some time ago, had little or no faith in the practical utility of wireless telegraphy, have now changed their minds and are taking up the subject. I believe it to be necessary, before I proceed to deal with the subject, to state that in my opinion a large amount of inaccurate and misleading information is being from time to time published upon it in the daily and even in the scientific press. I shall endeavour to correct some of the mis-statements which have been made.

As the title of my Paper implies, it is my intention first to describe fully the efforts I have made in order to tune or syntonise the wireless system, efforts which I am glad to say have been crowned with complete success. I also wish to mention something of the difficulties encountered in promptly publishing the results (whether successful or otherwise) obtained in the course of my experiments. A commercial concern, such as the one with which I am working, does not exist solely for the advancement of science, but especially for the purpose of securing a pecuniary return to those who have braved risks and undertaken sacrifices in assisting and forwarding the necessary experimental work. It is often considered possible that certain new methods and results may, if prematurely published before being fully patented, be utilised by persons whom I might call business rivals, thus preventing those who have borne the initial cost of the first tests from benefiting in a fair measure. I am, therefore, frequently prevented from promptly publishing the methods by which I have obtained interesting results. By quoting the dates of the British patent specifications and other publications, I hope to be able to establish, to a certain extent, the dates at which the various systems or methods were worked out. It may probably surprise some of you when I mention how comparatively long ago some of the patents which I shall discuss to-night were applied for and perfected.

Last winter I had the honour of describing before the Royal Institution of Great Britain most of the success obtained up to that date in communicating by means of my system from one place to another. It is my desire in this Paper to give a description of the further progress made, with special reference to the results obtained by tuning or syntonising the installations. So long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilisation of the system was imposed. With simple vertical wires, as shown in Fig. 1A and Fig. 2, connected directly to the coherer and spark gap at the receiver and transmitter, as used by myself before 1898, no really satisfactory tuning was possible. It was, however, possible to obtain a certain selection of signals if various stations in the vicinity used vertical wires differing very considerably in length. Thus two stations communicating over a distance of, say, 5 miles and using wires 100ft. long, would not interfere with the signals transmitted by the other two stations, say 2 miles from the first, which were using aerials only 20ft. long, and communicating over a distance of about 1 mile. The new methods of connection which I adopted in 1898, *i.e.* (see Fig. 8), connecting the receiving aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser so as to form a resonator tuned to respond best to waves given out by a given length of aerial wire, were important steps in the right direction. I referred extensively to this improvement in the discourse delivered before the Royal Institution on Feb. 2, 1900, and my first British patent specification referring thereto was applied for on June 1, 1898, No. 12,326, and published in due course. This mode of connection was also discussed by the technical press.*

It is remarkable that eminent scientists and engineers, such as Prof Slaby and G. Kapp, who have been good enough to discuss my work on wireless telegraphy, should be so badly informed on the subject in general as not to know that this method and many other improvements on my original system have been in use by myself and my assistants for several years. I wish to give you an illustration of what I mean. In a Paper on "Tuned or Multiple Wireless Telegraphy," by Prof. Slaby, of Charlottenburg, read on Dec. 22, 1900, and published in a special number of the *Elektrotechnische Zeitschrift*, he stated: "Up to the present the following method has been followed without exception:—The receiving wire was *suspended insulated and attached at the lower end to the coherer*, the other pole of which was connected to earth."

Again, G. Kapp, in an editorial review in the same publication, states:—"According to the Slaby d'Arco system and *in opposition to the Marconi system the receiving wire is earthed.*" The inaccuracy of these statements is very apparent if we compare them with the description given by myself nearly three years previously in the British patent applied for, as I have remarked, on June 1, 1898, published in July, 1899, and openly discussed by the scientific press of this and other countries a long time previous to the date of Slaby's Paper. At line 7, page 1, of my description, will be found the following passage: "According to this invention the conductor (aerial) *is no longer insulated, but is connected to earth* through the primary of an induction coil, whilst the ends of the imperfect contact (or coherer) are connected to the ends of the secondary one of the connections passing through a condenser." As you will notice, nothing is said in this patent of the necessity of insulating the vertical wire of the receiver. If the system described here had not been used by me I very much doubt whether we should have succeeded in maintaining communication with the East Goodwin lightship during 1899, in maintaining communication across the English Channel that same year during the meeting of the British Association at Dover, and in supplying the Admiralty in the course of the year 1900 with 32 installations, all of which passed an official 100 kilometre test (most of the distance being over land) at the rate of about three installations per week.

Leaving this subject for the present, I shall endeavour to describe the various steps made in the development of my syntonic system. I realised a long time ago that one great difficulty in achieving the desired effect was caused by the action of the transmitting wire. A simple straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves. If this was in the beginning an advantage, by allowing signals to be received with a small amount of energy over considerable distances, it proved later to be one of the chief obstacles in the way of obtaining good resonance in the receiver. Now, as Dr. Fleming points out so clearly in his Cantor lectures on "Electrical Oscillations and Electric Waves," delivered before this Society in November and December of last year, there is in connection with this part of the subject one point of great interest. "Both theoretical and experimental research show that in the case of conductors of a certain form the electric oscillations die away with great rapidity." In all what we call good radiators, electrical oscillations set up by the ordinary spark discharge method cease, or are damped out very rapidly, not necessarily by resistance, but by electrical radiation removing the energy in the form of electric waves. Many mechanical analogies can be quoted which will point out the necessity of designing a persistent oscillator, in order that syntony may become apparent in properly tuned resonators. Acoustics furnish us with numerous examples of this fact, such as the resonance effects produced by the well-known tuning-fork experiment. Other illustrations of this principle may be given, *e.g.*, if we have to set in motion a heavy pendulum by means of small thrusts or impulses, these must be timed to the period of oscillation of the pendulum, since otherwise its oscillations will not acquire any perceptible amplitude. An illustration of this fact occurred to me some time ago while I was watching the ringing of

* Paper read before the Society of Arts, May 15.

* See *The Electrician*, Vol. XLIII., p. 48; also Vol. XLIV., pp. 555-556.

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great bells in an Italian cathedral. As most of you probably know, the bells in many churches in Italy, as elsewhere, are rung from the bottom of the tower by means of ropes attached to the bells. The largest bells weigh several tons, and it usually requires two men to work for perhaps two minutes on the ropes before the combined effect of their pulls is sufficient to get the bell to attain an amplitude large enough to cause the hammers to strike. I observed on the occasion to which I allude that it required for each bell a number of well-timed pulls on the ropes in order to get them to swing, the larger bells requiring impulses further apart, *i.e.*, of a lower frequency, than the smaller ones. It is perfectly obvious that if the pulls on the ropes had been wrongly timed it would have been impossible with the same amount of power to ring the bells. The same kind of effect happens in a very small fraction of a second (instead of several minutes) when we try to induce electrical oscillations in a good resonator. If the form of this resonator be such as to cause it to be a persistent vibrator, *i.e.*, one in which the electrical oscillations are not rapidly damped by resistance or radiation of waves, then it is necessary for us to employ a number of properly timed electrical oscillations radiated from a persistent oscillator tuned to the period of the resonator we desire to affect.

As I pointed out before, a transmitter consisting of a vertical conductor as shown in Fig. 1 is not a very persistent oscillator.. Its electrical capacity is comparatively so small and its capability of radiating waves so great, that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it. From the results obtained it would seem as if the transmitter were sending out a great variety of electric waves, resembling therefore a source of white light, and that each resonator picks out and responds to its own particular wave length. This view, however, is incorrect; the fact that, given certain conditions,

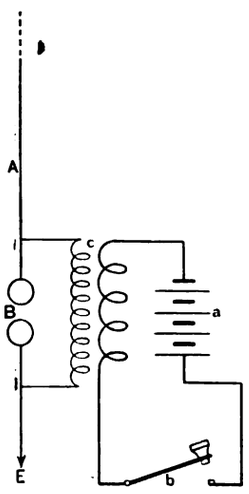


FIG. 1.

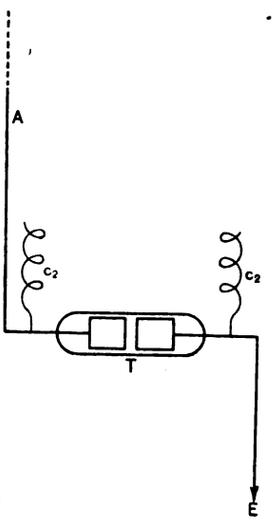


FIG. 2.

various resonators will respond, even if their period be different from the natural period of oscillation of a transmitter, is to be accounted for by the consideration that all the energy of the transmitter is radiated in only one or two swings, with the result that oscillations may be induced in resonators of different periods, whilst, if the same amount of energy be distributed in a great number of individual feeble impulses, their combined effect can only be utilised or detected by a resonator tuned so as to respond to their particular frequency. The tuned resonator will not then respond to the first two or three oscillations but only to a longer succession of properly timed impulses, so that only after an accumulation of several swings does the E.M.F. becomes sufficient to break down the insulation of the coherer, and cause a signal to be recorded.

Notwithstanding the disadvantages for obtaining electrical tuning, attributed to the form of transmitter shown in Fig. 1, selection of messages is possible when using, say, two or three transmitters having wires of considerably different lengths, and the induction coil or oscillation transformers on the receivers wound with varying lengths of wire in their secondary circuits, in order to cause them to be in tune or resonance with the length of wave of the transmitted oscillations, as pointed out in my British patent, No. 12,326, dated June 1, 1898. At page 1, line 19, this reads: "It is desirable that the induction coil should be in tune or syntony with the electrical oscillations transmitted, the most appropriate number of turns and most appropriate thickness of wire varying with the length of wave transmitted." The following experiment, which has been successfully tried, proves this point. At St. Catherine's, Isle of Wight, we had a transmitting station having a vertical wire 45 metres long, and at sea, 10 miles from our receiving station at Poole, a ship with transmitting wire of 27 metres. It is, therefore, obvious that the wave length of the electric oscillations radiated from St. Catherine's differed considerably from that radiated from the ship. Now, if at the receiving station at Poole we connected to a vertical wire two receivers, one having an induction coil with secondary in tune with the length of wave emitted by St. Catherine's and the other with that emitted by the 27-metre feet wire on the ship, if St. Catherine's and the ship transmit simultaneously two different messages, these will be picked up at Poole, and each message will be reproduced distinctly on its receiver. I pointed out in a patent specification dated Dec. 19, 1899, No. 25,185, page 2, that the best results are obtained when the length of wire of the secondary of the induction coils is equal to the length of the vertical wire used at the transmitting station, therefore the length of the secondary of the receiving induction coils was made equal to that of the transmitting wire. (Something of the same kind has been lately noticed by Prof. Slaby in what he calls an extension wire.)

These results, although in a way satisfactory, did not appear to my mind a complete solution of the problem. I found it impossible to obtain the two messages at the receiving station if the two transmitting stations were placed at equal distances from it. The following considerations may perhaps explain this failure. If the 27-metre transmitting wire was placed at the same distance from Poole as the 45-metre one, *i.e.*, 31 miles, the waves emitted by the 27-metre wire would be too weak when they reached Poole to affect the receiver. On the other hand, if the 45-metre transmitter was placed at 10 miles from the receiver, then the waves radiated by it would be so strong as to affect the receiver, tuned to respond to the 27-metre transmitter, and blur its signals.

It thus became apparent that some different form of less damped radiator was necessary in order to obtain more practical and more useful results. I carried out a great number of experiments by adding

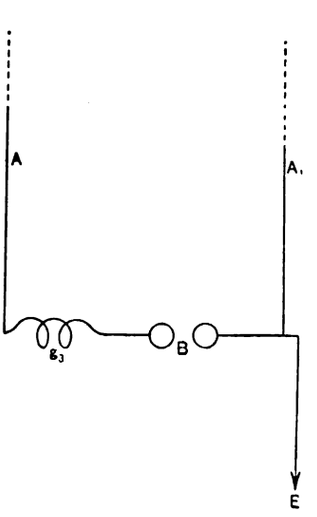


FIG. 3.

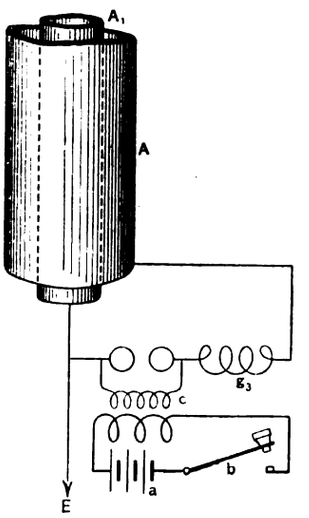


FIG. 4.

to the radiating and receiving wires inductance coils, on a principle similar to that suggested by Lodge in his 1898 patent (No. 29,069), but without obtaining any satisfactory results. The failure was probably due to the fact that the electrical capacity of the exposed conductors became too small in proportion to their inductance. I then tried various methods for increasing the capacity of the radiating system. The first and obvious mode of effecting this is by an augmentation in the size of the exposed conductor, but this method is not entirely satisfactory, in consequence of the circumstance that an increased surface means increased facility for radiating the energy during the first oscillations, and also because large plates or large exposed areas are impracticable on board ship, and are always difficult to suspend and maintain in good position during windy weather. The way out of the difficulty was discovered by adopting the arrangement shown in Fig. 3. Here we have an ordinary vertical radiator placed near an earthed conductor, the effect of the adjacent conductor being obviously to increase the capacity of the electrical radiating wire without in any way increasing its radiative power, and, as I had expected, syntonic results were not difficult to obtain with such an arrangement. Mention of this method has been made by Capt. Ferrie, one of the members of the French Commission which was present at the tests carried out across the English Channel in 1899, in a Paper on wireless telegraphy. See Paper "Etat Actuel et Progrès de la Telegraphie Sans Fil," read before the Congrès International d'Electricité, Paris, 1900.* Satisfactory results were obtained, and I was encouraged to continue my researches in order to improve the system. Early in 1900 I obtained very good

* See *The Electrician*, Oct. 26. 1900, p. 22 ("Electrician" Publishing Co.).



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results with the arrangement shown in Fig. 4. This arrangement is fully described in a British patent application applied for by myself on March 21, 1900, No. 5,387. In it the radiating and resonating conductors take the form of a cylinder, the earthed conductor being placed inside. This form of radiating and receiving areas is much more efficient than the one I have previously described. One necessary condition of this system is that the inductance of the two conductors should be unequal, it being preferable that the large inductance should be joined to the non-earthed conductor. I presume that, in order to radiate the necessary amount of energy, it is essential that there should be a difference in phase of the oscillations in the two conductors, as otherwise their mutual effect would be to neutralise that of each other. In the first experiments mentioned by Capt. Ferrie this was obtained by simply using an earthed conductor shorter than the radiating or resonating one. When I used an inductance between the spark-gap or oscillation producer and the radiating conductor, I found it possible to cause the electrical period of oscillation of the receiving cylinder to correspond to that of one out of several transmitting stations, from which one alone it would receive signals. The results obtained by this system have been remarkable. By using cylinders of zinc only 7 metres high and 1·5 metres in diameter, good signals could easily be obtained between St. Catherine's, Isle of Wight, and Poole (distance 31 miles), these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the Admiralty in the immediate vicinity. The closely adjacent plates and large capacity of the receiver cause it to be a resonator possessing a very decided period of its own, *i.e.*, it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves, which are sometimes probably caused by atmospheric disturbances, and which occasionally prove troublesome during the summer. It seemed very remarkable to me during my first

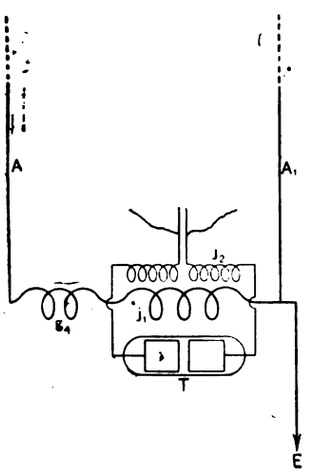


Fig. 5.

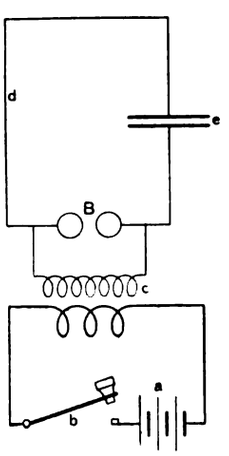


Fig. 6.

test that an arrangement similar to that shown in Fig. 4 should prove to be a good radiator and should enable such a considerable distance to be achieved with cylinders of so moderate a height. It is probable that the great majority of the electrostatic lines of force pass directly from one cylinder to the other, but it must be also true that a certain number leave the outer part of the external cylinder, exactly as in the case of an ordinary radiator. The receiver is not shown in the sketch, but consists of similar cylinders to those used for transmitting the receiving induction coil or oscillation transformer, being placed where the spark-gap is shown in Fig. 4. The capacity of the radiator due to the internal conductor is, however, comparatively so large that the energy set in motion by the spark discharge cannot all radiate in one or two oscillations, but forms a train of slowly damped oscillations, which is just what is required. A simple vertical wire, as shown in Fig. 1, may be compared with a hollow sphere of thin metal which, when heated, would cool very rapidly, and the concentric cylinder system with a solid metal sphere, which would take a very much longer time to cool. Mr. W. G. Brown suggested, in a patent specification dated July 13, 1899, No. 14,449, the use of two conductors of equal length joined to each side of the spark-gap, but he did not describe the inductance in series between them and the spark-gap, which, according to my experience, is absolutely essential for long-distance work. Another very successful syntonised transmitter and receiver system was the outcome of a series of experiments carried out with the discharge of Leyden jar circuits. Taking for granted that the chief difficulty with the old system, as shown in Fig. 1, lies in the fact, as already stated, that the oscillations are very dead beat, I tried by means of associating with the radiator wire a condenser circuit, which was known to be a persistent oscillator, to set up a series of persistent oscillations in the transmitting vertical wire.

An arrangement as shown in Fig. 6, which consists in a circuit containing a condenser and a spark-gap, constitutes a very persistent oscillator. Prof. Lodge has shown us how, by placing it near another similar circuit, it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars. But, as Lodge points out,* "A closed circuit such as this, is a feeble radiator and a feeble absorber, so that it is not adopted for action at a distance." I very much doubt if it would be possible to affect an ordinary receiver at even a few hundred yards. It is very interesting to notice how easy it is to cause the energy contained in the circuits of this arrangement to radiate into space. It is sufficient to place near one of its sides a straight metal rod or good electrical radiator. The only other condition necessary for long-distance transmission is that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit.

Stronger effects of radiation are obtained if the radiating conductor is partly bent round the circuit, including the condenser (so as to resemble the circuits of a transformer). I first constructed an arrangement as shown in Fig. 14, which consists of a Leyden jar or condenser circuit, in which is included the primary of what may be called a Tesla coil, the secondary of which is connected to the earth or aerial conductor. The idea of using a Tesla coil to produce the oscillations is not new. It was tried by the Post Office officials when experimenting with my system in 1898, and also suggested in a patent specification by Dr. Lodge, dated May 10, 1897, No. 11,575, and by Prof. Braun in the specification of a patent dated Jan. 26, 1899, No. 1,862. My idea was to associate with this compound radiator a receiver tuned to the frequency of the oscillations set up in the vertical wire by the condenser circuit. My first trials were not successful, in consequence of the fact that I had not recognised the necessity of attempting to tune to the same period of

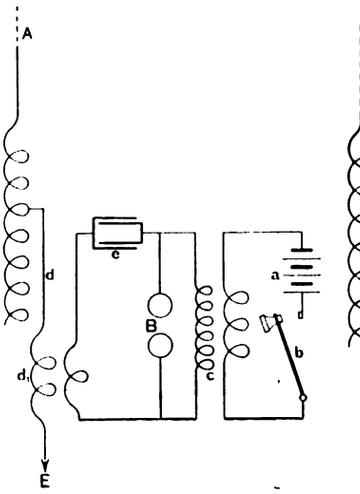


Fig. 7.

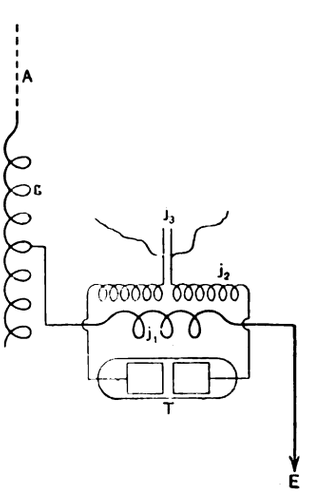


Fig. 8.

oscillation (or octaves) the two electrical circuits of the transmitting arrangement (these circuits being the circuit consisting of the condenser and primary of the Tesla coil or transformer, and the aerial conductor and secondary of the transformer). Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver. The syntonised transmitter is shown in Fig. 7. The period of oscillation of the vertical conductor A can be increased by introducing turns, or decreased by diminishing their number, or by introducing a condenser in the series with it. The condenser C in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity. The receiving station arrangements are shown in Figs. 8 and 9. Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I place an adjustable condenser across the coherer in Fig. 9. Now, in order to obtain the best results, it is necessary that the free period of electrical oscillations of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser. I stated that, in order to make the tuning more marked, I placed a condenser across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble but properly timed electrical oscillations being received, the effect of the same is summed up until the E.M.F.

* "The Work of Hertz," by O. J. Lodge, page 7.

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at the terminals of the coherer is sufficient to break down its insulation and cause a signal to be recorded.

In order that the two systems, transmitter and receiver, should be in tune, it is necessary (if we assume the resistance to be very small or negligible) that the product of the capacity and inductance in all four circuits should be equal. A more complete and detailed description of this system is given in a British patent granted to me, dated April 26, 1900, No. 7,777. I have recently found that Prof.

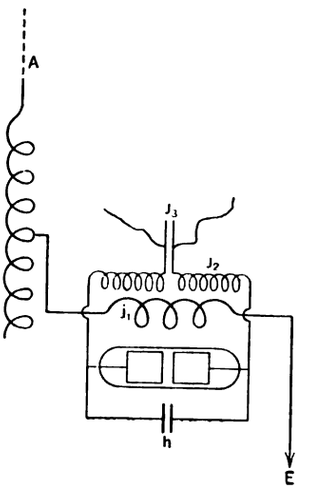


FIG. 9.

Braun has recognised the necessity of tuning the circuits of the transmitter and receiver when using a Tesla coil in order to obtain syntonic effects, but I am not aware that such a proposal was published prior to the description given in the above-mentioned patent.

Although little difficulty has been encountered in measuring the capacity used in the various circuits, the measurement or calculation of the value of the inductance is not so easy. I have found it impracticable by any of the methods with which I am acquainted

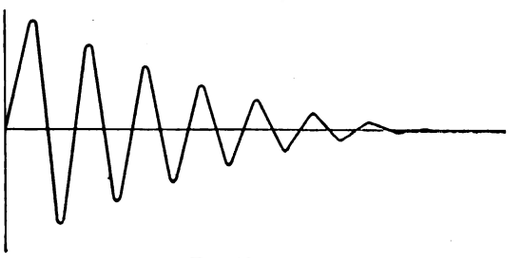

FIG. 10

directly to measure the inductance of, say, two or three small turns of wire. As for calculating the inductance of the secondary of small transformers, the mutual effect of the vicinity of the other circuits and the effects due to mutual induction greatly complicate the problem.

Experiments have confirmed the fact that the receiving induction coils having the secondary wound in one layer and at a certain distance, say 2mm. (to cause the capacity to be so small as to be negligible), have a time period approximately equal to that of a vertical conductor of equal length

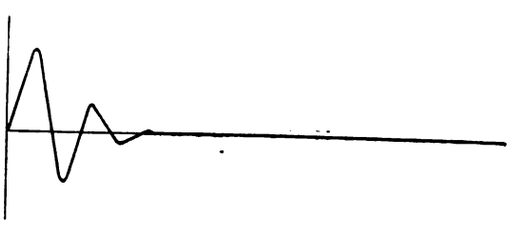

FIG. 11.

(see patent granted to G. Marconi, dated Dec. 19, 1899, No. 25,186). If, therefore, we are using an induction coil having a secondary 40 metres long on the receiver, I should use a vertical wire 40 metres long at both transmitting and receiving stations. By so doing I have the two circuits at the receiving station in tune with each other, and I only have to adjust the capacity of the condenser at the transmitter, which can easily be done, either by means of a condenser having movable plates that can be slid, more or less, over each other, or by adding or removing Leyden jars.

If we start with a very small capacity which we gradually increase, a value of the capacity will be reached which will cause signals to be recorded on the receiver. Supposing the receiving system to be within the sphere of action of the transmitter, then the signals will be strongest when the capacity of the condenser is of a

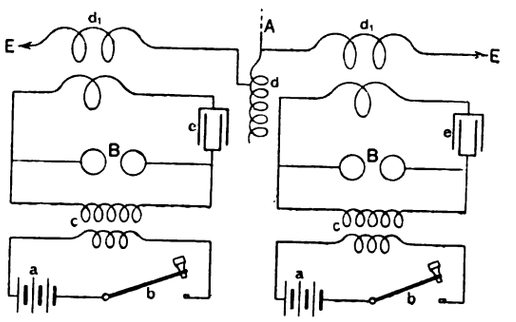


FIG. 12.

certain value. If we still increase the capacity, the signals will gradually die away, whilst if we go on increasing the capacity, and, at the same time, add inductance to the aerial, to keep it in tune with the condenser jar circuit, we are still radiating waves, but these do not affect the receiver. If, however, at the receiving station we

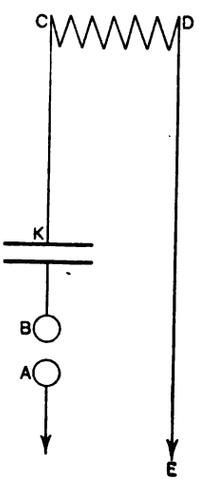


FIG. 13.

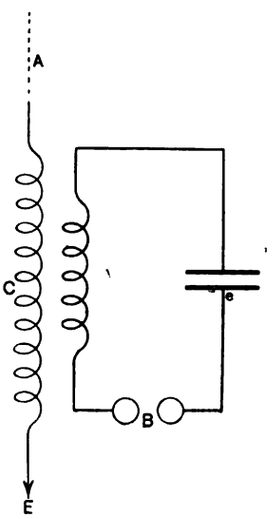


FIG. 14.

add inductance or capacity to the wire A, Fig. 9, and also to the ends of the secondary of J 2, we find ourselves able to receive messages from the transmitter although we are utilising waves of a different frequency.

*(To be concluded.)*

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Annual Catalogue (1900-1901) and Annual Report of the President and Treasurer (1900) of the Massachusetts Institute of Technology." (Boston: Rockwell and Churchill.)

"Annual Catalogue of the Purdue University, Lafayette, Indiana." 1900-1901. With announcements for 1902. (Indianapolis: W. B. Burford).

"A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations Aboard Ship," by Commander T. A. Lyons. Vol. I. (New York: John Wiley & Sons.) 25s. 6d.

"The Motor Engineer's and Electrical Worker's Handbook." (Ohio: W. Lintern.) 2s.

"Electric Lighting." By Prof. F. B. Crocker. Vol. II. Distributing System and Lamps. (London: E. & F. N. Spon.) 12s. 6d.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

*All Editorial letters to be addressed to* The Editor.

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"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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## THE TUNING OF THE WIRELESS TELEGRAPH.

"I have come to the conclusion that the days of the non-tuned system [of wireless telegraphy] are numbered." Thus spoke Mr. Marconi at the close of his lecture on "Syntonic Wireless Telegraphy" at the Society of Arts, on the 15th inst.—a lecture which we commence to reprint in our issue this week. Few people, if any, have so good a right as Mr. Marconi to express such an opinion, and yet the proposition it involves is so startling that it is difficult to accept it in its unqualified entirety. What does syntonic ether telegraphy accomplish that cannot be achieved by non-tuned apparatus? And is there no other possible solution than syntony for the difficulties of existing non-syntonic methods? These are questions which will naturally arise, and they must be satisfactorily answered before the scientific world can fully accept Mr. Marconi's dictum as to the pending universal use of syntony. Nevertheless, the lucid discourse by Mr. Marconi at the Society of Arts has gone far towards meeting such questions; and it cannot fail to have convinced every fair-minded hearer that in the syntonic system Mr. Marconi has so successfully perfected there is one very effective method, at any rate, of surmounting the vexatious difficulties and hampering limitations of the ordinary non-tuned methods. This much, we think, everyone will grant; yet this, as we hope presently to show, falls far short of demonstrating that the accurate tuning of sending and receiving apparatus to a definite wave-length is the only conceivable or probable, or even the best, solution. Time will show if it really is the only practicable solution; but in the meantime it may be profitable to cast our eyes around to see if any other natural phenomena promise useful material for alternative ways of getting over the difficulties.

First, however, let us briefly review Mr. Marconi's syntonic system, as described in his lecture. The phenomenon of resonance, of which syntonic telegraphy affords a particular example, is widespread throughout nature. In the mechanics of heavy bodies, we recognise it in the violent disturbances that well-timed vibrations, *e.g.*, of machinery, are capable of creating, while equally strong

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vibrations occurring at another and perhaps quicker rate produce no appreciable disturbance whatever. In acoustics, we recognise resonance in the ability of any given pure musical tone to evoke the same tone from any neighbouring instrument which is tuned to give out that note; thus the sounding of a pure middle C near a pianoforte will throw the middle C string into sympathetic vibration, while the adjacent strings will remain motionless. In optics resonance is exhibited, for example, in fluorescence and calorescence; but in phenomena of this description we have the notable characteristic that the resonant substance is responsive to a wave-length that is not identical with that emitted, although it is probable that the exciting wave-length bears to the evoked waves a similar relation to that which exists between a fundamental tone and its higher overtones, at any rate where the optical vibrations are free. Whether it is possible for tuned wireless telegraph apparatus to excite or to respond, in similar manner, to other wave-lengths than the fundamental tone, *e.g.*, the octave or the intermediate overtones, is a question that must seriously arise in connection with the extensive use of the syntonic method; but we will refer again to this matter presently.

Returning to the question of resonance, it will always be found that wherever this phenomenon occurs, in its true form, two conditions are absolutely essential—the one in the exciting apparatus or transmitter, and the other in the responding apparatus or receiver. For the transmitter it is essential that the impulses it sends out should follow one another in succession at definite and equal intervals of time, thus producing in the medium a wave-train of one special frequency. There may be other impulses, regular or irregular, superposed upon this wave-train, but the analysis of the composite impulses must always show as one of its constituents a wave-train composed of several simple and similar waves. For the receiver it is essential that it shall be capable of responding to the impressed wave-train whenever its regular impulses act upon it, and whether there are or are not other impulses superposed. In wireless telegraphy, not only is resonance between two given stations temporarily to be produced, but all resonance between these and other stations is, for the time being, to be rendered impossible; and this fact makes other conditions essential besides the two we have stated. Thus, not only must the transmitter produce a definite wave-train, but, for the time being, it must produce nothing else, neither another wave-train nor even an irregular impulse, or it may affect an outside coherer. And, as to the receiving station, it must be incapable of responding to any wave-train or stray impulse other than the particular wave-train of the transmitter to which it is temporarily mated. Perusal of Mr. Marconi's Paper clearly shows that these essential conditions have been successfully achieved in actual practice by the syntonic methods, for particulars of which we must refer our readers to the Paper itself. But it must be remembered that the number of stations thus worked is as yet comparatively small, so that there has been ample freedom in the selection of suitable wave-lengths, in order to prevent clashing. When the number of syntonised stations within any area has been greatly increased, the risk of syntony breaking down through confusion of wave-frequencies will be much enhanced. In the discussion on the Paper, Prof. Fleming humorously remarked that "it will now be possible to provide the Admiralty and the Post Office with instruments having an Admiralty or a Post Office frequency, and to register frequency just as a telegraphic address is registered, so that no one else could use that particular frequency." This is an idealised state of affairs which, we fear, is not capable of being realised in this crowded and wicked world. In the first place, the Admiralty would not be content with only one frequency, they would require the exclusive use of a large number; and so would the Post Office. As to private "registered frequencies"—the population of the civilised world is very large, and we are afraid there would not be enough frequencies to go round. If A's registered frequency were 49,465,327, it would scarcely be an effective protection to B to register for 49,465,328; probably, to encroach within the thousands or the ten-thousands would be disastrous. And, in any event, there would be nothing to prevent the evil-minded from erecting apparatus to respond to anyone else's private or official frequency, or even to flood the ether with false messages at, say, the Admiralty frequency. Not that these speculative matters are of immediate concern, however; the syntonic method seems likely to answer every practical purpose until wireless signalling becomes more general than it is at present.

And now as to other methods than the syntonic. It was some years ago that in discussing with a well-known physicist the best way of guiding ether waves for etheric signalling we received the suggestive reply that, "where possible, the best way of guiding ether signals is by means of a copper wire." This is undoubtedly a fact, and much that enthusiasts are claiming as being within the legitimate province of wireless telegraphy can be performed with infinitely greater convenience by means of an ordinary metallic conductor—most land signalling, for instance. The proper and especial province of wireless telegraphy is on the sea and wherever else moving objects are to be communicated with that cannot be reached by means of metallic conductors. But there are other methods of guiding ether signals besides the common one of making them slip along the ether enveloping a copper wire, methods that are strictly "wireless" in the Marconi sense. In syntonic signalling the ether waves are not guided; they spread out in all directions, although they only do useful work in one direction. Much energy is, therefore, wasted. Hence, we see that there are two distinct ways of confining a wireless message to a definite receiving station: (1) The syntonic method which is thus far effective, but is essentially inefficient; and (2) the guided wave method, which can be made efficient, but has not yet been made practically effective. If we consider the manner in which other forms of signals are directed through space, we find that in all cases the method of guiding, and not that of syntony, is preferred. Thus, the heliograph, the lighthouse, the fog-horn, the speaking-trumpet or megaphone, and the speaking tube, all afford examples of guided waves. And if we further inquire whether it is possible to guide the particular waves used in wireless telegraphy, we find that it can be done in two ways—viz., by reflection and by refraction. A metallic screen to cut off stray waves and a metallic reflector to enforce the energy of the beam of projected waves constitute a wireless telegraph transmitter analogous to a searchlight or a heliograph. Instead of a reflector, however, we may use a refractor composed of pitch or some other material having a high refractive index for long ether waves. Nothing on a commercial scale has yet, we believe, been accomplished by either of these methods; nevertheless, the results that have thus far been achieved with their aid render it somewhat rash to predict that "the days of the non-tuned system are numbered." Be that as it may, we may feel sure that in having brought the syntonic method to its present state of perfection Mr. Marconi has given wireless telegraphy a stimulus that will carry it forward with enhanced vigour, and we tender him our heartiest congratulasion upon this masterly achievement.

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## OBITUARY.

### COURTENAY BOYLE.

We deeply regret to announce the sudden death of Sir Courtenay Boyle, K.C.B., Permanent Secretary to the Board of Trade. This lamentable occurrence took place on Sunday last owing to sudden and quite unexpected failure of the heart's action. Sir Courtenay had not been in good health for some time past, but it was only within a few minutes of his decease that any very grave symptoms manifested themselves.

It is principally in connection with the relations of the Board of Trade to electric lighting and tramway enterprise that Sir Courtenay Boyle is known to the electrical profession, but in addition to the prominent position which he has held as Permanent Secretary to this Board since 1893, Sir Courtenay has had a very distinguished career in official life. He was born in 1845 in Jamaica and educated at Charterhouse and Oxford. During his college days he displayed considerable athletic ability, principally as a cricketer. In 1868 he became Lord Spencer's private secretary when that statesman took office as Viceroy of Ireland, and the next five years Courtenay Boyle spent in Dublin. In 1882, upon the re-appointment of Lord Spencer to the Viceregal office, Mr. Boyle again became his private secretary. During this period the celebrated Phœnix Park murders took place, and it was the painful duty of Mr. Boyle to identify the distinguished victims of that political crime. In 1886 he was transferred to the railway department of the Board of Trade as Assistant Secretary, a post which he retained until the year 1893, when, as already stated, he was transferred to the important post of Permanent Secretary, which he filled with such marked success until his premature decease at the age of 56.

The funeral took place at Hampton Church yesterday afternoon, and a special service was simultaneously held at St. Peter's, Vere-street, Oxford-street, W.

### E. W. PARSONÉ.

We regret also to record the death, in his 53rd year, of Mr. E. W. Parsoné, who for the last 30 years has been intimately connected with the submarine telegraph industry. Mr. Parsoné on leaving the University College School entered the service of the Great Western Railway Co., and in 1870 joined the staff of the late Sir Charles Bright and was employed in laying the cables of the West India and Panama Telegraph Co. He eventually was engaged on the staff of the India Rubber, Gutta Percha and Telegraph Works Co., and after being employed in the laying of cables along the French coast, and between Marseilles and Algeria, and Marseilles and Barcelona, he proceeded to the West Coast of South America and became manager of the first series of submarine cables placed in these waters between Callao in Peru and Valparaiso in Chili. He served with conspicuous ability in this post during the trying times of the war between these two countries, and made many enduring friendships among the native and foreign merchants.

In the cable steamer "Retriever," Mr. Parsoné surveyed the route for the cables which connect Salina Cruz in Mexico with Callao in Peru, and are the property of the Central and South American Telegraph Co. Returning to England in 1884, Mr. Parsoné was appointed manager of the West African Telegraph Co., and he organised the service on the string of cables connecting the Cape de Verde Islands and the principal settlements on the West Coast of Africa. While on the Congo river he visited Shark Point and reported to the Royal Geographical Society the locality of one of Diego Cam's beacons, the existence of which was suspected but was unknown to modern geographers. After remaining a few years on the West Coast of Africa, Mr. Parsoné came home and shortly afterwards proceeded to Brazil in connection with the South American Cable Co., of which he was still manager and secretary at the time of his death.

Mr. Parsoné had been connected with the Institution of Electrical Engineers since 1874, and for the last 20 years has been a Member. He was also a Fellow of the Royal Geographical Societies of London and Lisbon. The French Government had conferred on him the decoration of Officier de l'Instruction Publique, and the Government of Portugal had bestowed on him a Knight Commandership of the Order of Christ.

The death of Mr. Parsoné is a great loss to the submarine cable industry, owing to his accurate knowledge and intimate acquaintance with the business in its electrical, mechanical and commercial bearings. From the personal point of view his friends have lost a cheery companion, full of humour and of goodwill towards his fellow men.

## A WATT-HOUR METER.*

BY FRANK HOLDEN.

One of the earliest schemes for the measurement of ampere or watt-hours was to have an ampere or wattmeter, or, commonly, something apparently assumed to be one or the other, to indicate a distance or angle proportional to the amperes or watts, and, combined with this instrument, an arrangement for recording this angle or distance, and making a summation of the records. The final sum would, with a perfect instrument of this kind, be proportional to ampere or watt-hours for the period during which the summation took place, at least very closely on commercial circuits of almost any character if the instrument were allowed to record for a considerable time. This is true for the reason that, while a consideruble percentage of the individual readings may be in error, yet when a large number of these readings are made these errors practically cancel

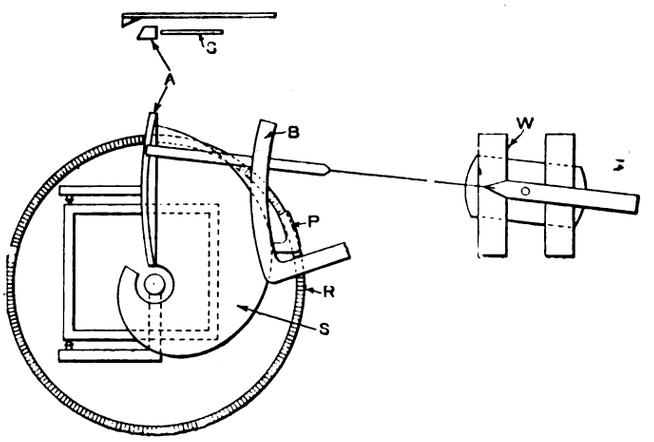


FIG. 1.

out, as positive and negative errors of each particular size are equally likely to occur. An examination of almost every, if not every, meter of this type shows that it either had an apparatus not sufficiently accurate in indicating the angle or length proportional to the watts, or was deficient in means for recording the same, even were it correctly indicated, and not uncommonly there was trouble in both respects. In addition to these difficulties there was commonly an electrically-wound clock that would not work for any extended period of time.

The meter which is the chief subject of this Paper does not, perhaps, in strictness, belong to this class, but it more resembles these meters than any others that have been heretofore described. For the purpose of comparison, and for illustrating how this idea has been carried into practice heretofore, one of the most intelligently designed and successful of these meters, the Frager, will be described. It is shown diagrammatically in Fig. 1. In this figure W is a watt dynamometer, the fine wire coil of which, suspended by a wire, carries a pointer, the end of which moves over the sheet metal snail or spiral S. An electrically-driven clock device uniformly rotates the vertical shaft carrying the snail, which makes one revolution every 2min. to 5min., depending on the size of the meter. With this also rotates a pawl, P, which lies over the circular rack R, which is geared to the indicating dials. The snail revolves until the wedge at the end of the pointer meets the metallic arc, when the pointer end with the wedge is raised until the pointer is locked by being pressed upward against the milled under-surface of a bridge piece, B, under which it moves freely until the recording operations begin. In time the pointer-end passes over the radial edge of A, which also revolves, and, dropping on to the snail depresses it, causing the pawl P to engage the rack, when the latter begins to revolve with the snail, and continues to rotate until the pointer passes over the edge of the snail, when the latter raises and releases the pawl. The angle of rotation depends

* Paper read before the Institution of Electrical Engineers on May 2.

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on the angle of the arc traced by the pointer on the snail, and this angle is dependent on the shape of the bounding curve and the position of the pointer just before and during the making of the record. It is evident that, by properly shaping the bounding curve of the snail, this instrument could be made to indicate watt-hours under ideal conditions. Taking into consideration the length of the pointer, 23cm., and one's general experience with reading of instruments at zero, it does not seem likely that a reading of the pointer high or low of 1·5mm. would be other than common. The length indicated by the pointer on the circular edge of A at full load is 76mm., so this would mean an error of 2 per cent. at full load, 8 per cent. at quarter, 20 per cent. at one-tenth, and 40 per cent. at one-twentieth load; and a displacement of even 0·7mm. would mean errors nearly as great as one-half these values.

Another source of error is in recording the deflection of the pointer, but in this particular instrument the error in doing this must be very slight, as the length of the arc traced on the snail by the pointer when the load is as low as 2 per cent. of the full load is 10mm., which could be recorded on the circular rack within 2 or 3 per cent. without necessitating too great structural refinement. When the load is double this, the arc on the snail becomes 20mm. long, which, with the same refinement, would be measured within about 1 per cent., while above this the errors would certainly be negligible. As there are a finite number of teeth, it follows that the distance moved by the pawls engaging the rack will not, in general, be an exact multiple of the space of one tooth of the rack, so that, in general, each record would be too

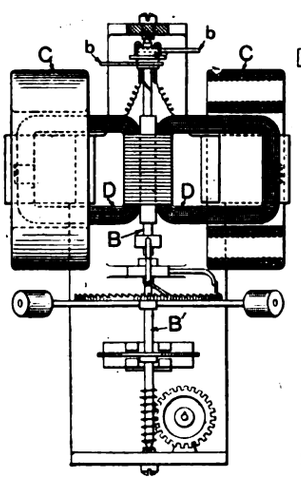


Fig. 2.

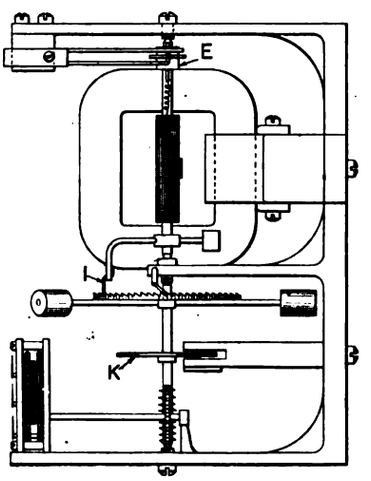


Fig. 3.

low by some fraction of one tooth. But the error from this source may be eliminated by setting the pointer to read a little high at zero. The fatal feature of this, then, as a measuring instrument would appear to be the impossibility of getting sufficiently accurate reading at low loads with so short a scale as 76mm., and this has been the general failing of all instruments of this class. Instruments of this type have, in the past, been so uniformly unsuccessful and short-lived, that it would seem a most unpromising field in which to work. However, they have for the most part, if not always, failed for very specific defects in either the clock-winding or measuring part, which it seems one could have foretold as being fatal ones; at least, one can see it plainly now.

In the meter to be described there has been an attempt at avoiding these defects by what are, in so far as the writer knows, new constructions, both in the clock-winding and the measuring mechanism. The measuring part of this meter is shown diagrammatically in Figs. 2, 3 and 4, in which CC are the main current coils, partly enclosing the shunt coils DD, which are mounted on the vertical axis B. In the construction as shown here it was intended to connect the coils astatically, so as to avoid any disturbing effect of the earth's field; but as the effect is of no commercial account, a more simple and powerful non-astatic arrangement of coils has been adopted for the future. The axis B carries at its top an ebonite cylinder E, about 6mm. in diameter, holding the terminals of the coils DD. To each of these terminals is soldered a phosphor-bronze strap, about 0·0013cm. thick. Each strap, after being wrapped partly around the cylinder, is soldered to the end of a very light spring F, which, again, is soldered to a stiff spring, mounted on an ebonite block. As may be seen from the figures, these straps tend to give the coils a clockwise rotation around the vertical axis, and the value of the rotating couple may be varied by means of adjusting screws G. The effect of the currents is to make the coils rotate in opposition to the springs. Coaxial with this axis, and below it, is another shaft, B', carrying a circular rack, which rests on three arms, which carry at their extremities three masses which may be screwed in or out for balancing purposes, a construction which has been adopted as giving a high moment of inertia for its mass. Further down is a cast-iron disc, K, which passes through the poles of a permanent magnet, and lower still is the usual worm and counting mechanism. Together with this, there is a clock, which will be described hereafter, for closing the shunt contact periodically, say once a minute. On the closing of the shunt circuit, the coils DD are rotated to the limits allowed by the surrounding coils, and at the same time the pawl I, engaging the rack, imparts the same angular velocity to the lower part, which continues to rotate after the coils DD are stopped, until the magnetic hysteresis in the disc K and mechanical friction bring it to rest. It is prevented from returning except very slightly by a stationary pawl. The shunt circuit being broken, the coils DD return to their initial position. Let

P = Average couple exerted by the coils for 1 watt being measured.
S = Average moment of force exerted by the springs.
D = Average moment of the force due to hysteresis in the disc.
$I_c$ = Moment of inertia of the deflecting parts—the shunt coils.
$I_r$ = Moment of inertia of the revolving part.
$\theta$ = Angle of deflection of the coils or deflecting parts.

When the coils are deflected because of the currents for producing W watts, the work done on all the moving parts is $WP\theta$. The work done on the springs is $S\theta$, and the work done on the iron disc is $D\theta$. Therefore the energy of the moving parts just before the coils are brought to rest is $(WP-S-D)\theta$. Of this total, the portion in the revolving part is

$$(WP-S-D)\theta I_r/(I_c+I_c).$$

The angle through which this will rotate before coming to rest is found by dividing by the moment of the force tending to stop it,

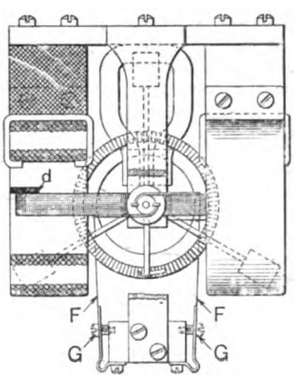


Fig. 4.

that is, D. The total angle of rotation, $\phi$, measured from the starting position, obviously will be this, plus $\theta$.

That is $$\phi=\theta+\frac{(WP-S-D)}{D}\,\theta\,\frac{I_r}{I_r+I_c}.$$

This reduces to $$\phi=W\frac{P\theta}{D}\,\frac{I_r}{I_r+I_c}+\theta\,.\,\frac{DI_c-SI_r}{D(I_r+I_c)}.$$

The first term of the second member of the equation is equal to the value of the watts multiplied by a quantity involving only constants, and therefore if $\phi$ is to be proportional to the watts, then the second term not involving W must be equal to zero.

$$\theta(DI_c-SI_r)/D(I_r+I_c)=0, \quad \text{or} \quad S=DI_c/I_r.$$

If this relation between S and D be established, then

$$\phi=WP\theta/D=W\times\text{constant}.$$

This apparently does not take into account the effects of friction, but, as a matter of fact, the frictional effects are nearly constant, and so merely change the apparent value of S or D.

The assumption is made, however, that the ratchet is perfect, and that it will hold the rotating part wherever it stops, whereas really the teeth are about 0·5mm. apart; but how this affects the readings will be shown later on. The method of calibrating is as follows:—After some experience with these meters one can judge by the rapidity of the return of the deflecting coils, approximately, when the proper tension is on the springs, and these are first adjusted approximately correct. The meter is then put on the full load, say 500 watts, and the shunt circuit closed long enough to allow the coils to move through the full angle. Then, if the lower part does not make two revolutions in coming to rest, which is the movement in a 500-watt instrument, it follows that the damping effect of the permanent magnet is too great, and it is reduced by an adjustable

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magnetic shunt across the poles, consisting of an iron screw passing through one of the poles toward the other pole, although, in the meter before you, this shunting is done by laying iron strips across the poles. When the adjustment for full load is completed the load may be reduced to one-tenth, and then, if the tension of the springs be correct, with ten closings of the shunt circuit, the lower part will make two revolutions. If it make more, the tension on the springs is increased by means of the screws G, and if less, the tension is decreased, until ten closings produce two revolutions. If a good guess as to the proper strength of the spring were made in the first place, there will be no need to re-adjust the magnet for the full-load reading, as it takes a very considerable change in the springs to produce an appreciable effect with full load, as the electrical forces are then relatively very great.

It is easy enough to set up a number of meters of different types and get very correct readings, but it is a more important and different matter that the properties of the instrument shall be constant.

On looking at the equation of the instrument

$$\phi = WP\theta \frac{I_r}{I_r + I_c} + \theta \frac{DI_c - SI}{D(I_r + I_c)},$$

it will be seen that $PI_rI_c$ and $\theta$ cannot change except by actual distortion of the parts, for they all depend purely on the dimensions of the construction, and so may be assumed to be constant. This leaves S and D only to be considered. With S must be included all

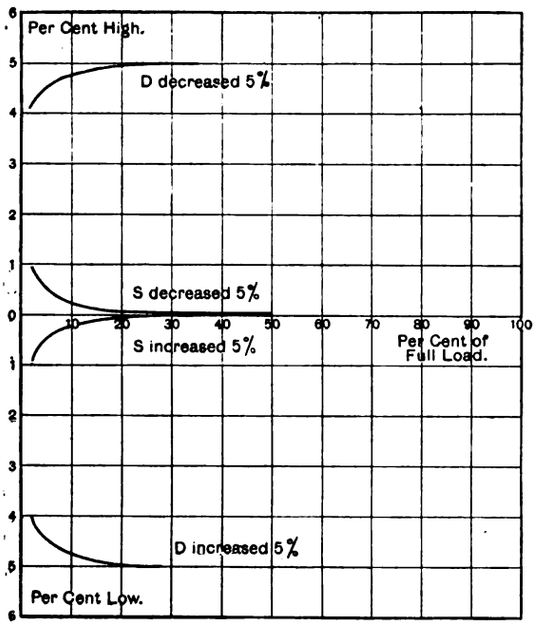



FIG. 5.

mechanical friction affecting the motion of the coils. The weight of these coils complete with the shaft is about 25 grammes, and it is a matter of experience that the pivot friction, even with a heavier load, will not alter appreciably in a considerable lapse of time. When new, it does not seem to be more than 2 per cent. of the couple of the springs; so that if it double, it will affect the reading of the instrument even at the lowest loads very slightly, as may be inferred from curve, Fig. 5. It may be safely accepted that the force of the springs if properly made will be constant. With D must be included all mechanical friction to which the revolving part is subjected, and this consists of the pivot and dial friction, and that of the two pawls. The weight of the revolving part is about 28 grammes, and, as in the case of the upper pivot, it does not seem likely that the pivot friction will alter seriously in a considerable time; and the fact that in several instruments the pivot's frictional forces have all been within 50 per cent. of a mean value, rather confirms this opinion. As the pivot friction is about less than 2 per cent. of the total damping force, it evidently may vary considerably in percentage without appreciably affecting the readings of the instrument. As it is not a matter of making the pivot friction small, but of making it constant, it is possible to make the pivots blunter than would be admissible in motor meters or indicating instruments generally, and as a consequence they are much less likely to be damaged in case of shock or vibration than in these instruments. There has not been a case of a jewel broken or damaged by a pivot in an experience with a dozen of these meters, although some have been subjected to intentionally rough usage.

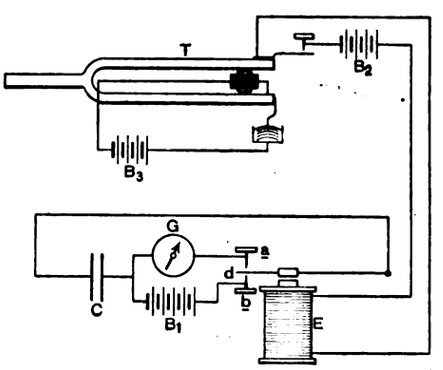
*(To be concluded.)*

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

*(Continued from page 60.)*

Before dealing with the nature of these discrepancies and the probable reasons for them, it may be well to describe one, at any rate, of the processes which have been employed for determining dielectric constants. In late years a large number of methods have been devised, but they are not all free from theoretical objections or practical difficulties. In some cases dielectric constants have been determined by processes in which the electric force is continuous and continuously applied, in other cases, by methods in which the electromotive force is alternating with various frequencies. As it will be pointed out presently, the frequency of the alterations of the electric force affects very sensibly in many cases the result. I will describe one method of measuring dielectric constants I have myself much used, which is especially convenient when working with liquid dielectrics. Briefly, it is as follows:—A condenser, C, is constructed consisting of two metallic surfaces separated by the dielectric to be tested, and it is desirable that the arrangement should be provided with some means for measuring both the temperature and the thickness of the dielectric (see Fig. 4). If this condenser is charged by the application of a known electromotive force to the two metal surfaces, and then discharged through a sensitive galvanometer of the ballistic type, the galvanometer will give a small throw or indication depending on the capacity of the condenser and the sensibility of the galvanometer. If, however, the condenser is charged and discharged through the galvanometer at very frequent intervals, the rapid series of discharges runs together into a practically continuous current. The best arrangement for producing this effect is the combination of an electrically-driven tuning fork with an electric switch. The electrically-driven tuning-fork consists of an ordinary tuning-fork giving any constant number of vibrations (say between 30 and 200),




T, Electromagnetic Tuning-Fork worked by Battery, $B_3$. E, Electromagnetic Vibrator worked by Tuning-Fork and Battery, $B_2$. C, Condenser, charged from Battery, B; and discharged through Galvanometer, G, by Vibrator, E.

FIG. 4.

maintained in vibration by means of an electromagnet. Each time the prongs of the fork separate or come together they are made to complete a circuit either through mercury or a platinum contact which closes the circuit of the battery through an electromagnet, so placed as to act magnetically upon the prongs, and these impulses coming at the right moment maintain the fork in a unit of vibration, and, therefore, intermit or break the current in the circuit a definite number of times per second. In the same circuit is placed a contact breaker driven by another electromagnet, which throws a tongue of metal backwards and forwards between two contact points. One terminal of the condenser is connected with this vibrating tongue, one terminal of the galvanometer is connected to one stop, and one terminal of the battery charging to the other stop; the second terminals of the condenser battery and galvanometer are all connected together, the arrangement being as shown in Fig. 4. When the tuning-fork is set in operation the tongue of metal connected to one terminal of the condenser vibrates in synchronism, and the condenser is alternately charged and discharged through the galvanometer. It is obvious that the galvanometer can be arranged to take either the series of charges or discharges of the condenser, and it is convenient to arrange a throw-over switch so as to read successively on the galvanometer the current due to the charges and discharges. The object of this arrangement is to detect the presence of true conductivity as distinguished from mere dielectric constant. It will be obvious that if the dielectric forming the condenser possesses any any true conductivity, then when the galvanometer is connected in

*Cantor lecture delivered before the Society of Arts, December 10, 1900.

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series with the battery and condenser so as to take the series of intermittent charges and manifest them as a continuous current shown by the galvanometer, this current will be greater than when the galvanometer is so arranged as to take the discharges of the condenser. These arrangements being made, it is then necessary to have in addition a means of interpreting the indication of the galvanometer and ascertaining what is the value of the current in amperes and microamperes corresponding to any deflection. If the galvanometer is a high-resistance galvanometer, and if the current given by the series of discharges is very small, the best way to interpret the meaning of the galvanometer deflection is by means of a potentiometer. A wire stretched over a scale divided into 2,000 divisions has passed through it a steady current, and by means of a Clark's cell the current through this wire is regulated to a certain value as follows :—A Clark's standard coil is connected to one terminal of the slide-wire and the galvanometer placed in series with it, the other end of the galvanometer being connected to a slider moving over the wire stretched on the divided scale. Assuming the electromotive force of the Clark's cell to be known at the temperature of the day (let it be, say, 1·434 volts at 15°C.), then the slider is set to make contact on the slide-wire at 1,434 divisions from the zero end, and the current from the secondary cell flowing through the slide-wire is then regulated by a rheostat until the galvanometer shows no deflection. When this is the case the fall of potential down the slide-wire is equal to 1 volt per 1,000 divisions, hence one division corresponds to $\frac{1}{1000}$th of a volt. A high resistance can now be inserted in the galvanometer circuit, and the slider is moved backwards or forwards over a few divisions until the galvanometer needle gives a certain observed deflection. Corresponding to this deflection we now know the difference of potential at the extremities of the galvanometer circuit, and if we know the resistance of the galvanometer and the value of the resistance in series with it, we at

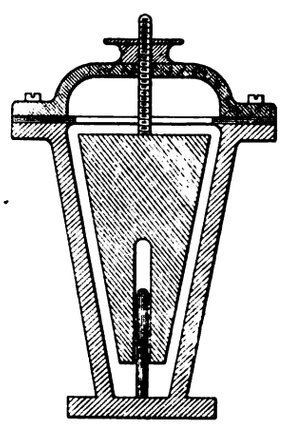

Fig. 5.—Cone Condenser.

once determine the value of the current in microamperes corresponding to a given observed deflection of the needle, or, if it is a mirror instrument, of the spot of light upon the scale. It is most convenient to employ for this purpose a galvanometer of the movable coil type which is fairly dead beat.

Having thus determined the microampere value of the deflection of the galvanometer, we have the means of interpreting the deflection of the galvanometer when the series of condenser discharges is being sent through it a known number of times per second. Let us suppose, for example, that 10cm. scale deflection, in the case of a mirror instrument, corresponds with 1 microampere, and that when working the galvanometer in connection with the condenser, as described, we find in any one instant 20cm. deflection, we know then that this corresponds to 2 microamperes throughout the galvanometer. If the tuning-fork employed makes 100 vibrations per second, then we also know that each contact flows through the galvanometer the 50th part of 1 microcoulomb. If the voltage of the battery charging the condenser is known, then we are at once able to determine the capacity of the condenser, for this last is equal to the quotient of the charge put into the condenser by the impressed voltage. Hence, assuming that 100 volts were employed to charge the condenser above described, its capacity in microfarads would be equal to $\frac{1}{5000}$th part of a microfarad. If, then, the same experiment is performed with the condenser plates the same distance apart, but the dielectric air instead of the selected solid or liquid, we are able to determine in the same way the capacity of the condenser when the air is the dielectric and the ratio of the capacity of the same condenser, where a steady dielectric is substituted for air to its capacity, when air is the dielectric constant of the given substance. This tuning-fork method is particularly applicable in the measurement of the dielectric constants of liquids. A suitable condenser for this purpose is easily made in the following manner :—A number of plates of aluminium are prepared, being made perfectly flat, and are held separated from one another by a very small distance by means of exceedingly small particles of glass placed on the corners of the plates, the whole of the plates being kept pressed together between two sheets of ebonite by a metallic clamp. Alternate plates of aluminium are then connected together and the arrangement constitutes an air condenser which, however, can be converted into a liquid condenser by plunging the plates below the surface of any fluid. Another condenser of a convenient form for experiments with dielectric constants of liquids was devised by the author for certain experiments carried out in conjunction with Prof. Dewar.* This condenser consisted of two cones of brass accurately turned to fit one another (see Fig. 5), the inner cone being kept concentric with the outer cone by means of an ebonite steady pin at the bottom, and a metallic screw passing through an ebonite washer at the top. By means of the screw the inner cone could be raised or lowered so as to alter the distance between the two cones by any required amount. In using this cone condenser to determine the dielectric constant of a liquid, its capacity is first determined by the tuning-fork method when the dielectric is air. The space between the cone is then filled with the liquid in question, and the capacity determined again ; the ratio of the two capacities gives the dielectric constant of the liquid. By these methods a very large number of measurements have been made by the author and Prof. Dewar of the dielectric constants of various liquids at different temperatures and frequencies.

In view of the extreme importance of the interconnection between refractive index and dielectric constant, it becomes essential to examine critically the nature of the exceptions to Maxwell's law. Investigation has shown that the values determined for dielectric constants are immensely affected in many cases by temperature and by the time of application of the electric force. Dealing first with the effect of temperature as mentioned above, a somewhat extensive examination has been made by the writer and Prof. Dewar of the effect of low temperatures on dielectric constants. One of the substances examined with great care was liquid oxygen. Prof. Dewar long ago showed that this substance had remarkable magnetic qualities, and a preliminary measurement made by us showed that its magnetic permeability had a value exceeding that of saturated ferric chloride. As liquid oxygen is transparent, and as its refractive index had been carefully determined by Profs. Liveing and Dewar, it was evidently desirable to measure its dielectric constant carefully. This was done by means of the tuning-fork method already explained, using a small aluminium condenser, consisting of 17 plates, which could be immersed in a vessel full of liquid oxygen. The result was to show that liquid oxygen has a dielectric constant 1·491† was 0·001031 of a microfarad. The above value has been substantially confirmed more recently by a measurement made by Dr. Fritz Hasenoehrl, at the University of Leyden, his value for the dielectric constant of oxygen being 1·465. The refractive index of liquid oxygen for two cadmium lines having a wave-length respectively 4,416 and 6,438 was determined by Profs. Liveing and Dewar to be 1·2249 and 1·2211. Calculating from the above measurements, the value of the refractive index for waves of infinite wave-length, we obtain the value 1·2181. The magnetic permeability of liquid oxygen was determined by a direct method consisting in the immersion of a small air core transformer under the surface of liquid oxygen.‡ The value thus obtained for the magnetic permeability of liquid oxygen was 1·00287. A more recent and very careful measurement of the susceptibility of liquid oxygen, made by an entirely different method, by Prof. Dewar and myself, showed that the value of the magnetic susceptibility of liquid oxygen is $323 \times 10^6$, and that therefore its permeability is equal to 1·0041. If we take the value of the square of the index of refraction of liquid oxygen for waves of infinite wave length, we obtain the number 2·4837 ; if we take the product of the dielectric constant of liquid oxygen as determined by Fleming and Dewar—namely, 1·491—and the value of its permeability as obtained by the direct method—namely, 1 00287—the product of these numbers is 1·495. If we take the latter value of the magnetic permeability as determined by the experiments on the susceptibility of liquid oxygen—namely, 1·0041—and take the mean value of the dielectric constants as determined by Fleming and Dewar and Hasenoehrl, which is 1·478, we find the value of the product of 1·478 and 1·0041 is 1·484, which agrees almost precisely with the value of the square of the refractive index of liquid oxygen for waves of infinite wave-length—namely, 1·4837—as determined by the experiments of Liveing and Dewar. This remarkable equality in the case of liquid oxygen between $i^2$ or the

* See Fleming and Dewar on "The Dielectric Constants of Certain Frozen Electrolyes at and above the Temperature of Liquid Air." *Proceedings* of the Royal Society, Vol. LXI., p. 299, 1897.

† See Fleming and Dewar on "The Dielectric Constant of Liquid Oxygen and Liquid Air." *Proceedings* of the Royal Society, Vol. LX., p. 358, 1897. The capacity of the small condenser with air as its dielectric at 15°C.

‡ See Fleming and Dewar on "The Magnetic Permeability of Liquid Oxygen and Liquid Air." *Proceedings* of the Royal Society, Vol. LX., p. 283, 1896.

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optical refraction index for waves of infinite wave-length and the numerical product of the value of its dielectric constant K and magnetic permeability $\mu$, is a very interesting confirmation of Maxwell's theory. We have in liquid oxygen a substance which possesses four qualities found together in no other substance, namely, optical transparency, almost perfect non-conductivity, a magnetic permeability greater than unity, and a dielectric constant nearly 50 per cent. greater than that of empty space.

*(To be continued.)*

## NATIONAL TELEPHONE COMPANY.

The annual staff dinner was held at the Trocadero Restaurant, Piccadilly, London, on Friday last, under the presidency of the general manager, Mr. Wm. E. L. Gaine, who was supported by Lord Kelvin, Sir Cuthbert Quilter, M.P., Sir Albert K. Rollitt, M.P., Mr. Albert Anns, Mr. C. M. Bailey. Mr. J. C. Chambers, Mr. C. B. Clay, Mr. A. E. Cotterell, Mr. J. T. Crowe, Mr. R. A. Dalzell, Mr. F. Gill, Mr. S. J. Goddard, Mr. W. Howe, Mr. P. P. Kipping, Mr. E. Forbes Lankester, Mr. C. F. Moorhouse, Mr. W. V. Morten, Mr. C. J. Phillips, Mr. Dane Sinclair, Dr. Walmsley, and others, the company numbering nearly 200.

After the toast of "The King" had been duly honoured,

The CHAIRMAN proposed "The National Telephone Company," and said: My lord and gentlemen, our most esteemed President, whose absence, I am sure, every man here to-night regrets, writes me how grieved he is to be again unable to be present at the annual dinner of the staff; but, as you know, his state of health and liability to bronchial trouble makes it too risky for him to be out after sunset. Mr. Forbes wished to express his appreciation of the loyalty and devotion which, individually and collectively, the staff showed in the important public service in which they played so prominent a part, and the directors thoroughly recognised this. At the last moment, too, gentlemen, Lord Harris, who has only just returned from South Africa, is compelled to be absent. It is my duty and pleasure once more to propose to you the health of "The National Telephone Company." We have seen a good deal in the newspapers and elsewhere as to the condition and the health of the National Telephone Company during the past year, but I do not think that we look altogether like a moribund lot. I must inflict upon you once more my annual statistics, because some of these figures are very instructive. Last year in Great Britain and Ireland we had 968 exchanges working. This year we have 999, and if we had dined a week later we should have had 1,000. Now I come to a rather remarkable condition of things. Notwithstanding all the threats and competition, suggestions of inefficiency, &c., we, last year, succeeded in adding to our clientèle 29,221 subscribers—(loud cheers)—against only 21,000 last year. We now have in the United Kingdom 205,000 subscribers, against 176,000 last year. We passed over our wires this last year no fewer than 712,000,000 messages—(cheers)—while the telegraphs, which have been in the Government hand more than 30 years, sent only 90,000,000 messages. The increase in the inland telegrams of the country during the past year was 2·88, the increase in the number of our messages was 15·3. So we are not quite moribund yet. But, of course, we have to face the changes which are going on around us. We are to have competition. We have heard a good deal of that for some time, and competition is already upon us in one or two places—in Glasgow, for example. It may interest you to know that, notwithstanding the competition of that very powerful body, the Glasgow municipality, the National Telephone Co. never had a more prosperous year, or a more successful year, than it had in Glasgow during the past twelve months. It was, indeed, a record year. And we have competition coming upon us in London. Well, I do not think we need be too pessimistic. Personally, I take rather the contrary view. I think that in all probability good judgment will prevail, and I doubt very much whether this competition will in the end be anything more than a competition to do the best that both of us can do in the interest of the public; and, if that is so, I am not sure that this competition is going to be for us so serious a matter after all. I do not feel at all alarmed, and I do not see, when you have regard to this great public service we are carrying on, and which is of the utmost value to the commercial community—I do not see that we have any cause for serious anxiety, and I feel certain that the Government and Parliament are bound to recognise that, to have regard to what is in the commercial interests of the country, and to see that this service is put on such a footing and conducted under such conditions as will render it practicable for us and others to do the best that can be done in the public interest.

The toast, which was coupled with the name of Sir Cuthbert Quilter, M.P., was drunk with great enthusiasm.

Sir CUTHBERT QUILTER, M.P., said: It is a heavy responsibility at any time to respond to the toast of the evening, and I feel on this occasion like "the least among the apostles" (laughter). But there are two points on which I will not yield to any of my colleagues, and they are my love for the great company to which we all belong and the length of the time with which I have been proud to have taken part in endeavouring to mould its destinies. They say that the company is now under a cloud. Believe me that the present cloud is nothing to the cloud which enveloped its infancy. I see my good friend Mr. Anns, and it reminds me of the earlier days when we were not surrounded by a trained and efficient staff such as we now have. In those days we had not such helpers as we have around us at the present time; but when we started we groped about in vain to find a man who could assist us in grappling with the many problems which, day by day, had to be dealt with. Then the board sat *en permanence*. There were no board days then, but we met every day, and I hope that, at any rate, we succeeded in laying the foundation of a great edifice which you will help to uphold and rear even still higher. It is not necessary that I should urge the desirability of a great enterprise of this kind being supported by His Majesty's Government as well as by the British public. I make bold to say that the treatment of this company by the Government has not been what it should have been. It might have been a great deal more liberal, and it ought to have been a great deal fairer. In my opinion, as a man of business, it might have been more business-like. For, what is happening? Money—the hard-earned money of the taxpayers—is being poured down below the streets in order to dispose of one of the most remarkable machines for bringing in money to the Government that has ever been seen in the history of the world. Even when you go to a sweetmeat machine in the street you have to put a penny in the slot. The Government take from £140,000 to £150,000 a year from us and do not put anything in the slot at all (laughter). Let us hope that the Government will learn wisdom in time, and pause before they thoroughly destroy this valuable bird, because I feel sure that many a year will elapse before they find anyone to produce so rare an ornithological specimen as has been brought out of the recesses of the Old Jewry by the original founders of the United Telephone Co. Gentlemen, to be serious, is it possible that if the people of this country could really understand the question that they would sit by and tolerate an operation of this kind? I consider the course that is being pursued by the Government with regard to the National Telephone Co. is not the wisest, either in the interests of the taxpayer or for the ultimate success of the operations they have in view. But I feel no fear in reference to the future of this company while the management is right. I care nothing for public appreciation or otherwise if only I am convinced that the management is sound, that the staff are thoroughly loyal, and that all are pulling in the same direction. It is always well for us in times like these to look at home and see if it is possible that the adverse impressions which are formed of our undertaking are in any way due to any fault of our own. I cannot believe that they are. This company was never so well managed as now, and I am very proud to have this opportunity of stating my believe on that point, and I hope that the few words I have addressed to you will have convinced you that, at any rate, one of the oldest friends of the company does not despair of its future.

Mr. C. M. BAILEY proposed "Our Guests," coupled with the names of Lord Kelvin and Sir Albert Rollit, M.P.

The toast was received with great cordiality, and

LORD KELVIN said: I have the honour and pleasure to speak for a very happy portion of this gathering. We have had a very excellent dinner, some good music, some charming comedy, and some very solid and permanent pleasure in listening to the speeches of your chairman and of Sir Cuthbert Quilter. We are all deeply interested in the prosperity of the National Telephone Co., and I was delighted to hear the manly and courageous and admirable manner in which Mr. Gaine spoke of the present position and prospects of the company (cheers). We have heard a great deal of hard times, of usage that does not seem to all our minds wholly fair, but Sir Cuthbert Quilter has told us that in the earlier times of the company it was under a cloud much denser, much less hopeful in respect of seeing through it and in respect of seeing it dispelled than the cloud under which he did not say we are now lying, but he said the cloud under which we were supposed to be lying. I am glad to hear what I believe myself, and that is that you are not under a cloud at all. You have in London and in Glasgow to face rivalry. I venture to predict that that rivalry will be which can get most good work out of the National Telephone Co. London will try to do something with he Post Office wires that are being laid down, but it must come to the National Telephone Co. to make the wires reach those who in the public interest must have the benefit of them. And the same thing may be said of Glasgow. I do not care what the number may be using the competing system in Glasgow, but however many there are, they must all get into touch with the National Telephone Co. if they are to get any real benefit from being subscribers either to the municipal telephone or this company's telephone. I am not going into the question of the wisdom of the Government in promoting two or three different organisations to be dealt with when the time comes for doing so, instead of leaving the country with one organisation. All I can say is, if the Government have made a great mistake, as I believe they have in their action, I do not think that it is a fatal one. On the contrary, I think the Government will come to see the right course, and I do not feel that, permanently, any injustice will be done; and, further, I venture to say that the future of this company promises to be more glorious, more beneficial to the public, and in all respects as admirable, or even more admirable than in the past. The company has done splendid service already, and you, gentlemen of the staff, I think you may safely confide in this, that you have an admirable work in hand, and are doing it well now with improved appliances. Mr. Sinclair is not an engineer to let any possibility of better appliances exist anywhere in the world without himself taking advantage of them and introducing them to you. This company have got at work just now the very best appliances in the world (cheers). There is nothing in Sweden, of which we have heard a great deal, nothing in Denmark, nothing in Germany, nothing in France, nothing in the United States of America, nor in Canada nor Australia, superior, I believe, at this moment to the appliances of the National Telephone Co. Admirable inventions have come from every one of the countries I have named. It is possible that every one of them, or some of them, may anticipate us English here at home in some beautiful and useful inventions. All I can say is, let there be any invention, made at home or by foreigners, and they will be welcomed by this company, and you, gentleman of the staff, I promise that you will get the benefit of them. I wish you, gentlemen, all possible happiness and success.

Sir ALBERT ROLLIT, M.P., said: I thank you for associating my name with this toast, but I cannot help thinking that you are following a

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very bad rule of the House of Commons in requiring two speeches to be made when one would do, especially a speech by so able an exponent of oratory and science as Lord Kelvin. To me the chief honour is to be associated with Lord Kelvin. It is now some years ago since he was my guest, when I was president of a provincial scientific society, and everyone knows that in the intervening time there is no one to whom science has been more indebted for its discoveries, and also for its applications, than to Lord Kelvin. I have said a word of the past, may I venture to add that I am looking forward at an early date to representing my University of London at, I think, the quin-centenary of the University of Glasgow, with which the name of Lord Kelvin is so prominently associated. There, wherever one goes, one is reminded of Lord Kelvin. As one of the directors of the National Company I should like to emphasise what has been said by Lord Kelvin and others how much we are indebted to our staff. I know of no company, I was going to say which is better served, but which is so well served as ours by Mr. Gaine, Mr. Anns, Mr. Sinclair, Mr. Goddard and you gentlemen present. I consider that we are under the greatest obligation to you for the development of the telephone. I am glad to have had assurances from Lord Kelvin that ours is the best system of telephony possible at the present time and that we are little likely to fall by the way so far as the adoption of the latest inventions are concerned. So I borrow from the wealth of Shakespeare to express the feelings of your guests: "We can no other answer make but thanks, and thanks, and ever thanks."

Mr. HOWE then proposed the toast of "Our Chairman" and referred to the feelings of regard and admiration which were entertained by the staff for their accomplished chief.

The toast having been heartily drunk, and Mr. Gaine having responded, a very pleasant function concluded.

## AUSTRALIAN NOTES.

(BY OUR OWN CORRESPONDENT.)

SYDNEY, *April 9th.*

**Electric Light and Power Distribution.**—Progress in electrical work in the new Commonwealth is steady if not very rapid, the tendency being to remodel existing plants on up-to-date lines. The Corporation of Melbourne, as an example, have recently bought out the three private companies who were supplying within the metropolis, and are putting in an extensive 440 volt three-wire system. The suburban portions of these companies' plant, including two generating stations at Richmond, have been taken over by the Electric Lighting and Traction Co. of Australia, and are also being remodelled and extended on the same lines. The same company will shortly be opening their new station in Adelaide (S.A.), with three 200 H.P. Willans-Peebles sets supplying a three-wire 440-volt network for the city area. The suburbs are ultimately to be supplied with alternate currents, the mixed system in this case being rendered advisable by the wide belt of park lands surrounding the city on all sides, and the small motor load which will be called for in the suburbs.

The Bendigo (V.) Electric Supply Co. are also replacing their 100 volt two-wire system by a 440 volt three-wire, at the same time largely increasing their power. The station will also supply the tramways, which are at present operated by steam, but have been bought up by the company. This work is being managed by Mr. Benj. Deakin, the representative of the British Insulated Wire Co., who have also equipped stations at Ballarat (V.), Freemantle (W.A.), and Coolgardie (W.A.). The Broken Hill Electric Light and Power Co. are doubling their plant by the addition of a 100kw. Belliss-Brown Boveri direct-coupled alternate-current set. No serious proposal has yet been made to employ electric power on the mines, although, with fuel at £2 a ton, every little economy is important. Electric traction underground is being considered by the big companies.

Launceston and Hillgrove remain the only water-power stations in Australia. At Launceston (T.) a 2,000 volt system is supplied by five 100kw. Siemens alternators driven by Thomson vortex turbines. This station is in the hands of the Municipal Council, who are making strenuous efforts to encourage a motor load by charging for power only 2d. and 1d. per unit on the Wright system. Thirty induction motors are already on the mains, and the number is rapidly increasing, a recently-placed order for 500 meters indicating the anticipated progress.

In New Zealand, water-power schemes are being considered by the Auckland City Council, who propose to utilise the falls in the Waitekauri Ranges, the Dunedin City Council, who have recently bought up the horse trams and instructed Messrs. Noyes Bros. to prepare a scheme for obtaining light and power from the Taieri river, and the Gisbourne authorities, who have obtained an estimate for bringing power from the Wairoa Falls. For steam-driven stations the Devonport (T.) City Council are borrowing £11,000, and Portland (V.) and Hawthorn (V.) authorities have schemes in hand.

The extensive system of electric distribution for Sydney, prepared last year by Major Cardew, is at last in a fair way to be carried out. The delay has been due to the resumption by the Government of the site on the shores of Darling harbour selected for the central station. The recently-reformed City Council, through the energetic mayor, Dr. Graham, have succeeded in bringing the Government to terms, and will shortly take over the site, which is eminently suitable, at a rental of £500 a year. Sydney is at present very partially supplied by three private installations, which will probably be bought out. The Corporation have powers to borrow £250,000. In electric traction rapid progress is being made. In Sydney the present Government traction station of 2,500kw. is taxed to its utmost, and the additional 4,500kw. three-phase 6,600 volt distributing system which is under construction is urgently needed. The Leichardt line (3 miles) has been brought over from steam to electric traction, making a total of 31 miles, which are worked by some 210 cars. There are 30 miles of steam lines still to be converted, and large extensions are in view as soon as the necessary power is available. The contract for 30 miles of 6,600 volt three-phase cable for connecting the power-house with the five sub-stations has just been let to the British Insulated Wire Co. at £38,800; and Messrs. Noyes Bros., Sydney, representing the Accumulatoren Fabrik Hagen, have obtained a £10,200 order for four Tudor batteries of 1,200 amperes maximum discharge. This is in addition to four similar batteries which are already being erected in the city and Newtown sub-stations by the same firm.

In Brisbane the Electric Tramway Company is adding 12 miles of line to the 33 already in service.* The Perth (W.A.) traction system has been so successful that the London directors recently handed over gratuities of £500 and £250 to their manager, Mr. Rogers, and engineer, Mr. Somerset, in recognition of the good work accomplished. Traction systems are also in progress in Auckland (N.Z.), Dunedin (N.Z.), Bendigo (V.), Ballarat (V.), Freemantle (W.A.) and Kalgoorlie (W.A.) and under consideration for Adelaide (S.A.), Rockhampton (Q.) and Wellington (N.Z.).

For power distribution high-pressure polyphase currents are now employed in at least three mining centres in Victoria. At Sandy Creek, Messrs. Newton & Co., of Melbourne, have equipped a 450kw. 2,400 volt Stanley three-phase generator for operating a gold dredging barge which has been running successfully for some six months. At Eldorado, a gold sluicing plant is operated electrically, power being generated by a 330kw. 1,000 volt two-phase alternator by a local maker, Weymouth of Melbourne. In addition to these a much larger system has recently been put in to operation at Charlotte Plains by the Deep Leads Electric Transmission Co. In this case, power is derived from three 400kw. three-phase 60 cycle 6,600 volt steam-driven General Electric alternators, and distributed to four shafts at distances up to 5 miles, to operate pumps, hoists, puddling pans, &c. The pressure is transformed at the head of each shaft from 6,600 to 440 volts. In three the pumps are driven by 250 H.P. induction motors, placed 350ft. below the surface, and constructed to be capable of operating under water, in case the shaft be "drowned out." In the fourth a Cornish pump is used, driven by a 400 H.P. induction motor at the surface. At the Mount Morgan (Q.) goldfields a 500kw. direct-current power and traction plant, designed by Mr. E. H. Hewlett has been in operation for some time. An extensive two-phase power distributing plant is under order from Messrs. Noyes Bros. (agents for the Westinghouse companies) for the new Queensland Government railway workshops at Ipswich, and the Kalgoorlie Electric Power Co.,

* The accounts of this company for last year show receipts amounting to £75,000 and an expenditure of £41,000—a ratio of 55 per cent.

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which is slowly maturing its plans, promises to supply the mines of that district with an up-to-date electrical system.

Telephony in Mining.—The telephone has, on account of the rough conditions encountered, met very little encouragement in Australian mines until a recent regulation in the Bendigo district (V.) necessitated a more complete system of signalling between the surface and the underground workings. At the Johnson's Reef Mine an underground telephone service is giving every satisfaction. But outside of this district the old clapper signals still remain the only means of communication between the surface and the workings.

Electric Lifts.—Electric lifts will quickly follow the introduction of electric power into our larger cities. The General Post Offices of Perth and Sydney have taken the lead, and one private firm in each city has followed suit. In Sydney Messrs. Edge and Edge are introducing Sprague elevators, and in Perth Messrs. Splatt, Wall & Co. Otis lifts. This business should offer possibilities to an energetic British firm.

The Tariff.—The Commonwealth tariff is awaited with interest in the electrical world. It is to be hoped that Mr. Barton will see the futility of trying to raise the Commonwealth revenue by choking an industry which cannot pretend to compete in manufacturing with the older countries. Australian engineering firms have their possibilities fully taxed to supply the demands of the mining and hydraulic industries which are more or less peculiar to Australia. In electrical plant, standard imported machinery will prove far more satisfactory than anything which could be manufactured out here at present. The long delays in delivery, of course, remain a great difficulty. This should be partially overcome as the demand becomes more steady, and the importing firms are enabled to carry stocks. The difficulty might be minimised by careful cataloguing. The excellent catalogues turned out by the Americans gives them a great advantage over British firms, which one would like to see reversed.

## CORRESPONDENCE.

### "GRADED" INSULATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to the following extract from a Paper by Mr. Mervyn O'Gorman, which appeared in your issue of March 15:—

The reason for objecting to bubbles is not usually appreciated: not only does the possibility of a single bubble increase the thickness of the dielectric throughout and thus add to the cost of the cable, but even the increased thickness is not as effective as the thinner dielectric if the insulator were continuous. This inefficiency of the thicker material (unless the increased thickness is equal to the diameter of the bubble) is shown by an experiment which is perhaps not as well known as it deserves to be:—If we arrange two conductors, A, C, at such a distance apart that the air is just able to withstand for an indefinite time, say, 10,000 volts maintained by a transformer, and then introduce between them a strip or two of glass

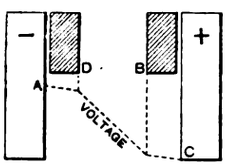


FIG. 1.

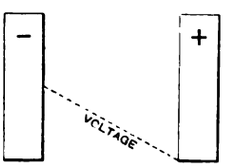


FIG. 2.

or ebonite, D, B, the insulation breaks down, although the glass is a more volt-resisting substance than an equal thickness of air. This experiment was shown by Tesla, and taken by him to show that ebonite was a less resisting substance than commonly supposed. The explanation, however, is very different and quite simple: the rate of fall of volts per centimetre of air is the highest the air can withstand; as glass has a higher specific capacity the potential gradient in the glass is less steep than in the air, and the consequent increased steepness in DB punctures the air; and the heated glass thereupon soon gets hot and gives way under the alternating potentials. (*Footnote.*—Fessenden's particulars of this experiment are, I think, erroneous.)

I enclose the following extract from a Paper of mine, referred to in the above extract, published in the *Transactions* of the American Institute of Electrical Engineers, March, 1898.*

* [Also, in abstract, in *The Electrician*, Vol. XLI., p. 526.—ED. *E.*].

We must have an electrically homogeneous dielectric, *i.e.*, one of the same specific inductive capacity all through. This is for two reasons. First, because if we have a dielectric A between two charged conductors, the introduction of a dielectric of greater specific inductive capacity, even if of infinite dielectric strength and ohmic resistance, will cause A to break down. To take a numerical case: Suppose we have two plates 1cm. apart, and attached to the terminals of a 10,000 volt alternating current dynamo (Fig. 3). Suppose the dielectric, air, to support 50 per cent. more than this pressure. Introduce two plates of glass of K = 8 each ½cm. in thickness. Since the voltage divides itself up inversely to the capacitance, we will now have 8.889 volts between C and D. This being at a rate of 17,778 volts per cm. and as it only supports 15,000, we will get a spark between C and D at every reversal of the voltage, which will quickly heat the glass and make it conduct. The full potential of 10,000 will then be between C and D, and a regular arc will form. Thus we see that the introduction of a good insulator will, in all cases where an intermittent or alternating voltage is used, have the paradoxical effect of weakening the insulation, unless the whole space is filled up with the material. This weakening is not generally apparent at once, as the spark takes some time to eat its way back, and this explains why many induction coils only last for a few years of operation.

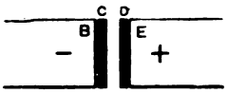


FIG. 3.

Another cause is that treated of by Poisson, Clausius and Maxwell. This is, that layers of dielectrics of different capacities and resistances show electrical absorption, and this theory has been proven experimentally by Muraoka, who showed that by taking two fluids, neither of which showed absorption, a layer of one on top of the other did do so.

I do not so much object to Mr. O'Gorman writing a Paper based upon a phenomenon first discovered and explained by me, or to his using my explanation, or to his using my drawings without giving any credit for either the discovery of the phenomenon, or for the explanation, or for the drawings, as one gets used to things like that. But I do object to the fact that, after writing the Paper based on my discovery, without giving credit for it, and after using my sketches and explanations, he should add insult to injury by saying that the explanation given by me is erroneous, thereby implying that I had given some other explanation than the one he had copied and given as his own.

I would say that the phenomenon was *not* first described by Mr. Tesla, but by me, in a lecture to the Pennsylvania railroad electricians, at Altoona, Jan. 5, 1891. Mr. Tesla is more fortunate than Mr. Keeley, in that whilst the latter never claimed to have talked with Mars, or to have discovered perpetual motion, or that he was going to transmit the power of Niagara to the Paris Exposition or a score of other ridiculous things, the literature of electrical science is so extensive that even the most conscientious may not be familiar with the history of a novel phenomenon.

The reason why—though familiar with the phenomenon—I never advocated the measures suggested by Mr. O'Gorman, is explained in the last sentences of the extract from my Paper. If we use different dielectrics we get absorption, and that is just what—as was shown by the admirable Institute Paper by Mordey—we do not want. In this connection I would say that my experience is that by using a perfectly homogeneous (so far as capacity goes) dielectric of paper and paraffin, treated as described in my publication before the Institute, the power-factor of a capacity current can be reduced to 2½ per cent., but I have never been able to make it any lower, and that only with exceptional care.—Yours, &c.,

REGINALD A. FESSENDEN.

Manteo, Roanoke Island, N.C., April 29.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I regret that when I referred to Prof. Fessenden I did not quote chapter and verse; I have, however, succeeded in introducing the proper reference in the copy of my Paper as it will appear in the Institution *Journal*. In my original draft I gave reasons for objecting to his explanation "the voltage divides itself up inversely to the capacitance," but in attempting to abridge my Paper I have unfortunately omitted the reference while leaving the criticism, which is meant to suggest that if anyone attempts to conduct the experiment according to Prof. Fessenden's particulars, he will find it

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uncommonly difficult. The experiment is no way fundamental to my Paper, and I was unaware that he had described it in 1891. My excuse must be that I cannot even now trace a report of it either in the English or American journals to which I have been able to obtain access. On the other hand, Mr. Tesla performed the experiment repeatedly in 1891 (Amer. Inst. E.E., p. 282). Tesla says: "If the two metal spheres are so far apart that no spark occurs, by inserting a thick plate of glass the discharge is instantly induced to pass." It will be seen, therefore, why Tesla's name is mentioned in the text and Prof. Fessenden's in the footnote instead of vice versa. I did *not* say that Tesla first performed it, though I naturally thought the experiment common property. For example, at the Crystal Palace Exhibition, Messrs. Swinburne & Co. showed how the high specific inductive capacity of glass made an air-gap break down,* how the glass got hot, was then pierced, how the fused glass filled the hole, and, being a good conductor, the arc in air remained (*Industries*, April 22, 1892).

With regard to Prof. Fessenden's reference to Maxwell, kindly observe that Maxwell points out that layers of dielectrics of different capacities and resistances may be arranged so as *not* to show any electrical absorption, provided only that $k/r$ (the product of specific capacity and resistance) is the same in all layers.

Prof. Fessenden, in spite of his using a homogeneous dielectric has "never been able, even with exceptional care," to get a power factor lower than 0·025. I may mention that Lombardi obtained half that figure with a mixture of paraffin and ceresine, and that there are unprejudiced tests on modern commercial cables which show power factors lower than 0 025 in spite of their somewhat heterogeneous character.

My proposed "grading" of the capacity of different layers does not require a greater diversity of electrical qualities than occurs in many modern cables, and in the discussion on Mr. Mordey's Paper I gave some reasons for the high power-factors in non-graded insulations. In this matter the advantage of "grading" should be considerable.—Yours, &c.,

London, May 22. MERVYN O'GORMAN.

## GRIMSBY ELECTRICITY WORKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your description of the electricity works here in your last issue, I should like to make one or two corrections. The siding is taken from the Great Northern Railway Co. With reference to the building, the active part in supervising this work has been taken throughout by Mr. Herbert Heap, the deputy borough engineer. The piling under the chimney, although specified, was not put in, the foundation being found satisfactory without using this. Sixty-five public arc lamps will be in use in the streets and 10 arc lamps in or around the station. We have three spare. The steam pipe covering was made by the Washington Chemical Co., and fixed by Messrs. A. Haacke & Co., of Liverpool and London.

I shall be glad if you will insert these corrections in your paper.—Yours, &c., W. A. VIGNOLES.

Grimsby, May 21.

# PARLIAMENTARY INTELLIGENCE.

## MANCHESTER AND LIVERPOOL ELECTRIC EXPRESS RAILWAY BILL.

The decision of Viscount Falkland's Committee of the House of Lords on this bill was given on Friday last, after 35 minutes' consideration, following Mr. Balfour Browne's reply for the promoters.

The CHAIRMAN asked whether the promoters guaranteed that the centre of gravity of the cars would be below the top rail when the car was fully loaded.

Mr. BLENNERHASSET, K.C. (for the promoters): Yes, sir, certainly.

The CHAIRMAN: How far below?

Mr. BLENNERHASSET: I am instructed to say 12in. below the top rail at least. If necessary, my scientific advisers take it that it could be more than 12in., but we are prepared to guarantee 12in. as a minimum.

The CHAIRMAN then announced that the Committee passed the preamble of the bill, and that the measure might proceed, but they would like to have a clause inserted guaranteeing the centre of gravity.

Mr. BLENNERHASSET said the promoters would bring up a clause carrying out exactly the wishes of the Committee.

Counsel for the petitioners against the bill stated that they intended to take no part in the discussion of clauses, indicating that they proposed to fight the bill in the House of Commons.

Later in the day the clause suggested by the Committee was brought up. It provided that "the cars or all the vehicles to be used on the railway shall be constructed so that when the car or other vehicle is fully loaded the centre of gravity shall be at least 12in. below the upper surface of the uppermost rail."

The bill was ordered to be reported to the House.

## METROPOLITAN ELECTRIC SUPPLY COMPANY'S BILL.

This bill again came before the Select Committee presided over by Sir H. Fletcher on Friday last on adjustment of clauses. The promoters brought up clauses in order to comply with the conditions laid down by the Committee in passing the preamble. These clauses are mainly directed to safeguarding the interests of the local authorities, and for securing the inclusion in the bill of the protective provisions of the company's 1890 provisional order.

The various new clauses (five in all) having been added to the bill, Mr. CRIPPS (Parliamentary agent), on behalf of the promoters, said that part relating to Paddington would be omitted. The Board of Trade required them to insert a clause in the bill relating to audit, this being the outcome of a memorandum by the Board of Trade auditor of the accounts of the company. He would ask the Committee not to deal with that. It had no specific connection with the present measure but bore upon the company's original act and on general legislation. He was in correspondence with the Board of Trade, and hoped to be able to induce them not to press the clause.

The CHAIRMAN said the Board of Trade had written to the Committee very strongly on the point, and they, therefore, could not omit the clause. It would be put in now on the understanding that it could be taken out afterwards if the Board of Trade did not persist in their objection.

Mr. CRIPPS suggested that the report of the bill should be allowed to stand over. He admitted that the clause would not do harm.

The CHAIRMAN: If it will not do harm it might just as well go in.

Mr. CRIPPS said it was unnecessary, and there was a good deal to be said against it. It was a proposal to alter the existing state of things without evidence that the alteration was necessary.

The CHAIRMAN: The Committee decide that the clause should be inserted.

## LONDON ELECTRIC UNDERGROUND RAILWAYS.

On May 14 the Joint Committee of the Houses of Parliament presided over by Lord Windsor continued the consideration of the various bills relating to the London underground electric lines. The scheme of the Central London Railway for making a loop at each end of their line to facilitate the running of trains was first gone into, Lord ROBERT CECIL, K.C., explaining that the only place where the extension would come into contact with any other railway was underneath a short portion of Bishopsgate-street. It did not compete with the North-East London line or the City and Suburban. There was no engineering difficulty in the way. The line would pass under Bishopsgate-street and Finsbury-circus, and it would bring Liverpool-street and Broad-street into the system.

Sir HENRY OAKLEY, chairman of the Central London Railway, said it was proposed to make a single line loop at each end of the railway. Power had already been obtained for the extension of the line to Liverpool-street, the original scheme being for a terminal station under the Great Eastern railway station, but it was understood that to meet their growing traffic the Great Eastern themselves contemplated an underground station there. That necessarily changed the scheme of the Central London, because it was clear that the Great Eastern were entitled to priority on their own ground. The Central London therefore found themselves in the position that their trains in the morning and evening were greatly overcrowded, and no more trains could possibly be run. Much time was at present lost in attaching and detaching the locomotives from the trains. That occupied 3min., and although by extra exertion it had been brought down to 2¾min., that could not be maintained. Consequently it was considered that it would be in the general interests to make a circle, so that the trains could run continuously and prevent the present unavoidable delay in changing. At present, moreover, there was always a train waiting, which was thus wasted. The manager of the railway concluded that, by means of the proposed slip, they could run a two-minute service in the busy times of the day, which would add something like 60 or 70 trains a day. They now ran about 700 a day. The same explanation applied to the Shepherd's Bush end, only there was no additional station required. The nearest approach which the extended line in the east end would come to any railway was under the Metropolitan close by Liverpool-street, and there it was 45ft. or 46ft. below. An interchange station could be accomplished with the North-East London Railway, and the Central London would welcome that line or the City and Suburban, but not both. It was proposed to make a subway to Broad-street and another with the Great Eastern, with access to the street for the public.

The CHAIRMAN: Do you not think that the most convenient way, so far as the traffic is concerned, would be to have a scheme of exchange stations in the centre of London to which the railways should converge?—The difficulty has always occurred to me that a scheme of that sort would cause such an aggregation of passengers that it would add considerably to the difficulty.

* In this case the air-gap was arranged to be within its breaking-down distance, but the whole thing is so trivial and so unimportant to my Paper that I much wonder at Prof. Fessenden's energetic onslaught.

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The CHAIRMAN: With regard to the Central London Railway, you think it is more convenient to have exchange stations and not another through route?—Certainly. There was not to be a junction of railways at Liverpool-street, but only an interchange.

Mr. LITTLER, introduced the case of the Charing Cross, Euston, and Hampstead Railway. There were two bills, he said, before the Committee. The Charing Cross, Euston, and Hampstead Railway was practically to serve a purpose which had been before Parliament for 20 years past. On three occasions lines had been authorised respectively from Charing Cross to Euston, St. Pancras and Kentish Town. It was a line which everybody recognised would be of great advantage even before electricity made it possible to carry out the work. Two extensions were proposed by the present bill. The first was to Golder's Hill, and the second to Highgate. It was proposed to have 13ft. tunnels, so that it would be possible to have motors, thus avoiding the necessity of having engines. and getting rid of vibration.

Sir DOUGLAS FOX said that by a 13ft. tube a thoroughly efficient permanent way and proper size wheels could be used, and it would allow motors to be attached to the axles of the cars. By that means the weight would be distributed. The great point was to avoid, as the Vibration Committee had shown, non-spring-borne weight. To do that they must adopt a different system and have rather more room. Their rights at present only extended to 11½ft. tubes, and as they had ordered machinery for the 13ft. tube they would be at a loss of £50,000 or £60,000 unless power was given to use the larger tube.

Mr. BUSHE, K.C., for the City and North-East Suburban Railway, said the line was to run from Bishopsgate-street to Waltham Abbey, 14 miles in length, four of which would be by tube and 10 in the open.

On May 17 evidence was given to show the necessity which exists for the proposed line, and the suitability of the route adopted by the promoters.

Mr. BALFOUR BROWNE, K.C., then presented the case for the North-East London Railway scheme. The line of route, he said, was from Cannon-street, via Bishopsgate-street, to Tottenham, a branch line going to Chingford from Stoke Newington. It was proposed to form a junction with the Piccadilly and City Railway, which scheme was promoted by the same set of financiers. The proposed junction would give through communication to the West of London, while a densely populated area would be served, and the line would become almost a necessary condition of the proposed workmen's settlement of the London County Council at Tottenham.

Sir DOUGLAS FOX stated that the North-East London line commenced by an end-on connection with the Piccadilly and City Railway at Cannon-street where a sub-way connection could be made with the District Railway. After passing under that line for some distance it would pass under Gracechurch-street, close to the Monument Station. It would then pass under Bishopsgate-street without interfering with the Great Eastern Railway, but if that company were willing a sub-way might be made to connect with the platforms at Liverpool-street. There would be no difficulty in connecting with the Central London Railway's proposed loop. The line would afterwards go by way of Kingsland-road to Tottenham. By interchange stations, communications could be made between the line north and south of the river. He was prepared to meet any objection raised on behalf of the North London Railway by having a system of insulated returns, and that would obviate all difficulty. He mentioned that in Liverpool under similar circumstances where there were telephones and other delicate instruments quite near the generating station, no difficulty was ever found to arise by this system of insulated returns on a short circuit, but he preferred to have that matter treated by the electrical engineers who would be called in due course.

Opposing counsel raised the question whether this matter had anything to do with the subject before the Committee.

The CHAIRMAN, after consulting with his colleagues, said the Committee felt it was not right to shut out the evidence in regard to insulation, having gone so far as they had, but they hoped it would not be gone into at great length and that evidence would be kept strictly to the point in regard to any conditions it might be thought necessary to impose.

When the Committee met on May 21 the CHAIRMAN (Lord Windsor) expressed their very deep regret at the sudden premature death of Sir Courtenay Boyle. His lordship referred to Sir Courtenay's public services, and said the Committee had hoped to have had the benefit of further evidence and advice from him.

Mr. LITTLER, K.C., senior counsel present, re-echoed the sentiments of the chairman on behalf of the members of the Bar.

The case of the Charing Cross, Euston, and Hampstead Railway was mentioned by Mr. Littler.

The CHAIRMAN said a communication had been received from the Board of Trade. The Committee had very carefully considered this communication, but saw no reason for altering their previous decision in regard to this railway.

The North-East London scheme was then further considered.

Mr. C. F. JENKIN, C.E., examined by Mr. MOON, said he was instructed to give evidence by Messrs. Siemens Bros. & Co., whose firm had carried out the electrical equipment of the Waterloo and City Railway, and had also in hand the experimental electrical work upon the District Railway between High-street, Kensington, and Earl's Court. Witness handed in a diagram showing the electric conductor and the return, consisting of two steel channels situated one above the other and supported by porcelain insulators standing on the side of the rail.

Mr. MOON: Is that a method under which, in the case of an accident, there is complete immunity from stray earth currents?—No part of the circuit is connected with the other. The whole system is insulated, and even if the insulation were to break down at one part no danger could possibly be done. It was only when simultaneous breakdown occurred on both the line and the return that any external effect could be produced. These two steel channels were the only conductors. There was no earth connection at all in the system. In the normal working of the railway the only possible earth currents would be due to leakage and defective insulation. The amount of the leakage would be entirely negligible and would be less than was found in the ordinary electric light works. A constant test would naturally be made and any leakage would be at once remedied. In any large electrical installation a breakdown at any point would be liable to allow the electric current to go into the earth, which would probably affect any telegraphs or telephones using the earth as a return. By the method he proposed, however, leakage could only occur by a simultaneous breakdown of two joints, one on each of the insulated conductors. If an earth connection, both positive and negative, occurred, there would be a breakdown and the trains could not run until it had been remedied.

Would that result in the current being switched off so that, except at the moment at which the contact took place, there would be no disturbance of the electric signalling apparatus near it?—The automatic cutouts would at once disconnect the sources of power from the circuits under ordinary circumstances. It would be only momentary, and might reasonably be expected to happen occasionally. It was much more likely to happen with tramway systems than with tube systems, such as he had described. Both electric light and tramway systems were more likely to produce earth currents than such a complete insulated system. It was most unreasonable to suggest that the streets in certain neighbourhoods should be forbidden for tramways or electric light or tube railways merely because the neighbouring steam railways were using the earth in the vicinity as a return circuit for their telegraphic systems. The obvious solution of the whole difficulty was to provide insulated returns for the electric signalling stations. That was a complete protection. It was proposed to have multiple motors on the railway. These motors would be distributed all along the train more or less regularly. There would be no necessity for a loop at the end of the system if a shunting-neck were provided beyond the terminus. As there would be no locomotive to shunt, all the train had to do was to run out to the other line, which would allow for a 2½min. service.

By Mr. LITTLER: The scheme proposed was not considered as a final one. Developments might take place, and the promoters of the line would take full advantage of them. It was assumed they would use 500 or 600 volts on the circuits, although it might possibly be 800. In the scheme they had assumed they would have three-phase transmission, with either rotary conductors or motor conductors at the stations supplying the system with continuous current.

Counsel for the Metropolitan Railway complained that the signals of the railway were interfered with.

The CHAIRMAN (to witness): I gather that, in your opinion, the remedy for this disturbance is that all electric works should have insulated returns?—I would not go so far as that. All that is necessary is that telegraphic and telephonic apparatus in the immediate neighbourhood should have insulated returns, but not all electrical works.

Then I am right in assuming that the risk is so small, in your opinion, that it does not matter how close these systems are to one another?—That is entirely my opinion.

Major PHILIP CARDEW, R.E., said he fully concurred with the evidence of Mr. Jenkin. Owners of electric services could protect themselves by having metallic returns. In the particular case under consideration the railway company, by proposing to use a completely insulated system were going beyond what was required by the Board of Trade. There was no danger of interference under such circumstances with railway signalling. So long as a railway in the immediate neighbourhood used earth to the complete the circuit there was always a remote risk of interference. He should have thought the Metropolitan Railway would have themselves removed the risks. He considered the railway companies ought to be prepared to maintain their signalling arrangements in an efficient state, having regard to the fact that electricity was so largely used all over London, and leakages of current could not be prevented.

Mr. GEO. WEBB, town clerk of Stoke Newington, said there was no objection to the line provided conditions were made protecting public traffic, and this the company were prepared to meet.

J. F. GOODAY, general manager of the Great Eastern Railway, opposed the bill. He admitted there was some overcrowding in the morning on that railway, and said the necessity of an extended service was present to their minds. They had, however, increased accommodation by 20 per cent., and relieved overcrowding to a considerable extent. They were providing trains for the early morning service to carry 850 workmen by increasing seating accommodation in the carriages. The board were not prepared to immediately carry out or go to Parliament with a scheme, but they submitted it to the Committee in order to show that the question was being considered, and to ask the Committee not to pass any scheme that would interfere with their use of the ground under their railway. In face of the probable report of the Vibration Committee, and the fact that the Central London Railway after a year's working found that they would have to alter their system, and also in view of the evidence of Mr. Jenkin that the North-East London promoters were not even prepared to say what scheme they were ready to adopt, the directors of the Great Eastern were not ready to recommend their shareholders to find money for any particular scheme in this Parliament, although the need of additional accommodation was recognised. Seeing that the Great Eastern had practically created the districts concerned, they ought to be allowed to provide the necessary accommodation. Their scheme was for a line from Chapel End to Low Leyton, under the existing line to Liverpool Street, from which it would proceed to Ilford. They would be, consequently, duplicating a great deal of their suburban lines by this proposal for an underground line. The board of directors had not formally passed the scheme, but had considered it. He thought the Great Eastern Company were better able to provide the necessary accommodation than Sir Douglas Fox & Co. It was absolutely impossible to construct the proposed lines of the Great Eastern if these other schemes were sanctioned.

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Mr. WILSON, engineer to the Great Eastern Railway, said he received instructions from his directors, acting upon which he consulted with Sir Benjamin Baker on July 4 last year, being before the depositing of the North-East London Bill. With Sir B. Baker he had considered how best the extension could be made to accommodate their increasing traffic, and they eventually decided that a tube railway under their existing line was the best course. Their proposed line would be 54ft. under the existing railway, which was the depth proposed in the North-East London and the City and Suburban Bills.

The North London Railway scheme was then briefly considered.

The Islington and Euston scheme was subsequently taken. The proposal is for an end-on continuation of the Islington extension of the City and South London, terminating in an exchange station connected with the Charing Cross and Hampstead line at Euston-road, the entire distance being 1½ miles.

Mr. H. RIGG, for the City Corporation, said the Corporation and the London County Council agreed that the scheme was a very useful extension, because it coupled up the great northern railway termini, and enabled people from those termini to reach the City.

Mr. MOTT, chairman of the City and South London Railway, said the extension would put all the railway lines of the metropolis into connection. The size of the tube for a certain portion would be 11ft. 6in., and some part 10ft. 6in., and some 2in. or 3in. less. They originally made a small tube, but enlarged it when extending it. They had since come to the conclusion, however, that there was no great advantage in having larger carriages, and were returning to the 10ft. 6in. tube. There was not the slightest vibration or complaint on their line. They tried motors under the carriages some years ago, but came to the conclusion that locomotives were the best. Their engines varied from 10 to 13 or 14 tons in weight. They hoped when they got to Islington to have a train every two minutes right through.

The committee then adjourned till to-day (Friday).

## CLYDE VALLEY ELECTRIC POWER BILL.

Sir J. T. Woodhouse's Committee sat on Thursday and Friday last to revise the clauses of this bill, the preamble of which they had passed, as announced on page 139 of our last issue.

Mr. J. WILSON, K.C., for the promoters, said his clients had framed a clause which would give the company the right to lay their mains through Port Glasgow and Hamilton, but not through Govan, Partick and Paisley. It would, however, be very serious for his clients to be cut off from Paisley. If the mains were taken round by the south of Paisley the distance would be increased by 4 miles and the cost by £20,000, and if they were taken round by the north the distance and expense would be still greater.

The CHAIRMAN suggested that the parties should come to an agreement. But they could settle this matter later.

Mr. WILSON said the promoters had considered the case of Port Glasgow, and were prepared to give up the right to go through Port Glasgow.

Mr. RUSSELL claimed exemption for the burgh of Hamilton. He said that the burgh authorities had no great objection to the mains going through the burgh if they did so by agreement.

The Committee decided against this claim.

Considerable discussion took place as to the position of burghs which in the future became authorised distributors, the outcome of the discussion being that the Committee decided to place them in the same position as burghs already authorised.

Mr. WILSON raised the point with reference to competition on the part of the company with the electric lighting undertakings of local authorities. The Committee had intimated their desire that words should be inserted in the bill to secure the subordination of lighting to power in the case of the company's supply, and he now proposed words, the effect of which was to provide that the quantity of power used for lighting should not exceed 25 per cent. of the total amount of power supplied in any single case.

The CHAIRMAN said the point had been taken that indirectly the local authorities might be competed with in their lighting undertakings by means of the mains provided for power. For instance, a small motor might be used in a hotel and be used to light the whole place. The Committee wished that point met.

Mr. ROBERT HAMMOND held that 5 per cent. was sufficiently high.

Mr. ROBERT ROBERTSON, C.E., Glasgow, considered 25 per cent. would leave a reasonable margin, and would amply safeguard the interests of the local authorities.

The CHAIRMAN said this was a new point, and the decision of the Committee would, no doubt, be taken as a precedent. He therefore thought the Committee should take time to consider their decision.

Subsequently the promoters volunteered to alter 25 per cent. to 20 per cent., and a clause with this amendment was approved and inserted in the bill.

With regard to Paisley the Committee decided to allow the company to enter that burgh in order to put in mains. The Corporation protested against the proposal and withdrew their counsel in order that they might be able to carry their opposition to the House of Lords.

The remaining clauses were settled, and the bill was ordered to be reported.

## WEST CUMBERLAND ELECTRIC TRAMWAYS.

On Tuesday the Select Committee of the House of Commons presided over by Mr. Seale Hayne considered this bill.

Mr. BALFOUR BROWNE, K.C., said it was promoted by a body of gentlemen who had formed a company, and proposed to raise £400,000 by shares and £100,000 by loan for constructing tramways and tramroads in the county of Cumberland. Of course, as the tramways were to be worked by electricity the promoters also sought power to erect a generating station, from which they would be prepared to supply electric current for all public and private purposes within certain limits. The tramway would begin in Cleator Moor, run through Hensingham to Whitehaven; through several small towns to Workington; by Lower Seaton and Flimby to Maryport; and thence along the coast, through favourite watering places, terminating at Silloth. The gauge would be 4ft. 8½in., and the tramway, which would be 31 miles in total length, would be divided, for the convenience of the local bodies who might desire to purchase, into 17 separate tramways. The tramway would serve beside 15 important villages, five large towns, the aggregate population of which amounted to 68,000, and in the whole district to be served there were 120,000 people. The estimate for the generating station and line was £361,597. The neighbourhood was very indifferently supplied with railway accommodation, and long detours had to be made at present to get from town to town. The bill had practically the unanimous support of the local authorities concerned, with the exception of Cleator Moor, the basis of whose opposition was the desire that the promoters should widen a bridge. He contended, however, that it was not the duty of a local authority to attempt to squeeze a company simply because they came for powers, and he asked the Committee not to put the promoters to the unnecessary expense of widening this bridge.

Evidence on both sides having been taken,

The Committee found the preamble of the bill proved, and expressed the opinion that the bridge in question was wide enough.

## YORKSHIRE ELECTRIC POWER BILL.

On May 13th the consideration of this bill was commenced by the House of Commons Committee presided over by Sir William Houldsworth. The same committee will deal with a rival measure (the South Yorkshire Electric Power Bill). Most of the towns of Yorkshire and many rural councils had petitioned against one or the other or both bills; and there is opposition from other directions.

Mr. PEMBER, K.C., for the Yorkshire Bill, said this bill, like the South Wales Bill of last year, and the Derbyshire and Nottinghamshire and the Cleveland and Durham Bills this year, was promoted by the principal representatives of a countryside teeming with manufacturing industries. These gentlemen formed themselves into a syndicate to promote this bill. There were over 60 names of persons of local importance; 13 of these employed 55,500 odd hands and used machinery of 42,000 H.P. Their works were rated at £216,000 a year. The collieries had an output of 16,000,000 tons of coal per annum. Outside the syndicate he was told that there were from 90 to 100 gentlemen ready to give evidence in favour of the bill, and the witnesses he should call used 16,000 H.P. and employed a very large number of hands. It was proposed by the promoting company to have four generating stations—at Methley, Wath, Thornhill, and Bingley. A radius of 16 miles from each station would practically cover the whole district. There were in the area five county boroughs, 13 ordinary boroughs, and 140 urban and rural districts, and these only administered to 130 miles out of 1,800. A small fraction only of these gave electricity supply, and such supply as there was was for tramways or lighting. At Leeds, for instance, the enormous amount of supply there went to the working of the tramways. He was told, further, that 11 larger boroughs had got works either commenced or in operation, and no doubt the Committee would hear what condition those works were in. Out of the 130 miles which was actually supplied with electricity only a very small amount was for power. Some 16 of the various authorities had provisional orders of recent or long standing, but these small schemes had very little chance of progress. As an instance he was told that nine of the larger boroughs sold for all purposes in 1899 only eight millions and a-half of units. The City of London Company alone exceeded that total considerably. In Bradford, Leeds, Halifax, Huddersfield, and Sheffield he was told that only two million units were sold, and that included the quantity consumed by the municipal tramways. The promoting company had done all they could to conciliate the authorities short of giving them an absolute veto. He thought the days of absolute veto were passed. The local authorities had been considered a great deal too much. He had grown used to the stings of these municipal hornets, and did not fear them much now. With regard to the South Yorkshire Bill, the main point in which that differed from the Yorkshire Bill was that it did not take in all the area that the latter did, and the promotion was of a totally different character. He did not think he would be putting it too strongly if he said that the South Yorkshire Bill was mainly, if not entirely, in the hands of a group of persons—highly respectable, doubtless—who had mostly got something to sell in connection with electricity. They were not Yorkshiremen, as the promoters of the Yorkshire Bill were, nor were they Yorkshire consumers. The South Yorkshire Bill absolutely excluded Leeds, Bradford and Sheffield from their area. Counsel having dealt briefly with the opposition of Barnsley, Bradford, Leeds and Sheffield,

Mr. G. H. LUMPTON, member of a Leeds woollen firm, said he was chairman of the promoting company. There was great necessity for electrical power in the whole of the district. Local authorities representing a population of nearly 400,000 had petitioned in favour of the bill. Barnsley was the only non-county borough against the bill; they objected to being supplied by the company and also refused a wayleave. Goole was not in the district of supply, nor were the eastern coal fields. The South Yorkshire Company sought no power to supply the railways and canals direct in their bill. The Yorkshire Company's scheme was a large and comprehensive one, and he thought it was the more popular. Their charges had been approved by the authorities supporting the bill, and they wished to adhere to them.

Mr. J. D. FITZGERALD (for the promoters of the South Yorkshire Bill) asked witness if his company stood out for railways and canals, and he answered in the affirmative. If two companies were authorised there

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would be a waste of capital, but his company would be able to raise its capital, even though both bills were passed by the Committee.

By Mr. GERALD FITZGERALD (for Sheffield Corporation): It was not the promoters' intention to make a distinction between county and non-county boroughs. They might wish to join up with the promoters of the Derbyshire and Nottinghamshire Company. He thought his company would be able to supply Sheffield cheaper than Sheffield could supply itself; but Sheffield had shown no desire to meet the promoters.

By Mr. WEDDERBURN (for Leeds): He admitted that he and two other members of the syndicate were members of the House-to-House Electric Lighting Co. in Leeds. That company was bought out by Leeds Corporation in 1893. He did not think it was hard on that Corporation that he was again before Parliament, and that he might have again to be bought out.

By Mr. WAUGH (for Bradford Corporation): There was no understanding that the undertaking, if sanctioned, would be sold, nor was it a fact that each person was to take out double the amount of capital he had subscribed as a member of the syndicate. It was never mentioned that they were to receive a considerable profit. The usual plans had been got out for the engineering works it was proposed to construct, and the public would be invited to subscribe to the company in an open way. The whole of the syndicate in the Yorkshire Bill were intimately connected with the industries of the West Riding and district.

Mr. W. CHESTERMAN (Messrs. Chesterman & Co. (Ltd.), Sheffield), said the Yorkshire Bill had been considered and adopted by the Council of the Sheffield Chamber of Commerce, and he had been deputed to give evidence in support of it. It was in the interest of the traders and the manufacturers of Sheffield that the bill should be passed. Foreign competition was very severely felt in Sheffield as elsewhere, and therefore the introduction of this electrical power into the district was very desirable, not only to Sheffield but to the West Riding generally. The bill would not interfere with the local authorities, but, in the opinion of the Chamber of Commerce, would tend to keep them up to the mark. Personally, he thought that railways and canals were quite outside the scope of the supply of corporations.

Other local evidence in favour of the bill was given.

Mr. DOUGLAS VICKERS (a managing director of Vickers, Son & Maxim) said that if the Sheffield Corporation could have supplied them at 1d. per unit, it would have been a great inducement to his firm to have taken their supply instead of putting down their own plant. If Sheffield Corporation wanted to compete with the promoters of this bill they would have to go where coal and water were cheap. Although there were collieries near Sheffield it was not a place where coal was cheap.

Evidence was called from Huddersfield, Leeds and Halifax in support of the bill, and it was urged that it would be to the disadvantage of those boroughs if they were excluded from the area of the bill.

Mr. H. S. CHILD, civil engineer, Wakefield, gave evidence in favour of the mines being supplied with electric power, and said that current would be of great advantage in sinking new mines.

Mr. M. H. MILLS, M.I.C.E., Mansfield, a director of the Barnsley collieries and mineral agent for Lord Mexborough, Lord Scarborough and other large landowners, said there had been considerable colliery development in the district in recent years. In his opinion electric power, as proposed to be supplied by the Yorkshire Electric Power Co., would be of great advantage to the collieries.

Mr. W. H. CHAMBERS, manager of the Denaby and Cadeby Main Collieries, said the output of his collieries was 1,000,000 tons a year, and they expected eventually to double that output. They used electricity now, but hoped to use a greater supply if this company were empowered to supply within the district. Witness had no doubt of the existence of coal seams a long way to the east of the Selby-Doncaster line. He thought electric power would be of the greatest value, even in the preliminary boring and sinking operations.

Mr. H. A. BRUNDELL, drainage engineer for Doncaster district, said the proposed supply of electrical energy would be of the greatest utility in drainage and sewage disposal in the district.

Mr. J. WAUGH, mechanical engineer, Bradford, said there was a great want of electric power in the smaller districts of Yorkshire, and it would effect a saving of 50 per cent. in the cost and maintenance of motive power. A cheap supply of electricity would also be of great advantage to agriculturists, to whom motive power was one of the heaviest items of expenditure.

Similar evidence was given by Mr. F. E. Nicholson, clerk of the Doncaster District Council; Mr. T. Baldwin, chairman, Horsforth District Council: Mr. Wheatley, chairman, Calverley District Council; Mr. C. J. Newstead, chairman, Wharfdale and Guiseley District Councils; Mr. F. Hall, clerk to the Ilkley Council; Mr. J. A. F. Aspinall, general manager of the Lancashire and Yorkshire Railway, and others.

Mr. T. MERSTON, manager of the Aire and Calder Navigation, spoke as to the importance of the efficient supply of electricity for driving canal boats, and said his company supported the Yorkshire Bill because the whole of the navigation was within the area of supply of the promoters.

Mr. A. WILLIAMS, general manager of the Leeds and Liverpool Navigation Co., said his company's navigation joined the Aire and Calder at Leeds, forming a continuous waterway between the east and west coasts. His directors had been considering the desirability of putting down electric power to drive their boats. They did not think it would be convenient to take power from each local authority through whose district the navigation ran, but that it would be much better to take it from a big company. It did not, however, matter where his company got electric power from, so long as they got it at the right price.

Mr. C. R. DYKE, manager of the Rochdale canal, said the Yorkshire section of his canal passed through the districts of seven local authorities, and it would, consequently, be much more simple for the company to get their electric power from one undertaking

Mr. J. PEATE, cloth manufacturer, Guiseley, supported the Yorkshire bill. As a member of the Leeds Council he agreed that the Council should protect their streets. He contended that Leeds should retain the right to supply within their own area, but thought they should be compelled to grant a way-leave to this outside company.

Mr. PEMBER on Monday announced that a settlement had been arrived at between the two companies, consequently the South Yorkshire Bill would be withdrawn. The main element of the agreement was that the Yorkshire Company accepted three gentlemen from the South Yorkshire Company on their board.

The CHAIRMAN: It is practically an amalgamation.

Mr. BALFOUR BROWNE said that was so. At the same time they would keep the South Yorkshire Bill alive until the amalgamation was effected.

The CHAIRMAN said Bradford, Sheffield and Leeds wished to be excluded from the Yorkshire Bill.

Mr. WEDDERBURN said the South Yorkshire Company had an agreement with Bradford by which they were to go through, by wayleave, an isthmus to the north of that city. How was the amalgamation affected by that agreement? Were the Yorkshire Company going to consent to the same arrangement?

Mr. BALFOUR BROWN said Bradford Corporation would give the Yorkshire Company no more than they had given the South Yorkshire Company.

Mr. JAMES SWINBURNE said he was not connected with the promoters in any way. It was proposed to put up something like 100,000 H.P. generating stations with the present capital of two and a-half millions. It was impossible, in a scheme like this, to give an accurate estimate beforehand as to what could be done with a given amount of money or how much a given thing would cost, because the whole of it was to some extent speculative. They could not tell where the supply was going to be or where the demand might come from. He considered the four generating stations were well placed. The scheme ought to be a great help to the local authorities, because it gave them the chance of putting down distributing mains only, without going to greater expense. If they found later that they could generate cheaper themselves they could do it. Maximum prices in a bill like this were simply to guard the undertakers from starting at a price they could not maintain, and also to prevent the company losing in the case of small consumers who were inconveniently placed and who demanded power. The consumer who used 200,000 units in a quarter of 700 hours must be a consumer with about 700 H.P. of plant.

In reply to Mr. Loder (a member of the Committee), Witness said the schedule in this bill was much more in favour of the consumer than that in the Cleveland and Durham Bill, or the South Wales Bill. The present promoters were taking their maximum at 100 hours and the other bills took the maximum at 400.

Continuing, Witness said that local authorities could very well decide at the end of five years whether they would put down their own station or not, but he thought they would find it better to take power from this company. It was of the greatest importance that the company should have the right to lay trunk mains through any district to supply places beyond. It was not a very difficult or troublesome undertaking to lay a trunk main carrying a few thousand horse-power through the streets, and it caused no more inconvenience than laying a water pipe to one consumer. It was nothing like breaking up the streets for laying water or gas mains, and they had not to be so particular about levels. It would be absurd for railway companies to think of taking up a supply of electric current from every local authority of the districts which they passed through. He also thought the canal companies would find their haulage cheapened by the employment of electric power.

Mr. WEDDERBURN: Why do you want to go through Leeds?—To get to the other side. If the company could supply equally cheap with the Leeds Corporation he would like equal rights of supply. Witness did not know that Leeds had supplied, or was ready to supply as cheaply as ⅝d. per unit. 'This company might supply chemical works at ⅜d. The company's mains would cost from £1,000 to £1,300 per mile.

The CHAIRMAN said the Committee had not yet decided whether the railways and canals should be supplied by the company or whethey they ought to take their supply from those local areas through which they passed.

Mr. GERALD LODER (a member of the Committee): Does it or does it not follow that if powers are given to the company to supply the railways and canals the company will have to lay their mains through those boroughs?

Mr. PEMBER: No, Sir, that is made absolutely clear in the bill.

Mr. GEORGE GIBB, general manager of the North-Eastern Railway, gave evidence in support of the bill and especially in regard to that clause which enabled the promoters to supply electric energy to the railways within the area of the company's supply. He said he supported the scheme not only on the general principle, but because it especially affected his own company's system. They wanted electric power not only for traction but also for workshops, cranes, signalling, and, in fact, for all purposes for which a railway company had to use power. If they were compelled to take their supply from the authorities through whose areas they passed it would, to some extent, retard the application of electric working.

Prof. S. P. THOMPSON said, after many years' close consideration to the subject of the supply of electrical energy for lighting and power, he was convinced that the most desirable way was by bulk, in the manner proposed by this bill. With regard to the matter of wayleaves he held a very strong opinion that an enterprise of this kind, which was for the benefit of a large number of important industries, ought not to be hampered by having to go to unnecessary expense in laying mains round the large cities and towns in order to supply consumers on the other side. He thought they should be allowed to pass through these cities and towns, but that actual routes should be left to arbitration; but the mains should not be laid through very busy thoroughfares. He could not see why Leeds, Bradford, or Sheffield should be

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allowed to depart from this principle. The present scheme was a large one, and he could not say what number of mains they would have to lay or what would be the size of the mains.

Mr. WAUGH said there were some streets in Bradford where, if mains were taken through, serious injury would be caused to water pipes and sewers.

The CHAIRMAN said this was a question the Committee would have to decide when the clauses were brought up.

By Mr. WEDDERBURN: Witness said it would cost the company £30,000 to lay their mains through Leeds. He agreed there should be no interference with the streets of a borough unless public necessity was shown. Consumers on the other side of Leeds would get current cheaper if the company were allowed to lay their mains through the city.

The CHAIRMAN: Am I right in understanding that Leeds can supply the railways and canals?

Mr. WEDDERBURN: Yes, it could do that as well and as cheaply as the promoters.

The CHAIRMAN: But what I mean is, is there no prohibition?

Mr. WEDDERBURN: No. (To Witness): Do you know that Leeds has offered to supply current at §d. per unit?—They cannot afford to do it unless they overcharge somebody else.

Re-examined: If Leeds can supply current cheaper than this company, they will have as good or a better opportunity of getting business than the company. But he did not think the Leeds system would permit of so cheap a supply. He thought it was a foolish policy for any city or borough to ask to be excluded.

This evidence completed the case for the promoters.

Mr. BALFOUR BROWNE, for Bradford, pointed out that in the Cleveland and Durham Bill he asked the Committee to keep in the area of supply a number of small boroughs, and if he were appearing for any small borough in this case he could not deny the arguments he then used. But he appeared for a large borough that had an installation of its own, and was supplying itself at as cheap a rate as this company could supply. And this company was not asking parliament to keep Bradford in the limit of its supply at all. Bradford was the owner of its own tramways and was supplying current to them at $1\frac{1}{16}$d. per unit, and he asked the Committee not to allow this company to come in by a side wind and compete against them for their best customers—the railways and canals. He suggested that Bradford should give a wayleave through the borough in order that the company might supply places beyond, but only on condition that they were not allowed to supply the railways and canals within the borough.

Mr. ROBERT HAMMOND thought the wayleave was unnecessary so far as Bradford was concerned. He did not agree with some of the conclusions given in evidence. His opinion was that the promoters of the bill had under-estimated the cost of distribution. Leeds had spent £161,000, and had not got mains everywhere. The question of supply to railways was one of public policy. A place of the size of Leeds could supply more cheaply than a company at a distance. The only thing the Leeds Corporation was afraid of was unfair competition. Sheffield, again, was doing its utmost to bring its electrical undertaking up to a high state of efficiency. There was no necessity for a wayleave at Sheffield. Leeds Corporation were endeavouring with success to meet the latest developments in electrical science.

Mr. R. A. CHATTOCK, electrical engineer to the Bradford Corporation, said that when their new buildings were finished they would be able to supply 20,000 H.P. In September last they had 1,777 consumers, equivalent to 72,841 8 c.p. lamps. They had 609 motors connected, equivalent to 2,622 H.P. 3,424,658 units were sold in 1900 and for the last two years there had been an increase in output of 1,000,000 units per annum. About 1,000,000 units were used for the tramways last year and about the same quantity by private consumers. There were 76,000 units used for public lighting. At present the Corporation supplied the Great Northern Railway Co. for lighting only. The Lancashire and Yorkshire Railway Co. were supplied by the Corporation with current for lighting and for power for motors equivalent to 58 H.P. That company had applied for a supply for 40 further motors. The Midland Railway Co. generated their own current. He felt that with their present and their extended works the Corporation would be quite able to meet any future demand for power. They hoped their extensions would be completed by the end of the year. The undertaking in Bradford was run on very economical lines compared with other electrical undertakings, and their total cost per unit was 1·16d., the lowest figure in the kingdom. This was for 1899. On the expenditure there was an income of £38,548, and the net profit for 1900 was only £2,731. The Corporation being themselves large consumers of electricity for power, their object was to get a good diversity factor and a good load factor, so as to decrease the cost to themselves, and that was where the advantage came in. They really got no other profit. The Corporation sold current for power to the Lancashire and Yorkshire Railway Co. at 1d. per unit, but he did not admit that they sold at a loss. In arriving at the profit and loss he put the profitable and unprofitable customers together.

Mr. J. H. COX, C.E., surveyor to the city of Bradford for 22 years, gave similar evidence. He said the suggestion that the promoters should come up with their mains to within a half-mile radius of the town hall was an impracticable one, because the population of the city was dense for a far larger area than a half-mile radius. Bradford asked to be placed on the same footing with regard to this bill as were Manchester and Liverpool with the South Lancashire Electric Power Bill, and to be totally excluded from its operation. The Corporation were, however, prepared to give the company wayleaves at the extreme west and the extreme east of the city, as they had offered to the South Yorkshire Company.

The CHAIRMAN: Supposing we excluded Bradford from the area altogether, it is quite possible that the borough may be extended, so that the wayleaves might come inside the boundary after all?—Yes.

Mr. WATSON, C.E., waterworks engineer to the Bradford Corporation, gave similar evidence.

Mr. FITZGERALD, for Sheffield Corporation, said they were endeavouring to perfect their electrical system, and as for a wayleave of any sort they would decline to make even the concession Bradford had made.

Mr. S. E. FEDDEN, chief engineer and manager of the Sheffield Corporation electric supply department, said £423,000 had been spent on their electrical undertaking, and they were now spending on new works, some of which had been commenced, a further £300,000. When they had fully extended their works the cost would be something like a million sterling. They would be able to meet all the requirements in the district. The motors used for power were giving every satisfaction. Their charge for current for power was 2d. per unit, and in the event of a consumer using his motor for 45 hours per week, he would get 25 per cent. reduction.

Mr. ROBERT STYRING, chairman of the Electric Light Committee of Sheffield, also gave evidence, and this concluded the case for Sheffield.

Yesterday, on behalf of the city of Leeds Corporation opposition,

Mr. H. DICKINSON, chief engineer and manager of the electricity supply department of the Leeds Corporation, said the Corporation took over the undertaking of the House to House Company in 1898. It cost them £388,000, and they had spent on additional works £170,000. When they had finished their extension the total cost would be about £700,000. They would be well able to produce all the electric current required for power in the district. Their highest actual charge for current was 2d., less 5 per cent. In 1900 they offered to supply current for power for §d. per unit, but this offer was declined. If the railways were taken away it would materially affect the supply to other consumers, because the railways would be among their best customers. There was a great objection to the Yorkshire Company laying their mains through Leeds, as that would add to the Corporation's many present difficulties.

Ald. R. WIGRAM, chairman of the Leeds Electric Lighting committee, said they had purchased the gas, water, and tramway undertakings in order to have complete control of their streets, and objected to the promoting company having a wayleave through Leeds.

Mr. PEMBER, K.C., for the promoters, having replied on the whole case,

The CHAIRMAN announced that the Committee had decided that the preamble of the bill had been proved. With regard to wayleaves, they would not exclude Bradford, Leeds, or Sheffield, but desired to express the opinion that they would like to see a prohibited area in each of these places agreed upon in a clause to be brought up. If no agreement was arrive at in any of these cases the Committee would be prepared to deal with it. With regard to the railways and canals, they passed the bill as it stood. With regard to Huddersfield and Barnsley, they did not know what had happened.

It was stated that in these cases a settlement had been arrived at, and that Halifax had been dealt with in a like manner.

Mr. BALFOUR BROWNE intimated that Sheffield, Leeds, and Bradford would withdraw from the inquiry altogether, and reserve themselves to oppose in the other House.

The Committee then decided to consider the question of the prohibitive areas.

The CHAIRMAN subsequently intimated that in the case of Huddersfield, Halifax, and Barnsley, prohibitive areas had been agreed upon by the parties, and with regard to Sheffield, Leeds, and Bradford, the Committee wanted from the promoters a clause undertaking that there should be a prohibitive area of a mile from whatever place they could suggest—either the Town Hall, the Cross, or the centre of the city. He hoped there would be no difficulty about the matter. They wanted the promoters to bring up a clause in harmony with their decision. They did not confine them to details.

The Committee declined the application of the Corporation of Dewsbury to put an electrolysis clause in the bill.

The Committee then adjourned until Tuesday, June 11.

## LONDON COUNTY COUNCIL TRAMWAYS EXTENSIONS.

The Select Committee of the House of Commons, presided over by Mr. Seale Hayne, on May 12 commenced the consideration of the bill of the London County Council, providing for a large number of junction and new lines, principally in connection with the tramway system on the south side of the Thames, the whole to be operated by electricity on the conduit system.

Mr. YOUNG, valuer to the London County Council, having given evidence as to the street improvements to be carried out in connection with the scheme, a number of local witnesses were heard in support of the Westminster Bridge-road to Borough High-street new line and the Camberwell Green to Forest Hill new line. After this evidence the case for the promoters closed.

Opposition was then offered and evidence given on behalf of the Governors of Dulwich College, who argued that the Camberwell Green to Forest Hill line would tend to depreciate the property of the college. This opposition was followed by that of owners and frontagers along several of the proposed routes, who admitted, however, that they had been indemnified by the associated omnibus companies.

On behalf of the London and South-Western Railway Co., against the York-road tramway and the Waterloo-road extension, Superintendent R. SHANNON, of the Metropolitan Police, Lambeth Division, referred to the congested condition of the traffic in the thoroughfares in question. Witness said that if a double line of tramway were laid along the York-road that thoroughfare would be rendered useless for tramway and all other purposes. It would be impossible to force the present traffic, which occupied the whole 33ft. of the roadway, into the 17½ft. which would be left.

Mr. TALBOT (for the bill) said that when electric traction came into use it was proposed to have fixed stopping places for the cars.

WITNESS said he did not think that would relieve the traffic much.

Mr. C. J. OWENS, general manager of the London and South-Western



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Railway Co., said his directors desired to offer the strongest opposition to the tramways proposed. The York-road line was ill-conceived and ill-designed, the natural trend of the population being south to north, and not along the river side from bridge to bridge. He thought the tramway proposed would be dangerous to the public. He asked the Committee at least to postpone the making of the York-road tramway and the Waterloo-road extension till after the authorised alterations to Waterloo Station were completed, or, preferably, to reject the proposals altogether.

The South-Eastern and Chatham Railway Co.'s case against the Southwark-street tramway was taken, and

Mr. VINCENT W. HILL, general manager of the South-Eastern and Chatham Railway, urged that the proposed tramway was unnecessary, and would seriously interfere with the working of his company's goods station at Blackfriars. He did not consider the fact that the tramway was to be worked by electricity would make much difference, as the cars would, equally with horse cars, be liable to be blocked. He denied there was any demand for the tramway.

The case of the Holborn Borough Council against the Farringdon-road extension was next considered, after which the Great Northern Railway Co's. opposition was taken.

Mr. W. J. GRINDLING, chief goods manager of the Great Northern Railway, said the proposed extension in the Farringdon-road would seriously interfere with the working of the company's goods station there.

Counsel having addressed the Committee,

The CHAIRMAN said the Committee found the preamble of the bill proved, except so much as referred to No. 6 tramway—the extension along the Farringdon-road—and No. 16—the York-road portion of the Westminster Bridge-road to Borough High-street tramway.

Clauses having been inserted by agreement for the protection of the County of London and Brush Provincial Electric Lighting Co., the bill was ordered for report.

## ELECTRIC LIGHTING IN MARYLEBONE (LONDON).

On Monday the Electric Lighting Provisional Orders (No. 1) Bill came before a Select Committee of the House of Commons, presided over by Mr. Caine. The object of the bill is to confirm two provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, relating to St. Marylebone. In a memorandum to the bill it is set out that in 1889 the Metropolitan Electric Supply Co. (Ltd.) obtained an order giving them electric lighting powers in the parish (now the borough) of St. Marylebone. In 1898 the Vestry (now the Borough Council) of St. Marylebone applied for an order authorising them to supply electricity in the borough in competition with the Metropolitan Company. This order was granted by the Board of Trade, but its confirmation was opposed by the Metropolitan Company and refused after hearing by a Select Committee. In 1900, after various representations had been made to the Board of Trade as to the necessity of a competitive supply in Marylebone, the Board granted an order to the Marylebone Electric Supply Co. (Ltd.). The confirmation of this order was opposed and refused by Parliament on the second reading of the bill. This session the Borough Council and the Marylebone Company both applied for orders, and the Board of Trade granted both applications with a view of giving Parliament the opportunity of deciding on the question as a whole. The orders were scheduled to the bill.

The parties were represented by Messrs. Sherwood & Co., Parliamentary agents, for the Borough Council, and Messrs. Rees and Frere, Parliamentary agents, for the company. Mr. Cripps, of Messrs. Dyson & Co., attended on behalf of one of the petitioners (the Metropolitan Electric Supply Co.).

It was announced that the bill would become an unopposed measure, an agreement having been arrived at between the Borough Council and the promoters of the company's order, as a result of which the latter was withdrawn, and the Council's order, which thus became unopposed, was accordingly referred back to the Committee on Unopposed Bills.

The area of supply of the Borough Council scheme is the whole of the metropolitan borough of St. Marylebone.

## HANDSWORTH DISTRICT COUNCIL BILL.

This bill came before Lord Morley, Chairman of Committees, on May 13th as an unopposed measure. The Council seek powers to construct tramways and to make connections with the Wednesbury and West Bromwich, the South Staffordshire and the Birmingham Suburban and Birmingham Central Tramways systems, and to work these ask powers either to buy electricity or start works for its supply, and also to supply electric current for lighting. The cost is put at £107,750 for tramways and £49,050 for lighting. Evidence was given as to street and other improvements, and Prof. Kennedy gave evidence as to the estimates. The bill was ordered to be reported to the House.

## TRAMWAY BILLS IN PARLIAMENT.

WIGAN CORPORATION.—A bill for conferring further powers on the Wigan Corporation, in regard to the construction of tramways (and for electric lighting), is being dealt with as an unopposed measure, and has been reported for third reading in the House of Lords.

CHESTER.—The Corporation bill to construct and maintain tramways in the city and outside districts has been reported to the House of Lords.

CLYDEBANK.—All opposition having been withdrawn this will now be treated as an unopposed measure.

## INDIAN TELEGRAPH RATES.

In the House of Commons on Friday last Sir E. SASSOON asked whether, as the reduction in the Indian telegraphs rate was being delayed in consequence of obstruction offered by Germany, the Secretary of the Treasury, for the Postmaster-General, would state the reasons which militated against the grant to the German Post Office of the right to land their Emden—New York cable at Waterville, Ireland.

Mr. A. CHAMBERLAIN said the German cable from Emden to the west of Ireland at present landed at Valentia. Germany had no cable of its own between Ireland and New York. The transfer of the landing place from Valentia to Waterville was at present the subject of negotiation, and it would be inexpedient that any statement should be made.

## CHEEFU—WEI-HAI-WEI CABLE.

On Friday, in the House of Commons, Sir E. SASSOON asked whether public tenders for the construction of the Cheefu—Wei-hai-Wei cable had been invited; and whether, in the interests of the public service and in view of the terms granted to the contracting company, the Government should not have undertaken the construction and working of the cable.

Mr. A. CHAMBERLAIN said the question of calling for public tenders had been carefully considered, but it was found that the arrangements between the Chinese Government and the Eastern Extension and Great Northern Telegraph companies as to landing rights in China, &c., rendered competition impossible. The Cheefu—Wei-hai-Wei cable formed a spur line to the submarine cable system of the Eastern Extension Company in China, and the advantages of having it worked by that company, under due restrictions as to the nationality of the staff, &c., were held to greatly outweigh any disadvantages resulting therefrom. The agreement with respect to the cable provided for the termination of the working agreement at any time at short notice if the arrangement was considered unsatisfactory. At the time the cable was laid the need for communication was urgent, and the Eastern Extension Company were in a position to do the work expeditiously on behalf of His Majesty's Government. He felt he must add that the Government had every reason to be satisfied with the company's readiness to meet their wishes in the matter.

# LEGAL INTELLIGENCE.

## Chloride Electrical Storage Syndicate (Ltd.) v. Fitch.

On Saturday last, in the Chancery Division, before Mr. Justice Cozens-Hardy, a consent order was made for an injunction to restrain the use of a secondary battery in an electric launch on the Thames in breach of the Rhodin patents, of which the plaintiffs own the English rights, and known as the company's "R" plate battery.

The defence was that defendant had bought the battery in ignorance of its being an infringement or that it had not been made by the plaintiffs.

## River Plate Construction Company.

In the Chancery Division, before Mr. Justice Farwell, on Saturday, the matter of an arbitration between the River Plate Construction Co. (Ltd.), James Capel & Co., and Mr. Charles Bright was heard.

Mr. C. E. E. JENKINS, K.C., said there were four applications by Mr. Bright, the first two of which were a motion to set aside an award, or, in the alternative, to have it remitted; and, secondly, an application to discharge the order making the award a rule of the Court. In a short preliminary statement counsel said the story might be taken to start with Mr. Chas. Bright, who was a citizen of the United States, and who was the owner—in equity, at all events—of the whole of the share capital of the company called La Sociédad Commercial de Monte Video. This company owned the tramways in Monte Video, the undertaking being worked by horse traction. Mr. Bright, having entered into the contract to purchase all the shares in the company, came over to England and entered into negotiations with certain financial groups with a view to turning this horse-traction tramway into an electric traction undertaking; and eventually, when all the work was done, a public company was formed to take over the undertaking, and he anticipated making a profit out of the transaction. In this connection he was introduced to a firm of brokers, Messrs. James Capel & Co., and a financial scheme was devised which involved the formation of two companies, one of which was formed and one not yet formed. In order to get the necessary funds, they formed the River Plate Construction Co. (Ltd.), which was a party to these proceedings, on August 10, 1899, and it was registered in the usual way under the Companies Acts. It had a capital of £120,060 in 1,200 ordinary shares of £100 each and 1,200 deferred shares of 1s. each. £126,000 was to be provided by Messrs. Capel, which was to be applied in subscribing for shares in this construction company. Then the money, the actual cash, was to be applied in paying for the shares which Mr. Bright had agreed to buy in La Sociédad Commercial. Then the necessary steps were to be taken towards obtaining authority to turn this horse tramway into an electric tramway. Incidental to that arose questions as to the concession. There were in reality two concessions—one in perpetuity and one for 50 and 25 years; but what was aimed at by the Construction Company was the consolidation of the two concessions into one concession for 75 years. When that was obtained and the necessary work done for conversion into an electric undertaking, a larger company would be formed which would take over the tramway undertaking. These somewhat elaborate arrangements were put into an agreement which was entered into on Aug. 10, 1899, the parties to which were Mr. Bright, the River Plate Construction Co. and Messrs. Capel, the brokers. There seemed to be some dispute on the evidence whether, at the time when Mr. Bright signed it and before he actually put his pen to it, the company had been

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registered or not. Counsel did not think it mattered whether it was registered then or later on; but the agreement had never been sealed by the company. Counsel read the agreement and went on to remark that Mr. Bright went out to Uruguay to get from the municipality the consent to electric traction. The parties to the agreement were aware that the municipality had no power to grant a concession for such a length of time as 75 years.

Mr. UPJOHN, K.C.: That is not admitted.

Mr. JENKINS: Mr. Bright succeeded in obtaining the concession for 75 years and completed his contract on conditions which the other side admitted were satisfactory. The award of the arbitrator (Mr. Chadwyck Healey) directed Mr. Bright to pay to Messrs. Capel £60,000 as purchase money for shares to the like nominal amount in the Construction Company (being one-half the ordinary shares), and that Messrs. Capel should, on receipt of the £60,000 transfer to Mr. Bright, 600 shares to the nominal value of £60,000 as fully paid, and that such transfer should forthwith be registered by the Construction Company. Counsel argued that the arbitrator had not properly determined the matters in dispute, and that the award should therefore be remitted.

His LORDSHIP (without calling on counsel for the other parties) refused the application, defending the propriety of the course pursued by the arbitrator in a 35 days' hearing. He also dismissed the second motion to declare the award void on the ground of uncertainty, and the third and fourth motions that he had not properly heard and determined the matters in dispute or that the award was bad on the ground of ambiguity.

Mr. JENKINS said he would like time for Mr. Bright to consider whether he should take the matter further.

His LORDSHIP said that as it was a matter of £60,000 to Mr. Bright he would give leave to appeal.

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Mr. BRIGHT appealed from the order of Mr. Justice Farwell to the Court of Appeal on Wednesday and Thursday and argued his appeal in person.

The appeal was dismissed with costs.

### George White and Another v. Arthur. (An arbitration.)

Mr. Justice Kennedy and Mr. Justice Phillimore had before them on May 3 a special case stated by an arbitrator. In October, 1898, a Mr. H. D. Barclay, trading as Barclay & Son, of whom Mr. George White was the assignee, entered into a contract with Mr. Robert Arthur for an electric lighting installation at the Princess of Wales Theatre, Kennington, London, for £5,000. The contract contained a clause that the whole of the work, except the plant, must be completed before Nov. 26, 1898, subject to a penalty of £15 per day, and that the plant must be completed by Dec. 10, 1898, subject to a penalty of £3 a day. The work was not completed by April 5, 1899, when the contractor received notice determining the contract. The contractor claimed for a considerable sum under the contract, and Mr. Arthur counterclaimed for a large amount, including £1,980, as penalities for non-completion within the time provided. The matter was referred to arbitration, and it was now contended for the contractor that the £1,980 was not recoverable from him, on the ground that the claim was for "penaltiee," and not for liquidated damages, and the present action was to decide whether the amounts specified in the contract were penalties or liquidated damages.

Counsel for the contractor contended that the word "penalty" in the contract must be taken to mean a penalty. If the Court looked at the document and the circumstances, he contended there was good ground for the assumption that the sums of money were not intended to be the measure of the damage sustained by the building owner, but merely a penalty held over the head of the contractor to force him to finish the contract by the proper date.

Mr. Justice KENNEDY delivered judgment, and said the Court had come clearly to the conclusion that, although the word penalty was used, it must be taken that the effect of the clause was to fix a sum as liquidated damages. Prima facie a person must be taken to mean what he said, and if he used the word penalty he must be taken to have meant a penalty, and if he said liquidated damages he must be taken to have meant liquidated damages. In the present case the contract provided a penalty of £15 for every day after Nov. 26, 1898, upon which the general work was not completed, and a penalty of £3 a day for every day after Dec. 10, 1893, upon which the plant was not completed. He thought these words tended to show that this was a case where the parties intended that these sums should represent an assessment, once and for all, of the damages which it might otherwise have been difficult to assess, owing to the fact that the work in question was to be done to a theatre, and it might be difficult to say what damage a man might suffer by delay in the completion of such work. It seemed to him, both from the difference in the two sums mentioned and looking at the nature of the work to be done and the place where it was to be done, that these amounts were intended to be liquidated damages. That view was strengthened by the clause in the contract which gave the engineers power, if necessary, to employ other contractors to complete the work, and which provided that the defaulting contractor should be liable for loss so incurred, without prejudice to his obligation to pay the penalties incurred by him under the contract. The Court held, therefore, the real intention in this case was that the amounts specified should be treated as liquidated damages.

### Electrolytic Plating Apparatus Co. (Ltd.) v. Holland & Co.

This action was mentioned before Mr. Justice Grantham in the King's Bench on Tuesday, Mr. Coleface, counsel for plaintiffs, asking that the hearing might be taken on June 13. His lordship stated that he could not make the arrangement proposed, but would allow counsel an opportunity of making an application later on.

### Carrall v. the New British Incandescent Electric Lamp Co.

In the Chancery Division on Wednesday Mr. Justice Byrne, in a debenture-holder's action, had before him a matter for judgment which came on in default of appearance by the company. The company was formed in 1898 with a capital of £30,000, and issued debentures for £7,950, of which the plaintiff was the holder of £2,000. The debentures were a charge on all the property of the company, and plaintiff's moneys had become payable. It was stated that a distress for rent had been put in, and that an order for the appointment of a receiver had been made by Mr. Justice Buckley. Mr. Justice Byrne made an order in the common form.

### National Telephone Co. v. Doublatt.

A case came before Judge Lumley Smith, K.C., and a jury at Westminster (London) Country Court on Monday on a claim by the National Telephone Co. for £10. 13s. 3d. for telephonic communication, &c.

Plaintiffs' case was that defendant, Charles Doublatt, of 52, Haymarket, signed a certain agreement for telephone service as a private subscriber, and the subscription now sued for was £10. 5s., and the balance of the claim was for stamp duty and service beyond the area of the county of London.

The defence was that defendant was deputy-manager of a restaurant at the address mentioned, and signed for the then proprietor.

Evidence was given that it was customary for managers in the restaurant line to sign for their proprietors.

The JUDGE said that proved the custom in that trade, but it was usual to make a man liable for what he signed in his own name, and so far as he could see this was an undefended action.

The jury found for plaintiffs. Judgment accordingly, with costs.

### National Telephone Co. v. Hutton.

At Barnstaple County Court on Tuesday Mr. A. T. Hutton, veterinary surgeon, was sued for £6. 10s., one year's telephone rent. The case was a test case. Defendant had arranged with plaintiffs to subscribe to the telephone on a yearly tenancy from Dec., 1899. Only one year's rent had been paid, and the wire had, therefore, been recently disconnected.

Mr. DRUMMOND, district manager for the company, said defendant appeared to consider he ought to have included in his subscription through communication with Ilfracombe, Combemartin, Lynton, and elsewhere. But the trunk telephonic system of the country was owned and worked by the Postmaster-General. The company only had the right of user, and in consideration of such trunk line not being established, subscribers were allowed an annual rebate of £1. 10s.

Mr. COX, district canvasser, denied that he had given promises, when obtaining orders, that trunk communication would be established forthwith.

Mr. SELDON, solicitor for the defence, declared that Mr. Cox had given such a promise to himself and others, and it was on this misrepresentation that subscribers had been obtained.

Judge BERESFORD said defendant could not get over the agreement, and judgment must be for plaintiffs for the amount claimed, but without costs.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

A demonstrator in engineering is required at the Municipal Technical Institute, West Ham. An advertisement contains further particulars, and applications must reach the Principal, Romford-road, West Ham, E, by June 12.

Applications are invited for the position of lecturer in electrotechnics at University College, Liverpool. Particulars from the registrar, and applications by May 31.

Maidstone Corporation require a resident electrical engineer. Salary £250. Applications by 30th inst.

Gloucestershire County Council require a science master especially qualified to teach in practical chemistry and physics, for Sydney Institute School. Salary £160 rising to £200. Applications by June 1 to the Institute.

Carlisle Corporation require a director of technical education for their Tully House technical schools. Salary £250 with 10 per cent. on grants earned. Further particulars from town clerk. Applications by 28th inst.

Gloucester Corporation require a chief assistant engineer. Salary £2. 5s. per week. Applications by June 7.

Reading Electric Supply Co. require a mains engineer. Commencing salary £130. Applications to the electricity works.

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Mr. Trevor Duesbury, chief assistant at Gloucester, has been appointed resident electrical engineer by the Sutton Coldfield Town Council.

Mr. R. Rushton, jun., formerly electrician at the Alhambra, Blackpool, has accepted an appointment as electrical engineer of a mining company at Buluwayo.



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**Alloa.**—Mr. Hogarth (Messrs. Buchan and Hogarth) has submitted a report on the tenders received by the Council in connection with their electric lighting scheme. The cost of the works is put at about £8,500. The Electric Lighting committee are to report to he Council on the subject.

**A Self-Registering Target.**—Herr A. d'Aubigné, a Swedish officer, and Herr L. Goransson, an engineer, have recently invented a self-registering target, worked electrically, which obviates the employment of markers. The target consists of a hardened nickel steel shield and transmission and receiving apparatus. The shield is divided into sections, each having rings or circles marking high or low and right or left hits, and at the back of each section is a pendulum, which, when the bullet strikes the target at this point, is set swinging, when an electric current transmits the result to the receiving apparatus, where there are indicators, as in the ordinary electric ring signal apparatus. At the same time the hits are registered by a perforated numeral on to tape paper running over two rollers. This latter registration is claimed to be of particular value in quick firing, as the totals can be immediately summarised from the tape.

**Asylum Lighting.**—The Bucks County Council have approved an electric light and power installation (estimated to cost £4,700) for the Stone Asylum, which is being enlarged at a cost of £37,000.

**Australian Lighthouses.**—Mr. J. Plummer, of Sydney, N.S.W., forwards some particulars of the lighthouses on the Australian coast, from which it appears that the greater portion of this coast is remarkably free from dangers to navigation. Lighthouses have, however, been erected at every available point, and some of the lights are visible at a distance of 12 miles. The most important appears to be that of Macquarie, at the entrance to Port Jackson, Sydney, which is claimed to be one of the largest and finest lights in the world, and a particularly excellent example of electric lighting. The light is on the Fresnell system, showing a flash of 8sec. duration per minute, with a range of 25 miles seaward. The apparatus was constructed by Messrs. Chance Bros., Birmingham, under the supervision of Mr. J. N. Douglas of the Trinity House. At full power the mean intensity of the electric flashes is between 5,000,000 and 6,000,000 candles. This was the first light of any magnitude in which the use of a dioptric mirror with an electric lamp was used. The electric light can be used at full or half-power.

**Barcelona.**—A commission appointed by the Spanish Minister of Public Works has recently issued a report on the subject of the establishment by a neutral customs zone at this port, where it is proposed to construct canals, docks, wharves, warehouses and railways, and to instal the electric light.

**Bingley (Yorks).**—On Monday the Council decided to invite tenders from the Gamewell Fire Alarm Co. and the National Telephone Co. for the installation of a system of Gamewell Fire Alarms in the district. The Council are supporting the Yorkshire Electric Power Bill by petition.

**Birmingham.**—At Wednesday's meeting the City Council adopted the report of the Electric Supply committee, and the accounts of the electricity department, summarised in our last issue.

**Blackburn.**—Owing to a loss during the past year of about £3,800 on the Corporation tramway undertaking it is proposed to abolish penny fares and to make a general increase on all routes but one.

**Blackpool.**—The Board of Trade inspection of the electric tramway to Marston took place yesterday.

**Bournemouth.**—The Borough Council have received sanction to a loan of £11,978 for public electric lighting. A communication from the Bournemouth and Poole Electricity Supply Co. relative to the sale of the company's undertaking to the Corporation has been referred to the General Purposes committee. The borough surveyor has been instructed to report generally on the supply of electric current to outside districts including Pokesdown, which are to be included within the borough.

**Brest.**—A company has been formed at Finistère to establish electric tramway connection between Brest and Le Couquet, and electric tramways are to be established at Lorient, in the same district.

Wireless telegraph stations have been established at Point St. Matthew and Ushant.

**Canal Haulage by Electricity.**—In the report of the superintendent of public works of the State of New York the State engineer has prepared a plan for dealing with the traffic on the State canals. The proposal provides for barges 150ft. long by 25ft. wide and 10ft. deep, to be worked by electricity and to travel in fleets, going from Albany to Buffalo in less than three days. The cost is estimated at about £11,000,000, which is about £1,400,000 less than the estimate for a larger canal project proposed by a commission appointed in March, 1899. The estimates include the building an Erie barge canal on a practically new route, £9,800,000; for deepening the Oswego canal to 9ft., £172,000; and for deepening the Champlain canal to 6ft., £1,094,500. The scheme includes locks of the most modern type, capable of passing two boats at once, and with power generated to pull the boats into and out of the locks, work the gates and valves, and provide for the electric lighting of the entire course of the canals. The towing-path would be done away with, as only electric or other mechanical motors are contemplated.

**Cardiff.**—The borough electrical engineer (Mr. A. Ellis) reported to the Lighting committee on Tuesday that the number of consumers connected to the mains was now 401, including Messrs. T. Owen & Co., paper millowners, who would require an equivalent of 950 8 c.p. lamps, producing an estimated revenue of between £400 and £600. The income of the electricity department for the year ended March last was £11,670, and, after payment of all charges, including depreciation, sinking fund and interest, a loss of about £300 would be shown, compared with £1,700 in the preceding year.

**Cathedral Lighting.**—Notre Dame Cathedral (Paris) is to be lighted electrically, at a cost of about £18,000.

**City and Guilds of London Institute.**—At the annual meeting, held at Mercer's Hall, London, last week, under the presidency of the Lord Chancellor, his lordship referred to the granting, last year, by Queen Victoria, of a charter of incorporation to the institute and to the admission of the institute's Central Technical College into the new organisation of the University of London, from which, it was anticipated, adequate recognition of engineering as an important university faculty would result. It was impossible (his lordship continued) yet to foresee the effect which the reorganisation of London University might have upon the higher branches of technical instruction provided at the Central Technical College, but it was satisfactory to those associated with the institute to know that in these and other matters affecting technical instruction to the masses the University Commissioners and Government Departments had shown every disposition to acknowledge the value of the work which the institute was doing. There had been an increase in the number of students at the Central College equal to nearly 20 per cent. last session. Every year they were providing a considerable number of highly-trained scientific men from the Central College and from the Finsbury College qualified to take high positions in the manufacturing industries of the country. The research work carried on by both ordinary and special students was of the utmost value. His lordship appealed to trade associations of both masters and men to take a more general interest in educational matters, and to encourage attendance at the technical classes established by the institute.

**Colchester.**—An inquiry was held here last week into the application of the Council to borrow £15,900 for extensions of the electricity works. The borough electrical engineer (Mr. A. R. Sillar) said they had overspent £664 upon the last loan of £6,500 as more meters were required than was expected, and owing to the rise in copper and the actual cost of service mains. £6,500 had already been expended to meet requirements of consumers in service mains and professional fees. The inspector (Mr. Meade-King) doubted if the Local Government Board would sanction such a payment out of the borrowed money. It was explained that £1,970. 5s. would be required for alterations to machinery owing to the proposed doubling of the voltage. They had more consumers than were anticipated. They were also to have electric tramways, and for these they would require an increase of power. It was intended to increase the capacity of the storage battery, to re-wind two motors and make alterations necessary for the higher voltage, &c. The remainder of the money would be for station extensions, purchasing new engine, feeder for the new barracks (£1,260), &c. Evidence was also given by the town clerk (Mr. H. C. Wanklyn), the chairman of the Electric Light committee (Councillor E. H. Barritt), and the borough surveyor (Mr. H. Goodyear).

**Cork.**—Owing to a strike of gasworkers, this city was in darkness a portion of last week, except in places where the electric light had been installed.

**Curaçoa.**—The subscription to the telephone service on this island is only 10s. per month, but the number of subscribers is continually decreasing.

The electricity supply works here have recently changed hands, and new generating plant from the United States has been introduced. The company owning the station instal lights at net cost price, and this concession has led to a considerable increase in the number of consumers. American imported oil is, however, very cheap on the island, and the electric lighting business is conducted at a very small margin of profit.

**Customs Duties.**—In the new customs regulations of New Zealand insulated copper wire imported in connection with electrical appliances has to bear a duty of 10 per cent ad val.

Under the new tariff of Venezuela, telephonic apparatus and adjuncts, and covered copper wires and cables, are subject to a duty of 25 centimes (2½d.) per kg.

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Plant and materials for railways, tramways, electric lighting, telegraphs and telephones are now admitted into British Honduras free of duty.

By the decision of the Japanese Minister of Finance insulated copper wire for electrical apparatus is in future to be dutiable at 5 per cent. ad val., and not 20 per cent. ad val. as previously decided.

**Edinburgh.**—During the past year the Corporation have received applications for electric light equivalent to 194.000 8 c.p. lamps—a record year.

**Electric Lighting Provisional Orders.**—The orders applied for by the Beverley, Ripon, Todmorden and Workington Corporations and the Honley, Birstall and Skipton District Councils have been granted by the Board of Trade.

**Exhibitions.**—An interesting exhibition was opened at the Town Hall, Stratford, E., on Monday last by the Mayor. Mr. Ald. Ivey, chairman of the Lighting and Tramways committee, is to be congratulated on an up-to-date collection of electrical apparatus for domestic and general use. A fine show of electroliers was especially noticeable, together with an infinite variety of accessories and sundries with which the public are becoming increasingly familiar. The exhibition has proved very popular, large numbers having visited the show during the week. The Mayor, in declaring the exhibition open, said the Electricity department regarded the show from a purely business point of view, the object being to make the public acquainted with the advantages which the applications of electricity offered, and especially to show the large assortment of fittings and apparatus from which consumers could select for their varied requirements. He pointed out that the Electricity department for the year ending March, 1900, had shown a profit of about £200, and Mr. J. K. Bock, their energetic engineer, was hopeful that the next returns would be found even more satisfactory. If the exhibition, which he now opened, led to an increased demand for current from their present consumers, and added to the number of those who were adopting electricity for lighting and other domestic purposes, it would have served a very useful purpose.

An exhibition of apparatus, accessories and sundries for electric lighting and other domestic purposes is to be held at Ilford in connection with the Council's electricity department.

**Exhibition Lighting.**—The lighting of the Irish section of the Glasgow Exhibition is carried out by a decorative scheme of garlands interspersed with shamrocks supplied by the Electric Lighting Boards Co. The café chantant at the Crystal Palace is similarly illuminated.

**Ferrol (Spain).**—A company has recently been established here with a capital of £65,000 (2,000,000 pesetas) for the generation and supply of electric energy to Ferrol and the small towns and villages round the bay. A waterfall at La Fervenza, about 12 miles from Ferrol, is being utilised. The fall is about 160ft. and about 2,000 H.P. is available. The company, whose shareholders are Spanish and French, is an offshoot of the joint-stock undertaking which has established the electric light at Caldas, Villagarcia, Carril and other towns. The works, which include the construction of a canal 2,275 metres in length, are expected to be completed about May, 1902.

**Flash Light Prosecution.**—At the Clerkenwell (London) Police Court, William Reed, manager to Messrs. A. Baker & Co., tobacconists, Pentonville-road, N., was charged with "unlawfully exhibiting a flash light so as to be visible from Pentonville-road, and to cause danger to the traffic," contrary to the London County Council bye-laws. The defence was that no danger was occasioned or likely to be occasioned by the electric flash light, that it had been in operation 15 months, and that the control of the matter was in the local borough council. The magistrate (Mr. Chapman), however, found the flash light advertisement was a source of danger, and fined defendant 40s.

**Fusan (Corea).**—A company has been established here, with a capital of 50,000 yen, to equip and work electricity works for lighting this city.

**Glasgow.**—In moving the adoption of the minutes of the Electricity committee on Thursday last, the convener (Bailie Maclay) said that in common with other departments of the Council, they were likely to have a small deficit at the end of the present financial year. That was accounted for by the fact that during the past 12 or 18 months they had had large capital expenditure, and that while their buildings were being erected and their plant installed they derived no revenue. This year they had an output of six million units, an increase of 50 per cent., and the plant they had now installed would give an output this year of probably 12 to 15 million units. The committee proposed to encourage the demand for current, and had taken the bold step of proposing to reduce the price of current. They proposed for the first hour a charge, as now, of 6d. per unit, and for the second hour and onwards 1d. By adopting a "flat" rate they punished the long-hour consumer, and, moreover, if they adopted a fixed rate, that would have applied to the charge for power, for which they had resolved to charge 1½d. per unit. The consideration of the minutes was postponed for a fortnight.

The Board of Trade inspection of the St. Vincent-place and Maryhill and St. Vincent-place and Kelvinside electric tramway routes took place on Wednesday.

**Government Telegraph Service.**—A series of replies has been forwarded by the secretary of the Postal Telegraph Clerks' Association to the Postmaster-General in connection with the alleged breach of faith regarding the status and pay of telegraphists in Government service.

**Grimsby.**—At the meeting of the Public Lighting committee on Monday the borough electrical engineer (Mr. W. A. Vignoles) reported that the lamps connected were over 3,000, and 1,400 were being wired; further 700 or 800 were expected shortly. The capacity of the present plant is equal to 12,000 lamps. £50 was unanimously voted to Mr. Vignoles for extra services rendered.

**Hampstead (London).**—The accounts of the electricity department for the March quarter show total receipts £11,628. 16s. 9d., compared with £9,346. 1s. 2d. for the corresponding period last year. For the year ended March 25 the total was £32,003. 0s. 9d., compaard with £30,652. 10s. 9d. in 1900.

**Huelva (Spain).**—The town pier has been fitted with arc lamps and has been lighted electrically since May 1. The Rio Tinto Company's pier has also been similarly fitted, enabling the extensive working operations to be conducted at night with facility. The company's great depôt, situate about a mile from the pier, is also now lighted electrically.

A Belgian firm has found a large portion of the capital to work a concession for lighting Ayamonte and several smaller towns in this district by electricity. The work will be completed this year.

Huelva will, in June, be provided with a public telephone service, the concession recently granted having been energetically proceeded with. There is a population in Huelva of about 21,000.

**Hull.**—An inquiry was held here last week into the application of the Corporation to borrow £17,000 for electric lighting extensions. The town clerk (Mr. E. Laverack) and the borough electrical engineer (Mr. J. S. Barnard) gave evidence in support of the application. There was no opposition.

**Ilford.**—Electric current will be switched on for the first time to-morrow (Saturday).

**King's College (London).**—The forty-first annual dinner of this college is to be held at the Trocadero Restaurant, Piccadilly, London, on Monday, June 24, when the Hon. Mr. Justice Byrne will occupy the chair. Mr. John Chapman, King's College, London, is hon. sec. to the committee.

**Leeds.**—The Corporation Tramways committee at their last meeting discussed the report for the year ended March 25 last, which shows a gross profit of £61,797. 1s. 4d., leaving a surplus after payment of interest (£16,662. 14s. 1d.) and sinking fund contribution (£14,076. 4s. 9d.) of £31,058. 2s. 6d., compared with £6,167. 8s. 6d. for the previous year. £7,038 is included in the expenses for depreciation of rolling stock, and out of the surplus the committee propose to set aside £10,000 for loss on the sale of two old engines which have been replaced by larger units, reducing the surplus for the year by the amount of this latter figure. The receipts from the electric lines amounted to £133,450, from horse traction £26,371, and from steam traction £20,786. During the year there has been considerable extension of the electric car service, resulting in the receipts from this branch being doubled compared with the previous year. There was an actual loss on the horse section of about £5,600, and a profit on the steam section of about £4,360. The full stock of 130 electric cars are at work on the Roundhay section of the lines, 20 further cars have recently been licensed, 20 additional cars are to be added at the end of June, and a further 20 in July. The fares to Roundhay Park are reduced from 3d. to 2d. as from to-morrow (Saturday).

The accounts of the electric lighting department shows that it has now 2,000 private customers, and that the receipts for the past year were £43,669 and the expenditure £29,155, leaving, after deducting £7,633 for sinking fund and interest, a net profit of £6,882, against £8,500 last year.

**Licensing of Tramcar Drivers.**—At the West London Police Court on Friday Mr. J. Clifton Robinson, managing director of the London United Tramways (Ltd.) was summoned for allowing a man to act as driver to one of the company's electric cars without a licence. Mr. O. Hanson, who represented the company, did not dispute the facts, and said the fault rested with the Scotland-yard authorities. Application was made to licence 200 drivers, but the police were so dilatory that they took close upon a month to satisfy themselves of the character of the driver in question, when they need only to have gone to Notting-hill. The man was an efficient driver, and was allowed to act as such, as the company felt certain that the man would ultimately receive the licence. Mr. Rose, however, imposed a penalty of 10s., with costs.

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**Light Railway.**—The Board of Trade have, after modification, confirmed the Mansfield and District Light Railway Order, 1901.

Middlesex County Council will apply for an order to authorise the construction of additional light electric railways in the counties of Middlesex and London.

The Barnsley and District Light Railway Extensions Order came before the Board of Trade on Wednesday for confirmation. The Great Central Railway Co. objected to a level crossing over their lines, but Mr. S. P. Sellon said the British Electric Traction Co. had many such crossings over both mineral and passenger lines, and that, though some of these had been in use five or six years, there had never been an accident. The chairman said the board would be advised to confirm the order, but the decision would be deferred until an inspector had visited the crossing.

**London County Council.**—At Tuesday's meeting £17,229 was loaned to Hampstead for electric lighting.

The Electrical Trades Union having called attention to the rate of wages for wiremen in the Council's list (8½d. to 9½d. per hour) as not that in general practice, and asking that the rate might be increased to 9½d., the Finance committee recommended that this increase should be adopted. The Council approved.

The Improvements committee reported on the action in the Court of Appeal by which it was held that the Council was liable to provide stand-by plant in the new station which they were, under the Holborn to the Strand scheme, building for the Metropolitan Electric Supply Co. The committee recommended that the matter be taken to the House of Lords, and this was agreed to.

On the recommendation of the Local Government and Taxation committee, it was agreed "That a letter be addressed to the Board of Trade, asking that legislation may be promoted to provide that lists of share and debenture holders in companies supplying gas, electricity, water or hydraulic power, or owning docks or wharves, or undertaking tramway, telephone, or other public services within the County of London shall be open to inspection."

The Highways committee were authorised to prepare specifications and to invite tenders by public advertisement for the reconstruction for electric traction of those portions of the Council's tramways between (*a*) the junction of Kennington-road with Westminster Bridge-road and St. George's-circus; (*b*) the Elephant and Castle, along New and Old Kent-roads, New Cross-road and Greenwich-road to the terminus at Trafalgar-road, Greenwich, and (*c*) the Elephant and Castle, via Newington Causeway, to St. George's Church, Borough, and thence, via Dover-street, to the junction of New and Old Kent-roads. Tenderers are to be allowed to submit their own designs of the yoke and insulation which they propose to supply. The length of these tramways is 6 miles 1,317 yards of double track.

**London Local Authorities and the Purchase Clauses.**—At the London County Council offices, on Thursday last, a conference of London local authorities was held to discuss the position of those bodies and of the London County Council in regard to the purchase clauses of the electric lighting acts and the various provisional orders, so far as they affect the purchase by the local authorities of generating stations for the supply of electricity in the metropolis. The City Corporation was amongst the authorities represented at the conference. The proceedings were conducted in private, and our representative was, therefore, unable to obtain admittance. The *Standard* learns that the discussion centred round the question as to the difficulties which stand in the way of local bodies in connection with the compulsory acquisition of generating stations where the supply of electric energy is in bulk. At a previous conference (see *The Electrician* for June 17, 1898, p. 262) a resolution was passed affirming it "as essential to the interests of London as a whole that the present purchase clause of the electric lighting acts, which applies to defined areas, should also be made to apply to such companies as propose to supply electric energy in bulk to the whole of London without regard to area." The County Council endeavoured to obtain the insertion in the Metropolitan Electric Supply Co.'s bill of 1898 (see *The Electrician*, July 8, 1898, p. 363), of clauses to give effect to that resolution, but the chairman of the House of Lords Committee on the bill (the Earl of Northbrook) stated that the Committee considered that, as the London County Council was not one of the local authorities authorised to purchase, they could not, with advantage, attempt to put a purchase clause into the bill, but that the Council could promote a bill to confer upon it powers in respect of the purchase of bulk generating stations and other works connected therewith. In order to give effect to the views of the conference, the Council, in December, 1899, submitted to the Board of Trade a draft clause framed to authorise purchase by the Council in cases where it was not the local authority; but the Board of Trade stated that, in view of the nature of the proposals in the clause, the matter became one upon which, in their opinion, the local authorities concerned should have the fullest opportunity of expressing their views. It was to discuss the position arising from these decisions that the conference held last week was called.

**Lowestoft.**—Last week an inquiry was held into the Council's application for powers to borrow £20,000 for electricity works. The consulting engineer (Mr. W. C. C. Hawtayne) supplied technical details and the town clerk (Mr. R. Nicholson) particulars as to the population, rateable value, &c., of the town.

**Mansfield.**—The Council are recommended by the Electric Lighting committee to proceed with their own scheme of electricity generation and supply, and not to take current from the Derbyshire and Nottingham Electric Power Co.

**Military Telephones.**—Herr E. Ljungman, a Swedish officer, has designed a new form of combined telephone and telegraph apparatus for use in military operations. The combined apparatus is said to be much smaller than that now in use. The instrument is intended for cavalry, and has, it is stated, been approved by the Swedish military authorities. A pocket telephone apparatus on similar lines has also been designed by Herr Ljungman, weighing 0·8kg., and is 13cm. long and 6cm. wide. A syndicate, called the Elektro-Militära Aktiebolag, has been formed to exploit this apparatus.

**Moss Side (Lancs.).**—The Council have completed the agreement with Manchester Corporation for the construction by the latter of electric tramways in this district.

**Nelson.**—Mr. W. A. Fraser has entered upon his duties as borough electrical engineer.

**Poplar (London).**—The Borough Council have, on the recommendation of their electrical engineer (Mr. A. Blackman), decided to put down additional plant at the electricity works at a cost of £52,348. It is estimated that, with these additions, the capital expenditure on plant will be reduced from £172. 16s. to £97. 10s. per kilowatt. Mr. Blackman's proposals received the cordial approval of the Electricity committee and of the leading members of the Council.

**Post Offices and the Factory Acts.**—The Postal Telegraph Clerks' Association has obtained the consent of Sir W. Foster, M.P., to propose a clause bringing all postal telegraph offices under the operations of the Factory Act.

**Private Bill Legislation.**—The report of the Board of Trade on the railway, tramway, electricity, &c., bills and provisional orders of the present session states that the total number of bills deposited was 190, compared with 213 in the previous session. The total capital proposed to be raised is £88,738,877, compared with £94,534,199. There are 36 bills relating to tramways (35 for England and Wales and one for Ireland), and the total length of line proposed is 335 miles, the total proposed capital being £4,433,527. Eleven bills relate to electricity supply (seven for England and Wales, two for Scotland and two for Ireland), and the total proposed loan and share capital is £12,549,332. In the 24 tramway orders it is proposed to construct over 24 miles of double and 47 miles of single track, the capital expenditure being inserted as £701,975. The total capital expenditure in connection with electric lighting provisional orders (108) is £1,994,608. Particulars of these provisional orders and bills were given in our issue of Jan. 4 last.

**Radcliffe.**—An inquiry was held here last week by Major Druitt, R.E., into the application of the Council to borrow £60,000 for electric tramways. Permanent way cost is put at £35,408 and overhead equipment at £10,652. There was no opposition.

**Russian Poland.**—On the Warsaw-St. Petersburg Railway it is intended to introduce electric lighting on all the passenger trains, and the owning company have just completed an installation at the terminus at Warsaw, where 400 lamps have been erected in the station, and the surrounding railway property is illuminated by 102 arcs at a total cost of about £6,000.

In the Warsaw district the following new electric lines have either been opened, are under construction, or have been decided upon: (1) A narrow-gauge electric tramway, 13 miles in length, running between Zgierz-Lodz-Pabianice, was opened in November last. (2) A line of electric tramway, 18 miles in length, running between Czenstochowa-Herby, with a branch line to Blachowny, is to be completed by 1902. (3) Running between the districts of Dombrowa-Sosnowice an electric tramway is to be constructed 35 miles in length, which will open up and connect the districts of Dombrowa, Zagorze, Niwka, Modrzejew, Sosnowice and Bendzin. Line No. 2, although only a short length, will serve a rich coal and iron district, where large factories and works have been established. It is also to form a connecting link with the German railway system, considerably shortening the transport distance of merchandise between Germany and Russia. Other electric lines are under consideration, of which particulars will shortly be announced. The contract for an electric tramway at Lublin has recently been secured by a German firm, and the line is to be constructed forthwith. The same firm has obtained the contract for the construction of an electric tramway at Radom, and also a concession for the lighting of the town by electricity.

**Ryde (I.W.).**—Gradually the townships of the Isle of Wight are adopting electric lighting. The latest town to fall into line is Ryde, whose somewhat ancient provisional order expires in June. A report

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from the Electric Lighting committee of the Town Council on the subject is about to be presented.

**San Paulo.**—The *Jornal do Commercio* (Rio de Janeiro) of April 29 states that the prefect, Dr. Antonio Prado, in an official communication to the Municipal Chamber, recommends that the proposal of the San Paulo Light and Power Co. to light parts of the city by electricity be accepted, and suggests that the municipality should obtain powers from the local government to enter into a contract with the company, which asks a subsidy. The present arrangement with the San Paulo Gas Co. appears to be that the municipality guarantees a consumption of 1,000,000 cubic ft. of gas per annum for 2,000 public lamps. The new proposal is that for all public lighting required in excess of this 1,000,000 cubic ft. electricity shall be used. The San Paulo Light and Power Co. is a Canadian undertaking which is introducing electric light and power into the city. San Paulo, distant about 300 miles from the capital of the State, Rio de Janiero, has a healthy climate and is a city of great promise. Power will be taken from a waterfall of enormous dimensions, and will be ready for supply in August, the company in the meantime using a steam plant.

**San Sebastian (Spain).**—A company has recently been formed to construct and equip an electric tramway between San Sebastian and Hernani, a distance of about 6 miles. Work on the line is shortly to be commenced. The town has already an efficient electric lighting service.

**Shanklin (I.W.).**—The Council in committee have decided in favour of electricity for public lighting. As announced in our issue of May 10, the ratepayers have, by a poll, also decided in favour of electric lighting.

**Southwark (London).**—The City of London Company have notified that they intend to apply for a provisional order for this borough.

**Stepney (London).**—Last week the Electric Lighting committee recommended that Mr. Arthur Wright be appointed consulting electrical engineer to the Council for five years at a retaining fee of £800 per annum, subject to the cancellation of Mr. Wright's agreement with the late Whitechapel Board of Works. The committee also recommended that Mr. W. C. P. Tapper be appointed borough electrical engineer and manager of the electricity department at a commencing salary of £350 per annum, rising by annual increments of £25 to £400 per annum. After discussion the matter was referred back.

**Sunderland.**—The British Electric Traction Co. is constructing tramways between Houghton-le-Spring and other points and Sunderland, and have applied to the Sunderland Corporation for running powers over the borough lines. The Sunderland Tramways committee, however, recommend that no such permission be granted, but that negotiations be entered into with the company to settle through rates for passengers and parcels.

The Board of Trade inspection of the Whitburn-road electric tramway took place on Wednesday, and the line was thrown open for traffic on the same day.

**Syra.**—An acetylene lighting company was started here in 1898, under what were considered very favourable conditions, but, owing to the competition of the electricity works established in 1899 the acetylene company has ceased operations.

**Taunton.**—Col. W. R. Slacke, R.E., held an inquiry here on Wednesday into the application of the Corporation to borrow £20,000 for electricity supply and £4,500 for refuse destructor. The town clerk (Mr. G. H. Kite) said £3,220 of the former amount was for providing current for the tramways which were to be worked by the British Electric Traction Co, the company undertaking to pay for a minimum consumption of 60,000 units per annum at 2d. per unit for seven years, or a total of £3,500, and the remaining £16,780 was required for general extensions of the electricity undertaking.

**Telegraphists for the Front.**—A detachment of specially-enlisted telegraphists, for the telegraph division of the Royal Engineers, for service in South Africa, left Aldershot on Tuesday.

**Trinidad.**—A Canadian syndicate has acquired a concession for the erection of electricity works and for the construction of electric tramways in Port of Spain.

**Walsall.**—The number of electricity customers on April 30 was 185. A profit of £120 was made on the electrical undertaking last year.

**Wandsworth (London).**—At last week's meeting of the Borough Council, Councillor Lance called attention to what he described as the "unfair methods" adopted by the County of London Company in the borough, and asked whether the Council could remedy a grievance under which, he said, all local consumers suffered. The company undertook to supply current at 7d. per unit for the first hour and a half's consumption, and at a reduced rate after. Under the impression that they were considerable gainers by this arrangement many consumers had no doubt been tempted to adopt the electric light. Councillor Lance then made a number of general charges against the company as to the methods adopted in obtaining the "maximum demand" register, and pourtrayed a set of circumstances under which he feared a great many families were mulct (under the maximum demand system) in the maximum charge that could be made by the company for electric current. Mr. Lance referred to a number of tests he had had made of the voltages at which electricity supply is given to consumers in the Wandsworth district by the County of London Company, and, after taking exception generally to the company and all its works, wound up by proposing—

"That, in view of the irregularities committed by the County of London and Brush Provincial Electric Lighting Co. (Ltd.), this Council take measures to secure the imposition of the full penalties to which, by the regulations of the Board of Trade, the company has rendered itself liable."

It having been pointed out by Councillor Hunt that it would be necessary to formulate their charges and send them to the company before the matter could be considered by the Board of Trade, it was resolved to refer the matter to the General Purposes committee, who were authorised to obtain technical assistance.

**Watford.**—The Council are applying for sanction to borrow a further £31,000 for additions, &c., at the electricity works.

**Wireless Telegraphy.**—We are informed that the British Admiralty have adopted Apps-Newton coils in the fitting up of some of the vessels of the British navy for wireless telegraphy, and have placed a large order with Messrs Newton & Co. for coils and transmitters.

**Worcester.**—An inquiry was held here last week into the application of the Council to borrow £4,950 for electric lighting. The town clerk (Mr. Southall) explained that the Council were obliged to extend their electricity works. An agreement had recently been entered into with the tramway company to supply electric current, but extensions were also needed to cope with the increasing demand from private consumers. As further extension was impossible at the Powick station the Council thought it advisable to purchase a site in Tybridge-street. That extension would cost £4,450, and the remaining £500 was for 60 incandescent electric lamps in place of gas lamps. The city electrical engineer (Mr. C. J. Sutherland) said that in time of flood or drought the one plant at Powick was useless. If extensions were made at Powick it would be necessary to build new works, and there were difficulties in the way.

**Workhouse Lighting.**—Protest has been made to the Local Government Board, by Barnsley Corporation, against the putting down of an independent installation by the guardians of Barnsley Union for the lighting of the workhouse buildings. The protest urges the greater economy of taking current from the Corporation mains.

Islington (London) Guardians have appointed a special committee to consider the question of wiring the St. John's-road and Cornwallis-road workhouses. Current will probably be taken from the Borough Council's mains.

**Electro-Harmonic Society.**—The annual meeting of this society is to be held at the Institution of Electrical Engineers, 28, Victoria-street, Westminster, on Wednesday next, at 4:30 p.m. The membership now numbers 332. The accounts show surplus assets at May 18, £59. 12s. 2d.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED, &c.

With a view to obtaining the best self-propelled lorry for military purposes, the *Secretary of State for War* offers three prizes (£500, £250 and £100 respectively) for the three self-propelled lorries which shall be adjudged, after trial, to be the best suited to military requirements. An advertisement contains some additional particulars, and all further information can be obtained from the Secretary, Mechanical Transport Committee, War Office, Horse Guards, London, S.W.

*Islington* (London) Borough Council Lighting committee require tenders for the painting of the arc lamp columns and crutches, of which 398 are in use in the borough. Tender forms, &c., will be available after 28th inst. from the borough electrical engineer. 50, Eden-grove, Holloway, N., and tenders must be sent in to Mr. W. F. Dewey, town clerk, Town Hall, Upper-street, Islington, London, N., by noon of June 11. See advertisement.

*Islington* (London) Borough Council Lighting committee are also prepared to receive tenders and to consider offers for "free" or "assisted" wiring in the district. Particulars are obtainable on written application to the borough electrical engineer, and offers and tenders must be sent in to Mr. W. F. Dewey, as above, by noon of June 11. See advertisement.

*Bermondsey* (London) Borough Council invite tenders for (*a*) construction of an artesian well and the supply and erection of pumping

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machinery, (*b*) supply and erection of water-softening plant. An advertisement contains additional particulars, and specifications, &c., can be obtained at the Town Hall, Spa-road, Bermondsey, or may be inspected (but not obtained) at the offices of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. Tenders to Mr. Frederick Ryall, town clerk, Town Hall, Spa-road, Bermondsey, by noon June 4.

The Electricity committee of *Poplar* (London) Borough Council invite tenders for the supply and erection of a storage battery at their Glaucus-street electricity works. Specifications, &c., from the electrical engineer's office, Glaucus-street, Bromley-by-Bow, E., and tenders to Mr. Leonard Potts, town clerk, Council offices, High-street, Poplar, E., by June 4. See advertisement.

*Eastbourne* Corporation invite tenders for the supply and erection of a fuel economiser, feed-water heater, pipe-work, &c., water storage tank, and overhead engine-room travelling crane. Further particulars are set out in an advertisement, and copies of the specification may be obtained of the town clerk (Mr. H. West Fovargue) after 25th inst. The works are to be carried out in accordance with the plans and specifications of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen Street-place, London, E.C., from whom further information can be obtained. Tenders (addressed to the town clerk, Town Hall, Eastbourne) by noon June 8.

*Eastbourne* Electricity committee invite tenders for 400 alternating current electritity meters, and for 200 volt incandescent lamps. Further particulars are set out in advertisements, and tenders must be sent in to the borough electrical engineer (Mr. J. Kempe Brydges) by noon of June 7.

*Rochdale* Corporation invite tenders for the supply and delivery of six specimen electric tramcars. The general conditions, specifications, &c., may be seen at the offices of Messrs. Lacey, Clirehugh and Sillar, 78, King-street, Manchester, and 2, Queen Anne's-gate, London (obtainable from the latter office only). Further particulars will be found in an advertisement, and tenders must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by June 7.

*Manchester* Corporation Tramways committee require electrical fittings for the lighting of the Queen's-road car shed. Specifications of Mr. J. M. McElroy, general manager, 55, Piccadilly, Manchester. Tenders, addressed to chairman, by 9 a.m., June 4. See advertisement.

*Farnworth* Urban District Council invite tenders for the overhead equipment of about 5 miles of tramways and for tramway poles. Some particulars are given in an advertisement, and specifications, &c., can be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh, and Sillar), 2, Queen Anne's-gate, London, S.W., and 78, King-street, Manchester (obtainable only at the latter address). Tenders to Mr. W. Tyldsley, Council Offices, Farnworth, by June 7.

*Warrington* Corporation invite tenders for the supply, delivery and erection of (*a*) one water-tube boiler and pipe-work, (*b*) one 500kw. high-speed Willans engine with direct-coupled continuous dynamo, (*c*) underground mains, stoneware conduits, &c. Specifications of Messrs. Preece and Cardew, 13, Queen Anne's-gate, London, S.W., and tenders to Mr. J. Lyon Whittle, town clerk, Town Hall, Warrington, by noon of June 13. An advertisement gives additional particulars.

*Taunton* Corporation require tenders for the construction, supply and erection of (*a*) one 250kw. steam alternator and one 15kw. motor generator, (*b*) switchboard extensions, (*c*) one water-tube boiler, superheater, jet condenser and air pump and piping. Specifications, &c, after to-morrow (Saturday), at the Municipal Buildings, Taunton, or can be seen at the offices of Messrs. Kincaid, Waller and Manville, 29, Great George-street, London, S.W. Tenders to Mr. G. H. Kite, town clerk, by 2 p.m., June 11.

*Edinburgh* Corporation invite tenders for ash-conveying plant for their Dewar-place electricity works. Specification from the resident engineer (Mr. F. A. Newington), or may be seen at (but not obtained from) the offices of the consulting engineer (Prof. A. B. W. Kennedy), 17, Victoria-street, London, S.W. Tenders to the town clerk (Mr. Thomas Hunter, W. S.) by June 15. See advertisement.

*Edinburgh* Corporation also invite tenders for the electric lighting installation, &c., of the first portion of the Colinton Mains Fever Hospital. Tenders to Mr. Thomas Hunter, W.S., by11 a.m. June 12.

*Glasgow* Corporation invite tenders for branch rubber-covered cables. Specifications, &c., can be obtained of Mr. W. A. Chamen, 75, Waterloo-street, Glasgow. Tenders to Sir J. D. Marwick, town clerk, City-chambers, Glasgow, by June 10. An advertisement contains farther particulars.

*Glasgow* Corporation also invite tenders for the supply of electricity meters. Tenders to Sir J. D. Marwick by June 10.

*Central Electric Supply Co.* (*Ltd.*) require tenders for the supply, delivery, and erection of three overhead travelling cranes for a maximum working load of 20 tons, and one ditto for a working load of 10 tons, to be driven by electric power and hand. An advertisement contains further particulars, and specifications, &c., can be obtained from the general manager of the company (Mr. F. J. Walker), 19, Carnaby-street, Golden-square, London, W., and can be seen at (but not obtained from) the office of Dr. A. B. W. Kennedy, 17, Victoria-street, S.W. Tenders to Mr. Walker before 10 a.m. June 12.

*Dundee* Town Council require tenders for the overhead equipment of the Seagate route of the city tramways. Specification, &c., can be obtained of Mr. Walter H. Tittensor, city electrical engineer, and tenders must be lodged with Sir Thomas Thornton, LL.D., town clerk, City-chambers, Dundee, by June 5. See advertisement.

*Dundee* Gas Commissioners invite tenders for steel steam piping, valves and accessories for the Dudhope-crescent electricity station. Tenders to Sir Thomas Thornton, LL.D., City Chambers, Dundee, by May 30.

*North-Eastern Railway* invite tenders for telegraph stores for the six months ending Dec. 31 next. Tender forms of Mr. Graves, telegraph department, York, and tenders to Mr. C. M. Wilkinson, secretary, York, by noon June 10. See advertisement.

*Exeter* City Council invite tenders for the equipment of their new electricity generating station, including boiler and engine-house plant, &c., main and exciter switchboards, cables, instruments, steel-plate coal bunkers and coal conveyors, and feed and condensing water tanks. Tenders to town clerk by June 14.

*Uxbridge and District* Electric Supply Co. invite tenders for the erection of an electricity generating station. Specifications, &c., may be seen at the office of Messrs. Kincaid, Waller and Manville, 29, Great George-street, London, S.W., where tenders must be sent by noon, June 4.

*Waterford* Electric Lighting committee are prepared to receive proposals as to the electric lighting of the borough. An advertisement contains some particulars, and additional information may be obtained from the borough surveyor, Mr. M. J. Fleming.

*Dublin* Lighting committee invite tenders for motors and motor generators, accumulators, meters and works wiring. Tenders to secretary, City Hall, Dublin, by 4 p.m. June 3.

*Tonbridge* District Council require boiler and engine-house plant, condensing apparatus, crane, switchboard and instruments, accumulators, mains, meters, &c. Tenders to clerk by 4 p.m. May 30.

*Aldershot* District Council require tenders for erection of electric lighting station buildings and chimney shaft. Particulars of the surveyor (Mr. N. F. Dennis), Aldershot, and tenders by June 4.

*Messrs. Siemens Bros. & Co.* (*Ltd*) invite tenders for earth work, concrete foundations, &c., at their new works at Stafford. Tenders by June 3.

*Wakefield* Corporation invite tenders for destructor cells, boiler, water-softening plant, &c. Forms of tender, &c., from city electrical engineer, and tenders to town clerk by June 10.

*Maidstone* Council require "free" wiring offers. Applications by 30th inst.

*Burnley* Electricity committee invite tenders for five injectors and one feed pump. Tenders by June 10.

*Salford* Corporation require steel poles and cast-iron bases. Tenders to town clerk by 3 p.m., June 3.

*Sunderland* Corporation invite tenders for steel plate coal bunkers and overhead gantry. Tenders by noon 31st inst.

*Ipswich* Corporation invite tenders for dry-back marine type boilers Tenders to town clerk by 10 a.m. June 8.

*Worksop* District Council invite tenders for 150 electricity meters. Tenders by May 29.

*Kingstown* (Ireland) District Council invite tenders for electricity generating plant, &c. Tenders to town clerk by noon May 30.

The *Crown Agents for the Colonies* (on behalf of Uganda Railway committee), Downing-street, London, S.W., invite tenders for galvanised iron telegraph wire. Tenders by June 11.

The municipality of *Uberaba*, State of Minas Geraes, Brazil, invite tenders, which have to be in by June 2, for the public and private lighting of the town by electricity. Particulars of this tender can be seen at the Commercial Intelligence Branch, Board of Trade, 50, Parliament-street, London, S.W.

There will be exhibited at the Inspectorate General of Telegraphs, *Lisbon*, up to 30th inst., particulars of the proposals and requirements of the Companhia Carris de Ferro, of Oporto, for the substitution of electric for animal traction on certain of the company's lines. Particulars can be inspected at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

Tenders have to be in by the 24th prox., invited by the municipality of *Colmenar Viejo* (Madrid) for a concession for 20 years for an electric lighting undertaking. The contract requires 150 16 c.p. lights for the municipality. Further particulars are contained in the "Madrid Gazette" for 19th May, which can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

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## TENDERS RECEIVED AND ACCEPTED.

The Shoreditch (London) Borough Council have received the following tenders for the supply of high and low-tension lead covered cable required during the ensuing nine months :—

| | | | |
|---|---|---|---|
| Henley's Telegraphic Works Co.(*accepted*) | £10,516 5 0 | W. T. Glover & Co.... | £10,766 18 4 |
| Siemens Bros. & Co... | 11,565 2 6 | British Insulated Wire Co..... | 10,649 3 4 |

Shoreditch Council have also, on a report presented by Mr. C. N. Russell, chief electrical engineer, accepted the offer of the Renewable Electric Lamp Co. for the supply of incandescent lamps to the Council. The offer includes an undertaking to renew the lamps at any time at from 7d. to 9d. each.

The tender of Messrs. Crompton & Co. has been accepted by the Metropolitan Asylums Board for electric generating plant for Tooting Bec Asylum at £6,650, the tender of the Lancashire Dynamo and Motor Co. (at £6,399), which (as announced in our issue of May 10) was accepted for this contract having been withdrawn. The latter company stated they had made a serious mistake in their figures.

Mr. Arthur Koppel has received an order from the Charing Cross and City Electric Co., for their new works at Stratford, for two sets of counter-current jet condensing plants for 25,000lb. of exhaust steam per hour each; and for six circular iron natural-draught cooling towers, each for 75,000 gallons of water per hour.

Portsmouth Corporation have accepted the tender of Messrs. Yates and Thom for five Lancashire boilers, two feed-pumps, mechanical stokers, economisers and steam, feed, and other pipes for £6,950. This tender was not the lowest by £1,000, but was recommended for acceptance by the Electric Lighting committee.

Partick Corporation have accepted the tender of Messrs. Stewart and Menzies for pipes, pumps. tanks, and heaters, &c.

Brighton Corporation have accepted the tender of Messrs. Redpath, Brown & Co. for steel work for the Southwick power house for £15,978.

Woolwich (London) Borough Council have accepted the tender of Messrs. Smith & Son for the erection of electricity and refuse destructor works buildings for £40,574.

Cleckheaton District Council have accepted tenders for the erection of an electricity generating station and a refuse destructor.

Swansea Corporation have received 14 tenders for the supply of a two-phase motor-alternator and switchboard, ranging from £1,146 to £2,693, and have referred the matter to their engineer for report.

## BUSINESS NOTICES.

Messrs. C. Lang and M. Plato (trading as Charles Lang & Co.), makers of and dealers in electrical goods, 28, Minories, London, E.C., and Bruckenstrasse, 13A, Berlin, have dissolved partnership. Mr. C. Lang continues under the old title.

We are asked to announce that a meeting is to be held at the office of Mr. T. Guthrie, 46, Queen Victoria-street, London, E.C., on Tuesday, 28th inst., at 2 p.m., for the purpose of forming the "National Electrical Contractors' Association," and Mr. Guthrie invites the attendance of electrical contractors' associations already formed and of contractors disposed to identify themselves with the movement.

The agency for the manufactures of the Elektrotechnische Institut, Frankfort-on-Main, has passed into the hands of Mr. G. Braulik. These manufactures include the Beez pocket volt and ammeter.

Mr. E. W. Silcock asks us to state that he has severed his connection with the Volt Electrical Co. and has joined the staff of Mr. J. Calmon, manufacturer and merchant of electrical accessories, 12, Grenville-buildings, Birmingham.

The Fuller-Wenstrom Electrical Mfg. Co. notify removal from 9, Red Lion-court, E.C., to more commodious premises at 110, Cannon-street, London, E.C.

Mr. R. W. Paul notifies that his office and showrooms have been removed from 44, Hatton Garden, E.C., to 68, High Holborn, London, W.C.

## BANKRUPTCIES, LIQUIDATIONS, &c.

The statement of affairs of G. F. Cook, electrical engineer, recently trading as G. F. Cook & Co. at Charles-street, Bradford, shows liabilities expected to rank £516. 10s. 8d., and net assets £188. 12s.

A meeting of the United Telephone Co. (Ltd.), in liquidation, will be held at 5, Moorgate-street, London, E.C., on June 26, to receive an account of the winding-up. Mr. T. A. Welton is liquidator.

The Electric Incandescent Lamp Regenerating Syndicate (Ltd.) is to be wound-up voluntarily. Mr. A. Banister is liquidator.

A meeting of Binko, Ridsdale & Co. (Ltd.) will be held at 3, Lothbury, London, E.C., on June 24 to receive an account of the winding-up.

In the bankruptcy of W. Haines, electrician, &c., Bury New-road Whitefield, Lancs., the trustee (Mr. F. H. Winder) has been released.

In the failure of H. Sewell, electrician, &c., Clifton-place and Birklands-road, Shipley, the trustee (Mr. J. A. Binns) has been released.

A first dividend of 2s. 6d. in the £ has been declared in the failure of J. D. F. Andrews & Co. (Ltd.), and is payable on Fridays between the hours of 11 and 1 at the offices of the liquidator, Mr. W. Hardy King, 13, Basinghall-street, London, E.C.

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**Sales by Auction.**—On Wednesday and Thursday, June 12 and 13, Messrs. Wheatley Kirk, Price & Co. will sell by auction, at the Victoria Foundry, Leeds, the entire contents, consisting of engineering tools, plant, and stores. Some particulars will be found set out in an advertisement, and catalogues, which are now in preparation, will shortly be obtainable, price 6d., of Mr. F. Riley, Victoria Foundry, Leeds, or of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Messrs. Wheatley Kirk, Price & Co. are instructed by the Edison and Swan Co. to sell by public auction, at an early date, at the Broadheath works, a quantity of surplus plant and effects, of which further particulars will be given in future advertisements, or can be obtained of the auctioneers, Albert Chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

Messrs. Fuller, Horsey, Sons, and Cassell will sell by auction at Trafalgar Works, Bow Common-lane, London, E., on Tuesday, June 11, at 11 a.m., a quantity of modern machine tools, some particulars of which are set out in an advertisement. Catalogues can be obtained of Messrs. Standring, Marshall & Co., solicitors, 14, Bedford-row, W.C., and of the auctioneers, 11, Billiter-square, London, E.C.

**Electrical Plant for Sale.**—Messrs Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and Albert-square, Manchester, have high-class electric lighting plant for sale, some particulars of which are set out in an advertisement.

**Rosin-Cored Solder.**—The Patent Solder Co. have sent us samples of their rosin-cored solder, which they claim can be employed without any additional flux. The solder is manufactured in four sizes and three different qualities containing guaranteed percentages of the metals. It consists of a tube of metal filled with a core of rosin. As the advantages and disadvantages of this metal can only be fully appreciated by long usage, it is to be regretted that the makers do not accompany their samples with testimonials.

**"Conduit Wiring and Erection."**—Mr. L. M. Waterhouse, engineer and general manager of the Simplex Steel Conduit Co., has prepared a little work on conduit wiring and erection for electric light installation, with special reference to the "Simplex" system for carrying out this work. Mr. Waterhouse points to the increasing proportion of buildings in this country which are being installed on this method. The work is published at 2s. by Messrs. S. Rentell & Co.

**B.T.H. Plant**—"Alternating-Current Fan Motors" is the subject of Pamphlet No. 95 issued by the British Thomson-Houston Co. Illustrations showing the construction of the alternating-current fan motor are given.

**"Teon" Belting.**—The success obtained by Messrs. Fleming, Birkby and Goodall in the manufacture of their speciality, "Teon" belting, has necessitated the laying down of extensive new plant for its manufacture, and the ceremony of christening this new plant took place at Halifax on Saturday last. This belting has only been on the market five years, and is claimed to have secured such popularity as to form quite an industry of its own at Halifax. "Teon" belting is made up of a specially woven fabric, into which a cement-like composition is heavily frictioned at a rapid rate, this composition being a secret process. The machinery which has been put down for the early stages of the manufacture of this belting was made at Edinburgh, and is of a special character. Messrs. Fleming, Birkby and Goodall have six mills in constant operation. The Liversedge business was established in 1795, the Halifax business in 1797, and the Brighouse branch in 1800. These branches were amalgamated in 1892.

**Supplies Catalogue.**—A revised catalogue of electric lighting supplies, bells, &c., is to hand from Messrs. Davies, Kent and Stewart, Berners-street, London, W., who call attention to the special inducements offered to shippers and wholesale houses for some of the goods listed.

**South American Directory.**—A useful English directory and commercial guide to Argentina is edited at Buenos Ayres by Mr. E. Danvers, and the new (4th) edition, just received, contains a large amount of valuable information to exporters and others having business relations with South America. With the ready help of numerous Government officials and many public and private friends, Mr. Danvers has compiled a really well arranged and helpful guide containing reliable particulars upon many subjects regarding which information is frequently sought.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or

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machines, which are not separately specified) from May 15 to 21, with the ports of destination :—

*Africa*—Cape Town, £739; Durban, £1,378 (including £662 telegraph material); East London, £206; Port Elizabeth, £101. *Argentina*—Buenos Ayres, £857. *Australasia*—Adelaide, £45; Launceston, £50; Melbourne, £3,457; Perth, £220; Sydney, £556; Wellington, £137; *Belgium*—Ostend, £60. *Burma*—Rangoon, £35. *Canary Islands*—Teneriffe, £48. *Ceylon*—Colombo, £58. *Denmark*—Copenhagen, £92 (telegraph wire). *Ecuador*—Limon, £17. *Germany*—Hamburg, £16. *Gibraltar*—£13. *Holland*—Amsterdam, £70; Rotterdam, £115 (telegraph material). *Hong Kong*—£17. *India*—Bombay, £560; Calcutta, £1,771 (including £161 telegraph wire). Madras, £980. *Japan*—Kobe, £6,534 (telegraph material); Yokohama, £1,228. *Portugal*—Lisbon, £50. *Russia*—St. Petersburg, £98 (telegraph material). *Sweden*—Gothenburg, £3; Stockholm, £110 (telegraph material). *West Indies*—Trinidad, £25 (telegraph material). Total £19,646, against £343,550 in the corresponding week ast year (May 16 to 22).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 24, 1901.

1,604. F. LEAVER. Brighton. An improved winding machine and reel for hose, ropes, electric cables, telegraph wires and the like.

1,643. C. JOLY. London. Improvements in or connected with air, gas, vapour, explosive, self-driving, inexhaustible power and like engines for power, lighting, heating, refrigerating, electrical and other purposes.

1,662. R. R. GIBBS. Liverpool. Improvements in or relating to trolleys and like currents collectors for electric railways and tramways.

1,663. J. HIGNETT. Liverpool. Improvements in or relating to trolleys and like currents collectors for electric railways and tramways.

1,670. T. BERNDT. London. Improvements in electrical eye-glasses or spectacles.*

January 25, 1901.

1,721. B. BRANDER. Birmingham. Electric balance for indicating or signalling maximum or minimum electric pressure or current.

1,742. B. G. LAMME. London. Improvements in dynamo-electric generators. (Date applied for under Patents, &c, Act, 1883, sec. 103, June 28, 1900, being date of application in United States.)

1,743. S. W. ANSTEE. London. The electric radiant heat and light cabinet for medical or curative purposes.

1,769. E. DUSSEK. London. Improvements in electric tramways or railways.

1,788. R. D. DE LIGNIÈRES. London. Improvements in or connected with alternate current motors.

January 26, 1901.

1,809. J. M. TAYLOR. Kingston-on-Thames. Improvements in electric railways.

1,849. A. BROCHET and G. RANSON. London. Process for the electrolytic preparation of the bases of the alkaline earths.

January 28, 1901.

1,872. R. MILLS. London. Improvements in current collectors and ploughs for electric tramway conduits.

1,890. J. T. NIBLETT. London. Improvements in electric storage batteries or accumulators.

1,894. J. H. GRAY. London. Improvements in electric meters.

1,900. J. D. F. ANDREWS. London. Improvements in telephone switching apparatus.

1,917. E. W. FARNHAM. London. Improvements in electric railway systems.*

1,929. H. F. FREED, I. FREED, and S. O. SPRING. London. An improved electric alarm.*

Jauuary 29, 1901.

1,965. H. ROSE, J. HALIFAX, and C. H. ANTROBUS. London. Improvements in and connected with positive rods for secondary electric batteries.*

1,981. J. T. NIBLETT. London. Improvements in electric storage batteries or accumulators.

1,994. V. I. FEENY. London. Improvements in and relating to electrical meters. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

January 30, 1901.

2,099. W. FAIRBURN-HART. Leeds. Improvements in relating to electric arc lamps. (The General Electric Company, United States.)*

2,117. C. D. ABEL. London. Mechanism for actuating electrical igniters for internal combustion engines. (The Gasmotoren Fabrik Deutz., Germany.)*

2,118. B. HOPKINSON. London. Improvements in systems of electrical distribution.*

January 31, 1901.

2,127. W. A. MALSON and S. R. MALSON. Sheffield. Improvements in or relating to electric fuse heads for blasting purposes.

February 1, 1901.

2,223. W. M. STEWART. Glasgow. Improvements in portable plugs and wall-sockets for electric circuits.

2,233. W. BROWN. London. Improvements in electric arc lamps.

2,238. E. P. BAIRD. London. Improvements in toll apparatus for telephones. (Date applied for under Patents, &c., 1883, sec. 103, July 2, 1900, being date of application in United States.)*

2,254. A. W. BROWN. London. Improvements in or relating to maximum electric meters.

2,272. W. R. EDWARDS. London. Improvements in means and apparatus used for propelling boats by electricity.*

2,285. C. W. GATWARD. Liverpool. Improvements in controlling mechanism for electric trolleys and the like current takers.

2,293. A. E. CARTER and THE REASON MANUFACTURING CO. (LTD.) London. Improvements in or connected with electrical switches.

February 4, 1901.

2,317. T. HOLT (LTD.) and F. A. HOLT. Manchester. An improvement in electric stop motions for warping machines.

2,320. W. HANCHETT. Manchester. Improvements in the method of covering cables, wires and conductors for electrical purposes with india-rubber or other insulating material and in machinery therefor.

2,322. H. GARSTANG. Blackburn. A double-wheel contact on a rocker for overhead electric tram contact.

2,345. E. S. HALSEY. Chicago. Electric meters. (Date applied for under Patents, &c., Act, 1833, sec. 103, July 5, 1900, being date of application in United States.)*

2,358. E. C. WILSON. London. Improvements in gear for collecting the current on electric locomotives, electric trams, electric cranes and such like machines.

2,363. F. LANDOLT. London. Electrode for galvanic cells.

2,394. R. B. RANSFORD. London. Improvements in distributing electricity and in apparatus for use therein. (La Société Anonyme des Brevets, Dolter, France.)*

2,411. M. KALLMANN. London. Improvements in and relating to electric meters.

February 5, 1901.

2,420. H. GARSTANG. Blackburn. Silent automatic switch arrangement for electric motors for church organs.

2,421. J. J. GREEN and E. O. GREEN. Halifax. Improvements in electric incandescent lamps.

2,428. E. W. COWAN and A. STILL. Manchester. Improvements in electric motor starting switches.

2,461. E. D. PAGE. London. Improvements in conduits for electric wires.

2,471. H. H. LAKE. London. Improvements relating to electric switches. (W. M. Scott, United States.)

2,474. L. MELLETT and A. F. HENDERSON. London. Improvements relating to transmitters for telephones*

2,488. C. F. ANTELL. London. Apparatus for disinfecting the transmitters and receivers of telephones.*

2,490. T. A. EDISON. London. Improvements in storage batteries.*

2,497. J. M. RICARD and F. C. CORY. London. Improvements relating to electric igniters.*

2,505. A. P. STROHMENGER and A. B. PESCATORE. London. Improvements in and in apparatus for obtaining metals by electrolysis.

2,523. A. B. BLACKBURN and E. S. W. MOORE. London. Improvements in means for the distribution of electricity on the three-wire system for electric traction on rails.

February 6, 1901.

2,536. W. LANGDON-DAVIES. London. Improvements relating to the commutators of dynamo-electric machines.

2,553. A. ECKSTEIN and A. E, ANGOLD. Manchester. Improvements in electric arc lamps.

2,570. W. J. MILDON. London. Improvements in or connected with electrical signalling apparatus,*

2,579. J. M. C. HERRGOTT. London. Fabrics for electric heating purposes.

2,587. G. ROSSET. London. Improvements in electric batteries.

2,607. A. F. BERRY and THE BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.). London. Improvements in electrical transformers.

February 7, 1901.

2,618. A. LOACKER and F. RIEDL. Manchester. Improvements in electrical heating apparatus.

2,619. A. LOACKER and F. RIEDL. Manchester. Improvements in electrically-heated smoothing irons.

2,636. A. PASS. Liverpool. Improvements relating to overhead electrica conductors such as trolley wires for electric trams and the like.

2,643. E. G. CRAVEN. London. Improvements in and connected with the diaphragms of phonographs and such like instruments.

2,659. HELIOS UPTON COMPANY and T. SPENCER. London. Improvements in electric arc lamps.*

2,689. F. M. STAUNTON. London. Improvements in or relating to electrolytic electricity meters.

2,692. L. LOBENTHAL. London. Improvements in incandescent electric lamps.*

2,696. W. LANGDON-DAVIES. London. Improvements in means for protecting electrical conductors.

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February 8, 1901.

2,729. Count A. de Dion and G. Boulton. London. Improvements in apparatus for regulating electric generators.
2,741. R. Hager. London. Electrode-plate for forming Planté cells.
2,776. Callender's Cable and Construction Co. (Ltd.) and J. O. Callender. London. Improvements in electric fuses.
2,779. W. G. Potter. London. Improvements relating to electric conductors.

February 9, 1901.

2,793. S. Cowper-Coles. London. Improvements in and in connection with the storage of electricity.
2,806. R. B. Leach. Manchester. Improvements relating to electric light fittings, such as electroliers, brackets, or the light.
2,830. R. O. Best and Ackroyd and Best (Ltd.). London. Improvements in means for electrically igniting miners' safety lamps.
2,834. F. G. Creed and W. A. Coulson. London. Improvements in or relating to telegraph apparatus.
2,835. E. Hermite and C. F. Cooper. London. Improvements in the manufacture of thermo-electric couples. (Date applied for under Patents, &c., Act, 1883, sec. 103, August 1, 1900, being date of application in France.)*
2,836. E. Hermite and C. F. Cooper. London. Improvements in the manufacture of thermo-electro couples.
2,838. H. J. J. Hummel. London. Apparatus for governing the output of dynamos when driven at different speeds.
2,853. G. W. Johnson. London. Improvements in electric batteries. (Société Paul Chapuy & Co., France.)
2,854. J. Wetter. London. Improvements relating to apparatus for starting and regulating or controlling electro motors. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co., Germany.)*

February 11, 1901.

2,880. H. Garstang. Blackburn. An automatic contact maker and breaker.
2,900. H. M. Salmony & Co. (Ltd.). London. Improvements in and relating to fusible cutouts for electric circuits. (Elektrizitäts-Gesellschaft, vorm. W. Lahmeyer & Co., Germany.)*
2,909. A. W. Hancock, J. Leighton and R. Hacking. London. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, telephones, telegraph, or like wires.
2,933. C. A. Wilde. London. Improvements in electrodes for secondary batteries or accumulators.
2,940. G. C. Marks. London. An improved system for transmitting messages, particularly telephone messages. (L. W. Southgate, United States.)
2,941. L. Gottscho. London. Improvements in thermo-electric batteries.

February 12, 1901.

2,962. A. H. Gledhill. Halifax. Improvements in guards for electric trolley wires.
3,002. M. Harloe. London. Insulator for electrical conduction wires. (Date applied for under Patents, &c., Act, 1883, sec. 103, September 19, 1900, being date of application in United States.)*
3,015. E. Whiting and R. C. Myddleton. London. Improvements in electrical alarm and other like apparatus.
3,026. L. Dion. London. Improvements relating to closed conduit electric railways.
3,030. F. G. Bell and M. Byng. London. Improved method of and means for holding and connecting the wires of telephone receiver and the like.
3,035. F. E. Shaughnessy and G. J. Thomas. Liverpool. Improvements in or relating to trolley or like currents collectors for electric tramways and the like.
3,036. A. B. Upham. Liverpool. Improvements in or in connection with trolley or like current collectors for electric railways and tramways.
3,847. J. S. Highfield. London. Improvements in apparatus for regulating pressure in electric mains connected to storage batteries.*
3,051. J. Stretch. London. Electric generators.*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

396. Behrendt. Electricity meters.
655. Vaughan (Vaughan). Electrically actuated mechanism applicable for various purposes such as the steering of ships, the working of engine room or like telegraphs or the training of guns.
814. Lamme. Method of and installations for operating two-phase electric motors. (Date applied for under International Convention, June 14, 1899.
1,022. Marks. (Continentale Jandus Electricitäts A. G. (Soc. Anon.) Electric arc lamps.
1,148. Siemens Bros. & Co. (Ltd.) (Foster and Nott). Troughs for electric cables.
1,407. Brown. Electric traction on the conduit and road contact systems.
1,450. Holme. (Silfverberg). Push for electric bells or the like.
1,555. Foresio. Method of transmitting electric energy through ether and devices for the same.
1,566. Wuillot. Electric accumulator plates.
1,583. Heyl-Dia. Manufacture of electric cables.
2,047. Eckstein and Mellis. Automatic electric switches or cutouts.
2,104. Stamp. Electric railways and tramways on the surface contact system.
2,384. Mordey. Alternate current distribution.
2,409. Kent. Electrolytic and like electrodes and electrical resistances.
2,700. Mershon. Method of and means for indicating speed or current frequency of electric generators. (Date applied for under International Convention, July 12, 1899.)
2,767. Nesell and Gouin. Long-distance relay magnetic telephones.
2,994. Kugel. Process for the electrolytic deposition of nickel or its allied metals or alloys of these metals.
3,237. Chamberlain and Hookham (Ltd.) and Holden. Electricity meters.
3,291. Wierre. Means for fixing electric incandescent lamps and globe holders for use therewith.
3,461. Westinghouse Brake Co. (Ltd.) (Newell and Herr). Electro-magnetic brakes.
3,922. Krull. Holders for electric incandescent lamps.
3,933. Oldfield. Method of and apparatus for reversing the trolley in electric tramcars and other like vehicles.
3,937. Kelvin. Apparatus for indicating and recording electric pressure and current.
4,157. Drake and Gorham. Electric accumulator traction.
4,248. British Thomson-Houston Company (Ltd.) (Rice.) Switches or circuit-breakers for high potential electric circuits.
4,287. Aitken. Telephone intercommunication systems.
4,527. Adams-Randall. Multiple-contact telephone transmitters and circuits relating thereto.
4,555. Lorrain (Bedell). Electric distribution.
4,622. Reichwald (Firm of Fried. Krupp). Mechanism for reversing electro motors.
4,818. Parker. Means of supporting electrodes or plates of electrical accumulators and in the manufacture of such electrodes and tools or appliances for use in such manufacture and a method of constructing such tools or appliances.
4,885. Parr. Electrical instruments for measuring current pressure and power in electric circuits.
5,046. Wright and Reason Manufacturing Co. (Ltd.). Electricity meters.
5,154. Bennett. Electric traction on a conduit system.
5,356. Gray. Electric cables.
5,382. Casella. Step-by-step printing telegraph instruments.
5,393. Strachan. Trolley poles and standards for electric traction.
5,841. Clutterbuck. Electricity meters.
5,928. Aitken. Telephone divided multiple board systems.
6,693. British Thomson-Houston Co. (Ltd.) (Moody). Electric transformers.
8,227. Fynn. Windings for dynamo-electric generators, motors, and converters.
8,457. Junge. Means for electrically lighting light ships and other stationary vessels.
9,260. Browne (Sanders). Electric light carbons.
9,955. British Thomson-Houston Co. (Ltd.) (Potter). Transformer systems of current supply for electric railways.
11,098. Paterson. Electric targets.
11,107. Edwards (Handwercke). Patterns or designs for electrically regulating the operating of card punching machines, embroidery machines and jacquard and other looms.
11,933. Lundell. Regulation of electric motors.
13,873. Whittingham. Electric switches.
13,874. Whittingham. Automatic electric circuit controllers.
13,892. Feeny (Allgemeine Elektricitäts Gesellschaft). Heating bodies for exciting electrical incandescence bodies made of second-class conductors.
13,971. British Thomson-Houston Co. (Ltd.) (Thomson). Rectifiers for alternating electric currents.
14,121. Marks (General Electric Co.). Methods of and means for electrically producing light.
14,550. Lake (Tesla). Insulation of electric conductors.
15,380. British Thomson-Houston Co. (Ltd.) (Steinmetz and Emmet). Systems of electrical distribution.
16,148. Ryan. Electrically propelled motor road vehicles.
16,697. British Thomson-Houston Co. (Ltd.) (Rice). Systems of electrical distribution.
16,798. Zappe. Underground conduits for electric conductors.
16,966. Sauer. Electro-motor.
17,184. Hewitt and Rhodes. Electric switches.
17,670. Alexander and Hunter. Method of combining a telephone with a system of electric bells.
17,846. Shore and Heap. Telephonic apparatus.
18,046. Poliakoff. Receiving apparatus for photophones and phonographs.
18,904. Crawford and Turley. Thermo-electric batteries.
18,967. Ransford (Miller). Electric incandescent lamps.
19,188. Johnson. Gramaphones and other sound recording and reproducing machines.
19,494. British Thomson-Houston Co. (Ltd.) (Reist). Dynamo-electric machines.
19,496. British Thomson-Houston Co. (Ltd.) (Steinmetz). Induction electric motors.
19,498. British Thomson-Houston Co. (Ltd.) (Hewlett). Circuit-breakers for electric currents.
19,506. Green. Electric arc lamps.
19,824. Burry. Printing telegraphs.
20,558. Birnbaum (Berliner). Combined telephone and electric bell circuits.

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19,945. THOMPSON (Sinding-Larsen). Incandescent electric lamps.
20,926. CROMPTON & Co. (LTD.), BRUNTON and HODGSON. Electric arc lamps.
20,942. BRITISH THOMSON-HOUSTON Co. (LTD.) (Potter). Systems of electric motor control.
20,943. BRITISH THOMSON-HOUSTON Co. (LTD.) (Day). Safety devices for electric-motor control systems.
20,960. EDISON. Reversible galvanic cells, or so-called storage batteries.

# COMPANIES' MEETINGS AND REPORTS.

## West India and Panama Telegraph Co. (Ltd.).

The forty-eighth ordinary general meeting of this Company was held yesterday, Mr. W. S. ANDREWS presiding.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice calling the meeting.

The CHAIRMAN said: Well, gentlemen, matters have been so very fully explained at recent meetings and in the report that I propose to come at once to the receipts from messages and subsidies for the last half-year, which amounted to £24,300, and compare with £22,643 in the corresponding half-year, thus exhibiting an increase of £1,656. The expenses for the same periods were £20,962, as compared with £21,432, or a decrease of £469 during the period under review. An amount of £243 less was received on subsidy account and £180 less on rebate, and these sums, of course, are allowed for in the figures which I have quoted. The expenses hardly call for details, the amounts involved being so small. As regards ships and repairs, the expenditure has been £8,121 for the past half-year, against £8,426 in the corresponding half-year, a small decrease of £306. In the number of words transmitted there has been a small increase in international words and a diminution in inter-colonial words—that is, in the number of words exchanged between the colonies themselves. The total result of it all is that there is an increase for the half-year of 7,034 words only. This slight activity, if it can be called activity at all, was chiefly concerned with Demerara and Colon. The loss on the sale of the "Duchess" is covered by the reserve against ships' depreciation, leaving only the very small amount of £187 to be adjusted. There is a balance of revenue of £3,337 after charging ascertained debits; £953 was brought over from last account, and the interest on the reserve fund amounts to £2,379. This all clubbed together amounts to £6,670. It will be seen that this sum is insufficient to meet the cumulative dividends on the first and second preference shares for the half-year, which amount to £11,769. You will have learned from the report that the Court of Appeal has confirmed the decision of Mr. Justice Farwell in so far as it is against the Company, while at the same time the formal judgment has been varied from what it was in the Court below. From the legal standpoint, I believe the difference between the two decisions is considered of some importance for some purposes. The counsel for the Cuba Company and this Company, however, have been unable to agree upon the precise form of words to express the difference, and the matter is still before the Court for the purpose of getting the formal judgment settled by the Lord Justices of Appeal. You will see, therefore, that this matter at present is not clear to anybody. Even counsel cannot agree upon it, and it must go back to the Law Lords. As, however, the matter is still *sub judice* I can say nothing more than that my colleagues and myself will be guided entirely by what seems to us the true interests of the shareholders in deciding upon the course to be taken in the future. In this position of matters, and having regard to the only fact before us of which we can take cognisance, namely, that the judgments of both Courts are against the Company, the Directors think it prudent to make provision for a possible final decision adverse to the Company, and having regard to all the circumstances which have already been stated to you it appears to them that the best way to do that is to carry forward a balance of £6,670 to the next account. As you know, this is not the first occasion on which the Company have had to go in arrears of its first preference stock, although that does not make the matter any the better. This occurred in 1880 and again in following years, and in December, 1884, the Company were in arrear on preference account to the large amount of £65,851. Nevertheless, by December, 1890, the arrears were all covered, and in 1891 there was a small dividend for the first time on the ordinary shares, which thereafter continued every half-year with one exception down to December, 1898. Then the dividends upon all classes had to be made up from the appreciation of the reserve for the year 1899, and for the first six months of 1900. This appreciation is now practically exhausted, so that you see we could not pay the preference dividends without trenching on the reserve fund, and that we are anxious not to do. The traffic increase which began at Porto Rico and appeared to be so promising when the United States of America first took possession, has not been sustained, and, indeed, the state of that important island, according to the newspapers, is very bad indeed, owing to the stagnation of all affairs, commercial and otherwise. Then again the question of the sugar industry in the West Indies affects the position of the Company very much. We are dependent on West Indian prosperity, and, unless something can be done to bring this prosperity about, I do not see a way out for the present. We have maintained now for over two years our low rates, but an increase of revenue from commercial business or from Government sources has not yet come to us as a consequence. With your approval, we propose to go on working at the reduced rates, and see what can be made of the position. The Spanish-American war in 1898 threw everything out of gear, and it must be remembered that we have, after all, had only two years' real experience —1899 and 1900. This period has not, so far, been encouraging, but then great public questions and political problems such as those involved in this case demand time for settlement. The shareholders, owing to our drawing upon the appreciation of the reserve, have not had to go without dividend, and the present is the first break in first preference dividends since 1883, and in ordinary, save one half-year, since 1890. We regret even this, but we believe we have done the best we could for you, and are now acting for the best in your permanent interests in the policy we recommend in the report, and which is the outcome of much thought and consideration. I now move the adoption of the report and accounts.

Mr. HENRY HOLMES seconded the resolution.

A discussion ensued, in which Mr. Birks, Mr. Kaslake, Mr. Friend Mr. Vears and other shareholders took part, regarding the prospects of the Company in the near future, one speaker pointing out that if the directors of the Cuba Submarine Telegraph Co. intended to enforce the agreement which was the subject of litigation to the very letter, it would result in throttling the West India and Panama Company; and this speaker asked the Chairman if he had any information as to whether the Cuba Company, having won their action, were prepared to discuss terms by which the onerous conditions of the agreement could be disposed of.

The CHAIRMAN in reply said he did not know what the Cuba Company were prepared to do, but he did not think the agreement was of such a desperate character as the honourable proprietor seemed to suggest. Undoubtedly several troublesome questions had been raised by it, but if once the business of the Panama Company were re-established on a decent footing he should not fear the agreement with the Cuba Company. With regard to the communications with the Colonial Office to which another honourable proprietor had referred, the whole position had been laid before the proprietors in the correspondence which had been issued.

The resolution was then carried.

Mr. H. Holmes was re-elected a director, and the auditors, Messrs. Deloitte, Dever, Griffiths & Co., were re-appointed.

A vote of thanks to the Chairman was carried unanimously, and the proceedings terminated.

## Bastian Meter Co. (Ltd.).

The fourth ordinary meeting of this company was held yesterday, Mr. C. O. BASTIAN presiding.

Mr. S. ROBINS (the secretary) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, from the report you will see that we have not written anything off our patents, and this is because we do not consider that they have in any way deteriorated. Indeed we have taken out a number of new patents this year which give us quite a new lease of life. Our patents are not likely to be superseded, because our meter is such an exceedingly simple instrument that it seems impossible to do without any of the parts which it now contains. We have, you will see, obtained the Board of Trade certificate, and that enables us to tender in a great many cases where we were previously unable to do so, as most consulting engineers now specify that the meters to be used in electrical installations shall be those approved by the Board of Trade. Another great advantage of the possession of this certificate is that it puts it out of the power of town councillors and consulting engineers to find arbitrary opportunity of raising serious objections to the use of any particular meter by asserting that it is an unworkable or impracticable instrument. As we shall sell the cheapest meter on the market we have every reason to think that it will meet a large demand. As to the balance-sheet this requires little explanation from me; but I have some figures not included in the balance-sheet which are interesting as showing the growth of our business. For the first 12 months of our existence our expenses may be put down at £1,596, the turnover £660, and the percentage of gross profit on that turnover 33 per cent. For the following 12 months (the period ending Dec. 31, 1899) the total expenses were £1,183, and the turnover £2,098, the gross profit upon that turnover being 55 per cent. For the next 12 months (the period now under review) expenses were £1,355, turnover £3,960, and gross profit 45 per cent. This reduction in gross profit is explained in the report by the notification that we have considered it advisable to replace free of charge certain defective meters sold by the company in previous years. Increased cost of materials also contribute to the reduced gross profits. Our manufacturing cost of the meters has been cut down to the lowest possible point, and we shall soon be in a position to make a reduction in the selling price, and so influence increased orders. I now move that the report and accounts be adopted.

Mr. D. J. COWLES seconded the resolution, which was carried.

Mr. U. Caintar, the retiring director, was then re-elected, as were the retiring auditors, and a vote of thanks to the Chairman and Directors terminated the proceedings.

A preference shareholders meeting followed, at which a resolution approving the issue of six per cent. debenture bonds for £6,000 was approved.

## Castner-Kellner Alkali Co. (Ltd.).

The report of the directors of this company announces that the amalgamation of the business of the Aluminium Co. (Ltd.) has been carried out, and the assets duly transferred to this company. The manufacture of sodium has been removed from Oldbury to new works erected at Weston Point, on the company's land, and plant with the most recent improvements is now at work. During the removal of some of the plant and the erection of the new works the manufacture of sodium had to be discontinued, and for this reason, and further owing to the continuance of the war, which had seriously affected the demand for sodium, the benefits

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anticipated from the amalgamation have not been fully realised; moreover, the net profits of the year from the other branch of the company's industry are less than in previous years in consequence of the exceptional and sudden rise in the price of coal and other raw materials.

The result of the trading is a gross profit of £65,581. 1s. 8d., out of which £15,550. 5s. 1d. has been expended in repairs, renewals and additions to the working plant. The net profit is £45,011. 14s. 11d., which, with £3,767. 17s. 8d. brought forward, gives £48,779. 12s. 7d. An interim dividend at the rate of 8 per cent. per annum was paid for the six months ended Sept. 30, and with other payments, an available balance of £22,131. 17s 3d. remains, out of which the directors recommend that £10,000 be appropriated to depreciation reserve, increasing that account to £25,000, and that one-half the suspense account (law suits) and one-fifth the expenses and costs of the amalgamation (together £5,364. 17s. 6d.) be written off; and that a dividend at the rate of 2 per cent. per annum be paid for the six months to March 31, making 5 per cent. for the year, carrying forward £2,266. 19s. 9d.

The company's processes are working very satisfactorily, and improvements are being continually introduced.

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**COMPAGNIE GENERALE DES VOITURES (PARIS).**—The annual meeting of this company was recently held. Towards the end of 1899, the company placed a number of electric cabs on the streets, but these were withdrawn in November last. The report stated that the experiment had proved altogether unprofitable, and that £180,000 had been sunk in the experiment. The president (M. Bixio) explained that the failure of electric motor cabs to produce the results expected was a sore disappointment. The causes of failure were various. The cost of maintaining the accumulators, which were of the most approved type, turned out in practice to be much greater than previous trials had led the directors to anticipate. The fares charged were necessarily very high, and as a consequence, the public did not patronise them. The experiment had been made on a large scale, with well-equipped workshops and charging stations. Of the £180,000 some £60,000 was totally lost, and the remaining £120,000 was so risky that they decided to call in the cabs and close the workshops in November.

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**CORK ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.)**—The fourth annual meeting was held on Friday last, Mr. E. LAZARUS presiding. The assistant secretary (Mr. A. Clements) read the notice convening the meeting. The Chairman, in moving the adoption of the report, said the tramway receipts were £1,774 more than last year, in spite of bad weather during the early part of the year and the war in South Africa, which took a good many people away from Cork. In the first four months of this year (1901), our worst months in the year, we have a little more than £600 increase over the 1900 figures. We therefore think we are doing well in Cork. Taking the population as 80,000, our having carried 5,137,141 passengers in the year means that we have carried the whole population over 64 times. With respect to lighting, this is not in the paying stage, from various causes. Under our act we are not empowered to charge more than 4½d. per unit. and to large power users we are supplying current at a very cheap rate, our largest customer only paying us an average of 1·1d. per unit. Now, as to the allocation of capital expenditure. Ours is a combined system, and we have to apportion our capital as the one or the other part of the undertaking takes more or less power. We have changed our allocation since last year because of the fact that, whereas in 1899 we generated something like 1,400,000 units, which were about equally divided between traction and lighting, in 1901 the traction undertaking took about the same number of units, and the lighting part took, perhaps, double as much as it did in 1899, and, consequently, we have had to adjust the capital expenditure in about that proportion.—The report was adopted.

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**GENERAL TELEPHONE CO. (STOCKHOLM)**—The report of the Allmänna Telephone Co. for the past financial year shows marked progress, a large accession of private subscribers being recorded. The directors have, during the year, had to consider two important questions—the action of the State Telephone Administration towards the company and the important Swedish-Russian enterprise with which the company has become associated. It appears that the Swedish Government has notfied the company of the discontinuance from July 1 next of the agreement whereby telephonic conversations can be carried on over both the State and the company's system on certain terms. From July 1 the Government have ordained that free intercourse over both systems shall be allowed, and the directors have intimated their dissent to this action on the ground that it will entail heavy loss to the company. It would appear that last year 448,303 intercommunication messages passed over the company's lines compared with 651,534 over the State lines. The directors ask that a postponement of the change, at any rate until after Aug. 31, may be granted to enable them to make the necessary arrangements to provide for the altered state of affairs. With reference to the operations in Russia, the company have pooled their interest in a concession for working the telephone in Moscow with the Cedergren Company, of Stockholm, which has obtained a similar concession for Warsaw, and the two concessions are to be worked by a Swedish-Danish-Russian company, recently formed. It is anticipated that the new central exchange now being erected by the Allmänna Company in Stockholm will be completed this year. Last year the company, by the erection of 4,927 new lines, increased its subscribers to 27,247, of which 22,809 are within and 4,438 without the Stockholm district. There are 151 rural exchange stations. The length of lines owned by the company is 26,348km. in Stockholm, and 12,107km. in the suburban district; 20,187km. are underground. The company has 573 employés. The net profits for the year were 316,000kr., the declared dividend being 8 per cent. on a total share capital of 1,800,000 kr. The reserve fund has been increased to 295,000kr.

**MIX AND GENEST, LTD. (BERLIN).**—The twelfth annual meeting was held on May 18, when a satisfactory balance-sheet was submitted. The gross profit was £55,400, of which £17,750 was absorbed by salaries, general expenses, and income tax; £11,700 is written off for depreciation, leaving a net profit of £25,950, out of which a 14 per cent. dividend has been paid. The report of the directors states that during the year contracts were placed by the German Government Telephone Department for multiple switchboards and telephone instruments of considerable magnitude. All departments of the company's business have been fully occupied. 1,700 hands are at present employed, and when the additional land recently acquired for further extensions of the works have been completed an area of nearly 10,000 sq. metres will be covered.

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**NEW GENERAL TRACTION CO. (LTD.)**—The fifth annual meeting was held on Tuesday, Capt. F. Pavy presiding. The chairman said the shareholders would see by the report that their position was a good one. They had not embarked in any doubtful projects, but had confined their operations within a small compass. This was the first time that any distribution had been proposed on the ordinary shares, which was evidence of a careful and conservative policy. He had often been asked why this company had not covered a larger field, and why they had not followed in the footsteps of some of the other companies doing the same class of work. In reply he would say that they had extremely able experts in tramway business, and they examined with great care the different schemes submitted, yet during this last year they came across only one or two schemes that appeared worth following up. Their gross profits for the year were £41,087. 7s. 11d., after deducting £10,739. 17s. for expenses, salaries, directors' fees, interest on loans, and £1,388. 16s. 9d. expended on new business. £37,030. 15s. 2d. was brought forward, making £78,118. 3s. 1d. The dividend on the preference shares paid in May amounted to £15,000, and this left £63,118. 3s. 1d. The directors proposed to transfer £7,000 to reserve against goodwill, £182. 8s. 10d. to meet the difference in the market value of Consols purchased and lodged as caution-money, and £10,000 to general reserve, which would stand at £30,000 and the reserve against goodwill at £20,000, leaving £45,935. 14s. 3d. to pay a dividend of 4 per cent. on the ordinary shares (absorbing £4,800) and £41,135. 14s. 3d. to be carried forward. With these reserves they had therefore over £90,000 to their credit undivided. This was allowing par value for the shares which they had taken in payment for the works they were carrying out. He would not like to put a value on these shares, but he hoped a good many of them will be worth more than par. There were only about three or four undertakings in which they were interested. The Douglas Tramway was a very small undertaking indeed, but upon that for two years running they had received 6 per cent. Norwich was their largest undertaking, and that had been at work for about nine months, and he had every reason to anticipate 5 per cent. on their invested capital in that concern. They had an investment at Coventry, where trade had been bad, but they were receiving a dividend on that investment. They had also about 20 miles of tramway in the outskirts of Philadelphia (U.S.A.), which would, if all accounts were true, prove their most valuable asset. With regard to the issue of fresh capital, he had deprecated further issues of 6 per cent. preference shares if it could be avoided. He and his friends had therefore put their hands in their own pockets and supplied money. Consequently there was a very large sum of loans secured, namely, £157,000. But now that these undertakings would all be completed within, he hoped, the next three months, they had decided it would be best to issue immediately £200,000 5 per cent. debentures, which would be an excellent investment well secured. He then moved the adoption of the report and accounts, which was carried.

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**RUSTON, PROCTOR & CO. (LTD.)**—The directors' report for the year to March 31 states that the balance of profit is £29,956. Expenses, interest, &c., bring the net balance to £10,026. Adding £1,115 brought forward, and transferring from equalisation of dividends account £5,000, makes the amount available for distribution £16,142. The directors propose a dividend of 5 per cent. on £250,000 for one year (£12,500), and on £100,000 from due dates of instalments (£2,125), leaving £1,517 to be carried forward. 10,000 additional shares have been issued at a premium of £1 per share, and were over-applied for.

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## NEW COMPANIES, STATUTORY RETURNS, &c.

**ARMOURED CONCRETE CONSTRUCTION CO. (LTD.)**—Reg. April 12, capital £5,000 in £1 shares, to adopt an agreement with Mr. H. C. Werner, and to carry on the business of manufacturers of armoured and ordinary concrete conduits, engineers, &c. The first directors are A. Johnston, F Candy and H. C. Werner (managing director and secretary).

**DESOLLE ELECTRO-PLATING CO. (LTD.)**—Reg. May 13, capital £70,000 in £1 shares, to acquire certain patents of M. E. L. Desolle, relating to electro-plating, and to carry on the businesses of mechanical, electrical and general engineers, metallurgists, &c. The first directors are J. M. Grant, G. C. Locket, W. R. Newburn, M. F. Rust and R. Sanderson.

**G. FAWLEY & SON (LTD.)**—Reg. April 20, capital £8,000 in £1 shares (4,000 preference), to carry on the business of electrical and ventilating engineers, metal workers, &c., at Halifax.

**FELTEN AND GUILLEAUME FABRIKS ELEKTRISCHER KABEL, STAHL UND KUPFERWERKS GESELLSCHAFT.**—This is the name of a company just formed in Vienna, with a capital of 6,000,000kr.

**FULLER, MACLEOD & CO. (LTD.)**—Reg. May 15, capital £10,000 in £1 shares, to acquire the business carried on at Red Lion-court, London, E.C., by J. L. Fuller, as Fuller & Co., and to carry on the busines s

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of merchants, factors, dealers in electrical accessories and equipment, dynamos, motors, &c., electrical engineers, makers of electrical and general engineering appliances, suppliers of light, heat and power, manufacturers of self-propelled and mechanically-propelled vehicles, &c. The subscribers are: J. A. Ewing, merchant; A. Kitchin, electrical engineer; A. W. Macleod, engineer; W. A. Dinwiddie (each with 100 shares); A. Tabor, F. Elwell and F. V. Macleod (with one share each). The first directors are A. W. Macleod and J. A. Ewing.

**D. F. LAING & CO. (LTD.)**—Reg. at Edinburgh May 8, capital £2,500 in £1 shares, to acquire the business of D. F. Laing & Co., Glasgow, and to carry on the business of electrical engineers, &c. The subscribers are A. Low, R. Wilson and D. F. Laing, electrician (each with 25 shares), and J. Wardhaugh, T. Logan, P. S. Laing and W. Pollock (1 share each). The first directors are A. Low, R. Wilson and D. F. Laing.

**LEWIS LIGHTING SYSTEM (LTD).**—Reg. May 17, capital £15,000 in £1 shares, to acquire patents, inventions, licenees and concessions relating to improvements in the production of acetylene gas, to manufacture and deal with electrical, magnetic, chemical and other products and accessories, and to carry on business as electricians, engineers, lamp makers, &c. The first directors are Major C. H. Tye and G. Goodland, C.E.

**MILLINGTON, EVERITT & CO. (LTD.)**—Reg. May 15, capital £3,000 in £1 shares, to carry on the business of electricians, suppliers of electricity, manufacturers of and dealers in electric motors, dynamos, and starting and regulating switches and electric apparatus of all kinds, electric light and power contractors, electrical and general engineers, motor carriage manufacturers, &c., and in particular to acquire from F. Millington the benefit of certain existing inventions relating to electric motors, starting resistance, and amperemeter and all patents connected therewith. The subscribers are F. Millington (electrical engineer), T. Newton (each with 200 shares), Mrs. M. Everitt, H. Rooke, T. L. Barker (engineer), A. E. Everitt (electrical engineer) and Miss J. A. Steading. The first directors are F. Millington and T. Newton.

**A. REYROLLE & CO. (LTD.)**—Reg. May 16, capital £20,000 in £1 shares, to acquire the business carried on as Reyrolle & Co., and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of electrical appliances, &c. The first directors are J. H. Armstrong, A. C. Reyrolle, W. Negus, A. N. L. Wood and A. Scholefield.

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**BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)**—The annual return to April 14 has been filed. The capital is £50,000 in £5 shares, 1,939 of which have been taken up; £5 has been called up and £9,670 received. Mortgages and charges, £20,000.

**COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)**—The annual return to April 11 gives the capital as £800,000 in £10 shares (40,000 preference) of which 40,000 ordinary and 20,000 preference have been taken up. £600,000 has been received. Mortgages and charges, £400,000.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—The annual return to April 14 gives the capital as £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each, of which 40,000 preference and 70,595 ordinary have been taken up. £1,105,950 has been received. Mortgages and charges, £600,000.

**GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)**—According to the annual return to April 12 the capital is £20,000 in 3,900 ordinary shares of £5 each and 500 founders' shares of £1 each, of which 2,586 ordinary and 500 founders' have been taken up. The full amount has been called up on each share, and £13,440 has been received. Mortgages and charges, £3,450.

**HOVE ELECTRIC LIGHTING CO. (LTD.)**—The annual return to March 25 gives the capital as £100,000 in £5 shares, 12,000 of which have been taken up. £5 per share has been called up on 11,000 and £3 per share on 1,000 shares. Mortgages and charges, £25,000.

**NATIONAL ELECTRIC WIRING CO. (LTD.)**—According to the annual return to April 15 the capital is £250,000 in £1 shares, 118,971 of which have been taken up; 15s. has been called up on each of 100,120 shares, and £74,768. 15s. has been received; 18,851 shares are considered as fully paid. No mortgages or charges.

**NOTTING HILL ELECTRIC LIGHTING CO. (LTD.).**—The annual return to April 2 gives the capital as £200,000 in 16,452 ordinary, 2,998 ordinary preference and 550 founders' shares of £10 each, of which 8,652 ordinary, 2,998 ordinary preference and 550 founders' shares have been taken up. £10 has been called up and paid on each share. Mortgages and charges, £50,000. Mortgages and charges issued jointly by the company and the Kensington and Knightsbridge Electric Lighting Co., £100,000.

**WILLANS AND ROBINSON (LTD.)**—The annual return to April 17 has been filed. The capital is £750,000 in £5 shares (75,000 preference), of which 50,000 preference and 50,000 ordinary have been taken up. £5 per share has been called up on 25,537 preference and 25,538 ordinary, and £3 per share on 10,000 preference and 10,000 ordinary shares; 14,463 preference and 14,462 ordinary shares are considered as fully paid. Mortgages and charges, £100,000.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27½d. per oz. (May 23). Consols (2¾ per cent.) 93⅞—94⅛ for money, 93⅞—94⅛ for account; 2½ per cent. 94—95 (May 23). Consols Pay Day, June 3; Stocks and Shares Continuation Days, May 29 and June 12; Ticket Days, May 30 and June 13; Pay Days, May 31 and June 14; Mining Share Carry-over Days, May 28 and June 11.

**KETTLE RIVER POWER CO. (LTD.)**—Subscriptions have been invited to an issue of £100,000 6 per cent. first mortgage debenture stock in a company formed by the London and British Columbian Goldfields (Ltd.) to carry out and develop certain concessions, &c., of the Cascade Water Power and Light Co. (Ltd.), a company incorporated by special act of the Legislative Assembly of British Columbia for utilising the Cascade falls of the Kettle river for generating electric current and distributing same within a radius of 40 miles of Grand Forks City, B.C. The falls are estimated to give a minimum power of 6,000 H.P. during the season when the waters are lowest. It is intended to commence with an installation of 2,000 H.P., at an estimated capital expenditure of £90,000. Favourable reports of the prospects of the company have been issued. Messrs. Kincaid, Waller and Manville, London, and the Hon. John Bogart, New York, are consulting engineers to the company. The lists close to-day (Friday).

**METROPOLITAN DISTRICT RAILWAY CO.**—A special meeting of this company is to be held at Westminster Palace Hotel on June 6, at which the shareholders will be asked to approve the bill authorising the conversion of the line to electric traction and an agreement with the Metropolitan District Electric Traction Co. (Ltd.).

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed May 30 a special settling day in 18,000 5 per cent. cumulative preference £10 fully-paid shares (Nos. 7,001 to 25,000) and £150,000 4 per cent. first mortgage debenture stock of the *General Electric Co. (1900) (Ltd.)*, and has ordered the same to be quoted in the official list. The Committee has also been asked to appoint a special settling day in the further issue of 30,000 6 per cent. cumulative preference £10 (£6 paid) shares (Nos. 160,001 to 190,000) of the *British Electric Traction Co. (Ltd.)* and 9,391 ordinary £1 fully paid shares (Nos. 7,501 to 11,425, 12,926 to 15,025 and 16,026 to 19,391) and 33,814 6 per cent. cumulative preference £1 fully paid shares of the *West London and Provincial Electric Supply Co. (Ltd.)*, and to allow 6,637 6 per cent. cumulative preference £5 fully paid shares (Nos. 1 to 6,637) of *Edmundson's Electricity Corporation (Ltd.)*, and £400,000 4 per cent. first debentures of the *Primitiva Gas and Electric Lighting Co. of Buenos Ayres (Ltd.)* to be quoted in the official list.

**TELEGRAPH MANUFACTURING CO. (LTD.)**—The directors have decided to pay a dividend on the ordinary shares for the half-year ended March 31, at the rate of 12 per cent. per annum and a bonus of 2 per cent., both tax free, making, with the interim, 12 per cent. for the year. £6,500 is put to reserve and £7,500 carried forward. The premium (£20,000) received on the issue of new ordinary shares in 1900 has also been placed to reserve.

**THORNEYCROFTS (LTD.)**—Rumour has it that a large issue of ordinary and preference capital is about to be made by Messrs. Thorneycrofts, of Chiswick.

**WESTERN TELEGRAPH CO. (LTD.)**—An interim dividend of 3s. per share (at the rate of 6 per cent. per annum), tax free, for the quarter ended March 31 is payable on June 24. The transfer books will be closed from June 17 to June 22 inclusive.

**WORCESTER TRAMWAYS (LTD.)**—The directors' report states that the Worcester and District Light Railways Order has been confirmed by the Board of Trade, the Worcester Tramways Bill has been remodelled and is now unopposed, and the Worcester (Extension) Light Railways Order is awaiting confirmation by the Board of Trade.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | May 11 | 726 | + 40 | 49 | 32,500 | + 3,653 |
| *Birmingham Tramways. | „ 18 | 4,670 | + 58 | 19 | 79,947 | + 1,395 |
| *Blackburn Corporation.. | „ 17 | 539 | + 100 | 20 | 8,851 | + 962 |
| Blackpool Corporation... | „ 16 | 415 | + 144 | †7 | 3,032 | + 570 |
| Blackpool and Fleetwood | „ 18 | 413 | - 113 | 20 | 4,698 | − 412 |
| Bolton Corporation ..... | „ 19 | 1,423 | + 198 | 7 | 10,354 | + 2,336 |
| Bradford Corporation... | „ 19 | 995 | + 542 | 7 | 6,843 | + 3,700 |
| Brisbane Trams ..... | Apl. 3 | 2,107 | + 447 | 13 | 26,547 | + 3,053 |
| *Bristol Trams & Carriage | May 17 | 4,430 | +1,656 | 19 | 77,875 | +23,110 |
| *Buenos Ayres & Belgrano | Apl. 21 | 2,661 | + 301 | 16 | 44,872 | + 8,097 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | ... | ... | ... | ... | ... | ... |
| City & South London Ry. | May 19 | 1,902 | + 563 | 20 | 39,633 | +14,663 |
| Cork Elec. Trams ..... | „ 16 | 559 | + 75 | 19 | 7,593 | + 913 |
| Dover Corporation ..... | „ 18 | 188 | + 14 | 7 | 1,457 | + 132 |
| Dublin & Lucan Rly. ... | „ 18 | 121 | + 9 | 20 | 1,707 | + 123 |
| Dublin United ..... | „ 17 | 3,777 | + 477 | 20 | 55,333 | - 1,208 |
| Dublin Southern Dist.... | „ 17 | 913 | + 153 | 20 | 15,143 | |
| *Dundee Corporation ... | „ 15 | 678 | + 287 | ... | ... | ... |
| *Glasgow Corporation ... | „ 18 | 11,441 | +1,727 | 20 | 178,915 | + 8,167 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 18 | 840 | + 214 | 7 | 4,816 | 1,231 |
| Hull Corporation..... | „ 18 | 1,600 | + 503 | 45 | 67,803 | +34,385 |
| Liverpool Corporation.. | „ 18 | 8,850 | +1,705 | 19 | 155,092 | ... |
| *Liverpool Overhead Rly | „ 19 | 1,644 | + 168 | 20 | 30,811 | + 2,583 |
| Perth (W.A.) Elec. Trams | „ 17 | 837 | + 494 | 46 | 30,692 | +22,667 |
| Portsmouth Corporation | „ 18 | 527 | - 155 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 19 | 3,620 | +1,416 | 20 | 61,116 | +22,437 |
| Southampton Corporat'n | „ 16 | 699 | + 348 | ... | ... | ... |

(a) These comparisons are for the corresponding week last year.
* Partly electrical. † Minus 3 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 15: | | Price Wednesday, May 22. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending May 22. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅜ | 8⅛ | 7⅜ | 8⅛ | 3 13 9 | ... | ... | ... |
| 13,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅜ | 9 | 8⅜ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) xd | 7 | 7½ | 7 | 7½ | 2 6 8 | ... | 7 1/16 | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 | 5½ | 5⅛ | 5⅜ | 3 18 3 | ,, ,, | 5 7/16 | 5⅜ |
| 24,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5⅜ | 6⅛ | 5⅜ | 6⅛ | 4 8 0 | March | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | 111½ | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 8½ | 9½ | 4 4 3 | February and August | 9⅜ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 | 13 | 12 | 13 | 4 12 4 | January and July | 12⅜ | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 123 | 127 | 122 | 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8 | 9 | 4 8 11 | ... | 8⅛ | 8⅜ |
| 30,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11½ | 12½ | 4 16 0 | March and September | 12⅜ | 12⅛ |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 105 | 108 | 105 | 109 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5 | 5½ | 5⅛ | 5⅞ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7½ | 8⅛ | 7⅛ | 8⅛ | 3 15 5 | ... | 8⅛ | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 7 6 | ... | 11 3/16 | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 105 | 103 | 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 | 104 | 102 | 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 12½ | 13⅛ | 13 | 14 | 4 5 9 | April and October | 13⅛ | 13⅜ |
| 13,750 | 10 | 9d. | Do. (85,001 to 98,750) | 12 | 13 | 13 | 14 | ... | ... | 13⅛ | 13 1/16 |
| £750,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | 111½ | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 11 5 | ... | ... | ... |
| 8,652 | 10 | 3/0 | Notting Hill Electric Ordinary | 15½ | 16½ | 16½ | 16½ | 4 13 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6⅜ | 5⅝ | 6⅜ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅜ | ⅝ | ⅜ | ⅝ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9.6 | St. James's and Pall Mall Electric Ordinary | 14 | 15 | 14½ | 15½ | 4 13 7 | February and August | 15 | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 93 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 55,000 | 5 | ... | South London Electric Supply Ordinary | 2⅜ | 2¾ | 2⅜ | 2¾ | ... | ... | ... | ... |
| 102,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 12⅜ | 12⅛ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 3⅞ | 4⅛ | 3⅞ | 4⅛ | 4 17 0 | April and October | 4 1/16 | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 124 | 129 | 4 14 6 | ... | 127⅛ | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 96 | 101 | 98 | 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 12 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2⅜ | 3⅜ | 2⅜ | 3⅜ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4⅛ | 4⅝ | 4⅛ | 4⅝ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 | 101 | 99 | 101 | ... | ... | ... | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ | 23⅝ | 23½ | 23⅝ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 | 116 | 114 | 116 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6¼ | 7 | 6½ | 7 | ... | ... | 6⅝ | 6½ |
| 13,600 | 10 | 5/0 | Do. 5% Preference xd | 9½ | 10 | 9½ | 10 | 5 0 0 | May and November | ... | ... |
| £220,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 99⅞ | 101⅞ | 99⅞ | 101⅞ | 4 9 3 | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 14½ | 15½ | 14½ | 15½ | 5 9 8 | ... | 15⅛ | 14⅞ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 4 | February and August | 12⅝ | 12⅜ |
| £240,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 119 | 123 | 120 | 123 | 4 1 9 | ... | 121 | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 5 4 4 | ... | ... | ... |
| 37,500 | 5 | 2/6 | Do. "B" | 5 | 5⅛ | 5 | 5⅛ | ... | ... | ... | 5⅛ |
| £230,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 8 | ... | 98⅜ | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) | 10½ | 11⅛ | 10⅜ | 11⅛ | 2 13 2 | ... | 11⅛ | 11 |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 101 | 104 | 103 | 104 | ... | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅜ | 1⅝ | 1⅜ | 1⅝ | ... | ... | ... | ... |
| 19,980 | 10 | 2/6 | Central London Ordinary | 9½ | 10 | 9⅝ | 10 | 2 15 0 | June and December | 9⅞ | 9½ |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5 | 5⅛ | 5⅛ | 5⅜ | 4 1 0 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 100 | 103 | 3 17 10 | ... | ... | ... |
| £555,000 | Stock | 1½% | City and South London Railway Ord. | 52 | 54 | 51 | 54 | 2 7 0 | February and August | ... | ... |
| 47,500 | 10 | 2/0 | Do. Ordinary (Nos. 22,501 to 70,000) | 5 | 5⅛ | 5 | 5⅛ | 2 5 5 | ,, ,, | 6⅛ | ... |
| £100,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 | 127 | 122 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture xd | 111 | 116 | 111 | 116 | 3 9 2 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 | 14 | 13 | 14 | 4 5 9 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | ... | ... | ... | ... |
| 10,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5⅛ | | 5⅛ | | ... | ... | ... | ... |
| 30,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4⅞ | 5⅛ | 4⅞ | 5⅛ | ... | ... | ... | ... |
| 30,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 | 22⅞ | 22 | 24⅜ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14⅜ | 15⅛ | 14⅜ | 15⅜ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 | 114 | 113 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | ... | ... | ... | ... | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7⅛ | 8 1/16 | 8⅛ | 8⅜ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13⅜ | 13 | 13⅜ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 105 | 103 | 104 | 3 17 2 | January and July | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 103 | 104 | 103 | 105 | ... | ... | 104 | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y 5% Mort. Debs. (1903) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1942) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3⅛ | 3¾ | 3⅛ | 3⅜ | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference xd | 4⅜ | 5 | 4⅜ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 | 12 | 11 | 12 | 1 13 4 | ... | 11⅛ | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock xd | 105 | 107 | 105 | 107 | 4 4 1 | ... | 108 | 106½ |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 61,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 2 2 | June and December | 94½ | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 15. | Price Wednesday, May 22. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending May 22. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £98,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 5 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... | 3½ 4½ | ... | June and December | 3½ | ... |
| £119,760 | 100 | 5% | Do. 5 per Cent. Debentures | 61 71 | 70 75 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 53 56 | 53 56 | 5 11 9 | Feb., May, Aug., Nov. | 54 | ... |
| £3,097,640 | Stock | 20/0 | Do. Preferred | 97 99 | 97 99 | 6 1 9 | " " | 98½ | 99 |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 10½ | 10 10½ | 2 7 7 | " " | 10¼ | 10½ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,022 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 5 | " " | 104½ | 101½ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary xd | 7 8 | 7 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. xd | 15 16 | 15 16 | 6 5 0 | " " | ... | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 80 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 10½ | 10 10½ | 6 13 4 | Jan., Apr., July, Oct. | ... | ... |
| £103,200 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 139 144 | 140 145 | 4 17 0 | Jan., Apr., July, Oct. | 144 | 140 |
| £1,236,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 94 | 91 94 | 3 14 6 | " " | 93½ | 92½ |
| £1,482,288 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 114 | 110 114 | 3 10 2 | May and November | ... | ... |
| 300,000 | 10 | 0/6 | Eastern Extension | 13½ 14 | 13½ 14 | 5 0 0 | Jan., Apr., July, Oct. | 14 | 13¾ |
| £230,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 116 | 111 116 | 3 9 2 | February and August | 113 | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 102 | 100 103 | 3 17 8 | February and August | 103½ | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% 102% | 100% 103% | 3 17 10 | May and November | 102 | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust | 9½ 10 | 9½ 10 | 5 5 0 | Jan., Apr., July, Oct. | 9 7/8 | ... |
| 180,043 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ 15½ | 14½ 15½ | 3 19 8 | " " | 15½ | 14 13/16 |
| 150,000 | 10 | 20.0 | Great Northern of Copenhagen | 33 35 | 34 34 | 4 8 3 | January and July | ... | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (w thn Nos | 100 103 | 100 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 37.6 | Indo-European xd [1 to 1,200) (red.) | 43 47 | 43 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brasilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 6 12 2 | March and September | 103½ | 103½ |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 1 | June and December | ... | ... |
| 11,239 | 9 | 4/0 | Reuter's | 7½ 8½ | 7½ 8½ | 4 14 1 | April and October | 7¾ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 124 129 | 124 129 | 4 13 5 | " " | 125½ | 125 |
| 15,000 | 10/0 | ... | West African Telegraph | 2 3 | 2 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 101 | 98 101 | 4 19 7 | March and September | ... | ... |
| 20,008 | 2½ | ... | West Coast of America | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 100 103 | 3 18 1 | January and July | ... | ... |
| 38,231 | 10 | 6d. | West India and Panama | ⅜ ⅝ | ⅜ ⅝ | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 5 6 | 10 0 0 | " " | 6⅛ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 5 | 12 0 0 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 14 4 | January and July | ... | ... |
| 207,920 | 10 | 2/0 | Western Telegraph (late Br sh'l'n Submarine) | 13¾ 14½ | 13¾ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14 | 13¾ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 102 105 | 4 15 8 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3½ 4 | 3½ 4 | 5 0 0 | August | ... | ... |
| 234,850 | 10 | 2% | Consolidated Telephone Con. and Manfg. | 2/3 2/9 | 2/3 2/9 | 10 18 2 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¼ ⅜ | ¼ ⅜ | 5 0 0 | November | ... | ... |
| 96,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 2 6 | National | 3½ 3¾ | 3½ 3¾ | 7 11 9 | February and August | 3⅞ | 3¾ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 10 12 | 10 12 | 5 0 0 | " " | 11¼ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 12 | 10 12 | 5 0 0 | " " | 11 1/16 | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ 4¾ | 4½ 4¾ | 5 14 3 | " " | 4 1/16 | 4 1/16 |
| £1000,000 | Stock | 2½% | * Do. Debenture Stock 2½ per Cent. (red.) | 87 90 | 87 90 | 3 18 8 | June and December | ... | ... |
| £2500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 8 | ... | 97⅜ | 96 |
| 171,504 | 1 | 0 2/3 | Oriental xd | ¾ 1 | ¾ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ 5 | 4½ 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ 5¼ | 4¾ 5¼ | 4 15 3 | June and December | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 106 | 103 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 8 0 0 | .. | ... | ... |
| 125,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | 1/16 1/8 | 1/16 1/8 | 7 7 8 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 11 | 10 11 | 6 16 4 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5¾ 6¼ | 5¾ 6¼ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference xd | 4½ 4¾ | 4½ 4¾ | 6 6 4 | " | 4 1/16 | ... |
| 90,000 | 2 | 3/0 | Brush Electrical Engineering | 1⅜ 1⅝ | 1⅜ 1⅝ | 3 8 7 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/3½ | Do. 3 per Cent. Pref. Non-Cum. | 2 2¼ | 2⅛ 2⅜ | 5 1 1 | " | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 3 2 | March and September | ... | ... |
| £135,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 103 | 4 7 5 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 14½ 15½ | 14½ 15½ | 4 16 9 | " " | 15 | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | " " | 5½ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 113 | 109 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1⅛ | ¾ 1⅛ | 7 2 3 | ... | ⅞ | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 98 | 94 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1⅛ | ¾ 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3½ 4 | 3½ 4 | 5 12 7 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 101 104 | 101 104 | 4 17 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,361 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1 1⅛ | 1 1⅛ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2½ 3½ | 2½ 3½ | 7 11 6 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 89 | 87 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 98 | 94 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5 5⅛ | 5⅛ 5⅜ | 7 7 10 | Half-yearly | 5⅜ | ... |
| 13,363 | 5 | 1/6⅛ | Do. Cumulative Preference | 5⅛ 6 | 5⅛ 6 | ... | ... | ... | ... |
| £110,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 106 | 104 107 | 4 4 5 | ... | ... | ... |
| 113,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1⅜ 2⅛ | 1⅜ 2⅛ | 5 6 8 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅜ 3 | 2⅜ 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 16 11 | January and July | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15⅜ 16⅜ | 15⅜ 16⅜ | 6 1 3 | February and August | 16 | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 6 | 5⅛ 6 | 3 15 0 | " " | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 111 | 107 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 13 0 | " " | 21⅜ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 35 39 | 35 39 | 5 7 8 | March and July | 36½ | 36 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1900 | 102 105 | 102 105 | 3 16 10 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11½ | 6 12 6 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ 6 | 5⅛ 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 1 | April and October | 10½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 6¾ | 6½ 6¾ | 4 8 11 | " " | 6¾ | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 0 | May and November | 106½ | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,202. [Vol. No. S. XLVII.] FRIDAY, MAY 31, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70m.


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## NOTES.

THE Comptroller-General of Patents, Designs and Trade-Marks knows how to make statistics interesting, and his report on the work of the Patent Office for the year 1900, together with the various tables appended to it, are worthy of careful perusal. Probably the most noticeable feature in the report is the continued decrease in the number of applications for British patents: 23,922 were applied for during the year under review, as compared with 25,800 in 1899, and 30,952 in 1897; and this decrease is mainly due to a falling off of British patentees, who numbered 23,069 in 1897, 16,889 in 1899, and 15,321 in 1900. Thus the decrease in British patents applied for in the United Kingdom during the past year has been about 10 per cent., while the corresponding decrease in British patents applied for by foreigners has been 3½ per cent. Considerably fewer patents have been taken out for Frenchmen and Germans this year, but the British patents taken out by Americans has somewhat increased—from 3,022 to 3,184—and the number of applications from the British colonies and possessions has decreased only slightly, from 533 to 510. It is satisfactory to note, however, that electrical patents do not share in this general shyness. With the exception of the class "Electric Lamps," the number of applications for patents for electrical machinery and appliances has considerably increased. Especially noticeable was the number of applications for electric traction patents, one particular firm alone being responsible for over 100. Another encouraging feature of the year's results is that the receipts of the Patent Office in the form of fees continue to increase, showing that the owners of patents are renewing their patents at a greater rate than ever, and thus indicating that the decline in the number of applications for patents is due merely to a temporary decrease in the inventiveness of the nation and not to any real industrial depression.

WHILE the bill to adjust the electric lighting areas of the metropolis in accordance with the London Government Act of 1899 is still on its way through Parliament, an interesting controversy is going on in the borough of Southwark, on the south side of the Thames. This new borough includes the parishes of Newington, St. George-the-Martyr (Southwark), and the district of the St. Saviour's (Southwark) Board of Works. The Newington Vestry built an electricity station some time ago, and are supplying a public and private lighting load, the connections amounting to some 500kw. The City of London Electric Lighting Co. owns a provisional order in the St. Saviour's, Southwark, district, and two other companies, the County of London Company and the London Electric Supply Corporation, also supply parts of the new Borough of Southwark, the latter company being to some extent in active competition with the Newington works. As was briefly noted in our last issue, the City of London Company has given notice that it is applying to have its provisional order extended to embrace the whole of the Southwark borough instead of a part. This application is being opposed by the Southwark Borough Council, who desire that their Newington provisional order, transferred to them by the Newington Vestry, should be extended to embrace the whole of the new borough. As the London Electric Supply Corporation and the County of London Company are, we believe, opposing both applications, the situation is by no means an ordinary one. Another interesting factor is that the London Electric Lighting Areas Bill, 1901, if it becomes law, will not afford a means of settling the whole question, as sec. 2, which provides for the adjustment of areas of supply as between companies and local authorities, is expressly not applicable to parts of company areas comprising the whole or the greater part of a parish.

THE *Financial Times* of last Saturday contains a long article on the question of inter-communication between the National Telephone Co.'s subscribers and the subscribers to the exchange system promised by the Post Office. We have



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repeatedly alluded to the absurdity of two competing telephone systems working in the same district, and to the natural disinclination of the National Telephone Co. to afford their competitors, who must perforce start with a comparatively small number of subscribers, facilities for communicating with all the subscribers of the older-established business. In the case of new municipal exchanges in the provinces this difficulty is to be got over by giving the municipal authority the option of obtaining a licence lasting eight years longer than the company's present licence, in which case the company may obtain an equal extension of time provided it assents to give certain intercommunication facilities, with a kind of sliding scale of terminal fees, and on other conditions which are not too onerous. Our contemporary suggests some similar arrangement in London, proposing that the company should be induced to allow Post Office subscribers to telephone to their own on certain conditions, receiving as a *quid pro quo* an extension of their licence for a period of years. In our opinion this would be one of the worst possible solutions of the difficulty, although possibly it might be acceptable to the company. A system of telephonic competition, involving a telephone service given by a company labouring under the difficulties of inadequate wayleave powers and a heavy tax levied by its competitor to make good the deficit in its own accounts, cannot be satisfactory, and it should not be prolonged. By 1904 a large part of the Post Office exchange system will probably be in working order, and if the Government were then to make use of its last opportunity to acquire the company's business at a valuation, London might finally be provided with a telephone system adequate to its commercial requirements.

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The aims of the National Physical Laboratory, as expounded in an able discourse by Dr. R. T. Glazebrook, at the Royal Institution last Friday, are, broadly speaking, to supply to the industries of this country a fuller measure of scientific and technical stimulus than at present exists. Inspired, as we believe they have been, with a sincere patriotism, and alarmed moreover at what they appear to regard as the imminent "industrial supremacy of Germany," the promoters of this new British institution have succeeded after long and strenuous efforts in inducing the Government to supply funds for the creation of a national physical laboratory, modelled on the famous Physikalische-Technische Reichsanstalt in Germany. As we have already announced, the spacious buildings and grounds of the royal estate known as Bushey House have been presented for the purpose, and plans for the alteration and equipment of this site are being rapidly carried into execution. When the actual work of the laboratory can be commenced, it is intended that a managing committee shall direct the researches which are to be carried on in the various departments.

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This committee will seek to keep in touch, on the one hand, with national industrial requirements and, on the other hand, with the particular lines of scientific research that would most effectively assist in developing these industries and in furthering progress. Dr. Glazebrook cited several examples of the class of work which it is hoped the laboratory staff will be able to undertake. Before doing so, however, he mentioned the triumph of German technical chemistry in the up-growth of the artificial indigo and aniline dyes industries; and, almost inevitably, the audience were informed of the vast numbers of "trained scientific chemists" engaged in individual German works for this class of industry. We have so often heard of those wonderful chemists, that we must confess to being decidedly tired of this sort of pleading, the fallacy in which has long since floated to the top and become plainly visible. Such arguments ignore altogether the essential principles which underly sound commercial factory organisation. It is unquestionably valuable for the few heads of departments to be trained scientific men, but when the "hands" are D.Sc.s and Ph.D.s it is not only a disservice to the industry, but a refined cruelty to the individuals. However, we will not labour the point.

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Among the subjects which were suggested as affording scope for useful research were several of an engineering character. The properties of iron and steel, when raised to a few hundred degrees below the melting point and cooled in various ways, are not perfectly understood, and further knowledge of them would be useful in countless industries. Another example cited by Dr. Glazebrook was the investigation of wind pressure on bridges and other large structures in relation to the area and shape of the exposed surfaces. This constitutes material for valuable research, though we do not quite see how it is to be carried out in Bushey Park, where half a gale of wind is the rare exception rather than the rule. The properties of glass, again, especially in relation to its chemical constituents, enter largely into the choice of glass for certain industries, such as the manufacture of thermometers and optical instruments. In Dr. Glazebrook's hands research in this direction will almost inevitably yield practical results that will be of value to the related industries.

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These are but a few of the immense number of researches, covering every branch of physical science and affecting almost every industry, by which the new institution under Dr. Glazebrook's direction may ultimately prove itself a truly national physical laboratory and a national boon. But it is necessary to walk before learning to run; and certain hints dropped in the course of the lecture last Friday indicate that Dr. Glazebrook is chafing under the limitations imposed by the alleged slenderness of the Government grant. Until the new laboratory has justified its creation by some practical result, however small, it is rather ungrateful to compare the funds given by the Government with the expenditure on the older and long-established Reichsanstalt in Berlin. Enthusiastic scientists are apt to overlook the fact that, regarded politically, the National Physical Laboratory is but an experiment; it is, indeed, quite rightly so regarded by the Government. If properly used, the funds already granted are amply sufficient to give practical proof of the industrial utility of the laboratory; and when that proof has been given the necessary funds for adequate extension of the work will not be withheld. To achieve this end, however, the energies of the laboratory staff must, from the commencement, be concentrated upon one or two distinctly practical lines of research. Diffuse and widely-elaborated researches, on the other hand, will exhaust

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the financial resources before any definite practical result can be reached. The favourite amusement of the scientific professor, of chasing indeterminate equations through remote labyrinths of physical uncertainties, is not a sport in which the director and staff of the National Physical Laboratory can indulge with impunity.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Bolama | May 20, 1901 |

Cape-Australian Cable.—The Eastern and Eastern Extension Telegraph Companies notify that the first section (between Durban and Mauritius) of their Cape-Australian cable has been successfully laid. The sections between Mauritius and Perth are expected to leave the Thames early in August, and the laying to be completed before the end of October.

The American Institute's Visit to England.—At the annual general meeting of the Institution of Electrical Engineers last night, an illuminated address was presented to the Institution on behalf of the American Institute of Electrical Engineers, thanking the Institution for the courtesies shown to members of the American society on the occasion of its visit to London and Paris last summer.

Personal.—Mr. Edward A. O'Keeffe has been unanimously appointed to the post of head science master and organising secretary of the Crawford Municipal Technical Institute, Cork. His long connection with the City and Guilds of London Institute Technical College, Finsbury, as senior demonstrator in the Department of Electrical Engineering and Applied Physics under Prof. Silvanus P. Thompson, should render his selection from 48 candidates a peculiarly happy one.——Mr. and Mrs. W. B. Esson were thrown out of their trap in Maidenhead on Saturday afternoon last. Mrs. Esson was much bruised and shaken; Mr. Esson escaped with a sprained wrist. The accident was due to a heavier vehicle overturning by sheer force Mr. Esson's trap while the latter was standing still. We congratulate our friends upon their narrow escape from more serious consequences.

Dublin Local Section of the Institution of Electrical Engineers.—The report of the committee of this section covers a period from February, 1900, to May, 1901. The average attendance at the meetings was about 40 (including visitors). Eight Papers were read, and the committee express their sincere hope that members will freely come forward with Papers during the next session. Since the formation the membership has increased from 41 to 58. The committee record the indebtedness of the section to the council of the Royal Dublin Society for their kindness in permitting the section to hold meetings at the Society's offices, and also thank the council of the Royal College of Science and Monsignor Molloy for a similar hospitality on certain occasions. The committee for 1901-2 is constituted as follows:—Prof. W. F. Barrett, F.R.S. (chairman); J. W. Towle (vice-chairman); C. A. Burge; C. P. C. Cummins; F. Gill; Monsignor G. Molloy, D.D., D.Sc.; A. E. Porte; W. Tatlow; P. S. Sheardown; F. T. Trouton, D.Sc., F.R.S.; G. F. Pilditch; M. C. Olsson.

Permanent Secretary to the Board of Trade.—The President of the Board of Trade has appointed Mr. Francis J. S. Hopwood, C.B., C.M.G., to be the Permanent Secretary to the Board or Trade in the place of the late Sir Courtenay Boyle, K.C.B. Mr. Francis Hopwood, says *The Times*, was born in 1860, and entered the Board of Trade in 1886, as assistant law clerk, during the presidency of the late Mr. Edward Stanhope. In 1888 Sir Michael Hicks-Beach appointed him assistant solicitor, and he subsequently became private secretary to the president. When, in 1893, the late Sir Courtenay Boyle succeeded Sir Henry Calcraft as Permanent Secretary, Mr. Hopwood was appointed secretary to the railway department. In that department he has been especially connected with legislation for the promotion of light railways, the development of electric traction, the prevention of accidents to railway servants, and the regulation of their hours of labour. Mr. Hopwood has also been much interested in legislation for the benefit of deep-sea fishermen both here and in the colonies, and in 1898 was created C.M.G. "for services in connection with colonial fisheries and other maritime questions." He was also a member of Mr. Asquith's Commission on the Metropolitan Cab Service and a British delegate to the International Railway Congress in 1895, when he was made C.B. In the following year Mr. Hopwood acted as hon. secretary to the chairman of the Select Committee appointed to inquire into the Jameson raid. He has also, on several occasions, been entrusted with official business in the United States, Canada and Newfoundland. It will be remembered that Mr. Hopwood took a prominent part in the settlement of the Taff Vale Railway dispute in August last.

A Two-Wheeled Electric Automobile.—In a recent number of the *Electrical World* there is a description of an electric autocar which is a resurrection of the Otto bicycle which used to be ridden in the eighties, we believe mostly by professors in South Kensington. The stability which was wanting in the bicycle is provided by the battery which is slung low, serving as a floor to the vehicle. Mr. Holson, the designer, places the motors crosswise to the axle, with a pinion at each end of the motor shaft, these pinions driving upon opposite sides of a two-faced bevel annular gear fastened to the hub of the wheel. The field frame of the motor rests in ball bearings in the hub frame, and the wires from the battery run through the hollow axle to the motor, which is enclosed in a malleable iron case. The motors are of 1 H.P., capable of developing up to 4 H.P., and are multipolar series wound. The hub casing has a diameter of 13in. From 15 to 23 amperes are required on level stretches and under normal conditions. The battery weighs 1,200lb., and consists of 40 cells, having a capacity of 30 amperes at a three-hour discharge rate. Mr. Holson claims to have driven his machine 45 miles on one charge, and to have attained a speed of 16 miles an hour. The vehicle weighs about 2,500lb. when carrying two passengers. The controller used permits of four speeds. The machine is steered by a pair of mechanical brakes of the friction type, one acting on each hub, and both being operated by a leathern strap held in the hand of the driver and functioning just as the reins do in guiding a horse. When both brakes are operated together the vehicle is brought to a standstill. The two wheels, which are placed abreast, have wire spokes, iron rims, and are 6ft. 3in. in diameter. They will take a 2in. solid rubber in the groove, but Mr. Holson has been using tyres made of rope. When the vehicle stops, an iron rod like a shaft is let down under the front platform, so that the passengers can get in or dismount without the machine moving.

The Mechanical Equivalent of Light.—Mr. Carl Hering, in a recent number of the *Electrical World*, deals with the experiments of Tumlirz and Thomsen on the mechanical equivalent of light. There must be different equivalents for each wave length, and the experiments were carried out to determine the average value. Tumlirz measured, by means of a specially-constructed air thermometer, the total radiation from a Hefner amyl-acetate lamp, including both heat and light, and then, by means of a thermopile, the relation between the light rays and the total rays. From these two he determined the mechanical equivalent of light and obtained the figure 0·00361 gramme-calories per second for the energy of the light emitted in a unit solid angle in a horizontal direction. This is equivalent to 0·0454 gramme-calories per second per spherical candle or 0·188 watts; thus, if we assume the mean spherical candle-power of an arc lamp to be 1 watt per candle, the light efficiency based on the Tumlirz constant would be about 19 per cent. That of the Nernst lamp at 1·5 watts per candle would be about 13 per cent.; that of incandescent lamps at 2·5 watts per candle about 7·5 per cent. or at 3 watts per candle about 6·3 per cent. The method used by Julius Thomsen was to measure by means of a thermopile the

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total radiation (heat and light) from a spermaceti candle burning 8·2 grammes per hour (this measurement does not seem to enter into the calculation); he then measured that part due to the light alone, by absorbing the heat rays in a layer of 20cm. of water, which he says completely absorbed them. The readings of the thermopile were calibrated by using a bulb of warm water in place of the lamp, the heat radiation of which could be calculated from Dulong's law. He thus finds that 1 kilogramme-metre in a second is equal to 84·9 times the energy of the luminous rays from a spermaceti candle burning 8·2 grammes per hour. He adds, "This is the maximum of the mechanical equivalent of light, and it may possibly still be somewhat reduced by subsequent experiments." The candle used by Thomsen was apparently the British standard, which consumes 120 grains, while 8·2 grammes would be 126·5 grains. Correcting for this increased consumption, and for the ratio of the Hefner to the British unit, makes the Hefner unit equal to 0·88 of that used by Thomsen. Thomsen's mechanical equivalent reduced to spherical Hefner units then equals 0·236 watt as the power for one spherical Hefner candle. Tumlirz's corresponding figure is 0·188, showing a very fair agreement, considering the difficulties involved in the measurements, especially as Thomsen merely claims his figure to be the maximum value.

**The Institution Visit to Germany.**—The following arrangements have been provisionally made for the Institution visit to Germany, and it is hoped that no important alteration in the programme will now be necessary. The party will be divided into three sections: Group A, visiting Berlin only; Group B, visiting Berlin and Dresden; and Group C, visiting Berlin, Dresden, Nuremberg, Frankfort-on-the-Maine, &c. The whole party will leave London on the evening of Saturday, June 22nd, and will travel by the Harwich and Hook of Holland route to Hanover, where they will be received on the Sunday afternoon. The members of the party are invited to visit the works of Messrs. Körting, and, on their return thence, to a dinner given by the town of Hanover on the same evening. The programme for the three groups subsequently to this, is briefly as follows:—

FOR GROUP A.

*Monday, June 24th.—Morning*—Journey from Hanover to Berlin. *Afternoon*—Visit to central electricity stations and to a converter station in Berlin. *Evening*—Reception and supper offered to the Institution by the Allgemeine Electricitäts Gesellschaft and Messrs. Siemens and Halske. (Ladies invited.)

*Tuesday, June 25th.—Morning*—Visit to Messrs. Siemens and Halske's works in Charlottenburg and to the electrical museum of this firm. *Afternoon*—Visit to the new elevated electric railway in Berlin. *Evening*—No special arrangement provided, but those members and ladies who may wish to take supper in the open air, in company with a committee of German electrical engineers, will find some tables reserved at a restaurant to be announced in the final programme.

*Wednesday, June 26th.—Morning*—Visit to the cable works of the Allgemeine Elektricitäts Gesellschaft, and to the tunnel under the river Spree. *Afternoon*—Visit to the Berlin works of the same company. *Evening*—Dinner given to the Institution by Messrs. Siemens & Halske and the Allgemeine Elektricitäts Gesellschaft. (Ladies invited.)

*Thursday, June 27th.—Morning*—**Either** (*a*), visit to the electrical railway to the Wannsee, and to the experimental high-speed electric railway; **or** (*b*) alternatively, the telephone exchange.

The official visit to Berlin ends at this point, but, in the afternoon, members of Group A are invited to visit the tool works of Messrs. Ludwig Loewe, and the works of the Union Elektricitäts Gesellschaft in Berlin. Alternatively to this, a visit may be paid to the technical high school, where Prof. Dr. Slaby has kindly promised to meet such members as may signify beforehand their wish to see the college. On the morning of Friday, June 28th, such of the members as are able to stay so long are invited to visit the tool works of the Niles Tool Company in Berlin.

Arrangements have been made by the German committee for the ladies of the party to visit Potsdam on Tuesday, June 25th, and places of interest in Berlin on Wednesday, June 26th.

FOR GROUP B.

*Up to mid-day, Thursday, June 27th*, the arrangements will be the same as for Group A.

*Thursday, June 27th.—Afternoon*—*Journey from Berlin to Dresden. *Evening*—Reception of the German Electro-Technical Society and of the Institution in the Gewerbehaus. (Ladies invited.)

*Friday, June 28th.—Morning*—Meeting of the German Electro-Technical Society (reading of Papers, &c.). *Afternoon*—Visit to the light and power stations of the town, and to the State heat-transmission plant and electricity work. *Evening*—Dinner in the Vereinshaus. (Ladies invited.)

*Saturday, June 29th.—Morning*—Meeting of the German Electro-Technical Society. *Afternoon*—Visits to the electricity works of the Dresden railway station, the electrically-driven repairing shops of the railway, Messrs. Kummers' works, or the Saxon accumulator works. *Evening*—Outdoor reception. (Ladies invited.)

On *Sunday, June 30th*, the members of the German society will visit "Saxon Switzerland," and any members of the Institution party who desire to do so can obtain tickets for the excursion. The price of tickets will be announced in the detailed programme.

In Dresden: On the Friday ladies will visit the "Grünes Gewölbe," and make a tour of the city; and on the Saturday they will visit the Meissen porcelain works, the cathedral, and Albrechtsburg.

FOR GROUP C.—Up to mid-day, Thursday, June 27th, as for Group A. From then to Sunday, June 30th, as for Group B.

*Monday, July 1st—Morning* and *afternoon*—Journey, Dresden to Nuremberg. *Evening*—Free.

*Tuesday, July 2nd*—Visit to the works of Messrs. Schuckert & Co. *Evening*—Entertainment (outdoor if the weather permit) offered by the Elektr. Akt. Gesellschaft, vorm. Schuckert & Co. (Ladies invited.)

*Wednesday, July 3rd.—Morning*—Journey from Nuremberg to Frankfort. *Afternoon*—Visit to the works of Messrs. Lahmeyer. *Evening*—Entertainment by the local electro-technical society in the Palmengarten. (Ladies invited.)

*Thursday, July 4th.—Morning*—**Either** (*a*) visit to Frankfort central station, and to single-phase motor installations in Frankfort; **or** (*b*) visit to central station at Wiesbaden. *Afternoon* and *Evening* (for those who signify their wish to join the party)—Visit to Homburg central station and electric tramway to Saalburg.

*Friday, July 5th.*—**Either** (*a*) whole-day journey, in part by steamer down the Rhine (as time permits), and in part by train to Cologne; **or** (*b*) *Morning*—Journey by railway to Cologne; and *Afternoon*—Visit to the Elberfeld-Barmen mono-rail electric railway. The final arrangements for the latter visit are not yet completed, but it is hoped that they may be satisfactorily made.

In either case the members will be in time to return via the Hook of Holland and Harwich to England, arriving in London on the morning of Saturday, July 6th.

Facilities will kindly be given by Messrs. Lahmeyer for any members who signify in advance their wish to do so, to visit an electrical mine pumping plant near Essen, or an electrically operated canal lock, near Dortmund, en route from Cologne to London. Extra travelling tickets, to be obtained locally, will be required for these visits. Members who wish to visit either of these places must stay in Cologne on the night of Friday, July 5th.

At Nuremburg on the Tuesday, and at Frankfort on the Thursday, arrangements will be made by Messrs. Schuckert and Messrs. Lahmeyer, respectively, to show the ladies of the party some of the points of special interest in the town.

**The Council of the Institution of Electrical Engineers has found it necessary to decide that, with the exception of candidates accepted for ballot, only members (of all classes in the Institution) and ladies accompanying them can be authorised to take part. Further particulars as to hotel arrangements, &c., may be obtained from the secretary of the Institution, and all applications to join the tour must be made on a form provided for the purpose before Saturday, June 15th. Earlier application is desirable, however.**

* Members of Groups B and C wishing to do so can, in common with those of Group A, alternatively (if so specified in the original application) visit the works of Messrs. Ludwig Loewe and of the Union E. G., or the technical high school on the Thursday afternoon, and can proceed to Dresden on the Friday morning, arriving there in time for the visits to works in the afternoon of that day.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), May 31st.**

PHYSICAL SOCIETY.

*5 p.m.* Ordinary Meeting in the rooms of the Chemical Society, Burlington House. Papers to be read: (1) "On a Model which Imitates the Behaviour of Dielectrics," by Prof. J. A. Fleming, F.R.S., and A. W. Ashton. (2) "On the Resistance of Dielectrics and the Effect of an Alternating Electromotive Force on the Insulating Properties of Indiarubber," by A. W. Ashton. (3) "Note on the Electrification of Dielectrics by Mechanical Means," by A. W. Ashton.

**MONDAY, June 3rd.**

SOCIETY OF ENGINEERS.

*7:30 p.m.* Ordinary Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "Concrete Subways for Underground Pipes," by A. T. Allen.

**THURSDAY, June 6th.**

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House.

RÖNTGEN SOCIETY.

*8:30 p.m.* Ordinary General Meeting at 20, Hanover-square, when a Paper will be read by Dr. Hugh Walsham on "X-Ray Diagnosis of Aneurism."

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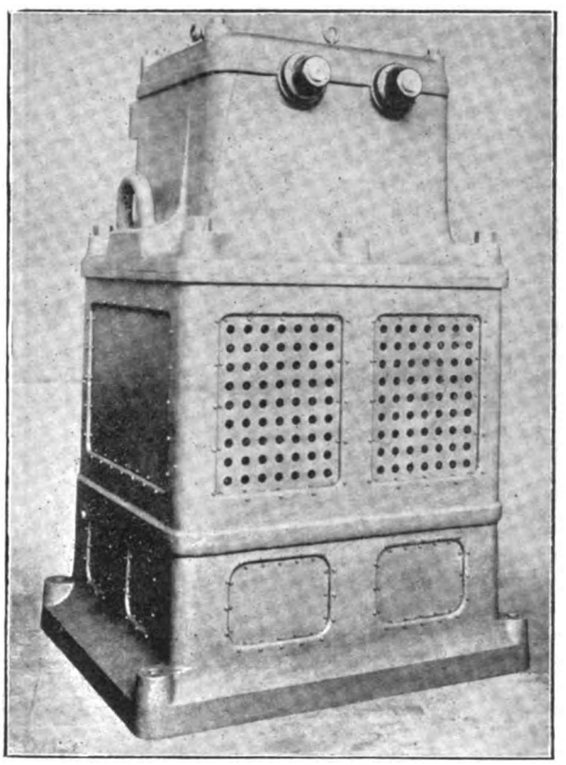
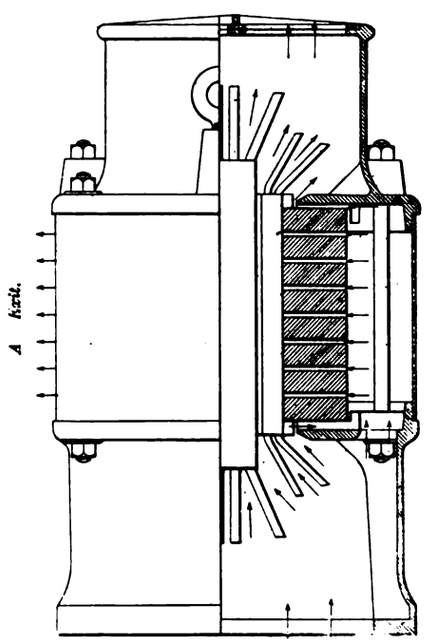
## LARGE WESTINGHOUSE AIR-BLAST TRANSFORMERS.

In the early days of electric power transmission, Westinghouse transformers acquired a high reputation for reliability and efficiency in operation. Pace has been kept with the



WESTINGHOUSE AIR-BLAST TRANSFORMER.

advance of progress to present practice, and in the two or three types of Westinghouse transformers on the market to-day the embodiment of all that has been proved best in transformer practice is secured. Our illustrations show the



SECTIONAL ELEVATION OF 550KW. WESTINGHOUSE AIR BLAST TRANSFORMER.

construction of the Westinghouse air-cooled transformer. The arrangement of the air passages is clearly shown; the air-current is forced through the base of the transformer, up through the coils, passes down one side and then transversely through the windings, discharging into the open air at the opposite side. The air-blast is supplied by electrically operated blowers. The materials used in the construction of these transformers are selected and subjected to stringent tests. The copper and iron losses are reduced to a minimum and, what is of special importance, the iron losses retain their initial low value. Tests extending continuously over some years have shown that the materials used and the form of design and construction adopted are as near perfection as possible.

The largest-sized transformers in the world are built on this principle. There are at the present time under construction at the Westinghouse works 20 air-blast transformers of 2,750kw. each for the Chambly Manufacturing Co. of Canada. This is stated to be the largest transformer order ever placed. Some idea of the size is gathered when one remembers that the transformers are 9ft. high and weigh about 11 tons each. The blowers for the cooling air supply are operated by Westinghouse alternate-current motors, having a guaranteed efficiency of over 98 per cent. at full load.

The 550kw. size, as illustrated, is used throughout in the sub-station equipment of the Manhattan Railway, New York, and has guaranteed efficiencies of 95 per cent. at quarter load, 97 per cent. at half load, and 97·75 per cent. at full load. Like all Westinghouse plant, these transformers have a considerable overload capacity. In the size illustrated an efficiency of 97·7 per cent. at 25 per cent. overload is guaranteed. With this load a continuous run of 24 hours will not produce a rise in temperature of more than 45°C.; with a 50 per cent. overload for two hours the rise will not exceed 50°C. The Manhattan transformers are guaranteed to withstand 25,000 volts between primary and secondary and between primary and core for a period of 30min., 30,000 volts for 1min., or 35,000 volts for 1sec. between the secondary and the core. The corresponding test pressures are 6,000, 7,500, and 9,000 volts respectively. The normal work performed by these transformers is the reduction of 10,500 to 390 volts for the feeding of rotary converters supplying the railway system.

## ELECTRIC POWER SCHEMES IN 1901.

The practice we instituted last year, of publishing a series of maps showing the areas to which electrical schemes before Parliament related, was greatly appreciated, we have reason to believe, by a large circle of our readers, who found this topographical information of considerable utility. We have therefore decided to continue this practice in connection with electric power schemes before Parliament during the current year, and we commence our annual serial with two schemes in the Midlands and in Durham respectively.

### I.—Derbyshire and Nottinghamshire Electric Power Co.'s Scheme.

A report of the proceedings in connection with the bill for this scheme has appeared in the "Parliamentary Intelligence" columns of our issue of May 17, p. 138. The bill is reported to the House of Commons for third reading, and appears to have a good prospect of ultimately receiving royal assent. The promoters are Sir E. H. Carbutt, Bart., Messrs. Faithfull Begg, F. Carver, F. Clench, D. Fox, A. Grove, M. H. Mills, W. O. Plowright and J. W. Thonkerey; and the engineers are Messrs. Bramwell and Harris. The area of proposed supply includes the counties of Nottingham and Derby, except that part of Derbyshire to the south of the river Trent and to the north-west of the boundary between the unions of Bakewell and Chapel-en-le-Frith. The proposed capital is £2,400,000, of which £1,800,000 will be issued in £1 preferred and deferred half-shares, with borrowing powers of £600,000. Power stations are to be erected at Newbold, Colwick, Trowell and Warsop. Within the entire area of 1,570 sq. miles there are 564 collieries, factories, mines and quarries, utilising a total of 282,000 I.H.P., and the total population is 1,025,000.

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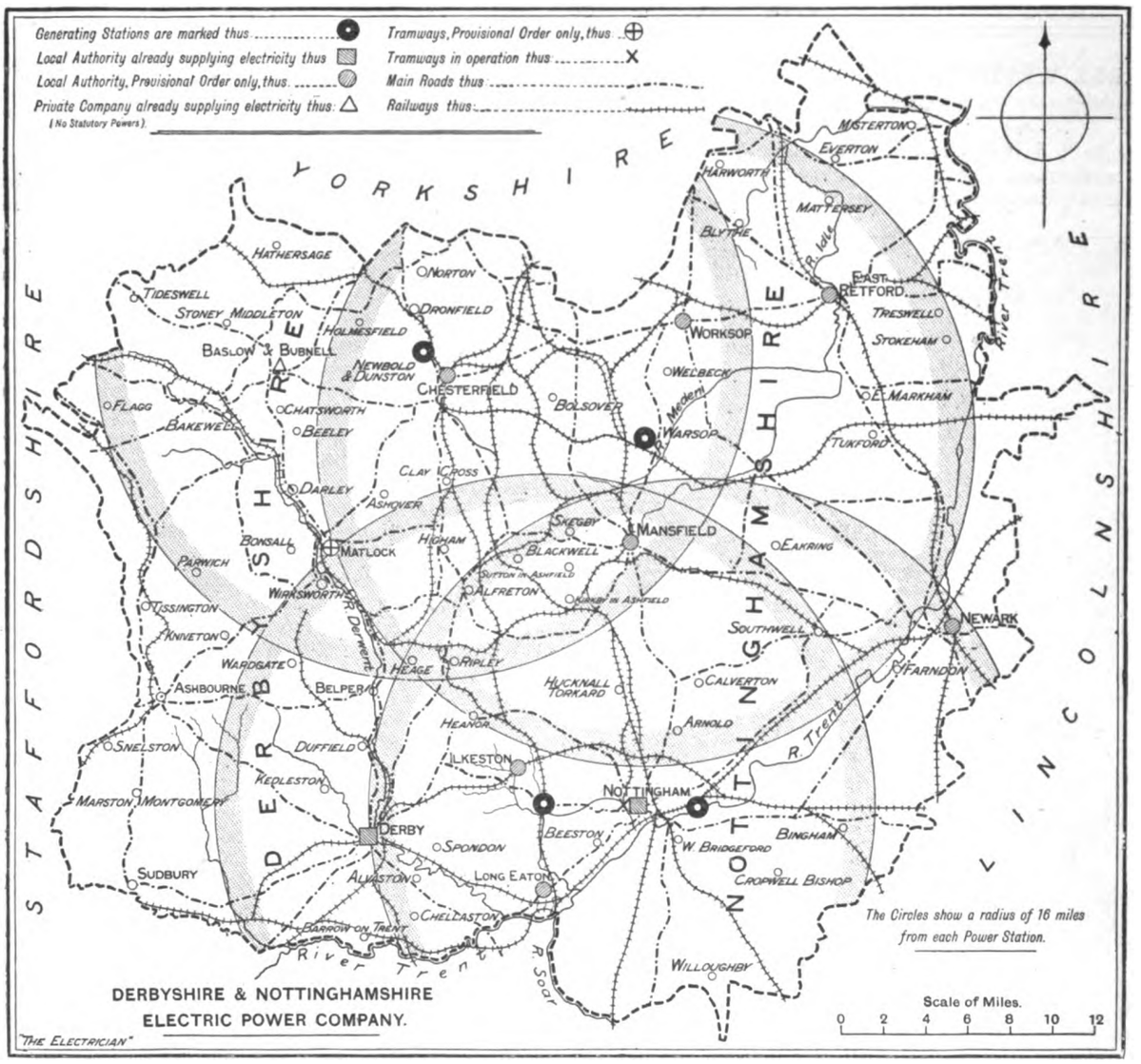

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### II.—Cleveland and Durham County Electric Power Co.'s Scheme.

The Parliamentary proceedings in connection with this scheme, which, like the above scheme, is reported for third reading in the House of Commons, were embodied in our report in the issues for May 3rd (p. 62) and May 10th (p. 102). The promoters are Sir T. Wrightson, M.P., Messrs. G. Ainsworth, H. Bell, A. J. Dorman, H. W. Hollis, W. H. Hopkins, A. Leith, A. F. Pease, H. P. Pease, M.P., E. L. Pease, W. R. Stobart, J. Forbeck, J. Walton, and R. E. Whitwell. The engineers are Messrs. Bramwell and Harris and Mr. A. A. C. Swinton. The total area of 820 sq. miles has a population of 750,000. There are 369 collieries, factories, iron mines, and quarries; and the total power at present in use in the area is about 180,000 H.P. Our map shows that the area includes several large and important towns. The share capital of this undertaking is £1,000,000 in £10 shares, with borrowing powers of £330,000.

## SYNTONIC WIRELESS TELEGRAPHY.*

BY GUGLIELMO MARCONI.

(*Concluded from page 175.*)

It is easy to understand that if we have several receiving stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit to any one of them without danger of the message being picked up by the other stations for which it is not intended. But, better than this, we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wire a number of corresponding receivers. Different messages can be sent by each transmitter connected to the same radiating wire simultaneously, and received equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe to be quite novel, I showed to several friends of mine, including Dr. Fleming, F.R.S., in the summer of last year, and to an Admiralty Commission. Dr. Fleming has made mention of the results I showed him, in a letter to *The Times*, dated Oct. 4, 1900, and in his Cantor lectures delivered before the Society of Arts in November and December, 1900. A further improvement has been obtained by the combination of the two systems. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly tuned induction coil, and all circuits must be tuned to the same period as already described. (See Fig. 16.)

The tuning of the receiver to respond to the period of the transmitter, as used in the old form of transmitter shown in Fig. 1, or in the new one shown in Fig. 7, has enabled results to be obtained over considerable distances with moderate heights. As already published by Dr. Fleming in the letter above referred to, signalling has been successfully carried out over a distance of 50km. with a cylinder only 1·25 metres high, 40in. in diameter. This has led to the possibility of constructing portable apparatus for army purposes which should be of great service in the field. I have succeeded in constructing a complete installation on a steam motor car. On the roof of the car there is placed a cylinder which can be lowered when travelling, its height being only 6 or 7 metres, and by this means communication has been easily carried out with a syntonised station over a distance of 31 miles. A 25cm. spark induction coil worked by accumulators and taking about 100 watts is used for transmitting, and the accumulators can be re-charged by a small dynamo worked by the car motor. I believe such an appliance might have been of use to the besieged garrisons in South Africa and China. A strip of wire netting laid on the ground is sufficient for earth connection, and by dragging it along communication can be established even when the car is travelling. I have recently obtained as good results by not using any "connection" to earth, but only utilising in lieu of earth the electrical capacity of the boiler of the motor car. I also find that signals can be transmitted a considerable distance with the cylinder in a horizontal position.

Last spring I recognised the desirability of carrying out tests between stations situated at much greater distances apart than had been attempted heretofore.† A station was established at the Lizard, Cornwall, and on the first attempt communication was effected with St. Catherine's, Isle of Wight, over a distance of 186 miles, which, I believe, is the record distance over which signals have been sent through space without wires. It is interesting to observe that signals were obtained over this distance with the transmitting apparatus as shown in Fig. 1, or with the arrangement shown in Fig. 7, provided always that a suitable resonating induction coil was employed at the receiving station. The amount of energy used for signalling over this distance is not more than 150 watts, but experiments with a larger amount of energy will shortly be carried out. In the case of the 186 miles transmission, the aerial conductor consisted of four parallel vertical wires 1·50 metres apart, 48 metres long, or in a strip of wire netting of same length. It is interesting to note that in order to communicate between my stations at Poole and St. Catherine's (distance 31 miles) with the same amount of energy and the same kind of aerial wire this must be 20 metres high to obtain signals of about the same strength as those obtained between the 186-mile stations with the 48-metre aerials. This goes to confirm many other results previously obtained, which indicate that with a parity of other conditions the distance varies with the square of the height of the vertical conductors at the two stations. I have always found this law fulfilled, if the height of the conductors at the two stations is approximately equal, although an attempt has been made recently to throw doubt upon its correctness.

You will admit that the progress achieved in syntonic space telegraphy must have enormously increased its field of application and usefulness, since a very great number of non-interfering stations can now be worked in the immediate vicinity of each other. It will probably be of interest if I give you a few examples of the progress made in the practical utilisation of my system. An eminent electrician recently expressed a doubt whether there was at present a single circuit worked commercially on a practical system of wireless telegraphy.* If earning a revenue from working installations can be termed a commercial working, even such an incomplete list of these as time will now permit me to give you, and which are now all in permanent working order, may be sufficient proof that a beginning at least has been made in the commercial utilisation of the system.

In March, 1900, there were in use in the Royal Navy in South African waters, five installations of my system. The Admiralty was apparently well satisfied with its working, since in May of last year they decided to extend its adoption to 32 more ships and land stations. The conditions of the contract were that each apparatus before being accepted should be satisfactorily worked by naval signalmen between two ships anchored at Portsmouth and Portland, over a distance of 62 miles, a considerable portion of which—*i.e.*, 18 miles—lies over land, with intervening hills, and the height of aerial wire was specified not to exceed on each ship 49 metres. The apparatus was delivered in a comparatively short time, no sets having been found unsatisfactory. The apparatus supplied to the Admiralty is, so far, all of the old pattern—*i.e.*, the non-syntonised system; and I have been informed that messages have been transmitted and received by naval signalmen between ships more than 160km. apart. It sometimes occurs that the unfamiliarity of the operators with the particular kind of apparatus used caused unsatisfactory results to be obtained, but I believe this trouble will soon disappear. I am glad to be able to state that arrangements are being made to instal my new syntonic apparatus upon several of His Majesty's ships. I believe that in no other navy in the world is wireless telegraphy being worked regularly over such considerable distances. My system is also used for communication between the Borkum riff and Borkum lightship in Germany, where an ordinary commercial charge is made for messages received from ships, and it is employed, further, on the Nord Deutscher Lloyd's mail steamer "Kaiser Wilhelm der Grosse."

According to an official report of the imperial postal authorities of Oldenburg, the total number of commercial wireless telegrams transmitted from and to the lightship between May 15 and the end of October amounted to 565, and of these 518 came from ships at sea, whilst 47 were transmitted to ships. Of the 518 telegrams, 35·7 per cent. were addressed to the North German Lloyd and 64·3 per cent. to other shipping firms. The installations are worked by ordinary operators in a most satisfactory manner, and on one occasion, assistance was obtained for a man who was taken suddenly ill on the Borkum riff, and it was thus made possible to hand him over promptly for medical treatment on shore.

The system has been in operation at La Panne, near Ostend, and on the Belgian mail steamer, "Princess Clémentine," which plies to Dover. With a height of only 22 metres on the ship it has been found practicable to communicate from Dover Harbour to La Panne, 43 miles away, and this installation has proved of value in saving life and property. Thus, recently, a barque was wrecked on the Rattel bank. The "Princess Clémentine," which happened to pass near, at once sent a message to Ostend, and, before leaving, was able to tell the shipwrecked sailors that assistance was on the way. The men were all saved.† On another day, coming within sighting distance of the Ruytingen lightship, situated about 15½ miles from Dunkirk, the captain of the "Princess Clémentine"

* Paper read before the Society of Arts, May 15.

† See *The Electrician*, Feb. 15, 1901, p. 609.

* See *The Electrician*, Nov. 30, 1900, page 211, and editorial article, page 205.

† See *The Electrician*, March 15, 1901, p. 267.

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observed that he was being signalled. It appears that the lighting apparatus of the Ruytingen had got out of order. The captain of the mail packet immediately despatched a message, which was received by the installation at La Panne, and repeated to the lighthouse department at Dunkirk. A crew immediately set out for the lightship and effected the necessary repairs, and the great inconvenience and danger of the lightship not being able to have the lights in order was averted.

Another instance of the usefulness of the wireless telegraphy in an emergency was furnished when the "Princess Clémentine" herself went ashore on the Belgian coast during a fog. Within a few minutes of the accident news of it was telegraphed from the stranded ship to Ostend, with the result that a tug was at once despatched to her assistance, and she got off at the next high tide. So successful has the installation of wireless telegraphy been on the

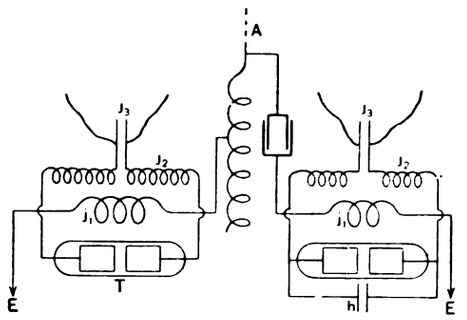


Fig. 15.

mail steamer "Princess Clémentine," between Dover and Ostend, that similar apparatus is to be fitted on the other vessels of the same fleet.

The system has been in use, furthermore, since March 1 last for ordinary commercial telegraphy between the Sandwich Islands, where a regular charge is made for the same. An installation has also been successfully carried out by my assistants for the French Government between Antibes, in France, and Corsica, a distance of 124 miles.

As has already been published in the daily papers, much use has been made of my system in the Navy during the voyage of the Duke and Duchess of Cornwall and York to Australia.

I have tried lately to ascertain how near a tuned transmitter which is radiating waves of a certain frequency must be to a receiver

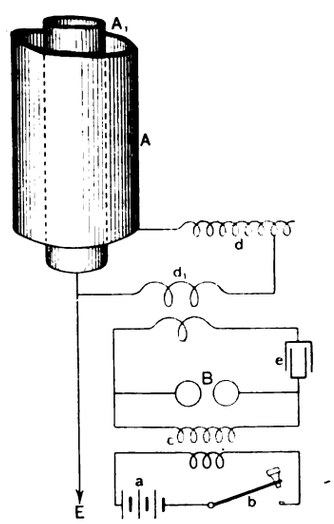


Fig. 16.

tuned to a different frequency in order that the said receiver shall be affected. I find that if we are working with oscillations which differ very considerably in period, a transmitter capable of sending signals 31 miles to a tuned receiver will not affect a non-tuned one at 50 metres. If the periods of oscillation of the two tunes are more similar to each other, then the non-tuned receiver may be affected even at several kilometres.

Considerable use is still made of the non-tuned system at my experimental stations, in order to be able to communicate with ships fitted with what I call the old system, and also in order to be able to communicate with the naval station at Portsmouth.

Before concluding, I wish to say a few words on a method proposed by Prof. Slaby, and with which I have also carried out some experiments. As transmitter, Slaby uses an arrangement as shown in Fig. 13, which consists of a vertical conductor, in which is interposed a condenser K and a spark-gap B. The top of the wire is not free, but is connected to earth through an inductance CD and a wire E. At the receiving station the arrangement shown in Fig. 17 is employed. It consists in a vertical conductor DC, connected to earth at C, which should be the nodal point of the waves induced in the wire DC, where there is joined another wire, termed an extension wire, of equal length. In this case Slaby places an apparatus which he calls a "multiplicator," connected to the coherer between the end of the extension wire and the earth, or by another arrangement (Fig. 17); he uses a loop wire FGHDCE, the multiplicator being placed between E and F in series with the extension wire J. By means of this arrangement, Slaby, on Dec. 22 of last year, showed the reception of two different messages sent from two transmitting stations situated at unequal distances from the receiving station to be possible, one station being at 4km. and the other at 14km., thus obtaining a result which may be considered similar to that obtained by me some months previously over larger distances (see Prof. Fleming's letter in *The Times* of Oct. 4, 1900). The information given in Slaby's Paper, as published in the *Elektrotechnische Zeitschrift*, is exceedingly incomplete. We are not told what was the amount of energy used for the transmission nor the height of the vertical conductor at the receiving station or at the transmitting station at the Aberspree Kablewurks. We are told that the transmission wire was suspended between the chimney shafts. Very little information is given as to the appliance which Dr. Slaby calls a multiplicator. G. Kapp, who is probably acquainted with the details of Slaby's work, commenting on this Paper of his, calls the instrument in question "an especially wound induction coil ('induction-spule') the function of which is to increase the E.M.F. of the oscillations at the ends of the coherer." Upon reading this for the first time, I assumed that the multiplicator was an oscillation transformer performing the function of those described in my patent dated June 1, 1898, and also described in my Royal Institution lecture of Feb. 2, 1901. As I subsequently, however, discovered, Prof. Slaby, referring to the multiplicator, states:—"This apparatus in its most simple form consists of a wire coil of a determined shape and form of winding,

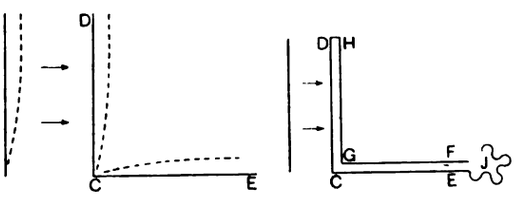


Fig. 17.

which depends upon the length of the wave. . . . I might call this apparatus, unknown to my knowledge up to the present, a multiplicator. It is not to be confounded with a transformer, as it has no secondary winding."

This statement appears to me very ambiguous, as I always have understood that what we call transformers need not have a distinct secondary winding. An appliance called an auto-transformer was used by the Westinghouse Company for regulating the E.M.F. supplied to house lighting installations, which consisted in a single winding, a certain number of turns acting inductively on the adjacent ones. (See "The Alternate-Current Transformer," by J. A. Fleming, Vol. II, pp. 187, 188.) One of the first transformers ever made is shown in the work above referred to, Vol. II., pp. 6 and 7. At page 6 we read:—"Page really made the first experiment in auto-induction and showed that different parts of the same conductor might act as primary and secondary circuits to each other, if in contiguity."

I installed the apparatus described by Slaby at Niton, Isle of Wight, and at Poole, using wires 35 metres high, but with the receiving wire earthed at C (Fig. 17) of the loop I could receive nothing although I tried various frequencies of oscillation. It is, however, probable that I might have received, had I been working over much shorter distances than 50km., as Slaby did in his demonstration, or had I used a greater height of wire. By using, however, my method of connection—*i.e.*, introducing between the vertical wire and earth an oscillation transformer having its circuits tuned to the frequency given by an ordinary vertical radiating conductor of length equal to the Slaby wire AC. I succeeded by means of extremely sensitive coherers in obtaining communication. I then tried the following experiment:—I took down the earth wire ED, and the inductance DC, and used only the conductor AC insulated, with the condenser in circuit for transmitting. An enormous strengthening of the signals at the receiver was immediately obtained, which obviously means a greater ease of working, and the possibility of obtaining signals over greater distances. The reasons which demonstrate that a closed circuit, such as is employed by Slaby, must be a poor radiator, are obvious to those who have studied and read the classical works published since the time of Hertz's experiments.

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Dr. Slaby, however, states that the inductance at the top of his loop confines the oscillations to the vertical part AC. If this be the case, the frequency of these local oscillations cannot be equal to that of the whole circuit ACDE, which it has been stated was so easy to calculate, if the translations of Slaby's Paper I am relying on are correct. I believe that, notwithstanding the inductance CD, a considerable amount of energy must pass to earth through the earth wire, which acts as a leak uselessly dissipating energy which should be radiated into space in the form of ether waves. If these conclusions are correct, I am not at all clear as to what necessity there is for employing the earthed conductor ED and the inductance. It is not necessary for obtaining syntonic effects from transmitting stations placed at unequal distances from the receiver, as this can be obtained when using the primitive form of transmitter shown in Fig. 1; and Slaby has not yet described how to obtain different messages from transmitters situated at equal distances from the receivers, which is much more difficult in my experience; nor does it appear possible, with the method he describes, to transmit various messages at the same time from one sending wire as can be done with the system I have just explained. The distance obtained with the closed transmitting arrangement must be comparatively small.

As I have already stated, communication over a distance of 300km. is now being maintained with my system, but I am not aware of anything approaching even 100km. being achieved with the loop transmitter. It may be said that long distances of transmission are not necessarily an advantage, but I notice that the Navy wants long-distance apparatus supplied to it. I have also tried connections similar to Slaby's extension wire in the receiver, but I find that the real sifting out of waves is done in the oscillation transformer, although sometimes it may be desirable to increase the period of oscillation of the aerial conductor by adding inductance to it, or at other times to decrease its period by placing a suitable condenser in series with it. I trust it will not be thought that I wish in any way to minimise the importance of Slaby's work. I only wish to get at the facts and to draw a discussion on a very interesting subject.

Time does not permit me to refer to a great number of experiments upon which I am now engaged, or which have been carried out by others, but I hope on a future occasion to describe better results. I have come to the conclusion that the days of the non-tuned system are numbered. The ether about the English Channel has become, in consequence of great wireless activity, exceedingly lively, and a non-tuned receiver keeps picking up messages or parts of messages from various sources which very often render unreadable the message one is trying to receive. I am glad to say, however, that I am now prepared with syntonic apparatus suitable for commercial purposes. And, as my final word on the general subject for the present, let me say that those who are responsible for the recent development of wireless telegraphy into a practical science cannot fail to find great satisfaction in the reflection that, as already life has been saved that without this discovery would have been lost, so, in the future, apart from its manifold commercial possibilities, valuable as these are, humanity is likely to have before very long to recognise in telegraphy through space without connecting wires the most potent safeguard that has yet been devised to reduce the perils of the world's sea-going population.

## DISCUSSION.

Dr. FLEMING, F.R.S., said that as he had been permitted to be a little behind the scenes, and had seen some of the apparatus before it was made public, he was able to entirely confirm Mr. Marconi's statements with regard to his experiments. A very great stride forward had been made in syntonic telegraphy. The subject was not a new one—in fact, a large number of patents had been taken out in connection with it, most of which, however, embodied more hope than experience. In spite of the fact that there were so many claims of priority in the matter, he had the strongest possible conviction that Mr. Marconi was the first person to actually achieve a true syntonic telegraphy with electric waves. He had done that in virtue of having followed out to their logical issue the fundamental scientific principles of the subject which he had so clearly grasped, one of which was the essential distinction between the radiative and the non-radiative circuit. Many inventors and patentees had professed to have obtained syntonic telegraphy with a simple open aerial insulated radiator of the Marconi type. Although it was possible to produce a kind of bastard syntonic telegraphy by that means, it was not possible to produce true syntonic telegraphy, because the aerial simply produced a sort of etheric impulse or explosion, and not a true train of waves. It was just as possible to produce true syntonic telegraphy by those means as it would be to cause one whip to crack by cracking another near to it. When a closed circuit was taken, which was a powerful absorber of electric energy and associated with a radiative circuit, a means was obtained for producing a true train of waves. If those two circuits were tuned together a great improvement was effected on anything previously accomplished. Mr. Marconi had not only constructed a receiver capable of receiving trains of waves, but also capable of not receiving those not adapted to it. No train of waves would act upon his syntonic receiver except those which had a particular period. An analogy might be found in a cork floating on water, which would be bobbed up and down by any wave, long or short, which went over it; but a heavy log of wood floating on the water and tethered to the bottom of the sea by a spiral spring would only be caused to bob up and down by waves having one particular period. The former corresponded to a simple coherer, and the latter to a syntonic receiver of the kind described in the Paper. He quite agreed with Mr. Marconi that the days of the non-syntonic telegraphy were numbered, because no one would chose a receiver capable of being affected by every vagrant wave when such an instrument as Mr. Marconi's latest form of receiver was available. Among the possibilities which lay in front of the invention was that it would be immediately possible to provide the Admiralty and the Post Office with instruments having an Admiralty or Post Office frequency, and to register frequency just as a telegraphic address was registered, so that no one else could use that particular frequency. He had had the privilege of riding on the motor car described by the reader of the Paper, and, when many miles from home, they were able to communicate with their hotel and order their lunches. In conclusion, he offered his warmest congratulations to Mr. Marconi on the immense strides he had made in the improvement of his initial invention.

Capt. KENNEDY, R.E., said he wished to explain, in common justice to Mr. Marconi, some of the points connected with the operation of the system in South Africa. A scheme was suddenly conceived and hastily executed of sending apparatus and assistants to instal the system at Durban. But instead of setting it up at that port, it was sent to the Front. No poles were available, and the attempts to substitute kites and balloons were unsuccessful. For want of labour and proper materials progress was slow, and eventually the work was stopped. On arriving in Natal, on the first opportunity, he handed the whole system over to Captain Percy Scott, who worked it most satisfactorily on board the ships at Durban up to the time he left South Africa. The operations in Cape Colony were entirely experimental, and would have succeeded had they been given a fair chance.

The CHAIRMAN (Prof. Ayrton) in proposing a vote of thanks to Mr. Marconi for his admirable Paper, said that, after listening to what wireless telegraphy had already done in saving life and ships, they realised why the reader of the Paper, although so young, had acquired fame; why he had won that more substantial reward which sometimes went with fame, but often did not, and also grasped why he had earned what should be dearer to him than fame or wealth—the gratitude of all peoples for having so courageously developed a new sense for the world. Although still far away, he thought they were gradually coming within thinkable distance of the realisation of a prophecy he ventured to make four years ago, of a time when, if a person wanted to call to a friend he knew not where, he would call in a loud, electro-magnetic voice, heard by him who had the electro-magnetic ear, silent to him who had it not. "Where are you?" he would say. A small reply would come, "I am at the bottom of a coal mine, or crossing the Andes, or in the middle of the Pacific." Or, perhaps, in spite of all the calling, no reply would come, and the person would then know his friend was dead. Let them think of what that meant, of the calling which went on every day from room to room of a house, and then think of that calling extending from pole to pole—not a noisy babble, but a call audible to him who wanted to hear and absolutely silent to him who did not; it was almost like dreamland and ghostland—not the ghostland of the heated imagination cultivated by the Psychical Society, but a real communication from a distance based on true physical laws. On seeing the young faces of so many present he was filled with green envy that they, and not he, might very likely live to see the fulfilment of his prophecy.

Mr. MARCONI, in reply, thanked Dr. Fleming for his kind remarks. To him he was also indebted for valuable advice on many subjects he did not understand, and in which Dr. Fleming's theoretical knowledge was of great value. In reference to Captain Kennedy's remarks, he wished to give an explanation. When the war broke out in South Africa he was asked whether he could send his apparatus out there. His associates, in reply, made two proposals: (1) To send apparatus for work at the Front, and (2) between shore stations and the transports at Durban. The proposal of using the apparatus at the Front was not accepted by the War Office at the time. The apparatus was sent out without poles because he was informed they would be found at Durban. On the arrival of his assistants in South Africa they pluckily volunteered to go to the Front, thinking the system might be worked with advantage to the English army; but, on reaching the front, poles could not be obtained by which to raise the wires. At that time, according to his old-fashioned system, this was absolutely necessary. Captain Baden-Powell came to the rescue with some well-designed kites, and signals were transmitted about 18 miles. Although the system was never used during operations in South Africa, it was not the fault of the system.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Proceedings of the Royal Society." No. 445. Vol. LXVIII. (London: Harrison & Sons). 3s.

"Science Abstracts." May. Edited by W. R. Cooper. (London: E. and F. N. Spon). 2s.

"Journal of the Institution of Electrical Engineers." April. No. 149. Vol. XXX. (London: E. and F. N. Spon). 5s.

"Transactions of the American Institute of Electrical Engineers." April. No. 4, Vol. XVIII. (New York: The Institute). 50 cents.

"Holidays in Eastern Counties." by Percy Lindley. (London: Great Eastern Railway Co.)

"Telephone Lines and their Properties." By W. J. Hopkins. New edition. (London: Longmans, Green & Co.) 6s.

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## POLYPHASE EQUIPMENT OF FACTORIES.

In a Paper read by Mr. W. Wyld before the Birmingham section of the Institution of Electrical Engineers on March 27, the author, after dealing with the elementary theory of polyphase working, gave a short description of the polyphase plants in English factories and a table of the number of aggregate outputs of such plants installed in Europe and the United States. We give these latter *in extenso* below, as well as the appendix to the Paper, which summarises the principal examples of polyphase equipments in factories :—

*Liverpool Grain Elevator.*—The first combined power and lighting plant was installed at Liverpool for the Grain Storage and Transit Co. in the early part of 1897. It is a three-phase plant of 180 H.P. The lighting and power are both derived from the same circuits, and, in spite of the antipathy to this practice, no difficulty has been experienced in the regulation.

*Glasgow, Edinburgh.*—About this time (1897) a small three-phase plant of about 100 H.P. was installed in Glasgow, and another of about 130 H.P. in Edinburgh.

*Sir Thomas Richardson, Hartlepool.*—In the same year Sir Thomas Richardson & Sons, of Hartlepool, laid down a large plant aggregating about 1,250 H.P. There are two large flywheel generators and a smaller machine of 100kw. for night shifts. In the shops are installed some 25 motors, which vary in size from 65 H.P. to 10 H.P.

*General Electric Co., Manchester.*—In 1898 the General Electric Co., of Manchester, put in a three-phase plant at their factory in the Adelphi, Salford. The generator is of 200 H.P., and the motors, 30 in number, vary from 16 H.P. to ½ H.P.

*Bristol Carriage and Waggon Co.*—The Bristol Carriage and Waggon Co. about this time had their works remodelled, and a polyphase plant of 400 H.P. was installed. There are seven motor circuits, one to each shop, and the motors, 10 in number, vary from 65 H.P. to 2 H.P. each. There are 750 glow-lamps and 32 arcs supplied from the same generator as the motors, and no difficulty has been experienced with the regulation. This plant has given such satisfactory results that another 400 H.P. generating set is being added.

*Anglo-Swiss Milk Co., Aylesbury.*—The Anglo-Swiss Condensed Milk Co.'s factory at Aylesbury is equipped with a three-phase plant. The eight motors installed vary in size from 10 H.P. to 1½ H.P. each.

*North-Eastern Steel Works, Middlesbrough.*—At the North-Eastern Steel Works, Middlesbrough, there is a two-phase plant, consisting of two generators of 350 H.P. each and 11 motors—six of 40 H.P., five of 20 H.P.

*D. Y. Stewart, Glasgow.*—Messrs. D. Y. Stewart, of Glasgow, have a three-phase plant of 450 H.P., consisting of two generators of 250 H.P. and 200 H.P., and a large number of motors.

*Beyer and Peacock, Manchester.*—Messrs. Beyer and Peacock, of Manchester, have a three-phase plant of 400 H.P., consisting of two generators of 200 H.P. each, and a large number of motors of 50 H.P., 30 H P , and 20 H.P. each.

*Hawthorn and Leslie, Newcastle-on-Tyne.*—Messrs. Hawthorn and Leslie, of Newcastle-on-Tyne, have a three-phase plant of 280 H.P. for driving the machines in their shipyard.

*W. Dixon & Co. Glasgow.*—Messrs. Dixon & Co., of Glasgow, have a three-phase plant of 660 H.P., consisting of three generators of 220 H.P. each, and a large number of motors for various purposes in their chemical works.

*Kirkstall Forge, Leeds.*—The Kirkstall Forge Co , of Leeds, have a 150 H.P. three-phase plant in their works.

*Brown, Marshall, Birmingham.*—Messrs. Brown, Marshall & Co., of Birmingham, have a small three-phase plant of about 70 H.P. in their carriage and waggon building works for driving the machinery in one of their shops.

*J. Thompson, Wolverhampton.*—Messrs. John Thompson, boiler makers, Wolverhampton, have recently installed a three-phase plant of 460 H.P., consisting of two direct-coupled steam alternators of 230 H.P. each, and a corresponding number of motors.

*J. Rogers & Sons, Sheffield.*—Messrs. Joe. Rogers & Sons have recently installed in their large cutlery works in Sheffield a two-phase plant of 320 H.P., consisting of two direct-coupled high-speed generators of 160 H.P. each. These alternators have only eight poles each, which give the low frequency of 21·3 cycles per second. There are seven motors of 25 H.P. to 7 H.P. each, used for working grinding wheels, hoists, fans, stamps, &c. Owing to the low frequency a motor generator is used for arc lighting.

*Patent Shaft.*—Whilst at the Patent Shaft and Axletree Co.'s works at Wednesbury we have a plant of 420 H.P., consisting of two three-phase generators of 210 H.P. each, and some 30 motors, varying in size from 50 H.P. to 5 H.P., the small ones being in use on travelling cranes.

As I am connected with this last-mentioned plant, perhaps I can give a few details of it which may be of interest. The power house, which was built to the designs of the author, comprises boiler house, engine room, and the necessary offices, stores and test room, and is large enough to accommodate 2,000 H.P. In the boiler house are four Babcock and Wilcox water-tube boilers of 200 H.P. each, also a feed-water heater by the same firm. The boiler house is so arranged that the coal is tipped direct from the railway siding into the bunker opposite the fronts of the boilers. These are fed by either a horizontal duplex Tangye's pump, or a Gresham and Craven line steam injector, which deliver either through the above-mentioned heater or direct into the boilers.

The generating plant consists of two direct-coupled sets of 210 H.P. each, running at 375 revs. per min. The engines are of the compound two-crank, single-acting enclosed type by the Mirrlees, Watson Co. The generators are of the well-known Brown, Boveri three-phase type, having rotating fields and stationary armatures, the periodicity being 50, and the voltage across the phases 350. They are "star" connected with a neutral terminal, which, as already stated, serves for the lighting of both arc and incandescent lamps at 200 volts. The exciters are direct-driven, their armatures being fixed on an extension of the generator shaft.

The switchboard, which is fixed on a gallery commanding a view of the whole engine-room, consists of two generator panels carrying main triple pole switch and fuse, ammeter, voltmeter and field rheostat, the latter being of the Ward Leonard make, one synchronising panel, having synchronising apparatus, main voltmeter, with three-way switch for throwing the voltmeter across any of the three phases, a recording voltmeter and fuses for the neutrals of four generators, two feeder panels, each carrying two sets of triple pole switches and fuses, and two ammeters, two lighting panels, each carrying one four-pole switch and three ammeters, one being for each phase. The panels are of polished marble, supported on an iron framing, placed 4ft. from the wall, while a glass roof and end doors keep out dust, &c., from the connections and terminals, and provide easy access to the back with a good light.

The main cables or feeders are of the British Insulated Wire Co.'s make, and are drawn into Doulton conduits, the power mains having three twisted cores, while the lighting mains have four cores, the fourth being for the neutral return. The sizes of these cores vary from $\frac{37}{.083}$ to $\frac{19}{.083}$. These feeders run from the main switchboard to distributing switchboards fixed in sub-stations at various points in the works. These distributing switchboards carry six power and six lighting sub-circuits each, with triple-pole switches and fuses for the power, and single-pole switches and fuses for the lighting. There are separate bars for power and lighting which can, in case of emergency, be inter-connected by means of plugs, thus providing for supplying the 'bus bars from either power or lighting feeders. A neutral bar is provided to which each lighting sub-circuit is connected, and in each sub-station the lighting circuits are balanced as nearly as possible. The sub-circuits consist of similar cables to the feeders, and are also drawn into Doulton conduits, triple-core for the motors and two-core for the lighting.

The motors have been arranged to replace separate engines, and to drive on to the existing shafting in order that no disturbance might be made in converting to the new system. The lines of shafting in most cases have been split up so as to be driven in smaller groups for greater economy.

I may here remark that the whole of the transfer was effected without stopping any of the workshops.

One of the Goliath cranes has been converted from steam to electricity ; the motor replaced the boiler and engine which were previously used. The reducing gear consists of a raw-hide pinion fixed on the motor shaft of the crane, which operates the various motions. The motor controller is of the Brown, Boveri type, and consists of a reversing switch connected in the stator circuit and controlling resistance in the rotor circuit. These switches are interlocked, and the whole controlled by one lever, so that the motor is started, the speed controlled, and the direction of rotation is reversed by the movement of this one lever. The motor derives its current from three trolley wires fixed on the usual overhead system.

In the foundry are two new electric travelling cranes, each operated by three motors. One is for a maximum of 20 tons, and has two motors of 10 H.P. each and one of 5 H.P., the other is a 5-ton crane and has two motors of 7 H.P. and one of 3 H.P. The two larger motors are in each case for lifting and longitudinal motions, and are provided with controlling rheostats for reducing the speed. As a result of experience 10 additional cranes are now being fitted with three-phase motors and controllers, and another generating set of 500 H.P. is being erected in the power house.

The lighting of the works is done by some 500 glow-lamps and 60 arc lamps ; the latter are run six in series on the 200 volt mains, and no difficulty has been experienced in the regulation, although the lighting is taken from the same generators as the motors. The whole of the wiring for the lighting is enclosed in "Simplex" steel conduits.

Since the plant was started over a year ago it has worked most successfully. The economy has been very marked, and will show still better results when all the cranes which are now being converted are electrically driven, and the new plant is in operation.

During the recent inquiry of the Parliamentary Committee upon the Electric Power Bills there was a good deal said about the effect of a good load-factor upon the cost of generation of electricity. As is to be expected, we get a very good all-day load on my station, and the load-factor for the past year was 42·01 per cent. ; and, with an output of 554,000 B.T.U. per year, the works cost of generation—viz., coal, water, wages, oil and stores—work out to the remarkably low figure of 0·552d. per unit, whilst the cost of distribution, *i.e.*, the motor attendants, crane men and arc-lamps trimmer, &c., works out at 0·215d., so that the works cost of the energy delivered at the shafting or machines is 0·552d. and 0·215d. = 0·767d. per B.T.U. I do not mean that this low figure is necessarily due to the plant being

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APPENDIX.—Examples of Polyphase Equipments in Factories.

| Name. | Factory. | Two or three phase. | ~ | Total H.P. of generating plant. | Number and size of motors and how employed. |
|---|---|---|---|---|---|
| Pelzer Mfg. Co., South Carolina, U.S.A. ... | Cotton spinning and weaving | 3 | 40 | 3,000 | 15 110, 4 75, 2 50 and 4 5 H.P. To shafting. Small ones direct to pumps and fans. |
| Westinghouse Co., East Pittsburg ..... | Elec. engineering | 2 | 25 | 1,500 | 57. To shafting and hoists. |
| Pommah Mills, Taftville, Connecticut ..... | Cotton spinning | 3 | 50 | 670 | 2 synchronous. Self-starting. To shafting. |
| Columbia Cotton Co., Columbia, S. Carolina | Cotton spinning | 3 | 36 | 1,360 | 20 65 H.P. On ceilings. To shafting. |
| Simmonds Saw Mills, Fitchburg, Mass. ..... | Saw mills..... | 2 | 50 | 600 | 11. To shafting. |
| Killner-Partington Paper Pulp Co., Sarpsborg | Paper making ... | 3 | ... | 4,000 | 1 200 H.P., &c. To shafting. |
| Nyhmmars Bruk, Sweden ..... ..... | ... | 3 | ... | 105 | 1 75 H.P. To shafting. |
| Eisenhütten Akt. Düdelingen, Luxemburg | ... | 3 | ... | 3,200 | Many of various H.P. To pumps, fans, cranes, &c. |
| Antonienhütte, Silesia ..... | Zinc smelting, &c. | 3 | ... | 600 | Many of various H.P. To pumps, fans, cranes, &c. Above and below ground |
| Edlerschacht Station, Germany ..... | Mine ..... | 3 | ... | 500 | 1 350 H.P. Pumping. |
| Paper Pulp Co., Albbruck, Germany ..... ... | Paper pulp works | 3 | ... | 500 | 1 400 H.P. and several smaller. To shafting. |
| Cotton Spinning Co, Arlen, near Singen .. | Spinning & w'ving | 2 | ... | 450 | Several 180 and 100 H.P., &c. To shafting. |
| Mechanical Weaving Co., Jourdain, Alsace | Weaving works . | 3 | ... | 350 | Several various H.P. To shafting. |
| Duméril Jaegló & Co., Thann, Alsace ..... | ... | 3 | ... | 300 | Large number small. To shafting. |
| F. and T. Frey, Guebwiller ..... | Spinning & w'ving | 3 | ... | 250 | Group driving by a number. |
| Dr. A. Feer Ernst Lärrach, Brombach ..... | Cloth print works | 3 | 50 | ... | Large number. Group driving. Current from Rheinfelden. |
| Waiblingen & Etab, Hurzog. Logelboch... | Silk weaving ... | 3 | ... | ... | Number of small. Special method of driving looms. |
| Gutter Tile Factory, Bexbach, Mittelbexbach | Gutter tile ..... | 3 | ... | 80 | Number of small. To machines. Also two three-phase locos. |
| Adolphütte, near Bautzen ..... | Brick factory ... | 3 | ... | 125 | 5 of 10 to 60 H.P. Driving presses, pumps, &c. |
| Bergverwaltung, Raibl ..... | Mine ..... | 3 | ... | ... | 1 65, 1 35, 1 12 and 1 6 H.P. Driving shaft elevator and pumps.* |
| Röchling Works, Diedenhofen ..... | Iron & steel w'ks | 3 | ... | 830 | Several various H.P. Driving elevators and pumps. Also machines at two |
| P. Schweryer & Co., Nerdingen, Germany... | Sugar refining ... | 3 | ... | 500 | 94 1 to 5 H.P. Direct-coupled to centrifugal machines. [distant pits. |
| Royal Dutch Co., Maastricht, Holland ... .. | Paper m'f'cturers | 3 | ... | 450 | Several. Driving machines. |
| Soc. des Usines Rémy, Wygmael, nr. Lourain | Starch making... | 3 | ... | 1,050 | Several of various sizes. Shaft driving, also centrifugal machines. |
| Soc. Anon. "La Louisiane," Ghent, Belgium | Spinning factory | 3 | ... | 500 | Several of various sizes. Group driving. |
| Cie. Générale d'Traction Electrique, Brussels | Canal navigation | 3 | ... | 1,000 | 60 of 5 to 10 H.P. Working small locomotives. |
| Société Anon. des Charbonnages Espérance et Bonne Fortune, Montegnec-les-Liége | Mine ..... | 3 | ... | 600 | Several. Mining work. |
| Usine de Désargentation, Hoboken-les-Anvers | ... | 3 | ... | 250 | Several. Driving shafting. [furnace gas engine. |
| Soc. Anon., John Cockerill, Seraing, Belgium | ... | 3 | ... | 150 | 2 60 and 1 120 H.P. Driving cement works and shafting. Blast |
| Motte Dewavrin Mill, Tourcoing, France ... | Spinning mills... | 3 | ... | 345 | Several. Driving spinning machinery. |
| Lorthiois Bros., Tourcoing, France..... | Weaving mills... | 3 | ... | 147 | Several 1 H.P. Independent. Driving heavy damask looms. |
| A. Bouchon, Nassandres (Eure) ..... | Sugar factory ... | 3 | ... | 340 | Many. Driving whole machinery. |
| Aciéries de France, Isbergues (Pas de Calais) | Engineering works | 2 | ... | 300 | Many. Machines, tools, &c. |
| Phillipe Bunan Varilla, Paris ..... | ... | 3 | ... | 150 | Several. Driving machinery and a dredger. |
| Weyher and Richmond, Pantin (Seine)..... | Engineering works | 2 | 40 | 600 | 17 50 H.P. down to 3 H.P. Driving machinery, cranes, &c. |
| Aubrives and Villerupt, Meurthe and Moselle | Engineering works | 2 | ... | 300 | For machinery, cranes, &c. |
| Gillet et Fils, Villeurbanne, near Lyons ... | Dyeing & finishing | 3 | ... | ... | Large number. Independent and group driving of mangles, &c.† |
| Mining & Metallurgical Co., Horcajo, Spain | Mine ..... | 3 | ... | 1,300 | 4 250 H.P. centrifugal pumps, lifting water 500m. |
| Oerlikon Co., Zurich, Suisse ..... | Engineering works | 3 | ... | 1,800 | 94 various sizes. Machines, tools, cranes, &c. |
| Escher Wyss & Co., Zurich, Suisse ..... | Engineering works | 3 | ... | ... | 100 various sizes. Machines, tools, cranes, &c. |
| Brown Boveri & Co., Baden, Suisse..... | Engineering works | 2 | ... | 450 | 100 ‡ to 100 H.P. Machines, tools, cranes, &c. |
| Von Roll Iron Works, Gerlafingen, Suisse ... | Iron works ..... | 3 | ... | 300 | Several. Driving machines and tools. |
| Von Roll Iron Works, Rondez ..... ..... | Iron works ..... | 3 | ... | 350 | Several. Driving machines and tools. |
| Alioth Electrical Co., Münchenstein, nr Bâle | Engineering works | 3 | ... | ... | Several. Driving machines and tools. |
| Von Moos Iron Works, Lucerne ..... ... | Iron works ..... | 2 | ... | 400 | Several 200, 120 H.P., &c. Direct driving of rolling mills.‡ |
| Pott Spärry, Flums ..... ..... | Calcium carbide . | 3 | ... | 2,450 | Several. Dressing and crushing plant and 18 150kw. furnaces. |
| Bally and Sons, Schoenenwerd ..... | Boot and shoe ... | 3 | 20 | 100 | 10 of 10 H.P. downwards. Driving shafting. |
| E. Skoda, Pilsen, Austria ..... ..... | Steel foundry ... | 3 | ... | 650 | Several of various H.P. Driving high-speed foundry cranes. |
| Brigl and Bergmeister, Nicklasdorf, Austria | Paper factory ... | 3 | ... | 165 | 1 130 H.P. Driving wood grinders. |
| Spinning Mills, Vöslau, Austria ..... ..... | Worsted spinning | 3 | ... | 240 | Several of various H.P. Driving shafting. |
| Seigkam Jasefthal, Austria ..... | Paper factory ... | 3 | ... | 500 | 6 of 3 to 105 H.P. Driving shafting. |
| Reali Mill, Treviso, Italy ..... | Paper mill ..... | 3 | ... | 400 | Several 160, 90, 70 H.P., &c. Driving shafting. |
| Vonwiller & Co., Romagnano Sesia, Italy ... | Paper mill ..... | 2 | ... | 1,125 | 6 of 120, 1 of 200 H.P. and many smaller. Driving shafting. |
| Wild and Abegg, Turin, Italy ..... ..... | Spinning mills... | 3 | ... | 1,330 | 300, 200, 150 and 50 H.P. Lighting and driving mills. |
| Frua Banfi & Co., Legnano, Italy ... ..... | Spinning mills.. | 3 | ... | 2,200 | 600, 500, 400, 330, 250 and 125 H.P. motors. Lighting and driving mills.§ |
| Ing. Muggiani Company, Intra, Italy ..... | Spinning mills... | 3 | ... | 720 | 300, 200, 120 and 100 H.P. Lighting and driving mills |
| Nine Spinning Mills, Como, Italy ..... | Silk spinning ... | 3 | ... | ... | Great number small motors. Independent driving of silk looms.¶ |
| Manifattura Festi Rasini, Villa d'Ogna, Italy | Spinning mill ... | ... | ... | 560 | 2 of 230 and 150 H.P. Driving and lighting mills. |
| Fratelli Visocchi, Atina, Italy ..... | Paper mill ..... | 3 | ... | 600 | 280, 200 and 40 H.P. Driving and lighting mills. |
| Egidio and Pio Gavazzi, Desio, Italy ..... | Silk spinning ... | 2 | ... | 930 | 2 of 120 H.P., 300 small motors for direct driving of looms. |
| Leger Hefti, Ponte St. Pietro, Italy ..... | ... | 3 | ... | 760 | 2 of 300 H.P. (300 revs. per min.). |
| Niggeler and Küpfer, Palazzolo sull'Oglio... | ... | 3 | ... | 600 | 250, 150, 50 H.P. and many smaller motors. Driving mills. |
| Fubter Bébié, Gravellona-Toce ..... | ... | 3 | ... | 225 | 1 120 H.P., 1 40 H.P. Lighting and driving mill. |
| Ant. and And. Ponti, Solbiate Olona ..... | Weaving factory | 3 | ... | 220 | 80, 30 and 6 H.P. Group driving. |
| Francesco Rossi, Perale..... | Paper factory ... | 3 | ... | 725 | 2 140, 1 200 H.P., and many smaller. Machine driving. |
| Gioachino Zopfi, Bergamo..... | Cotton spinning | 3 | ... | 300 | Large number. Machine driving. |
| Ernesto Ceriana, Frassinetto-Po..... | Cement works... | 3 | ... | 220 | 1 90 H.P. and smaller. Lighting and driving. |
| Salesiana Mill, Mathi..... | Paper mill ..... | 3 | ... | 210 | 1 170 H.P. Lighting and driving. |
| G. Marzotto & Sons, Valdagno..... | Spinning mills... | 3 | ... | 330 | 2 140 H.P. Lighting and driving. |
| Biancho & Co., Intra..... | Spinning mills... | 3 | ... | 200 | 1 200 H.P. Lighting and driving, current from Intra central station. |
| Ernesto Breda & Co., Milan..... | ... | 3 | ... | 120 | Several. Driving works. |
| Fraschini and Porta, Brescia ..... | ... | 3 | ... | 120 | Several. Driving works. |
| V. Bass & Co., Turin..... | Cotton spinning | 3 | ... | 150 | 1 120 H.P. Driving works. |
| Procharoff & Sons, Moscow ..... | Weaving mills... | 3 | ... | 2,600 | Large number, various sizes. Single and group driving. |
| Baranoff Works, Karabanowe ..... .. ..... | Cloth spinning, &c. | 3 | ... | 1,600 | Large number, various sizes. Single and group driving. |
| Balaschinskaya Manufactur, Moscow ..... | ... | 3 | ... | 1,800 | 140, 70, 40, 15 and 5 H.P. Single and group driving. |
| Water Works, Moscow ..... | ... | 3 | ... | 900 | 20 20 H.P., of special design for vertical pumps. |
| Alagir Mining, &c. Co., Darg Koch, Caucasus | Mining & chemical | 3 | ... | 500 | Large number. Ore washing and pit driving. |
| Twarskaya Manufactur, Twer, Russia ..... | ... | 3 | ... | 450 | Large number. Driving shafting. |

* Current from public supply.
† Current from Société Lyonnaise des Forces Matrices du Rhône.
‡ Current also from Rathausen Central Station.
§ Current from Vizzola central station.
Run off Ossolana and Intra supply stations.
¶ Current from supply station.

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APPENDIX.—Examples of Polyphase Equipments in Factories—*continued.*

| Name. | Factory. | 2 or 3 phase. | ~ | Total H.P. of generating plant. | Number and size of motors and how employed. |
|---|---|---|---|---|---|
| Wladikawkas Rly. Co., Port of Noworosiska | ... | 3 | ... | 1,000 | Large number Driving conveyors, lifts, cranes, &c. |
| Riasan Ural Railway Co., Tamboir Station.. | Railway shops ... | 3 | ... | 720 | Large number. Driving lathes, machine tools, &c. |
| Nicolai Rly. Co., Alexandrow, St. Petersburg | Railway shops ... | 3 | .. | 330 | Large number. Driving lathes, machine tools, &c. |
| Zimin Mills, Dreana ..... | Spinning & wving | 3 | ... | 630 | Large number. Driving looms. |
| Tube Rolling Mills, St. Petersburg..... | Tube rolling..... | 3 | ... | 540 | Large number. Driving rolling mills and machine tools and lighting. |
| Bromley Engine Works, Moscow ..... | Engineering..... | 3 | ... | 350 | Large number. Driving shops. |
| Brass and Copper Rolling Mills, Koltschugin | Brass and copper | 3 | ... | 300 | Large number. Driving mills. |
| Tschetwerikow Factory, Porodischtschi..... | Cloth making ... | 3 | ... | 300 | Large number. Driving mills. [machine tools. |
| Sisterbeck Rifle Factory, Sisterbeck ..... | Rifles, &c..... | 3 | ... | 80 | Number of small of 7, 1, 2, 3, 10 and 20 H.P. Separate driving of |
| Colomna Engine Works, Russia ..... | Engineering ..... | 3 | ... | 600 | Large number. Separate driving of machine tools. |
| Grain Storage and Transit Co., Liverpool ... | ... | 3 | ... | 180 | 2 18, 1 60, 1 26, 3 5 and 1 3 H.P. Driving conveyors and lighting sheds |
| Sir Thomas Richardson & Sons, Hartlepool . | Engineering..... | 3 | 41 | 1,200 | 25 of 60, 45, 25, &c., H.P. Driving shops. |
| General Electric Co., Manchester ..... ... | Elec. engineering | 3 | 45 | 200 | 30 of 36 to ¼ H.P. Single and group driving. |
| Bristol Carriage and Wagon Co., Bristol ... | Carriage & wagon | 3 | 50 | 800 | 10 of 65 to 2 H.P. Shop driving. |
| Anglo-Swiss Condensed Milk Co., Aylesbury | Dairy ..... | 3 | ... | ... | 8 of 10 to ½ H.P. Driving dairy machines. |
| North-Eastern Steel Works, Middlesbrough | Iron and steel ... | 2 | 40 | 700 | 6 40 and 5 20 H.P. Driving machine tools, cranes, &c. |
| D. T. Stewart & Co., Glasgow..... | ... | 3 | ... | 450 | ..... |
| Beyer and Peacock & Co., Ltd., Manchester | Engineering..... | 3 | ... | 400 | 50 30 and 20 H.P., &c. Driving machine tools, cranes, &c. |
| Hawthorne, Leslie & Co., Newcastle-on-Tyne | Engineering..... | 3 | ... | 230 | Many motors. Driving machine tools in shipyard. |
| W. Dickson & Co., Glasgow .... ..... | Chemical works.. | 3 | ... | 660 | Large number. Driving machines. |
| James Rogers & Sons, Sheffield ..... | Cutlery..... | 2 | 21·3 | 320 | 2 25, 1 22, 2 12, 1 7 and 1 5 H.P. Driving grinding wheels, hoists, &c.* |
| John Thompson, Wolverhampton ..... ... | Boiler works ... | 3 | ... | 460 | Several. Driving shafting. |
| Kirkstall Forge Co., Leeds ..... ..... | Forge ..... | 3 | ... | 150 | Several. Driving shafting. |
| Patent Shaft and Axletree Co. (Ltd.), Wednesbury | Bridge-building & engineering | 3 | 50 | 920 | 2 50, 2 40, 3 30, 13 20, 6 10, 2 7 and 2 5 H.P. Single and group driving machinery, cranes, hydraulic pumps, &c., also lighting. |
| Brown, Marshall & Co. (Ltd.), Birmingham | Carriages & wagons | 3 | 45 | 70 | 1 40 H.P. Driving shafting. |
| Fletcher, Russell & Co., Warrington ..... | Engineering..... | 3 | ... | 160 | 2 20 H.P., &c. Direct driving Roots' blowers, and machine driving. |
| Bolckow, Vaughan & Co., Middlesbrough† | Iron and steel ... | 3 | ... | 3,000 | Several. Driving shops, &c. |

* Motor-generator for arc-lighting. † In course of erection.

polyphase, but I thought that this data would be interesting, inasmuch that it bears out to such a marked degree the effect of the load-factor on the costs.

*Bolckow, Vaughan & Co.*—As a further sign of the growth of favour for polyphase plants in the country, I may mention that Bolckow, Vaughan & Co., the large iron masters, are now erecting a power-station at Eston, near Middlesbrough, for the driving of their works and the lighting of the town, and this is to be on the three-phase system. The size of the first generating sets, of which two or three are being installed, is 1,500 H.P. each.

It is seen, then, that since the introduction of polyphase factory equipment into this country in 1897, there have been no less than 16 installations started, amounting in the aggregate to about 10,000 H.P. I venture to think that the growth to this amount of a system in its first four years in this very conservative country of ours promises well for its success and development in the future.

*Table of Polyphase Plants in use.*

| | | | |
|---|---|---|---|
| United States of America | 5 | plants aggregating | 7,130 H.P. |
| Sweden .. ..... | 2 | ditto | 4,105 do. |
| Germany ..... | 15 | ditto | 7,685 do. |
| Holland ..... ..... | 1 | ditto | 450 do. |
| Belgium ..... ..... | 6 | ditto | 3,550 do. |
| France..... ..... .. ... | 8 | ditto | 2,182 do. |
| Spain ..... | 1 | ditto | 1,300 do. |
| Switzerland ..... | 9 | ditto | 5,850 do. |
| Austria ..... ..... | 4 | ditto | 1,555 do. |
| Italy ..... . ..... | 22 | ditto | 12,035 do. |
| Russia..... . ..... | 16 | ditto | 12,700 do. |
| England .. ..... . | 16 | ditto | 9,450 do. |
| | 105 | | 68,192 |

## ELECTRICITY WORKS ACCOUNTS.

### South London Electric Supply Corporation (Ltd.).

Many of the results exhibited in our table summarising the accounts of this company are hardly surprising in the circumstances attending the working. The somewhat excessive cost figures shown must be partly attributable to the disuse of the dust destructor scheme in its entirety, and to the delay in the installation of the economiser and condensing plants. It is necessary to explain in reference to our table that the number of units taken as the basis in calculating the costs "per unit sold" include the units used on the works for lighting, meter testing and motors as well as the output to the street arc lamps. The inclusion of the "units used on works" has, of course, the effect of slightly lowering the cost figures as compared with those usually rendered in our tables. It will be noticed that, even so, the fuel and the oil, waste, &c., items are excessive, and there appears in the original accounts an item of £3,000 "contribution chargeable to and paid by contractors" in reduction of the expenditure on these two items. In our table the sum has been deducted merely from the aggregate generating costs.

The dust destructor was started at work about the beginning of last year, and remained at work until the end of October, when, in consequence of proceedings taken by the local authorities it had to be shut down for alleged effluvia from the chimney. For the destruction of the refuse of the parish and the supply of 25 arc lamps, the company were to have received a contract price per ton of refuse destroyed. During the period the destructor was at work last year the company received £1,261 for the destruction of refuse and from sales of clinker and mortar. The collective management and property charges stand at a most reasonable figure although including £1,200 paid to the directors in fees.

It will be noticed that the "working profit" was a minus quantity in both years, and that the credit balance arises from interest received.

The lamp connections were ahead well last year, the total increasing by 69·1 per cent.

### Woolwich District Electric Light Co. (Ltd.).

A splendid improvement has taken place in the position of this undertaking. With an output during last year over 79 per cent. above that of 1899 the costs in all departments have diminished. The result is that even with a lower total revenue per unit the working profit in its relation to the mean capital was half as much again as in 1899, and it was possible to distribute a dividend of 5 per cent.

In comparing the cost values at this station with those at other stations it is necessary to note the low load-factor which characterises the load. In 1899 this was only 6·44 per cent., and last year it had risen to no more than 7·11 per cent. With the natural exception of the fuel item, the costs are all below what might have been expected under the existing conditions of load. Not only are the economic results excellent, but the advance in the total lamp connections of no less than 102 per cent. augurs well for the future.

Out of the working profit £600 was placed to the depreciation fund, and £762 paid in interest on loans. The balance, together with that brought from the preceding year's account amounted to £1,426.

During the year additional ground adjoining the works was secured on lease, and with additions to the boilers a new 250kw. generating set was installed.

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| | SOUTH LONDON. | | WOOLWICH. | |
|---|---|---|---|---|
| *Undertaking Worked by* | South London Electric Supply Corporation [(Ltd). | | The Woolwich District Elec. Light Co. (Ltd). | |
| *Date of Commencement of Supply* | October, 1899. | | September, 1893. | |
| *System of Supply* | 2-wire alternate current, with transformers in | | Continuous current 3-wire. | |
| *Chief Engineer* | H. W. Sprunt. [pits. | | A. J. Fippard. | |
| **YEAR ENDED** | DEC. 31, **1899.** | DEC. 31, **1900.** | DEC. 31, **1899.** | DEC. 31, **1900.** |
| **QUANTITIES—** | | | | |
| Units generated | — | 1,508,682 | — | 313,717 |
| ,, **SOLD (TOTAL)** | — | **1,250,441**[j] | **141,518** | **253,651** |
| ,, sold to consumers | — | 928,131 | 141,518 | 253,651 |
| ,, sold for public lighting, &c. | — | — | — | — |
| ,, used on works | — | 322,310[k] | — | 13,087 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | — | **13·4** | **10·5** | **11·9** |
| Maximum supply demanded | — | 950 kilowatts | 251 kilowatts | 407 kilowatts |
| Number of public lamps | — | 25 (15 amp.) | — | — |
| Number of consumers | 385 | 660 | 103 | 149 |
| Connections to mains in 8-c.p. lamps | 25,625 | 43,322 | 9,610 | 19,425 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | **46,900** | **93,800** | **13,430** | **21,240** |
| **CAPACITY OF PLANT IN KILOWATTS** | **1,500** | **3,000** | **430** | **680** |
| **CAPITAL—** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** |
| **AUTHORISED (TOTAL)** | **£487,500** / **£325** | **£487,500** / **£163** | — / — | — / — |
| Share | 325,000 / 217 | 325,000 / 108 | £25,000 / £58·1 | £25,000 / £36·8 |
| Loan (including Debenture charges) | 162,500 / 108 | 162,500 / 54·2 | — / — | — / — |
| **RECEIVED (TOTAL)** | **311,325** / **207** | **324,980** / **108** | **27,000** / **62·8** | **35,000** / **51·5** |
| Share | 311,325 / 207 | 324,980 / 108 | 20,000 / 46·5 | 25,000 / 36·8 |
| Loan (including Debenture charges) | — / — | — / — | 7,000 / 16·3 | 10,000 / 14·7 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | **176,175** / **117** | **162,520** / **54·2** | — / — | — / — |
| Share (unissued) | nil / — | nil / — | } 5,000 / 11·6 | nil / — |
| Share (uncalled) | 13,675 / 9·11 | 20 / 0·007 | | |
| Loan (including Debentures) | 162,500 / 103 | 162,500 / 54·2 | — / — | — / — |
| **REPAID (TOTAL)** | — / — | — / — | — / — | — / — |
| **RESERVE OR SINKING FUND** | — / — | — / — | — / — | — / — |
| **DEPRECIATION FUND** | — / — | — / — | — / — | 100 / 0·147 |
| **EXPENDED (TOTAL)** | **219,285** / **146** | **255,497** / **85·2** | **35,728** / **83·1** | **47,817** / **70·3** |
| Lands and buildings | 72,034[a] / 48·0 | 76,538[a] / 25·5 | 3,599 / 8·37 | 6,493 / 9·54 |
| Plant | 76,285[b] / 50·8 | 98,505[b] / 32·8 | 21,312 / 49·6 | 28,344 / 41·7 |
| Mains | 69,486 / 46·3 | 78,504 / 26·2 | 10,327 / 24·0 | 12,476 / 18·4 |
| Miscellaneous | 1,479 / 0·986 | 1,951 / 0·650 | 489 / 1·14 | 504 / 0·741 |
| **BALANCE OF CAPITAL ACCOUNT** | **+92,040** / **61·3** | **+69,483** / **23·2** | **−8,728** / **−20·3** | **−12,817** / **−18·9** |
| **REVENUE—** | **Total.** / **Per unit sold** | **Total.** / **Per unit sold** | **Total.** / **Per unit sold** | **Total.** / **Per unit sold** |
| **TOTAL** | **£7,622** / — | **£17,721** / **3·402d.** | **£3,303** / **5·600d.** | **£5,638** / **5·335d.** |
| Revenue from supply | 7,365 / — | 16,068 / 3·085d. | 3,125 / 5·300d. | 5,482 / 5·188d. |
| ,, meters, &c. | 228 / — | 372 / 0·071d. | 68 / 0·115d. | 102 / 0·097d. |
| ,, public lighting | — / — | — / — | — / — | — / — |
| ,, sale of lamps, &c. | — / — | — / — | — / — | — / — |
| ,, miscellaneous sources | 29 / — | 1,281[l] / 0·246d. | 110 / 0·186d. | 54 / 0·051d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | **£8,229**[e] / — | **£18,611** / **3·571d.** | **£2,192** / **3·717d.** | **£2,918** / **2·762d.** |
| **WORKS COSTS** | **2,412** / — | **14,875** / **2·853d.** | **1,596** / **2·706d.** | **2,054** / **1·944d.** |
| *Generation of electricity* | *2,145* / — | *14,091*[m] / *2·704d.* | *1,524* / *2·584d.* | *2,022* / *1·914d.* |
| Fuel (including cartage, &c.) | 1,370 / — | 10,279 / 1·972d. | 755 / 1·280d. | 1,244 / 1·178d. |
| Oil, waste, water, stores | 192 / — | 1,005 / 0·193d. | 119 / 0·202d. | 105 / 0·099d. |
| Wages at station | 501 / — | 5,027 / 0·965d. | 392 / 0·665d. | 467 / 0·442d. |
| Repairs and maintenance at station | 12 / — | 780 / 0·150d. | 258 / 0·438d. | 206 / 0·195d. |
| *Distribution of electricity* | *267* / — | *317* / *0·061d.* | *72* / *0·122d.* | *32* / *0·030d.* |
| Wages, &c. | 140 / — | 117 / 0·022d. | 67 / 0·114d. | 19 / 0·018d. |
| Repairs, renewals of mains, &c. | 127 / — | 200 / 0·038d. | 5 / 0·008d. | 12 / 0·011d. |
| *Public lighting* | — / — | 77 / *0·015d.* | — / — | — / — |
| Attendance | — / — | } 77 / *0·015d.* | — / — | — / — |
| Renewals | — / — | | — / — | — / — |
| **MANAGEMENT AND PROPERTY CHARGES** | **2,558** / — | **3,737** / **0·718d.** | **596** / **1·011d.** | **864** / **0·818d.** |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *147* / — | *87* / *0·017d.* | *322* / *0·546d.* | *452* / *0·428d.* |
| *Management* | *2,411* / — | *3,650* / *0·701d.* | *274* / *0·465d.* | *412* / *0·390d.* |
| Salaries | 1,837[c] / — | 2,286[n] / 0·439d. | 137 / 0·232d. | 273[c] / 0·258d. |
| Stationery, &c. | 229 / — | 387 / 0·074d. | 28 / 0·048d. | 32 / 0·030d. |
| Establishment charges | 213 / — | 389 / 0·075d. | 28 / 0·048d. | 47 / 0·045d. |
| Law charges, &c. | 132[d] / — | 588[o] / 0·113d. | 80[a] / 0·136d. | 60[b] / 0·057d. |
| **FINANCIAL RESULTS—** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** |
| **WORKING PROFIT FOR YEAR** | **−£607**[f] / **−0·278%**[p] | **−£890**[f] / **−0·375%** | **£1,111** / **4·29%** | **£2,720** / **6·51%** |
| Sum carried to Depreciation Fund | — / — | — / — | 100 / 0·386% | 600 / 1·44% |
| Sum carried to Reserve or Sinking Fund | — / — | — / — | — / — | — / — |
| Net interest on loans (incl. Debenture charges) | 902[g] / 0·411%[p] | 1,373[g] / 0·578% | 282 / 1·09% | 762 / 1·82% |
| **BALANCE FROM LAST ACCOUNT** | — / — | — / — | **−370** / **−1·43%** | **+69** / **0·165%** |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | **295**[h] / **0·135%**[p] | **483**[h] / **0·203%** | **359** / **1·39%** | **1,426** / **3·41%** |
| *Deficit* | — / — | — / — | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | 2½% / — | 5% / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 108% | 105% | 66·4% | 51·8% |
| Expenditure per kilowatt capacity | £5. 9s. 7d. | £6. 4s. 1d. | £5. 2s. 0d. | £4. 5s. 10d. |
| **REVENUE PER KILOWATT CAPACITY** | **£5. 1s. 7d.** | **£5. 18s. 2d.** | **£7. 13s. 7d.** | **£8. 5s. 10d.** |
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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,
1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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## THE EARTH AS A CONDUCTOR.

Leaders of physical science in times past have propounded manifold theories of the magnetic and electrical properties of the earth. This planet has been variously regarded as a magnet, a condenser, a charged sphere, a displacement current in the ether, a dielectric, and as an electrolyte. Few, however, have paid much attention to the properties of the earth as an ordinary electrical conductor. It is true that telegraph and telephone engineers have long taken advantage of the electrical properties of earth and sea to dispense with a return metallic conductor; but there have not been wanting theorists who have asserted that in this respect the earth does not act as a conductor, but as a huge condenser, the return current being, they said, purely imaginary. Be that as it may, the use of the earth has proved practically effective in places where there are no other circuits to cause interference; and no harm has been done by using the earth in this manner. When, however, in later years, electric tramway engineers copied their elder brethren of the telegraph and telephone, the theorists abandoned every previous theory and advanced the alarming view that the earth was an electrolyte. Now an electrolyte, when we meet with it in a scientific laboratory, is a tangible object that possesses very definite properties. A given current in amperes passed through it between two metallic plates for any given time in seconds, hours, days or years, will produce, at the points where the current enters and leaves, an amount of electrolytic decomposition that any theorist can calculate to the tenth place of decimals. From the thraldom of these calculations there is no easier escape than from the law of gravitation. FARADAY laid down the laws of electrolysis, the theorists declared the earth to be an electrolyte—all the rest followed. Meanwhile the tramway engineers proceeded apace with the work of covering the face of the earth with the overhead trolley system. So the theorists came out of their laboratories and made notes of the amount of return current in these tramways. Some of this return current they discovered came back to the station through the well-conducting rails of the tramways, but all the rest of the return current they regarded as doing the mischievous work of electrolytic decomposition in the

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earth. So they calculated the weight of metal in tons per annum that all this current must be dissolving away from the metal pipes in the vicinity of the trolley lines, and showed the figures to the owners of these pipes, who were naturally very much upset. To prove their point, the theorists invented little lecture-table models, with tiny metal pipes buried in a soft, damp mess serving—libellously withal—to represent the earth; and when the owners of pipes saw how these bits of metal became corroded, they grew still more afraid of the overhead trolley, and they threw every possible obstacle in the way of its adoption near their own underground pipes. Yet, curiously enough, the pipes in the vicinity of earth-return traction plants that had been running for years and years did not dissolve away as fast as the calculations required them to do, but showed a healthy tendency to last almost for ever. Nevertheless this did not shake the theorists nor lessen the alarm of the pipe-owners, who took the theorists to Parliament to complain about the grievance, and, latterly, have been exceedingly busy in the committee rooms.

This active hostility, indeed, is now being pursued in Parliament with such vigour, and is repeatedly supported by so dazzling a display of scientific evidence, that, in our desire that the progress of electric traction shall not receive unmerited a serious check, we have gone to some trouble to investigate the merits of the anti-trolley pretensions. Among the literature which has come before us in making this enquiry are two important documents on the subject of electrolysis from tramways, the one a report on "Electrolysis in the District of Columbia," ordered to be printed by the United States Senate, and the other, a Paper on "Some New Ideas as to the Electrolytic Mode of Action of the Return Currents of Transmission Installations," read by M. CLAUDE before the Société Internationale des Électriciens, at Paris. Inasmuch as it deals more directly with the logical position of the anti-trolley party, we shall consider M. CLAUDE's Paper first. The two main assumptions upon which theorists have based their calculations and predictions regarding electrolytic troubles are: (1) That the earth, soil or sub-soil, or whatever it be called, is an electrolyte pure and simple; and (2) that practically all the current which leaves the tramway rails and enters the surrounding ground must necessarily pass into metallic pipes in the neighbourhood. Both these assumptions are fallacious; and we feel sure that when the experimental evidence is placed before them, even the most ardent supporters of the electrolytic hypothesis will admit that the dangers from electrolysis have been enormously overstated. M. CLAUDE finds that the earth acts to a very large extent as an ordinary conductor, though partially as an electrolyte, and that, generally speaking, only a small proportion of the current leaving the track rails enters into neighbouring metallic pipes. The data upon which theoretical calculations have been based are thus doubly cut away. Space does not allow of our describing all the experiments upon which M. CLAUDE bases his conclusions. Suffice it to cite one or two examples. First, as to the properties of the earth; we will quote M. CLAUDE:—

By the help of that remarkable instrument—the O'Keenen meter—I have carried out on the spot experiments which have confirmed this hypothesis to an unhoped-for degree. By suitably increasing the resistance shunting of the little motor of this apparatus I have been able to use it to measure very small currents passing under the influence of varying differences of potential into plates of lead buried in the solid. By weighing these plates before and after, I was in a position to see if the action was really equal to the product of the ampere-hours into the electro-chemical equivalent of lead. Now, the action is generally less than the theoretical amount, which practically suggests a conductance which is partly metallic. Further, for an equal quantity of electricity, the action is very feeble for small voltages. Thus a lead plate submitted to a potential of 23 volts as compared with the neighbouring rails diminished in weight in five days by 100 grammes, instead of 230 grammes as indicated by theory—*i.e.*, about one-half of the theoretical loss; while another plate, submitted to a difference of potential, difficult to measure, but about 1 volt, only suffered in 45 days the almost negligible loss of 20 grammes, although its weight should have been diminished by 500 grammes. Here, by reason of the low voltage, the loss was reduced to $\frac{1}{25}$th of its theoretical value. In these experiments I only used lead plates, being of opinion that in the case of iron it would be difficult to discriminate between electrolytic action and the simple action of air and moisture. I was, therefore, very glad of the confirmation in regard to iron which the experiments of Mr. Herrick, published in the last number of the *Street Railway Journal*, May, 1900, bring to bear on the experiments I have just mentioned. According to this experimenter, who, does not appear to have occupied himself with the effect of the magnitude of the difference of potential, the corrosion of iron only reached 3·5 per cent. of the theoretical loss; the differences of potential were probably small. Whatever the cause, the result is therefore certain. It may be explained by saying that the soil acts as if it were composed of a metallic resistance shunted by an electrolytic cell.

One can see, indeed, that if such a combination be subjected to an increasing difference of potential, so long as this difference of potential is less than the electromotive force of the electrolyte, no current will pass through the electrolyte, and the conductive process of the combination will be purely metallic. From the moment, however, when the electromotive force is exceeded a larger and larger chemical current will circulate, of which the proportion to the total current will be greater and greater.

**Secondly, with regard to the discovery that "the earth currents are much larger than is generally believed, but those which circulate in pipes and which alone are dangerous, are, on the contrary, much smaller," we will again quote from M. CLAUDE's Paper:—**

Let us take a battery of two or three accumulators, connect the negative pole, after the tramway service is stopped, to the rails of a network, and the other pole, through the variable rheostat and an ammeter, with the neighbouring gas and water pipes. By means of the variable rheostat we can subject the rail-pipe system to an increasing difference of potential, which can be measured by the voltmeter, and in virtue of which a certain current, measured by the ammeter, will circulate through the earth between pipe and rails. If the earth really behaves as a metallic salt electrolyte the metal differing from that of the electrodes (because this salt is generally a sodium salt, and the electrodes are of iron or lead) the current should remain very small until the point which corresponds to about 1 volt, and at which the applied difference of potential exceeds the counter-electromotive force of the soil, and only from that point should the current increase considerably. In reality the current becomes large from the start, increasing almost exactly in proportion to the difference of potential; that is to say, up to 2 volts at least Ohm's law holds good for the circuit. In the various instances I prolonged the experiment sufficiently—for 20 minutes sometimes—without appreciably reducing the current, so that there can be no question of confusing the phenomenon with a charging of the pipes under the influence of polarisation capacity.

Here we have the first anomaly. It seems that, instead of behaving as an electrolyte, the earth behaves as a metallic conductor, so that polarisation can only be a negligible quantity.

Let us now repeat the same experiment in the neighbourhood of the negative feeder, always after the tramway service is stopped. In this case the difference of potential between rails and pipes, which is created by the battery, is equal to the difference of potential which exists during running. We find that we must generate a very large current—at Havre 23 amperes between gas pipes and rails, at Rouen 23 amperes between rails and water pipes, &c.

Now so strong a current is alarming. It is alarming because, its effect being to maintain between rails and pipes a difference of potential equal to that which is maintained, when the tramway is running, by the stray current which circulates in the pipes, it seems to give an approximate measure of this. I say an approximate measure, because in the experiment in question the current returns more or less from along the whole length of the pipe, while the stray current circulating in the pipe during working can only return to the rails in the dangerous area, and must, therefore, be distinctly smaller though of the same order. This did not fail to alarm me in my first experiments, for such large currents circulating in the pipes would corrode them in a very short time. I was, therefore, led to no longer content myself with this indirect method of measurement, and to measure the current circulating in the pipes during working directly by a simple method. I always found the currents 10, 20, 50 times smaller than those foreshadowed by the former method of measurement. What is the meaning of this contradiction? It is not difficult to account for. In measuring the current in the pipe during

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running, as well as in measuring the current taken from the battery, these currents certainly circulate between pipe and rails upon the application of the same difference of potential. Nevertheless, there exists this essential difference between the two experiments. During running this difference of potential is maintained, not only by the return to the rails of the current emanating from the pipe, but also by stray currents through the earth. In the experiment made after running has ceased, this difference of potential can only be maintained by the experimental current, the only one which exists. And as the current in the pips when the tramway is running is very small compared with the experimental current, we must conclude that during running it is the terrestrial currents which play by far the greater part in the creation of the difference of potential between pipes and rails. Therefore, in contradiction to the second of the commonly-accepted hypotheses, and in conformity with Mr. PARSHALL's opinion, nearly all the stray currents, instead of passing into the pipes, go directly through the earth to join the return feeder.

It is fortunate that this is the case, for stray currents attain proportions which few experimenters seem to have suspected. Thanks to special methods, I have been able to measure this proportion, and can assert that with the best bonded networks it never falls below 12 or 15 per cent., and rises to 25 or 30 per cent. in the case of networks not so well constructed. On the other hand, the currents which circulate in the pipes of our networks are always very small—1 to 4 amperes in the worst case—a cast-iron pipe of 50cm. diameter, well jointed and placed under the track—whilst in the majority of instances currents are of the order of tenths or hundreds of an ampere.

Finally, we come to the evidence afforded by the United States official report. America has been the early home of the electrolytic scare, and in that part of the world, at any rate, the alarms have not always been without justification. In America, however, conditions often obtain which are favourable to electrolysis, while these same conditions are impossible under the regulations of the British Board of Trade. For instance, the report before us mentions, among other examples of a similar kind, a line on which "the difference of potential between the track and the ironwork of the bridge is about 10 volts, the bridge being negative; when the car is near and using current the difference is 40 volts." In another case, where the difference of potential is "as high as 16 volts positive to the track," it is stated that "it is safe to say that current from this road does not affect the water mains to any extent." In still other examples differences of potential as high as 25, 30, 55 volts are mentioned. All these examples show that the trolley practice of the United States affords no ground whatever for suspecting electrolytic troubles in the United Kingdom, but that, on the contrary, in the light of M. CLAUDE's experimental evidence, the Board of Trade regulations of this country, as they stand, are an ample safeguard against injury to buried metallic pipes in the neighbourhood of earth-return electric traction lines.

## THE WINDING OF CLOSED COIL DRUM ARMATURES

BY WM. BECKIT BURNIE.

The winding formulæ commonly used for drum armatures are so numerous and so different that it is exceedingly difficult to memorise them all. It is possible, however, to get all these formulæ from one single expression obtained by considering the total number of conductors passed over in all the winding steps from a starting point until we arrive again at the same point. Suppose that the conductors are numbered consecutively from 1 upwards in a clockwise direction round the armature, the view being from the commutator end; and let us travel through the windings by passing along conductor No. 1 away from us, and on where the copper leads us. Let $y_1$ and $y_2$ be the *algebraic* spacing numbers, reckoning clockwise as the positive direction, so that if the back connection is from 1 to 18, and the front connection from 18 to 3, $y_1$ and $y_2$ will be respectively 17 and $-15$. Now, on reaching the third straight conductor, through which we pass, we have travelled round our armature past $(y_1+y_2)$ spaces. If there are N conductors and $m$ independent windings we must repeat this operation $N/2m$ times before we have travelled through all our conductors and reached the starting point. Before completing this we must travel round our armature a number of times which will depend on the type of amature, and thus we have

$$(y_1+y_2)\frac{N}{2m}=KN,$$

where K is the number of times we have been round the armature.

Thus, $$\tfrac{1}{2}(y_1+y_2)=Km.$$

Now let us consider what values K will have for different armatures. The motion round the armature may be divided into two parts, a portion which we will call the "principal motion," and which is equal to a revolution for each set of $2p$ conductors with wave windings ($2p$ being the number of poles) and equal to nothing with lap armatures; and a portion which we will call the "creep," which depends on the armature type, and which prevents the winding after it has made one complete cycle and arrives at a commutator segment from passing through its starting point.

Now, if $K=A+B$, where A is the number of times the principal motion would send us round the armature, and B is the number of revolutions due to the creep, we have, for lap armatures, $A=0$, for wave armatures, $A=\pm\frac{N}{2pm}$, as we go round once for every $2p$ conductors and must pass through $N/m$ before reaching our starting point.

With regard to the creep we can determine it for the following five cases, and shall see that the same expression can represent it in each case.

*a. Lap wound simplex parallel or multiple circuit connected.*—In this case we only go round the armature once, as can easily be seen by considering a developed lap winding diagram, so that $B=\pm 1$.

*b. Wave wound simplex parallel connected.*—Here we can most easily determine B by considering the passage round $1/2p$ of the armature, that is from brush to brush. We have to travel through $N/2p$ conductors as we have $2p$ different circuits, and in this travel the creep has taken us, forward or backward, $1/2p$ of a revolution; so that in passing through all the conductors the creep would cause a displacement of $\pm\frac{N}{N/2p}\times\frac{1}{2p}=\pm 1$. B therefore $=\pm 1$.

*c. Armatures with two circuits, or series connected.*—In this case we cannot say that in going from brush to brush we pass through $N/2$ conductors, even though we have two circuits only, as the number of conductors will not be a multiple of the number of poles, and the brushes will not be exactly symmetrically placed with regard to the windings at every instant. But as we have to turn our armature, to get from a multiple circuit to a two-circuit machine from $2p$ circuits in parallel to 2 in parallel, we can say that for the same total creep in a two-circuit armature, we must pass through $p$ times as many conductors as in an armature with $2p$ circuits, and reduce our creep for N conductors in the ratio of $1:1/p$. We thus have total creep = (creep for similar multiple circuit armature) $\div p$.

*d. Self-re-entrant multiplex windings.*—These windings consist of two or more entirely independent windings, each similar, and each of which may be considered separately. Each will consist of $N/m$ conductors, and B for each will be the same as for an armature of the same type of only one winding.

*e. Mutually re-entrant multiplex windings.*—A mutually re-entrant winding is one somewhat similar to the above, save that the several windings are not independent, and that having travelled through one we arrive not at its starting point, but at the starting point of the next, and so on. We obtain the same effect as with the self-re-entrant winding—that is, we have several circuits in parallel, so that if $n$ is the number of separate windings mutually reentrant our creep must take us round the armature $n$ times as rapidly as it would with an armature with the same number of conductors joined up in a

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simplex winding. Thus B = $n$ × (value of B for similar armature connected as simplex).

Before expressing all these results by a single formula, it will be convenient to denote the $p$ which occurs in the formula at the end of the paragraph on two-circuit windings by another letter, $b$, as otherwise we shall have two $p$'s in our formula which depend on different conditions. These two quantities, $b$ and $p$, are always, however, numerically equal for a two-circuit machine.

The formula embracing all the results is $B = \pm n/b$.

Then,
$$K = A \pm \frac{n}{b},$$
$$\therefore \quad \tfrac{1}{2}\{y_1 + y_2\} = m\left\{\pm\frac{N}{2pm} \pm \frac{n}{b}\right\}, \quad . \ . \ . \quad (I.)$$

the $N/2pm$ term being the principal motion term omitted where lap winding is used,

where $m$ is the number of entirely independent circuits,
$n$ is the number of mutually re-entrant circuits,
$p$ is the number of poles,
N is the number of conductors,
$b = p$ or 1,

according as the armature is series or parallel connected. It is the number of bifurcations of current due to the method of connecting, as apart from the use of multiplex winding.

The value of $(y_1 - y_2)$ depends on whether we decide to use a chord winding. Putting chord windings aside for the moment: in order that each conductor shall have an E.M.F. induced in it which shall change sign as nearly as possible at the same time as the E.M.F. of conductors connected in series with it, we must have

$$(y_1 - y_2) = 0 \text{ for wave}, \quad . \ . \ . \ . \quad (II.)$$
$$(y_1 - y_2) = \pm\frac{N}{p} \text{ for lap}, \quad . \ . \ . \ . \quad (III.)$$

as nearly as possible, and of course $y_1/m$ and $y_2/m$ must be odd. Before considering chord windings we will work out a few examples from the above formulae.

1. A wave-wound duplex six-pole drum with 102 conductors on the periphery, parallel connected. Here, as we have 102 conductors, we cannot have two separate windings, for 51 conductors will not make a winding.

Therefore $n = 2$, $m = 1$, $b = 1$, $p = 3$, $\frac{1}{2}(y_1 + y_2) = \pm\frac{102}{6} \pm \frac{2}{1}$ $= \pm 15$ or $\pm 19$.

Take $+19$. For reasons which we will consider later $\pm 15$ will not do. The winding table is—

| Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|
| 1 | 20 | 39 | 58 | 77 | 96 | 13 |
| 13 | 32 | 51 | 70 | 89 | 6 | 25 |
| 25 | 44 | 63 | 82 | 101 | 18 | 37 |
| 37 | 56 | 75 | 94 | 11 | 30 | 49 |
| 49 | 68 | 87 | 4 | 23 | 42 | 61 |
| 61 | 80 | 99 | 16 | 35 | 54 | 73 |
| 73 | 92 | 9 | 28 | 47 | 66 | 85 |
| 85 | 2 | 21 | 40 | 59 | 78 | 97 |
| 97 | 14 | 33 | 52 | 71 | 90 | 7 |
| 7 | 26 | 45 | 64 | 83 | 102 | 19 |
| 19 | 38 | 57 | 76 | 95 | 12 | 31 |
| 31 | 50 | 69 | 88 | 5 | 24 | 43 |
| 43 | 62 | 81 | 100 | 17 | 36 | 55 |
| 55 | 74 | 93 | 10 | 29 | 48 | 67 |
| 67 | 86 | 3 | 22 | 41 | 60 | 79 |
| 79 | 98 | 15 | 34 | 53 | 72 | 91 |
| 91 | 8 | 27 | 46 | 65 | 84 | 1 |

The table read from left to right along the horizontal lines will give us the path through the copper on the armature. "Up" means that we pass along the conductor away from the commutator end, and the back connections are bracketed at the top and the front connections at the bottom.

Next, with regard to the possibility of making a particular type of winding out of a given number of conductors. We can do this if we can get $\frac{1}{2}(y_1 + y_2)$ a whole number, and if the winding is not self re-entrant before reaching the point where it should be. That is, if $N/2m$ and K are prime to one another, or if $\frac{1}{2m}(y_1 + y_2)$ and $N/2m$ are prime to one another; that is, if $2m$ is the highest common factor of $(y_1 + y_2)$ and N. . . . . (IV.)

We see from this condition why $\pm 15$ was not possible for the above armature.

*Chord windings.*—Any of the above windings can be turned into a chord winding by slightly displacing the even numbers with regard to the odd ones. The best plan is to determine $(y_1 + y_2)$ by means of our formula (I.) and then fill in the odd numbers in the table. Then determine the value of $(y_1 - y_2)$, which must be the nearest even number to the fractional or whole value given by formula (II.) or (III.). This value of $(y_1 - y_2)$ will give us a winding with as long a chord as possible, and to turn it into a chord winding we must add to or subtract from it a multiple of $4m$. In order that we may obtain a winding with which the brushes shall have the ordinary forward lead we must algebraically decrease $y_1$ if the armature runs in a clockwise direction, and increase it if the armature runs in a counter-clockwise direction. Thus, for the example given above, $(y_1 - y_2)$ can equal 0; but if we decrease $y_1$ and make $(y_1 - y_2) = 4$, we get $y_1 = 17$, $y_2 = 21$, and the first line of our winding table becomes

| Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|
| 1 | 18 | 39 | 56 | 77 | 94 | 13 |

to run clockwise. The amount by which the chord may be shortened depends, of course, on the pole angle and the shape of the fringe.

With regard to the voltage produced by any armature: The number of circuits will be $2\frac{nmp}{b}$, the letters having the same significance as in our formula (I.), so that, if V is the average volts per bar, the volts of the machine will be $\frac{NbV}{2nmp}$, and $V = \frac{2Frp}{10^8}$, where F is the flux per pole and $r$ is the revolutions per second. Thus the voltage $= \frac{NbFr}{nm10^8}$.

In the armature when connected a commutator segment can be connected to each front end connection, and by making a diagram of the windings we can easily see how commutator segments can be missed out or interpolated by cross connecting; and we can determine similarly what different brush arrangements can be used.

We will take a few examples of the application of the formula, giving in each case only the first line of the winding table.

2. A lap-wound quadruple winding, six poles, about 120 conductors.

$$p = 3, \quad b = 1, \quad n \times m = 4, \quad N = 120 \text{ (about)},$$
$$\tfrac{1}{2}(y_1 + y_2) = m\left\{\pm\frac{n}{b}\right\} = \pm 4.$$

If we use 120 conductors $m = 4$ and $n = 1$, with 122 conductors $m = 1$ and $n = 4$, from condition IV.

With 124 conductors 4 is the highest common factor of N and $(y_1 + y_2)$, so that $m = 2$ and $n = 2$.

Then,
$$(y_1 - y_2) = \pm\frac{120}{3} \text{ (about)} = \pm 40.$$

The nearest possible to this is $y_1 = 23$, $y_2 = -15$, and our table begins

| Up. | Down. | Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|---|---|
| 1 | 24 | 9 | 32 | 17 | 40 | 25 | 48 | 33 |

for each of the above three cases. To represent symbolically the degree of re-entrancy of a winding we will use the method used by Parshall and Hobart, who express the winding by figures of the type (22), the number of figures representing the number of independent windings ($m$) and the number of turns, counting the outer turn as 1, representing the number of circuits mutually re-entrant ($n$). The three cases mentioned above are then represented by—with 120 conductors 0000, with 122 conductors (222), with 124 conductors (2)(2).

3. A wave-wound two-circuit eight-pole duplex armature, with about 120 conductors.

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Here, $p=4$, $b=4$, $n\times m=2$, N = 120 (about),

$$\tfrac{1}{2}(y_1+y_2)=m\left\{\pm\frac{N}{8m}\pm\frac{n}{4}\right\}.$$

Taking $m=1, n=2$, we see that 120 conductors will not go, but 124 or 116 will give a whole number within the brackets.

With 124 we get $\frac{1}{2}(y_1+y_2)=\pm15$ or $\pm16$ the latter value failing with condition IV.

With 116 we get $\frac{1}{2}(y_1+y_2)=\pm14$ or $\pm15$, the value $\pm14$ failing with condition IV.

Taking $m=2, n=1$, we see that 120 conductors will not go, but 116 conductors will give a satisfactory result with $\frac{1}{2}(y_1+y_2)=14$.

We then have three armatures to choose from, the commencements of the winding tables being given below.

With 124 conductors $y_1=y_2=15$, symbol (Q).

| Up. | Down. | Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|---|---|
| 1 ... | 16 ... | 31 ... | 46 ... | 61 ... | 76 ... | 91 ... | 106 ... | 121 |

With 116 conductors $y_1=y_2=15$, symbol (Q).

| Up. | Down. | Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|---|---|
| 1 ... | 16 ... | 31 ... | 46 ... | 61 ... | 76 ... | 91 ... | 106 ... | 5 |

With 116 conductors $y_1=y_2=14$, symbol OO.

| Up. | Down. | Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|---|---|
| 1 ... | 15 ... | 29 ... | 43 ... | 57 ... | 71 ... | 85 ... | 99 ... | 113 |

4. A wave-wound simplex multiple circuit six-pole armature with about 120 conductors.

Here $p=3$, $b=1$, $n=1$, $m=1$, N = 120 (about),

$$\tfrac{1}{2}(y_1+y_2)=\left\{\pm\frac{N}{6}\pm1\right\}=\pm19 \text{ or } \pm21.$$

21 and 120 having a common factor we must use 19.

120 conductors $y_1=y_2=19$, symbol O.

| Up. | Down. | Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|---|---|
| 1 ... | 20 ... | 39 ... | 58 ... | 77 ... | 96 ... | 115 ... | 14 ... | 33 |

5. A wave-wound triplex multiple circuit six-pole armature with about 120 conductors.

Here $p=3$, $b=1$, $n\times m=3$, N = 120 (about),

$$\tfrac{1}{2}(y_1+y_2)=m\left\{\pm\frac{N}{6m}\pm\frac{n}{1}\right\}$$

Taking $m=1$, $n=3$, we get $\frac{1}{2}(y_1+y_2)=\pm23$ or 17. Taking $m=3$, $n=1$, 120 conductors will not go, and 126 gives values which do not satisfy condition IV.

Selecting the case where $m=1$ and $\frac{1}{2}(y_1+y_2)=17$ we have 120 conductors $y_1=y_2=17$, symbol (QQ).

| Up. | Down. | Up. | Down. | Up. | Down. | Up. | Down. | Up. |
|---|---|---|---|---|---|---|---|---|
| 1 ... | 18 ... | 35 ... | 52 ... | 69 ... | 86 ... | 103 ... | 120 ... | 17 |

## REPORT OF THE COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

**The following is an abstract of the report of the Council of the Institution of Electrical Engineers for the session which has just closed. It was presented at the annual general meeting last night:—**

**Local Sections.**—The Council has to report the creation of new local sections in Birmingham and Calcutta. It congratulates the Institution on the good work that has been done by the various local sections during the past year, and feels that the first session during which they have been in full operation has given ample proof of the need for the movement inaugurated in 1898. The Council shares in the deep sorrow felt by the Dublin local section in the grievous loss that it and the whole Institution has suffered by the death of the first chairman of the section, Prof. G. F. FitzGerald.

**Elections and Transfers.**—It is with pleasure that the Council reports that it has elected as honorary member during the twelvemonth now ending Mons. E. Mascart, to whom, as president of the International Electrical Congress of Paris in 1900 and as vice-president of this Institution, the Council attributes much of the success of the Institution visit to the Paris Exhibition. The increase in the membership of the society continues satisfactory. During the past 12 months there have been elected 21 members, 89 associate-members, 5 foreign members, 140 associates, and 173 students, making a total of 428.

**Deaths and Resignations.**—It is with deep regret that the Council records the loss to the Institution by death of one honorary member, Adolphe Cochery; one chairman of a local section (member), Prof. G. F. FitzGerald; two local hon. secretaries, Col. P. B. Walker (member), Don Señor F. De Vasquez (foreign member); six members, E. H. Bold, C. E. Grove, C. Hall, W. Johnson, E. W. Parsons, E. Willmore; four associate-members, M. C. Dent, W. M. Oliver. H. Reason, H. K. Tavaria; seven associates, H. H. Eley, H H. Fawckner, S. Hearne, W. O. Ross, E. C. Short, G. Smibert, F. C. H. White; and two students, E. J. Morrah and C. Stewart. Two members, one associate-member, three foreign members, 13 associates, and 12 students have resigned since the date of the last report.

**Ordinary General Meetings.**—The good attendance at meetings referred to in the last report has been maintained during the present session, and the discussions on the various papers read have been both valuable and interesting. The Institution again owes its thanks to the Institutions of Civil and Mechanical Engineers and to the Society of Arts for their generous permission to use their rooms for meetings.

**Publications of the Institution.**—The current year will mark the completion of the thirtieth volume of the publication of the Institution *Journal*. The general index to Vols. XXI. to XXX. is, by order of the Council, in active preparation, and it is hoped that it will be ready for issue during the present year. The wish having been expressed by many members that a uniform case for binding the Journal should be prepared, the Council has approved a pattern case in special waterproof cloth, to be supplied at a small charge to those members who wish to have them.

The value and importance of *Science Abstracts* is now becoming more widely recognised, and the publication is, it is hoped, increasing in usefulness. The number of abstracts appearing has increased from 2,000 in 1899 to 2,525 in 1900, and the Council desires to record its thanks to the joint publication committee of the Physical Society and the Institution, to Mr. W. R. Cooper, the editor, and to the abstractors, who, by their combined efforts, have produced so full a record of current work in electrical and general engineering, and in physical science.

In addition to the Papers read at ordinary general meetings in London, the following Papers, selected from those read at meetings of local sections, have been accepted for publication:—

June 14, 1900 (Dublin)—"Dublin Corporation Electricity Supply Scheme," R. Hammond, member.

Nov. 14 (Glasgow)—"Electricity Supply," W. A. Chamen, member.

Nov. 27 (Manchester)—"Relative Advantages of Direct Current and Three-phase Distribution for Small Installations," H. A. Earle, member.

Jan. 14, 1901 (Newcastle)—"Electrically Driven Machine Tools and their Advantages for Use in Engineering Workshops," G. Ralph, associate-member.

Feb. 12 (Manchester)—"On the Training of Electrical Engineers," Dr. J. T. Nicolson.

Feb. 13 (Glasgow)—"A Method of Compensating Voltmeters for Voltage Drop in Long Feeders," M. B. Field, member.

Feb. 26 (Manchester)—"On the Use of Storage Batteries in Connection with Electric Tramways," G. A. Grindle, member.

Feb. 27 (Birmingham)—"Inaugural Address of the Chairman," Dr. O. Lodge, member.

March 12 (Manchester)—"The Application of Steam Power to the Generation of Electrical Energy," J. S. Raworth, member.

March 15 (Calcutta)—"Inaugural Address of the Chairman," F. G. Maclean, member.

March 27 (Birmingham)—"Polyphase Equipment of Factories," W. Wyld, associate-member.

March 29 (Calcutta)—"The Insulation of Conductors of Electricity in India," K. A. Scott-Moncrieff, member.

The publication of the following Papers in the *Journal* as original communications has been ordered:—

"Note on Air-Gap and Interpolar Induction," F. W. Carter, associate.

"On the Absolute Values of Capacity Measurements," J. Elton Young, member.

"The Regulation of the Potentials to Earth of Direct Current Mains," A. Russell, member.

"Note on Resonance with Alternating Currents," A. Russell, member.

"Note on Duplexing Cables," H. H. Kingsford, member.

**Annual Premiums.**—The Council has awarded the following premiums for Papers and communications:—

*The Institution Premium* (value £25) to Mr. M. O'Gorman, member, for his Paper entitled, "Insulation on Cables."

*The "Paris Electrical Exhibition Premium"* (value £10) to Mr. W. Duddell, associate-member, for his Paper entitled, "On Rapid Variations of the Current through the Direct-Current Arc."

*The "Fahie Premium"* (value £10) to Mr. A. C. Eborall, member, for his Paper entitled, "Some Notes on Polyphase Sub-station Machinery."

*An Extra Premium* (value £10) to Mr. J. S. Highfield, member, for his Paper entitled, "Storage Batteries in Electric Power Stations controlled by Reversible Boosters."

*Four Extra Premiums* (value £5 each) respectively to Mr. M. B. Field, member, for his (Glasgow local section) Paper entitled "A Method of Compensating Voltmeters for Voltage Drop in Large Feeders"; to Mr. W. Wyld, associate-member, for his (Birmingham local section) Paper entitled "Polyphase Equipment of Factories"; to Mr. G. Ralph, associate-member, for his (Newcastle local section) Paper entitled "Electrically Driven Machine Tools and their Advantages for Use in Engineering Workshops"; and to Mr. F. Holden, member, for his Paper entitled "A Watt-Hour Meter."

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*The First "Students' Premium"* (value £10) to Mr. C. B. Nixon, student, for his Paper on "Application of Electrical Power to Machine Tools."

*The Second "Students' Premium"* (value £5) to Mr. F. J. Hiss, junior student, for his Paper on "Recent Work on Hertz Wave Phenomena and its Application to Wireless Telegraphy."

*The Third "Students' Premium"* (value £5) to Mr. J. H. Vigor, student, for his Paper on "Rotatory Converter Problems."

*An extra "Students' Premium"* (value £3) to Mr. J. H. West, student, for his Paper on "Accumulators."

Papers which were not in type by April 30 were reserved for consideration in awarding premiums in 1902; but, on the other hand, certain Papers which were received too late for consideration in 1900 have been taken into account in making the present award.

**Salomons Scholarship.**—The Council has awarded two Salomons Scholarships, value £50 each, one to Mr. J. D. Griffin, of the Central Technical College, and one to Mr. Herbert Ashlin Skelton, of King's College.

**David Hughes Scholarship.**—The sum of £2,000, referred to in the last annual report as having been bequeathed by the late Prof. Hughes to found the "David Hughes Scholarship" in the Institution, has now been received from the executors, and the Council has determined that, for the present, the manner of award shall be the same as that of the "Salomons Scholarship." They have selected Mr. C. J. Hopkins, of the Central Technical College, as the David Hughes Scholar for the present year, the amount of the scholarship being £50.

**Students' Class.**—In order to assist students of the Institution to study the electrical exhibits in the Paris Exhibition, the Council appointed 20 student reporters, contributing to each £5 towards the expenses of his visit, each of these students, on his return, submitting a report of the exhibits in a special branch of electrical engineering allotted to him by the Council. The following list contains the names of the students appointed, together with the subjects on which they were respectively called upon to report:—

J. F. Avila, arc and glow lamps and their fittings; A. Buckney, supply meters; F. H. Clough, switchboards and switches; R. Fisher, motors used in mining; A. J. L. Hurst, trolley line apparatus; J. T. Irwin, alternating-current and single-phase generators; T. L. James, moving platforms; F. K. Jewson, novel telephone apparatus; L. R. Lester, non-integrating meters; C. N. Nettley, polyphase generators; R. L. Pearson, bi-polar machines; M. Solomon, electro-chemistry (excluding accumulators); C. T. Stephenson, direct-current multipolar generators; H. J. Thomson, electro-metallurgy; W. A. Toppin, indoor wiring; A. I. Tracey, cables; S. A. Tunbridge, laboratory instruments; G. E. Turnbull, indoor electrical fittings; J. H. West, accumulators; F. P. Whitaker, electrical signalling (of all kinds).

The accounts submitted by the students have for the most part been very favourably reported upon, and several of them have been read and discussed at meetings of the students' section. Thirteen meetings of the section have been held during the session, at which students' reports and other Papers were discussed. The Council desires to express its thanks to the members of the Institution who have been good enough to preside on these several occasions.

Visits to the following places were, at the request of the students' committee, arranged for the students by your secretary during the year, and the Council wishes again to record its thanks to those firms and gentlemen who so kindly gave facilities to the students to visit their works:—The Bankside station of the City of London Electric Lighting Co, the Davies-street station of the Westminster Electric Supply Corporation, the Manchester-square station of the Metropolitan Electric Supply Co., the Willesden station of the Metropolitan Electric Supply Co. the Board of Trade Laboratory, the Central London Railway, the London United Tramways, the Waterloo and City Railway, the Works of Messrs. Easton, Anderson and Goolden, the Electric Welding Co., Messrs. Elliott Bros., India-Rubber, Gutta-Percha and Telegraph Works Co., Messrs. Siemens Bros. & Co., and the Thames Iron Works Shipbuilding and Engineering Co.

In addition to the above, the Council sanctioned the proposal of the students' committee to arrange a visit to the Manchester district during the Easter recess. Thirty-two students took part in this visit, which lasted four days, and the following works were visited:—Cunard Steamship Co.'s R.M.S. "Lucania," Messrs. S. Z. de Ferranti, the General Electric Co., Messrs. W. T. Glover & Co., Messrs. Hick, Hargreaves & Co., Lancashire and Yorkshire Railway Co.'s Carriage Works, the Liverpool Overhead Railway, the Liverpool Tramways, Manchester Corporation Dickinson-street station, Messrs. Mather and Platt, Pumpfields Generating station (Liverpool), Tudor Accumulator Co. The Council would include these firms in the list of those to whom their thanks are due. They congratulate, also, Mr. L. R. Lester, the honorary secretary of the students' section, and the Committee of that section, on the success of the visits.

**Sectional Committees.**—Having regard to the great increase in the number of members, and in the applications of electricity in engineering and the arts, and with the view of increasing the interest of the whole membership in the work of the Institution, the Council has created four sectional committees, each consisting of one or two members of the Council, with a number of representatives of the special interest represented, chosen from members outside the Council. The number of members appointed by the Council was originally small, but the committees were given power to add to their number, with the instruction that the added members should be, for the most part, drawn from the general body of members of the Institution. The committees were appointed to represent the following interests:—(1) Traction, Light, and Power Distribution; (2) Telegraphs and Telephones; (3) Manufacturing; (4) Electro-Chemistry and Electro-Metallurgy. The Council hopes that if they will report on the relations between the Institution and their respective branches of electrical engineering, and on the special conditions or requirements for the time being of those branches, and if they are able to find a number of suitable representative Papers, each in its own section, for reading at meetings of the Institution, in addition to Papers submitted in the ordinary way, the committees may prove very helpful not only to the Institution but to the industry.

**Annual Accounts and Financial Position.**—The Council has again to congratulate the Institution on its financial position, for, notwithstanding the several heavy items of expenditure, there was a surplus of receipts over expenditure at the end of the year amounting to £1,549. The sum of £128. 9s. 4d. was invested on account of Life Compositions, leaving on December 31 a balance of £32, which has since been invested. The estimated realisable amount of subscriptions outstanding on December 31, 1900, was £400, and none of this is taken into account in the balance sheet now presented; more than £170 of this has since been received.

**Building Fund.**—This fund shows steady progress, having risen from £7,044 to £8,421 during the year 1900. Of this £426 was contributed to the fund by members, and £729 was transferred by the Council from the general funds of the Institution.

**Wilde Benevolent Fund.**—The capital mentioned in the last report as having been generously presented by Dr. Wilde for the endowment of a Wilde Benevolent Fund has been invested in Great Eastern Railway Co.'s Metropolitan 5 per cent. stock. No call has yet been made on the fund, which is at present administered by the Council of the Institution.

**Local Honorary Secretaries.**—It was with the deepest regret that the Council received the notification of the death of two of your local honorary secretaries—viz., Señor Don F. de P. Vasquez, who had represented Spain since 1895, and Col. P. B. Walker, who had represented New South Wales since 1893. They have appointed Mr. Arthur Jackson, of Madrid, and Mr. J. Y. Nelson, of Sydney, to fill these offices respectively. Owing to the increase of membership in the Argentine Republic, the Council, following precedent, decided to separate into two the previous joint secretaryship for the Argentine and Uruguay. Mr. Oldham, who has since 1886 acted as local honorary secretary for the two Republics, retains the local honorary secretaryship for Uruguay, and Mr. Ernest Danvers has been appointed local honorary secretary and treasurer for the Argentine.

**Special Committees.**—During the year the Council has appointed special committees, which are now in active operation. One of these is revising the wiring rules of the Institution, and another is considering the possibility of drawing up a set of model general conditions for electrical contracts. In each of these cases the Council is receiving the welcome assistance of delegates from other bodies interested in the questions under discussion. A committee has also been appointed to determine whether it can recommend the Council to take any action, and, if so, to recommend the course to be followed, to assist the electrical industry in connection with the matters dealt with in Mr. Magden's Paper, read before the Institution in February, entitled "The Electrical Power Bills of 1900: Before and After."

**Board of Trade Regulations.**—At the request of the Council and by the consent of the Board of Trade, Lieut.-Col. Crompton and Mr. W. M. Mordey attended an inquiry of the Board of Trade in February, 1901, as delegates from the Council, to express the views of the Institution on the question of a proposed reduction from 8d. to 6d. of the maximum price per unit chargeable for electricity supply. They explained how the reduction of the maximum rate below 8d. per unit might make it commercially impossible for small towns to obtain electricity supply, and pointed out that experience indicated that the maximum was not usually maintained longer than was necessary to make the undertaking self-supporting. The result of the inquiry was that no absolute rule was to be made to reduce the maximum rate to 6d. per unit if good cause could be shown for an 8d. or 7d. maximum in individual cases.

**Employment Register.**—The Council having at various times received applications, both from employers and candidates for employment, has authorised the formation of an "Employment Register," which will be available for the use of those members (of all classes) who are not actually in employment, or who have given notice, or are under notice, to leave the appointments which they respectively hold. The forms in connection with this register are in preparation, and will, it is hoped, be ready by the beginning of the new session.

**The Library.**—(*Report of the Secretary*).—I have to report that the accessions to the library during the 17 months from January 1, 1900, to the date of the annual general meeting, numbered 79; nearly all of these were kindly presented by the authors or publishers. The number of visitors to the library in the 17 months from January 1, 1900, to the date of the annual general meeting, has been 785, of whom 53 were non-members.

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**The Albert Medal.**—The Albert Medal of the Society of Arts has been awarded by the Council this year to His Majesty the King, who has graciously consented to accept it. The grounds of the award are principally the services the King has rendered to the Society, and through it to the arts, manufactures and commerce of the country, by occupying the position of president for 38 years; but reference is also made to the active interest he has long taken in international exhibitions, and the actual work he did as president of the British Commission for several foreign exhibitions, and also as president of the series of exhibitions held at South Kensington.

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## A WATT-HOUR METER.*

BY FRANK HOLDEN.

*(Concluded from page 180.)*

Driving the dials takes about 3 per cent. of the total damping force, but the fact that all the dials so far tested have taken about the same forces for running makes it seem that they will be constant in their friction, or, should they change, they will have less friction with lapse of time and use, as in the case of those used with the Thomson meter. The uniformity in the force needed to operate the indicating dials taken from many meters was noted by Mr. Evershed in his recent Paper. The damping effect of the two pawls amounts to about 8 per cent. of the total damping force, and seems to be unaffected to any appreciable extent by a considerable change in the surface of the ratchet. Any change here would undoubtedly be in the direction of becoming less as the rubbing surfaces polish; and it cannot become very much less in any event, as a considerable amount of the energy is consumed in raising the pawls over the teeth, and this depends on the mass of the pawls and the depth of the teeth, either of which will alter but little in a very considerable period. So far there has been no sign of alteration in the energy consumption due to the pawls. The curves given in Fig. 5 show the effects of varying the values of S and D 5 per cent., from which it may be seen that a considerable variation of S does not appreciably affect the readings. The permanence of the hysteresis brake is entirely a matter of experiment. There is no doubt that the tungsten steel magnet, with its poles so thoroughly joined by iron, will be permanent; and the pretty uniform magnetic characteristics of cast iron, even when taken from widely different sources, would lead one to suspect it to have constant hysteretic properties, and for this reason it has been chosen in place of sheet iron or steel. There has been no evidence so far that the hysteresis brake is other than constant enough for commercial purposes. The most significant evidence

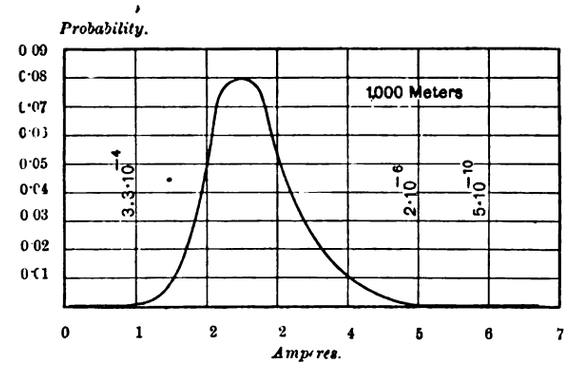


FIG. 6.

as to the permanence is the result of tests on a meter that had been in existence 12 months, and after that time was 1·0 per cent. too high at full load, and another meter, after six months, had changed not more than 0·5 per cent. and perhaps less.

The total damping force in the meter here this evening is about 458 dyne cm., which seems remarkably small, and is undoubtedly smaller than that employed in any other meter, at least for a maximum force. It is constant regardless of the load, whereas in the Arago disc brakes the moment of the force is proportional to the load, and becomes very small on low loads; consequently in the latter case there is needed a much higher maximum moment of the damping force. The moments of the forces acting on the different parts have been pretty approximately determined. The couple due to the dynamometer at full load is 30,000 dyne cm. The moment of inertia of the deflecting coils is one-third that of the revolving part, and as $\theta = 0{\cdot}40$ nearly and the angle of revolution $\phi$ of the revolving part is, for full load, $4\pi$, the average couple of the springs and the total damping force may be calculated. This gives

$$S = 316, \text{ and } D = 710.$$

From these values may be calculated the lower limit of reading of the instrument, which is reached when the dynamometer forces are not more than equal to the sum of S and D, the opposing forces; that is, the lower limit is reached when

$$WP = S + D$$

$$W = (S + D)/P = 31\,6.$$

This is equivalent to $\theta/4\pi$, which is evidently the lower limit, because of other considerations.

* Paper read before the Institution of Electrical Engineers on May 2.

The following results of a test are quite consistent with the above:—

| Watts. | Contacts. | Revolutions. | Revs. per watt per contact. |
|---|---|---|---|
| 25 | 0 | 0 | 0 |
| 30·5 | 17 | 1·02 | 0·00198 |
| 50·5 | 20 | 2·015 | 0·001975 |
| 100 | 10 | 2·01 | 0·00201 |
| 201 | 10 | 4·04 | 0·00201 |
| 401 | 10 | 8 15 | 0·00203 |
| 600 | 10 | 12·10 | 0·002016 |
| 800 | 5 | 8 00 | 0·00200 |
| 1,000 | 4 | 7·98 | 0 001975 |

The larger sizes may be constructed to start under 2 per cent. of full load, which is sufficiently low for commercial purposes, without reducing the damping force to too small a value. As stated before, S includes a very small couple due to friction, which is too small to be measured with any definiteness. D includes the force due to

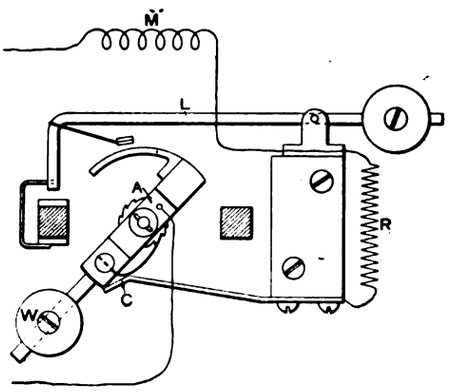


FIG. 7.

the two pawls equal to 57 dyne cm., and the force required to drive the dials is equal to 21 dyne cm. From the force exerted by the two coils and their dimensions it is found that the field inside the field coils is, at full load, closely 95 gausses. From this it is evident that the greatest possible error which may result from the influence of the earth's field is 4 per cent. at $\frac{1}{20}$th full load, which is, commercially, of no account. The deflecting coils are copper-wound, and have a resistance of about 450 ohms. In series with this is about 550 ohms of German silver in a 100 volt instrument, so that the temperature coefficient of the combination is 0·22 per cent. per degree C. The temperature coefficient for hysteresis being zero or slightly negative at ordinary temperatures, it follows that the tem-

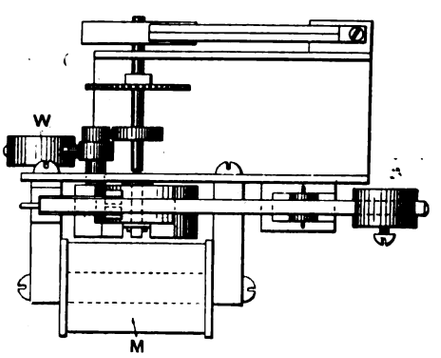


FIG. 8.

perature coefficient of the instrument will be very closely 0·22 per cent. When constructed for 200 volts the coefficient would be about 0·13 per cent. The loss in the series coils is, in the small sizes, between 5 and 6 watts, at full load. The shunt circuit is closed for one second once each minute, and consequently the average shunt loss in a 100 volt meter having a shunt resistance of 1,000 ohms is 0·17 watts. As the shunt current is 0·10 amperes, it would be possible in the case of the use of a large number of meters that there might be considerable rushes of current because of a large number of shunts closing simultaneously, and if 1,000 meters were on one circuit it would be possible for this intermittent current to be as great as 100 amperes. The probability of the existence of various currents for supplying the shunts' loss has been calculated for 1,000 meters, and is shown by the curve Fig. 6. From this it is found that on the average for 0·75 of the time the total current will be between 2 and 3 amperes, while a current exceeding 10 amperes will not exist for more than $5 \cdot 10^{-10}$ of the time, that is, one hour in 500,000 years.

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The theory of the instrument as given heretofore was virtually based on the assumption that there were an infinite number of teeth in the circular rack, so that there was no lost motion. Even at the lowest loads, the greatest possible error from this source for individual readings would not be more than 5 per cent. with the teeth of the rack spaced a millimetre apart. It may be shown that the average error introduced from this cause would be one-half the angle subtended by one tooth of the rack. Even with a dozen readings, the probability of the average error being appreciably different from this is very small. All that is needed, therefore, to eliminate this error is to make the individual movements of the rotating part too great by an angle equal to one-half that subtended by one tooth of the rack. From the general equation of the instrument, it will be seen that this may be done by making S less than would theoretically be required by an amount sufficient to increase the second term of the equation by the desired constant quantity. This is unconsciously done in calibrating.

One characteristic, and perhaps one of the fatal characteristics, of meters of this type, has been the large errors at low loads, and almost always for very similar reasons to those given in the case of the Frager meter; whereas, in the meter which has just been described, it has been found that the accuracy over the whole range of the instrument is good. The reason of this will be seen in comparing two of the most nearly analogous operations in each. In the case of the Frager meter there is the necessity of measuring or indicating a very small angle when the load becomes small, which is very difficult to do correctly. Errors from other sources in this instrument are negligible. The most nearly analogous operation to indicating this angle is, in the new type of meter, the performing of the work $WP\theta$ on the moving parts of the meter. P and $\theta$, it will be seen, are dependent on the mechanical construction, and $\theta$ being as large as 0·40 radians and determined by stops, must therefore be very definite. There is never, then, the necessity of measuring or indicating a very small angle, as in previous meters of this class, and that is the one great reason why it has been possible to obtain high accuracy at all loads within the range of the instrument with a comparatively simple construction. The clock mechanism for operating the short-circuit contact, which must be closed and opened at regular intervals, is shown in Figs. 7 and 8. The clockwork is the same as that used in ordinary 2s. or 3s. clocks, only the seconds wheel and escapement parts being used. The weight W carried by the shaft S drives the seconds wheel through the pawl P, which engages with a ratchet wheel on the seconds wheel shaft. The weight falls, and in so doing rotates the armature A until one end touches the contact C. Between C and L there is a resistance R, and from L there is a connection by way of the coils of the winding magnet M to one of the mains. The other of the two mains is connected to the framework of the clock. When A and C touch, a current passes from P through M and R to C, and thence by A through the frame of the clock to N. This current is not sufficient to magnetise the winding magnet so as to rotate the armature A, but is sufficient to attract the iron arm L towards the pole of the magnet nearest it. The arm L carries at its end a spring contact, S, tipped with silver, which, when the arm L is towards A, makes contact with the cylindrical end of A. The effect of this is to short-circuit the resistance R and to afford a path more direct, and of lower resistance, from L through A to the frame. The current through M is now large enough to rotate A, and in so doing to raise the weight W. The movement of A is accelerated until its end passes from under the contact S, when the circuit is broken. The kinetic energy of rotation is then expended in the further raising of W. The current through M being interrupted, the magnet cores are demagnetised, and L falls away to its original position. The weight W descends in driving the clock, and in time the cycle is repeated with a frequency very closely four per minute.

The power required to operate this arrangement has been measured by passing the current through the armature of a Thomson-recording watt-hour meter while a known constant current was in the field coils. The angular movement of the Thomson armature per cycle of the clock-winding gear would then be a measure of the energy consumed per cycle. In this way it has been found that the average power required on a 100 volt circuit is very closely 0·005 watts. The construction is used for either alternating or continuous currents, except for changes in the resistance R and the winding M. The shaft of the seconds wheel carries a snail-shaped piece of fibre, against the periphery of which press two pieces of light steel watch-spring, forming one terminal of the contact arrangement. The other terminal travels with the fibre snail, and is so placed that the latter, in rotating, gradually raises the springs until they drop on to the revolving contact terminal, off the edge of which they finally drop. The springs move so quickly that the spark at breaking is too small to cause a prohibitive amount of wear.

## DISCUSSION.

Mr. SYDNEY EVERSHED did not think there were any particular points in the design of the meter which he cared to criticise, for the simple reason that he was inclined to think that the meter of the future would not be one containing a clock. But he admired the way in which Mr. Holden had worked out the problem of what he might call a ballistic galvanometer meter. Mr. Vignoles and himself had worked at this idea some time ago, and found it perfectly useless, but it had never occurred to them to utilise a hysteresis brake in the way the author had, and it would appear that Mr. Holden had hit upon the very thing for which they had been seeking. As the author very justly said, the constancy of this brake could be determined only by observation and experiment. In the same way as what they called transformer iron, hysteresis effect varied with time, and particularly with temperature. In common with all meters containing clocks this particular one used very little power, *i.e.*, very little electrical power It might possibly use several man power to keep it right; probably all clock meters would. He found it very difficult to classify this meter, but he could not help thinking that what Mr. Holden had said about the Frager meter was a sort of funeral oration for all feeler clocks, and his Paper was a little misleading because it implied that the present meter belonged to this class. Although he did not think this was the case, nevertheless he did not know what class to put it in. In a sense, all meters were motor meters. There was one in which the current operated a motor which had an escapement brake. There was another meter in which there were two motors with escapement brakes going at different rates, the rates being controlled by the watts. This was the case with the Aron meter. Another very curious form of meter, which he did not think had yet been properly described, had buckets fitted to the motor. These buckets were full of something on a sort of endless chain arrangement, and the more current there was the more buckets were hung on. The mechanism of this was supplied by nature, viz., electrolysis, which really was only an electric motor devised by nature. The electrolysis motor naturally appeared to be simple, because all the wheels were not visible. The real truth was that the buckets had a way of partly emptying themselves; sometimes a positive bucket dropped something into a negative bucket, so that the resulting heap that was weighed did not give a very accurate measure of the current. Finally, there was the simple motor meter, in which the meter worked an eddy current brake, and, in his opinion, this was the simplest of them all. He naturally thought so now because he had pinned his faith to it, but he had pinned his faith to this type of meter long before he invented it, otherwise he would not have gone on with it. Clock meters were only devised to escape the difficulty—or supposed difficulty—of making the commutator of the motor work sparklessly for long periods, and also to get over the difficulty of friction in an ordinary motor. These two difficulties did not seem to him to be insuperable. He saw no essential difference in making and breaking contacts in a clock than making and breaking contacts in a commutator except this: By means of a clock they got a spark, and by means of a decent commutator they did not. In contrasting any of the meters containing clocks, which make and break circuits, and in that way inferentially measure the electrical power being supplied, with the plain motor meter driving a brake, one was at once struck with the fact that the ordinary simple motor meter had only one moving part, and if that were made properly it should and did give very much less trouble and want very much less attention than a meter containing a large number of working parts such as any clock meter must contain. The only reason why the Aron meter had been so successful was that it was so perfectly made. He did not wish to imply that in the future the Aron meter would not be perfectly made, but as time went on, and competition became extremely severe, there would be a great temptation to reduce not only the number of parts in all meters, but the workmanship put into them in order to make them cheaper, and this would be the time when the difficulties of the clock meter would come in. The motor meter being essentially a simpler meter, the difficulties were less serious. The question was, "What is the meter of the future?" He thought it very probable that, like the gas meter, there would only be one type, but no man could possibly say whose meter was the meter of the future. One could only say try them all and let the best win.

Mr. R. HAMMOND asked Mr. Holden to tell them in his reply whether he had plotted out a curve showing the efficiency of the meter throughout its varying loads. He had very often tested meters which were exact at about half-load, and then registered too quickly. He liked time tests and varying loads. There was also another test which Mr. Holden had not considered it worth while to apply—viz., on a 200 volt circuit. There had been occasions, he believed, when a variation in pressure had occurred at the consumers' terminals, and he would like to ask Mr. Holden whether he had tested the meter to stand varying voltages. Then, again, when a meter was in a pleasant atmosphere, as it was then, it could work very nicely, but meters did not get put into such pleasant surroundings in ordinary application. They often got stuck away in very damp cellars, and it would be interesting to know whether the accuracy of the instrument was affected by its surroundings. Another question which interested them was the cost of the meter. Somebody had to pay for it, and it would be very gratifying to him to know that so good a meter could be produced upon commercial lines, and, finally, that the upkeep would not be disappointing.

Mr. H. HIRST said that, with regard to Mr. Evershed's remarks on the Aron meter, he could only say that the price would be all right as time goes on, and that it would not wear out so quickly as he seemed to think.

Mr. A. P. TROTTER said he had one of these meters under test in the Board of Trade laboratory, but could say nothing about its accuracy at present. Other meters had the disadvantage which this had from a testing point of view—viz., it was very difficult to get a counting run upon it. It was very necessary for those who calibrated these instruments that there should be a clock-working dial which would count the revolutions and the decimals of a revolution. As to the Paper, he asked for further information as to Fig. 5. He had examined it several times, but could not quite make it out.

Prof. AYRTON replied to Mr. Hammond's query as to the variation of pressure at the consumers' terminals, and stated that the meter did not take this into account, and if the supply company dropped the pressure the bill quite rightly went down. Energy meters, however, had this



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defect—viz., that if the supply company, as the Westminster Company had been alleged to have done, raised the pressure and broke the lamps, the bill went up, and that obviously was not what a meter ought to do. A meter ought to fine the supply company when the pressure went up and the lamps were damaged. All these feeler meters appeared to him to possess a very great disadvantage, because they were really intermittent meters, *i.e.*, they did not give a continuous record, but only took into account the state of things at certain fixed times. Mr. Evershed had said so much about meters in relation to their law that he would say no more on that point, but would rather direct a few words to a law relatively to meters. He did not know what the law relatively to meters was, and therefore he would put this as a question. Suppose Mr. Holden put one of his intermittent meters to measure the energy given to his (Prof. Ayrton's) house or factory. Whilst he (Prof. Ayrton) did nothing to disturb other consumers or disturb the meter in any way, he was within the law, and what he could do was this: He could put in his house another clock of his own, and he would use this to close a switch, and it would keep it closed during 55sec. or even 59sec. out of every minute, and it would open the switch during the remaining second. He supposed this was legal in his own house, and also, of course, in his laboratory, where electricity was supplied for experimental purposes, and this would be one of his experiments. During that longish period—55sec. or 59sec.—he should charge accumulators, and during the remaining second he should do nothing. His bill would be nought, and he would receive a very large amount of electrical energy free.

Mr. C. W. S. CRAWLEY asked if Mr. Holden had taken into account the effect of Foucault currents on the hysteresis brake.

Mr. A. CAMPBELL, speaking on the question of the variation of the earth's field, which Mr. Holden had stated was 4 per cent., though it should be borne in mind that it might be 4 per cent. either way, and in the case of a meter being installed which was too large for the number of lights, this might be important. He also would like to know if the spark was more pronounced with alternate currents than with continuous currents. He did not know what the size of the contact in this meter was. If it only lasted a second, and that second more or less determined the impact that caused the motion of the moving part, he thought the spark might be more important, possibly, with alternating current. But no doubt Mr. Holden had tested it. His last point was on the question of overload capacity. It was always important that a meter should stand overloads; some did and some did not, and this was a point he would like to hear something about from Mr. Holden.

Mr. F. HOLDEN, replying as to the question of testing over long periods, said the Board of Trade had had one for about a year. Only a few of these meters had as yet been built. There had been some remarks made as to meters with clocks, and he felt very much as Mr. Evershed did. They were a complication but in some way they seemed to work well and the trouble was not really with the contact. This was negligible. As to which was the best meter, the only way was to test. As to the point of accuracy raised by Mr. Hammond, he thought the table of figures given on page 224 gave an idea, although these figures were slightly unfavourable to the meter used for these tests as it had a certain amount of looseness in the upper coil which was the real cause of the variation of the constant in the last column. As to overload, he had tested the meter up to 500 per cent. overload, and it was still accurate. It could be seen from the construction of the watt dynamometer that any variation in the voltage would not affect the meter at all. As to its working in bad surroundings, he could not very well bring a damp cellar into the meeting, and in order to show it at work that evening he had had to make the best of the situation. He did not know how much it was going to cost, but this had been estimated by one of the largest meter manufacturers in Europe and was said to be cheap. As suggested by Mr. Trotter, he intended to put an addition to the scale, divided into 100 parts. As to Fig. 5, he said the four curves shown gave the amount the meter would read in percentage of full load, high or low, with different loads. Prof. Ayrton had devised a way of cheating the instrument, but he did not think there was much in this, because it was necessary to get the clock and the meter to synchronise, and if this were not done the meter might charge for current not actually taken. To take a special case: With the load on for one second out of very minute, and this second happened to synchronise with the time of closing contact, the meter would charge 60 times too much. As to Foucault currents, there could hardly be any marked effect as the induction passed through the disc in such a way that there might be none generated. Mr. Campbell was quite right as regards the earth's field. Of course, it might read 4 per cent. high or low, and to a certain extent this was the case, but as to whether it was important or not, he could not say, as he had not been able to get hold of any figures to enable him to work the thing out accurately in a definite way. It really depended on how much energy was taken at 5 per cent. of full load. If a small amount was taken, then a high accuracy was not needed, and he imagined this was the case almost generally. There was not much difference between alternating and continuous currents, although the former was a harder problem to work out by the clock method.

The usual vote of thanks concluded the discussion.

**Telegraphone Test.**—According to the *Electrical World* of New York, a successful test of the telegraphone in connection with long-distance telephonic transmission was recently made on a Boston-New York telephone circuit, and the conversation was recorded by the telegraphone and subsequently reproduced by it with great distinctness. A test between New York and Chicago was not so successful owing to its having been made during extremely wet weather.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 182.*)

We turn, then, again to the question of the discrepancies, and we ask, how is it that such substances as water, alcohol, ether, and glycerine, which in their pure condition are all good insulators and therefore dielectrics and optically transparent, show such marked disobedience to Maxwell's law? A careful investigation of this point has shown that temperature is largely accountable for the discrepancy. By means of the cone condenser above described, Prof. Dewar and I have measured the dielectric constant of ice, frozen alcohol, frozen glycerine, and numerous other organic or inorganic frozen liquids, and have discovered that in all cases cooling them to a very low temperature destroys entirely these high dielectric values. Thus, for instance, if the dielectric constant of ice is measured with an electric force applied either continuously or alternating 1 to 200 times a second, the temperature of the ice being 0°C, the value of the dielectric constant found is represented by a number in the neighbourhood of 80. If, however, the ice is cooled down to the temperature of liquid air the dielectric constant of the ice falls to a value near to 2·4. In the same manner, if the dielectric constant of alcohol is measured at ordinary temperatures the number is found not very far from 25, but if the alcohol is frozen and cooled to the temperature of liquid air, we find by the above described methods a value 3·12. Again, the dielectric constant of glycerine determined at ordinary temperatures gives a value 56, but if determined at the temperature of liquid air, a value 3·9. If we gather into one table the results of a number of these low temperature measurements of dielectric constants taken at a frequency of 120 per second, and arranged so as to show the values of the dielectric constant at 15°C. and at – 185°C. (the temperature of liquid air), we see at once the immense influence which temperature has upon the fundamental qualities of a dielectric. For the sake of comparison, the values of the square of the optical refractive index ($i^2$) for very long wave-lengths or for certain wave-lengths in the visible spectrum have been placed in contiguity.

**Table II.**—*Dielectric Constants (K) at Different Temperatures.*

| Substance. | K at 15°C. | K at –185°C. | Sq. of refractive index $i^2$. |
|---|---|---|---|
| Water ..... | 80 | 2·4 to 2·9 | 1·779 (D line) |
| Formic acid..... | 62 | 2·41 | ... |
| Glycerine..... | 56 | 3·2 | ... |
| Methyl alcohol ..... | 34 | 3·13 | ... |
| Mononitrobenzol..... | 32 | 2·6 | ... |
| Ethyl alcohol ..... | 25·8 | 3·11 | 1·831 |
| Acetone ..... | 21·85 | 2·62 | ... |
| Ethyl nitrate ..... | 17·72 | 2·73 | ... |
| Amyl alcohol ..... | 16 | 2·14 | 1·951 |
| Aniline..... | 7·51 | 2·92 | ... |
| Castor oil..... | 4·78 | 2·14 | 2·153 |
| Ethylic ether ..... | 4·25 | 2·31 | 1·805 |
| Olive oil ..... | 3·16 | 2·18 | 2·131 |
| Carbon bisulphide ... | 2·67 | 2·24 | 2·01 |

The conclusion to which the figures in the above table lead us is that, whereas at ordinary temperatures there is an enormous difference between the dielectric constants of certain substances and the square of their optical refractive index, a continual lowering of the temperature destroys a large part of this disagreement. On the other hand, there are some substances in which even at ordinary temperatures Maxwell's law is very approximately fulfilled, as shown in Table III:—

**Table III.**

| Substance. | Dielectric constant K. | Sq. of optical refractive index ($i^2$). |
|---|---|---|
| Sulphur..... | 4·73 | 4·89 B |
| Paraffin ..... | 2·29 | 2·022 |
| Petroleum..... | 1·92 | 1·922 |
| Petroleum oil ..... | 2·07 | 2·075 |
| Turpentine ..... | 2·23 | 2·128 |
| Benzine ..... | 2·38 | 2·26 D |

Exceptions, however, are more numerous than accordances, and we find no apparent fulfilment of the law in the case of the following substances:—

**Table IV.**

| Substances. | K. | $i^2$. | Substances. | K. | $i^2$. |
|---|---|---|---|---|---|
| Glass (light flint) | 6·57 | 2·375 D | Mica ..... | 6·64 | 2·526 |
| Glass (dense)..... | 10·1 | 2·924 | Quartz ..... | 4·55 | 2·41 |
| Calcite ..... | 7·7 | 2·734 A | Tourmaline ... | 6·05 | 2·63 |
| Fluorspar ..... | 6·7 | 2·05 | Rock salt ..... | 5·85 | 2·36 |

*Cantor lecture delivered before the Society of Arts, December 10, 1900.

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In the case of gases there is a very fair agreement between K and $\mu^2$.

Then, turning to the question of frequency, it has been found that at the rate at which the electromotive force is applied and removed or reversed has a great influence upon the dielectric constant. Generally speaking, we may say that the higher the frequency the lower the dielectric constant. On the other hand, many substances exhibit, so to speak, a great constancy under variation in frequency. By the employment of electrical oscillations it is possible to determine the dielectric constant with very rapid alternations of electric force. It appears, however, that whether we use a continuous electric force or a continuous force alternating 30,000 million times a second, the dielectric constant of water is a number not far from 80. On the other hand, in the case of alcohol the same variation in frequency reduces the dielectric constant from 25 to about 6 6. Ice is more sensitive to change in frequency than water, and an increase in the frequency which does not affect the dielectric constant of liquid water reduces that of ice to a value between 2 and 3. In considering the causes of the discrepancies it is obvious that if light waves consist of alternations of electric force, then, since the visible spectrum is comprised between the limits of 400 and 800 billion vibrations per second, there is an enormous gap between the highest frequencies it is possible to command in experimentally measuring dielectric constants and the frequencies which give rise to optical effects. The whole of these effects give us reason to consider that the numerous discrepancies and exceptions to Maxwell's law are really dependent upon temperature and frequency. It is obvious that in making comparisons we can hardly expect to find the law fulfilled unless the alternations of electric force are comparable with the number of vibrations per second in the ray refracted.

Of late years it has been possible to test the matter in another way. We are now able, as will be explained in the next lecture, to produce electric waves which are known to have all the properties of light, except visibility. Many recent investigations have had for their object the determination of the refractive index of water, alcohol, and other bodies for electric waves of great wave-length lying far beyond the region of the ultra red spectrum. For water the refractive index found for these electric rays is a number in the neighbourhood of 8·9.* The square of this number 8·9 is very nearly 80, and hence is in very good agreement with the value of the dielectric constant of water determined by purely static electrical methods, and either with continuous electric force or electric forces very slowly alternating.

It is impossible to dismiss this part of the subject without raising one question. Why is it that certain kinds of matter have such exceptionally large dielectric constants, which at ordinary temperatures are so different in value from the square of the optical index of refraction? The answer to this is that electric force produces two effects when acting on any space occupied by dielectric matter. In the first place it creates an electric strain in the ether or true electromagnetic medium, which strain is immediately responsive to the stress. In the next place it operates on the molecules of the matter, producing an additional strain or displacement; and it is not a little remarkable that those substances which have high dielectric values are those which easily suffer chemical decomposition by displacement or removal of some radicle. Some interesting facts connected with dielectric constants of solids and liquids have been noted by C. B. Thwing.† He has pointed out that, for a large number of substances, the dielectric constant is 2·6 times the density, and that the dielectric constant can be predetermined for many substances by calculation. The dielectric constant of a body can be calculated by an additive law in accordance with the following rule:—The product of the molecular weight of the substance and its dielectric constant divided by its density is equal to a sum formed by multiplying 2·6 times the number of atoms of each kind by their atomic weight, except in the case when the molecule contains certain radicles, when each radicle has in addition a multiplying constant differing from 2·6.

Hence, if K = Dielectric constant,
M = Molecular weight,
D = Density,
$a_1$, $a_2$, &c. = Atomic weights or elements of radicles,
$n_1$, $n_2$, &c. = Number of atoms or radicles,

we have $$K = \frac{D}{M}(2{\cdot}6a_1n_1 + 2{\cdot}6a_2n_2 + \&c. + ka_3n_3 + \&c.).$$

The factor 2·6 is employed if the element is an atom of hydrogen, oxygen, carbon, &c, and the factor $k$ if it is a chemical radicle OH, CO, COH, $NO_2$, $CH_2$, $CH_3$, or S, having values as follows:—

| Radicle. | Molecular weight. | Value of $k$. | Radicle. | Molecular weight. | Value of $k$. |
|---|---|---|---|---|---|
| OH | 17 | 80·6 | $CH_2$ | 14 | 2·86 |
| CO | 28 | 52·0 | $CH_3$ | 15 | 3·12 |
| COH | 29 | 33·8 | S | 32 | 0 016 |
| $NO_2$ | 46 | 67·6 | | | |

* See Fleming and Dewar, *Proceedings* of the Roy. Soc., Vol. LXI., p. 2, 1897, "On the Dielectric Constants of Ice and Alcohol at very Low Temperatures."

† *Zeits. Phys. Chem.*, Vol. XIV., 1894.

Thus the dielectric constant of water ($H_2O$) which is a hydride of hydroxyl, having molecular weight = 18 and density = 1, is given by the formula

$$K = \frac{1}{18}(2{\cdot}6 \times 1 + 80\,6 \times 17) = 75{\cdot}4,$$

and that of ethylic alcohol ($CH_3$, $CH_2$, HO) by the formula

$$K = \frac{0\,815}{46}(3{\cdot}12 \times 15 + 2{\cdot}86 \times 14 + 80{\cdot}6 \times 17) = 25{\cdot}6.$$

These values agree fairly well with the results of experiments. This remarkable rule supplies us with a clue to the meaning of these large dielectric constants. We see that the presence in a molecule of a chemical radicle, or portion more easily detached than other atoms, seems to indicate a line of easy cleavage in the molecule of which the electric force takes advantage. It appears, therefore, that the simple properties of the electromagnetic medium filling space are profoundly modified by the presence of ordinary matter in the same place.

Briefly, then, it may be stated that Maxwell's theory consists in the assumption that the effects we call electric displacement, or otherwise electric charge, and that which we call magnetic flux or magnetic induction, when they exist in a space free from gross matter, are affections of a medium capable of storing up energy in two different forms. The dielectric constant of the medium or the displacement per unit of electric force, and the magnetic permeability of the medium, or the magnetic flux per unit of magnetic force, are both altered by the presence of matter. The first quality is always increased, the second may be increased or diminished, and is enormously increased by the ferromagnetic substances. These two qualities determine the speed of transmission of a disturbance or an electric wave through the medium, and an electric wave is created whenever a very sudden electric displacement is made or released. The moment, however, that we attempt to resolve the processes into mechanics or the simple movement of matter possessed of inertia and resisting some kind of change of configuration, we are met with many difficulties. The first question that presents itself is as to the nature of the elastic reaction of this medium against stress. What is the kind of deformation the medium resists? It cannot be a simple compressional elasticity or resistance to change of volume, as in the case of air. That would imply that the ray could not be polarised, whereas both in the case of light and electric rays they can or are polarised or made non-symmetrical with respect to the direction of propagation. Can the elasticity, then, be a simple resistance to shearing or change of form? This elastic solid or jelly theory of the æther fails to meet requirements in many points. Then a third hypothesis is that the elementary portions of this medium do not resist either compression or shearing, but resist absolute rotation round any axis. This rotational theory of the æther has been developed of late years in great detail by Dr. J. Larmor, who has shown that it meets in many remarkable ways the demand of physical theory.* The temptation to try and construct a purely mechanical theory of the æther, in which displacements and fluxes are visualised as changes of configuration or motions, is very great.

We are unable to make ourselves a mental picture of any physical processes which we are not able in the ultimate issue to resolve into motion, either past or present. If we could resolve all the operations in the electromagnetic medium into mere motions of a substance possessing the single attribute of inertia, it would in one sense satisfy our mental demands. But the æther, if it exists at all, must have many more functions (some perhaps yet unsuspected by us) than those of merely conveying vibrations. The æther cannot be, as Lord Salisbury once suggested, only the substantive corresponding to the verb to undulate. If that is the case, we may do well to refrain from attempting too much mechanical interpretation, and, whilst resting on the fact that the definite changes we call electrical displacement and magnetic flux are directed or vector changes in a universal medium, admit that the ultimate analysis of the nature and structure of æther, energy, and matter, will carry us far beyond the region of the ideas of motion, inertia, or force.

It may, however, be asked, Where is the proof in all the above facts that the optical æther is identical with the electromagnetic medium? So far all that we have passed under review has been proof that if electromagnetic effects are propagated from place to place with finite velocity, that velocity will be measured by the reciprocal of the quantity $\sqrt{K\mu}$; and it has been shown that this electromagnetic velocity in vacuum, air, other gases, also in certain liquids and solids, is equal to the measured velocity of light rays through that material. Our conviction that the propagation of light through transparent matter is not an effect wholly or entirely due to the mere matter, is based for one thing on the proof we have of the practical identity between the mean velocity of light coming to us Jupiter's satellites and the actually measured velocity in air at the earth's surface. In like manner the dielectric constant and magnetic

* For an exposition of Dr. Larmor's views, see *The Electrician*, Vol. XLV., p. 483, July 20, 1900; or his book, "Æther and Matter," University Press, Cambridge, 1900.



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permeability of the very best vacuum we can produce differ so exceedingly little from the same qualities of an air-filled space at ordinary pressure and temperature that we cannot well believe these properties of the space are wholly due to the matter occupying it when taking out all but $\frac{1}{1000000}$th makes so little difference. The demonstration that light has an undulating nature, rests upon all the well-known facts of interference. The creation and similar properties of undulations having an electrical origin travelling through space with equal velocity and exhibiting all the properties of visible light has afforded more than ground for a suspicion, it has given an almost perfect proof that the basis, the undulating material, and the nature of that undulation must be similar in the two classes of phenomena. The proof of these statements and some brief examination of the facts will occupy our attention in the lecture next week. It would involve a demand on your time entirely out of question to attempt even to mention the various theories of the structure of the electro-optic æther which have been evolved in the last century. Suffice it to say that any effort to go beyond a mere description of physical phenomena lands us in the logical necessity of assuming an omnipresent medium which we must endow at least with the attributes of inertia and mobility. One of the difficulties which has to be met in constructing any hypothesis of the æther structure which will be consistent with ascertained fact is to explain how it can store up enormous quantities of energy drawn from and given up to matter, and yet offer, as far as we can see, no resistance to the movement of matter through it. A full discussion of this question is to be found in a valuable treatise on "Æther and Matter," by Dr. J. Larmor. The theory which seems to unite best the known facts is that which assumes the æther to be possessed of a rotational elasticity—that is, each element of it resists absolute rotation in any direction, but its different parts can be moved about otherwise without resistance. Dr. Larmor shows how in such a stagnant æther we can create strain centres which he calls *electrons*, which can move about freely in the stationary æther as a kink on a rope can be displaced on the rope. These electrons are of two types, positive and negative. Atoms of matter are assumed to consist of congeries of electrons in stable orbital motion round each other. These electrons when free constitute electricity, and when in motion give rise to electric currents and magnetic force. The trend of physical research is everywhere opening up the view that electricity has an atomic structure, and that what we may call the *atom of electricity* is the ultimate element in the structure of material molecules. The researches of Prof. J. J. Thomson have shown that in the cathode discharge in vacuo we are concerned with electrical or electrified corpuscules of which the mass is of the order of $\frac{1}{1000}$th of that of a hydrogen atom.* The theory to which we are now referring makes these corpuscules, electrons or gaseous ions, the constituents of which atoms are built up, and according to Dr. Larmor's views they are themselves to be regarded as strain centres in the æther of a peculiar kind. If this electronic theory stands the tests of analytical discussion then material atoms may be regarded as built up of atoms of electricity, and these in turn as structures formed out of peculiar collocations of strain in the æther. The elaboration of what may be called the atomic theory of electricity will perhaps occupy as much of the scientific attention in the twentieth century as the discussion of the atomic theory of matter has occupied in the nineteenth. The scientific method has opened avenues of research which have led to wonderful additions to our knowledge of matter in the ten decades that are past, and there are hopeful signs that an insight may yet be gained, of some real nature, into the structure of the electromagnetic medium of which both electricity and matter seem to be but localised configurations due to special forms of strain and motion.

*(To be continued.)*

* See *Phil. Mag.*, December, 1899, Prof. J. J. Thomson, "On the Masses of Ions in Gases at Low Pressures." Also *The Electrician*, Vol. XLIV., p. 228.

# CORRESPONDENCE.

## OSCILLATORY DISCHARGES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The problem of getting an oscillatory discharge from a condenser and of inventing some simple way of altering the period of the oscillations is one of considerable importance, and several solutions have been given. The method of Mr. Mizuno, which you reprinted in your last issue, is one of the simplest of these solutions, and his theoretical investigation is most interesting. By simply shunting the condenser by a non-inductive resistance he shows that we can vary the frequency of the oscillations throughout a wide range. It also follows from his equations that, even if the circuit is non-oscillatory to start with, we can make it oscillatory by shunting the condenser.

The only drawback to Mr. Mizuno's method is, as he points out, that the damping factor is always increased, and hence, that the free vibrations die away more rapidly. To get over this difficulty I would suggest another method in which, as the following investigation shows, the damping factor can be diminished, so that we can actually increase the number of the free oscillations whilst being able to alter the frequency between wide limits.

The method is to wind a secondary coil of wire round the inductive coil and to vary the frequency by altering the resistance between its terminals. As by this means we can reduce the voltage there will be less risk of the resistance coils being broken down through sparking. The following is an outline of the theory in the case when the magnetic leakage between the coils is negligible. I have followed very closely Mr. Mizuno's mathematical methods. The only new symbols introduced are M, the mutual inductance between the two coils, N, the self-inductance, $x$, the resistance, and $i'$, the current in the secondary. I use the symbol K for the capacity of the condenser.

Then
$$\frac{q}{K} = Ri + L\frac{di}{dt} + M\frac{di'}{dt},$$
$$0 = xi' + N\frac{di'}{dt} + M\frac{di}{dt}.$$

Hence, since $i = -\frac{dq}{dt}$ and $M^2 = LN$ by hypothesis, we easily get by algebra

$$\frac{d^2i}{dt^2} + \frac{R + \frac{N}{Kx}}{L + N\frac{R}{x}}\frac{di}{dt} + \frac{i}{K\left(L + N\frac{R}{x}\right)} = 0.$$

This equation being in the standard form, we see that the oscillations of current in the primary are the same as those in a coil (R′, L′) where

$$R' = R + \frac{N}{Kx} = R + \frac{M^2}{LKx},$$
$$L' = L + N\frac{R}{x} = L + \frac{M^2R}{Lx}.$$

Now, by Kelvin's rule, the discharge will be oscillatory if $4L'$ is greater than $KR'^2$.

After a little reduction this condition becomes, $4L$ must be greater than $K\left(R - \frac{N}{Kx}\right)^2$.

Hence, by properly choosing $x$, we can *always* make the discharge in the primary circuit oscillatory.

Again, the damping factor is $R'/L'$, and this is less than $R/L$, provided that L is less than $KR^2$.

If L be greater than $\frac{1}{3}KR^2$, the frequency of the oscillations will get less and less the smaller the resistance in the secondary. If L be less than $\frac{1}{3}KR^2$, then the frequency is a maximum when

$$x = \frac{N}{KR}\frac{KR^2 + L}{KR^2 - 3L}.$$

It will be seen that theory shows that this method of altering the frequency is perfectly feasible, and if the quantities are properly chosen the damping can be very considerably diminished. I expect it will be found that several experimenters have used this method, as it is a well-known result that bringing a closed coil near the inductive coil of an oscillatory discharger alters the frequency. As the problem, however, admits of a satisfactory solution which indicates the proper lines on which to work, it may be of interest to some of the readers of *The Electrician*.—Yours, &c.,

Richmond, Surrey, May 25. ALEXANDER RUSSELL.

## POLYPHASE WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be greatly obliged if you would allow me to correct a few errors that have occurred in your report of my last lecture at the Society of Arts on the above subject. Referring then to p. 166 of your last issue (May 24) I would like to make the following remarks:—

1. The current densities given apply to the *stator* conductors only. In these, the full load current density will be between

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1,100 and 1,500 amperes per square inch for usual standard motors.

2. The peripheral speed of rotors will not exceed 6,000ft. *per minute* with standard motors.

3. The ampere wires *per inch* of stator bore at full load will lie between 300 and 450 for standard motors between 5 B.H P. and 100 B.H P.

The above figures must, of course, be used in conjunction with the other data given, and are only to be taken as a guide when getting out the preliminary design.

4. The flux-densities quoted do not apply to hole-wound motors, only to slot-wound machines.

5. Satisfactory power factors and good starting performance can only be attained with induction motors when the air-gap length (and consequently magnetic leakage) is small. These small air-gaps *may* be a source of weakness in polyphase traction motors unless the bearings are carefully and frequently inspected; naturally also the shafts and bearing supports must be specially stiff for work of this kind.

6. Earthing the middle points of the (star-connected) generators and step-down transformers was mentioned by me as being common practice, as is also the modification of this method of working—namely, the use of a fourth wire of small section instead of the earth connection. The object is, of course, either (*a*) to help balance the system, the neutral wire carrying only the out-of-balance current; or (*b*) to work the lighting load at a smaller pressure than the motor load; or (*c*) to make use of both these advantages. In factory installations, for instance, it is frequently convenient and economical to work in this way, running lights at 200 volts and motors at 350 volts; it is a standard method of working conforming to good modern practice.

In order to conform, with a minimum of expenditure, to the Board of Trade regulations relative to three-core high-tension cables, the steel sheathing of such cables should be connected to the earthed middle points of the star-connected armatures at the generating end and to the earthed middle points of the step down transformers or high-tension motors at the receiving end; in addition, the sheathing should be connected to earth at frequent intervals along the transmission line. Under certain circumstances (particularly when an out-of-balance current may be expected), the steel sheathing may be supplemented by a thin copper taping laid on directly beneath it, and therefore in good electrical connection with it along the whole length of the cable. Such a method of working is particularly applicable to the high-tension cables supplying motor generator or rotary converter sub-stations where the load is wholly balanced; a leakage from one core to earth would be noticed in the generating station either by blowing the fuse or circuit-breaker in the particular phase, or by affecting the instruments in that phase, according to the magnitude of the fault.—Yours, &c., A. C. EBORALL.

## THE BRIGHTON CABLE CONTRACT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some weeks ago you published a series of letters which had passed between the Brighton Corporation and the Cablemakers' Association *re* the contract for the supply of cables to the former which my company was fortunate enough to secure. I have waited to see whether any further letters would be published, but the correspondence appears to have stopped very abruptly. The Cablemakers' Association stated, and seemed to prove to their own satisfaction, that the prices of the Union Cable Co. (Ltd.) were higher in the aggregate than those quoted by some members of the Association. It is impossible for anyone to say whether this is so or not without having the actual tenders for reference. I have a copy of the Union Cable Co.'s tender—which was in strict accordance with the Brighton specification—and, assuming that the members of the Cablemakers' Association based their tenders on the "standard" tables set out in the printed circular issued by the Association in October last, their statement with regard to price would appear to require some further proof.

In making their comparison of prices the Cablemakers' Association altogether ignore the question of conductor resistance, but if they quoted in accordance with these "standard" tables, the resistance is a considerable factor in the calculation. The greater portion of the contract price is for 1 sq. in. conductor cable, of which 7 miles are required. For this conductor (and for all others in proportion) the Union Cable Co. (L'd.) guaranteed a resistance of 0·0422 ohms per mile at a temperature of 60°F., whilst the Cablemakers' Association guarantee only 0·044176 ohms at . . . temperature. The "standard" tables omit all mention of the temperature at which resistance is to be measured, but if we assume that it is to be at the usual 60°F., then it seems to me that, all other conditions being equal, the value of the cables to the engineer is in inverse proportion to these resistance figures. The Union Cable Co.'s resistance is 4·68 per cent. better than the Cablemakers' Association's and as the Cablemakers' Association's lowest tender (£13,365) is only 4·2 per cent. lower than the Union Cable Co.'s (£13,952), it would appear, taking the 1 sq. in. conductor cable as a standard, that the Union Cable Co.'s tender really was lower than the lowest Association tender by 0·48 per cent. on the value of the cables alone. If we add to the Association tender (*a*) cost of return of empty drums, and (*b*) the one-third cost of drums which the Cablemakers' Association insist on being paid in the event of drums being retained for a longer period than three months, even leaving out of consideration the fact that the buyer's engineer is buying exactly what he wants to buy, and not just what the seller wants to sell to him, I do not think there can be much doubt as to which is the more favourable tender for the buyer.—Yours, &c.,

J. A. BLACKWOOD,

London, May 29. Secretary to the Union Cable Co. (Ltd.).

# PARLIAMENTARY INTELLIGENCE.

## LONDON ELECTRIC UNDERGROUND RAILWAYS.

The Parliamentary Joint Committee inquiring into the various London underground railway schemes resumed their inquiry on Friday last, Lord Windsor presiding.

Mr. SHAW, for the Dean and Chapter of St. Paul's Cathedral, said his clients were anxious to know whether they would be prejudiced by not having appeared before the Committee.

The CHAIRMAN said non-appearance before that Committee would not prejudice anyone in the way feared by Mr. Shaw.

Counsel in opposition to the Charing Cross, Euston, and Hampstead Railway corrected an impression that the opposition to that bill of residents in Hampstead was withdrawn. They still maintained their petition on the ground of route, as it was contended that no portion of the heath ought to be encroached upon.

The King's-road scheme was then proceeded with.

Mr. BALFOUR BROWNE, K.C., stated that the route was from Eel Brook Common, Fulham, and went through a densely populated district, of which King's-road was the main artery, and then turned a little south under Chelsea Hospital, and terminated at Victoria, where it would feed the District Railway. He understood arrangements would be made to form an interchange station with the proposed railway from Paddington to the Oval at the point where they would cross, close to Victoria station, so that the line would be in touch with the north and south lines as well as the east and west lines of the District Railway.

Mr. B. LESLIE, M.I.C.E., partner of Sir John Wolfe Barry, said the stations on the proposed railway would be at the terminus (Wandsworth Bridge-road), Sloane-street, Manor-street, and Victoria, the other terminus. The whole of the district was at present without railway accommodation except that the West and South London Junction Railway ran through a narrow neck of it. There was no east and west connection at all south of the District Railway. The area was 2½ sq. miles. The only direct route from Walham Green to Victoria was by omnibus or by the circuitous District Railway route. The railway fare was 3d. third class, and the time occupied 20 minutes. By the proposed railway the distance would be covered within 10 minutes, and the third-class charge 2d. The size of the tube would be 11ft. 6in. A subway at Victoria would enable passengers to reach the District, the London, Chatham and Dover, and the London, Brighton and South Coast railways.

Mr. BALFOUR, architect and surveyor, against the scheme, contended there was no need for railway communication between the western parts of King's-road to Victoria. The only communication needed was exclusively east and west. A line to join with the proposed Brompton and Piccadilly Railway would be best. He was strongly opposed to the present scheme, unless a public necessity could be shown, and considered that no more tube railways ought to be constructed until engineers knew more about the subject.

Lord KNUTSFORD; Then we must give up the idea of railways in London altogether!

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WITNESS: It is not that; but I think the subject wants more consideration. This railway would go underneath the Grosvenor property, without any advantage to the tenants. He thought the stations were even more serious than the tubes, as the stations produced the damage, which proceeded a good distance around. On the Grosvenor estate there were cracks in the buildings which were not there before the building of the railway, but whether it was due to vibration or the subsoil he could not say.

The Piccadilly and City Railway was then taken.

Mr. BALFOUR BROWNE, said the line would start from an end-on junction with the North-East London Railway at Cannon-street, where there was convenience for an interchange with the District Railway. It then proceeded to Ludgate-circus, passing St. Paul's Cathedral on the south. There would be a station at Ludgate-circus. The route was then by the Law Courts, where there could be a subway to Wellington-street, where there would be an interchange with a line sanctioned two years ago. The line then went to Charing-cross, with a station there, and terminated with an end-on junction with the Brompton and Piccadilly line. He ventured to think that the Brompton and Piccadilly was intended as a block line, but thought there ought to be an end-on junction with that line. If permission were not obtained then the Piccadilly and City had a means of exchange with the Hammersmith and Charing Cross Railway, and the promoters of that line were anxious to form an end-on junction, which he was prepared to do if he could not force a junction with the Brompton and Piccadilly Railway.

Sir DOUGLAS FOX said the Piccadilly and City Railway was promoted by the same persons as were promoting the North-East London. They had carefully avoided St. Paul's by going under Carter-lane, and had avoided the congested area at the Mansion House. There ought to be an exchange station at Piccadilly. They had powers for a 13ft. 6in. tube, but probably they would not go beyond 13ft. If there was a through connection, the Brompton and Piccadilly Railway would require a larger tube than they had at present got powers for.

Mr. BALFOUR BROWNE, next described the route of the West and South London Junction Railway, which would be composed of four separate lines. The first would begin at Bishop's-road and terminate at the Marble Arch, the second from Marble Arch to Victoria, the third from Victoria down Vauxhall Bridge-road to the edge of the river, and the fourth under the river, past the Oval, terminating at Camberwell New-road. They proposed to have a subway at Paddington connecting with the Great Western Railway, and one at Victoria as already described. A subway at Vauxhall would connect with the South Western line. It was proposed to make the generating station at Camberwell New-road, where land was scheduled for the purpose. The City and Brixton Railway had also apportioned a part of the land for their generating station.

ARTHUR J. BARRY, C.E., partner in the firm of Sir J. Wolfe Barry, said the railway under consideration would open up connection with 17 railway companies existing and proposed.

Sir DOUGLAS FOX, on behalf of the North-West London company, stated his objections to the proposed West and South London Junction Railway going underneath their projected line near the Marble Arch, but expressed willingness to come to an arrangement to make an end-on junction with the promoters of that line.

The Committee then adjourned until June 11, having had all the schemes laid before them.

## DERBY CORPORATION BILL.

The bill promoted by the Derby Corporation for powers to extend the boundary of the borough, and to extend tramways and effect various improvements, came before a committee of the House of Commons, presided over by Mr. Bill, on Monday last week.

Mr. POPE, K.C., said it was proposed to extend the tramways which the Corporation had already acquired throughout the extended borough, and to run them electrically.

On Tuesday, Mr. JOHN WARD, borough surveyor, said the extensions would increase the total length of lines from 4½ to over 17 miles, and the total cost of the extension and improvements was estimated at £293,535, including £90,000 for electrical equipment and £46,000 for generating station, machinery, &c. Of this sum £52,000 had been authorised by the Derby Corporation Act, 1899. The existing tramways were 4 miles 6 furlongs in length, and it was proposed to add 13 miles 1 furlong to them and to work the lines electrically. The Corporation bought the tramways in 1899 from a company for £32,000, and it was proposed to serve all the added districts as far as possible. The first step would be to convert the existing lines to electric traction on the overhead system. It was proposed to have the power station in Full-street, and the estimated cost of the tramways worked out at £5,412 per mile of single track, after allowing for old materials, concrete, &c., on the existing routes. The estimate was as follows:—Permanent way, paving and rails, £151,535; purchase of office and rebuilding, £6,000; total, £157,535; electrical equipment of tramways, £90,000; generating station, buildings, &c., £46,000—total, £293,535. From that had to be deducted the amount granted in 1899 (£52,000), making the total £241,535. There was a bonâ fide intention to construct the tramways.

The further consideration of the bill was adjourned until June 10.

## ECCLES CORPORATION BILL.

Last week a Committee of the House of Commons considered this bill, under which powers are sought to reconstruct existing and make new tramways.

Mr. RAM, K.C., who appeared for the promoters, said the tramways were now owned by the Corporation, who proposed to double the line which went to Manchester. It was proposed to adopt the overhead trolley system.

The TOWN CLERK (Mr. Hickson) said the tramways were laid in 1877, and were leased to the Manchester Carriage and Tramways Co. until the beginning of the present year. It had been agreed that the tramways should be constructed. Salford was to work the Eccles tramways and pay interest on the capital expended by Eccles. The cost of the tramways was estimated at £65,000.

The various clauses having been considered, the bill, amended, was ordered for report.

## BRADFORD CORPORATION BILL.

Last week a Select Committee of the House of Commons considered this bill for, *inter alia*, power to construct from 15 to 16 miles of double track tramway, at an estimated cost of £368,168. After evidence in support of the measure had been given by the surveyor (Mr. Cox), it was intimated that the opposition of the Shipley Council had been withdrawn.

Mr. WAUGH said there was a clause in the bill under which the Bradford Tramways Co., who had a line which ran through the same district, thought they would be subject to unfair competition. Therefore, the promoters had agreed that they would not open their tramways until Jan. 31, 1903, on which day the lease of the company would expire.

The Committee proceeded to the adjustment of clauses, and then adjourned till June 10.

## LOCH LEVEN WATER-POWER SCHEME.

In the House of Commons on Thursday last week, on the motion of Mr. Caldwell, a bill was introduced to incorporate and confer powers upon the Loch Leven Water and Electric Power Co. to enable them to construct and maintain water power and electric generating stations at Loch Leven.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The Indian Government require the services of an electrical engineer as professor on the staff of the Civil Engineering College, Sibpur. Some particulars are given in an advertisement, and applications have to be sent in to the Secretary, Public Department, India Office, London, by June 29.

A demonstrator in engineering is required at the Municipal Technical Institute, West Ham. An advertisement contains further particulars, and applications must reach the Principal, Romford-road, West Ham, E., by June 12.

Grays Thurrock Urban District Council require a resident electrial engineer for their electricity works at Grays, Essex. Salary £150 per annum. Applications by June 6 to Mr. C. E. Hatten, clerk to the Council. See advertisement.

Southwark (London) Electric Lighting committee require a temporary engineer-in-charge. Applications to town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, London, S.E., by 4 p.m. June 4. See advertisement.

An electrician-in-charge is required for the Canterbury electricity works. Applications to the chief engineer, Mr. Norman Staniland. See advertisement.

Morse embossers are required by the May-Oatway Fire Appliances (Ltd.). See advertisement.

The Council of the Harris Institute, Preston, require a lecturer in mechanical engineering, and assistant lecturers in mathematics and physics and chemistry. Applications by June 17.

Gloucester Corporation require a chief assistant engineer. Salary. £2. 5s. per week. Applications by June 7.

Epsom District Council require a resident electrical engineer. Applications to clerk by June 8.

Owing to the appointment of Mr. A. G. Bird as resident engineer and manager to the Guernsey Electric Supply Co., the Bristol Electrical committee have promoted Mr. H. H. Couzens to the vacant position, and Mr. J. H. Bolam, B.Sc., has been selected to fill Mr. Couzens' place.

**Bacton-Emden Cable.**—A new submarine cable between this country and Germany was laid on Friday and Saturday last, the shore end at Bacton having been completed on Friday night. The work was carried out by the German c.s. "Von Podbielski."

**Blackburn.**—The receipts of the electricity department for the past year amounted to £14,465. 3s. 5d., against £11,843. 10s. for the previous year, an increase of 22 per cent., and the expenses were £9,383. 1s. 10d., against £7,135. 0s. 2d., leaving a gross profit of £5,082. 1s. 7d., against £4,708. After paying interest and sinking fund instalment there was a balance of £273. 7s. 8d., against £19. 1s. last year. The cost of generating had been reduced from 1·65d. per unit to 1·32d., and the total costs, including management and distribution, from 2·07d. per unit to 1·78d. There is an equiva-

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lent of 56,524 8 c.p. lamps connected, an increase of 10,524. During the year applications were received for supply to 54 additional motors, which now total 94, or an aggregate of 280 B.H.P. The number of consumers is 670, an increase of 66, and the average price per unit sold was 2·7d. The total output for the year was 1,159,861 units sold, an increase of about 53 per cent. During the year two additional 250kw. generators were put down, bringing up the capacity of the works to 3,280 H.P. The maximum load was 1,112kw. on March 23 last. In concluding his report on the subject, the borough electrical engineer (Mr. A. S. Giles) states that he is not prepared to advise any reduction in the charges in face of the high price of coal, and the department could not afford to abolish meter rents altogether. He recommends the committee to adopt a meter rent of 2s. per quarter for all sizes up to 50 amperes, which would cover interest and sinking fund on outlay.

**Bridlington.**—Application has been made to the Board of Trade for an extension of time to comply with the terms of the Council's provisional electric lighting order.

**Country House Lighting.**—Lord Rosebery is having an electric lighting installation put down at Barnbougle Castle, N.B. The generating plant consists of a Parker dynamo (giving 100 amperes at 160 volts) driven by a 20 B.H.P. Hornsby-Akroyd oil engine. There are also 60 Tudor cells. The number of lights will be about 200. Messrs. Anderson and Munro are the contractors.

**Croydon.**—Extensions of the electricity supply mains, estimated to cost £1,200, have been authorised.

**Devonport.**—The official inspection of the electric tramways of the Devonport and District Tramways Co. will take place on Saturday.

**Dover.**—The sea front is to be electrically illuminated again this year, the contract being placed with the Dover Electricity Supply Co.

**Edinburgh.**—The tramways of the modern Athens are at present cable-drawn, and a very large expenditure indeed has been involved in their construction and equipment, but it has been, or is being, found out that cable-drawn tramways are unsuited to a city like Edinburgh. Many claims were put forward as to the advantages of cable tramways when the subject was first discussed, experts were consulted, estimates prepared and the total cost of construction and equipment put at £500,000. The Edinburgh and District Tramways, the lessees of the line, and the Edinburgh Corporation are just now at loggerheads. Edinburgh is blessed with what is known as a "circular route," and the tramway company are desirous of dispensing with this route, and, in fact, have already stopped the trams with a view to turning out of work as many as possible of the auxiliary cables and cars. The company point out that instead of half a million sterling expenditure £1,200,000 has been expended on these lines, equal to nearly £30,000 per mile of single track. There are 95 cars running on the new city or "auxiliary" lines, and the tramway company calculate that if these auxiliaries can be dispensed with a reserve of cars would be available whenever required. Speaking broadly, cable-drawn cars in Edinburgh cannot be said to have proved a complete success, and it is locally held that the advent of electric lines will be heartily welcomed.

At a specially convened meeting of the Corporation on Wednesday it was resolved to serve notice on the National Electric Traction Co. requiring them to transfer to the Corporation their powers under the Portobello and Musselburgh Tramways Order, 1900, for the construction of tramways so far as these are within the jurisdiction of the Corporation. The Council will pay a proportion of the promotion expenses.

**Electric Omnibuses.**—A concession has been secured by the Accumulatorenfabrik Gesellschaft, Vienna, to establish and work a service of electric omnibuses between Hirschwang and Payerbach The vehicles are on the Lohner-Porsche hub motor system, built by Messrs. J. Lohner & Co., Vienna, the electrical energy being furnished by a battery of Tudor cells.

**Electricity in Mining.**—The largest working mining plant in Sweden is that of the Gränsesberg Iron Mines in the south-west, where last year 650,000 tons of ore was raised. The owning company has bought up an extensive electrically-driven turbine plant belonging to the Gränsesberg Ironworks, and the entire power of one of the falls in the district has, during the year, been transmitted electrically to the mines, resulting in the displacement of nearly 300 miners. A capital expenditure of 1,150,000kr. has been made, and plant for working a further 1,200 effective H.P. is to be put down, bringing the total power at the disposal of the owners to 2,500 H.P.

**Elmore Copper Process.**—The *Financial News* of 28th inst. states that it has been decided to introduce the Elmore copper process into Cornwall, and to apply the process to low-produce copper sulphides.

**Frankfort-on-Main.**—The municipal Council has voted £42,500 for extending the electric lighting station.

**Government Education Bill.**—At a Council meeting of the Association of Technical Institutions recently, it was decided to call a special meeting of the Association to consider the Government Education Bill and to recommend the adoption of resolutions approving strongly the general principles of the bill, and urging the Government to pass it this session, with such amendments as may prove necessary. The Council will put before the special meeting proposed to be called certain amendments to the bill.

**Greece.**—Concessions for the electric lighting of Calamata, Syra and Patras have been secured by the La Société Hellenique d'Electricité (Système Thomson-Houston).

**Greenwich.**—The Borough Council will oppose a proposed application by a company for a provisional order.

**Halifax.**—A Board of Trade report has been issued on the explosion at the electricity works on Dec. 10, which resulted in the death of a labourer. The report states that the cause of the explosion is not clear, but was probably owing to the unsoundness of some of the steam pipe material. The steps taken to provide for expansion of the pipes in the boiler-house were faulty, and no means were provided in the engine-room for drawing the pipes. Having regard to the pressures used, it would have been advisable for ribs to have been provided at the flanges of the cast-iron pipes; or, better still, that some other material should have been used in their construction. Although on two previous occasions fractures of the pipes had occurred at the same works, the report states that no steps of practical use had been taken to prevent similar occurences.

**Holidays in the Eastern Counties.**—Those of our readers intending to take their holidays in the Eastern counties should secure a copy of a recently-published work edited by Mr. Percy Lindley, 30, Fleet-street, London, E.C., entitled "Holidays in Eastern Counties." The book is excellently illustrated, and gives much readable information concerning the points of interest in these counties. Particulars concerning railway routes, hotels, boarding houses, boat hiring, &c., are given, the correctness of which is guaranteed by the fact that the book has been prepared under the ægis of the Great Eastern Railway Co.

**Hull.**—During the past year the electricity department has expended on capital account £36,177, the total expenditure to date amounting to £169,979; £4,203 has been added to sinking fund. The number of consumers is now 1,541, an increase over last year of 215; 1,307,075 units have been sold, an increase of 33 per cent. The gross receipts were £24,577, expenditure £13,736, balance £10,840, and after payment of all charges (including sinking fund, interest, &c.) there is a net profit of £1,231, which has been placed to reserve fund. 42 motors have been connected during the year. It is proposed to reduce the charge for current by ½d. per unit.

**Kendal.**—The Council have received sanction to a loan of £14,000 for electricity works.

**Kilburn.**—A petition, signed by 176 Kilburn High-road shopkeepers, has been presented to the Council, urging them to associate with the Hampstead Council in the electric lighting of the thoroughfare. One side of the High-road is in Willesden and the other in Kilburn.

**Lancaster.**—The Council on Wednesday rejected a proposal of the Electric Light committee to give the late borough electrical engineer (Mr. W. A. Fraser), who has just been appointed to a similar position at Nelson, and who returned from South Africa a few weeks ago after 12 months' leave of absence, £20, as part of the special expenses incurred in his return. The action of the Tramways committee in refusing an offer from a Birmingham firm to construct and work the tramways in the borough was confirmed.

**Light Railways.**—The Lizard Light Railway Co. (incorporated by the Lizard Light Railway Order, 1898) give notice of intention to apply for a light railway order authorising the substitution of level crossings over railway lines instead of bridges for the working of the railway by electricity instead of by steam.

The Rhondda Valley Light Railway Order has been submitted to the Board of Trade for confirmation. Objections to the Board of Trade by June 21.

The British Electric Traction Co. give notice of intention to apply for the following light railway orders:—

Crewe and Nantwich.
Spen Valley and Morley Extensions (railways in Morley, Birkenshaw, Drighlington and Gomersal).
South Shields and Sunderland.

The Potteries Electric Traction Co. are applying for an order authorising light railway extensions in Hanley, Burslem, Stoke-on-Trent and Wolstanton. Objections to the secretary, Light Railway Commission.

Application is to be made by the Crowland and District Light Railways Co. for an extension of time for constructing the lines authorised in 1898.

The Lancashire Light Railways Co. intend to apply for an order authorising the construction of light railways in Turton, Tottington, Ramsbottom, Rawtenstall, Bury and Haslingden.

The Auxiliary and Light Railways and Tramways Co. are applying for an order authorising the Woolwich, Eltham and District Light Railway.

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Application is to be made for an order authorising the construction of the Preston-Lytham light railways connecting Lytham, Warton, Freckleton, Newton-with-Scales, Clifton-with-Salwick, Lea Ashton, Ingol, Cottam, Preston and Fylde.

Messrs. W. Oates and J. S. Hartley are applying for an order authorising the incorporation of a company to construct light railways in and between Holmfield and Southowram.

Application is to be made for an order authorising the construction of light railways in Elland, Southowram and Hipperholme.

**Manchester.**—The electrical equipment of the new electric tramway routes was officially inspected by Mr. A. P. Trotter on Thursday last, and the permanent way was examined by Col. Von Donop on Friday. The lines will be opened for traffic on 6th prox.

**Melton Mowbray.**—The question of public lighting is at present before the Council. Tenders from the local electric light company and the gas company (the former for three years or more and the latter for a quarter only) have been received, and a special committee has been appointed to consider and report on the estimates.

**Municipal Telephones.**—Notice is given by the Post Office that arrangements will shortly be made for telephone trunk line working in connection with the exchange established at Glasgow by the Corporation.

**New Zealand-Australia State Cable.**—A *Times* telegram from Wellington states that a proposal has been discussed by representatives of New Zealand and the Australian Federated States as to the laying of a New Zealand-Australia State cable. The proposal of Mr. Ward, representing New Zealand, is that the cable should be laid (a tender is said to have been received from a London firm to make and lay the cable for £220,000). A 1d. a word rate between the two countries is suggested. It is said that the proposal is being officially submitted to the Federal Government by New Zealand.

**Newport (Mon.).**—As reported in our issue of May 17, the Corporation have decided to accept tenders amounting to £55,056 in connection with the establishment of a power station in Corporation-road with a view to the electrical equipment of the tramways, the whole scheme being estimated to cost £96,000 (forming part of a total expenditure of £130,000 on electricity account). A town's meeting last week invited the Council to rescind this decision, and a poll of the ratepayers may possibly be taken.

**Oldham.**—The Park-road, Glodwick-road, and Leed-road electric tramway routes were officially inspected on Friday. The inspector (Major Druitt) said slipper brakes must be provided before he would recommend the Board of Trade to sanction the running of the cars.

**Ore-Milling by the Edison Process.**—Under the title of "The War of Titans," Mr. Theodore Waters, in "The Idler" for June, has an interesting article on Mr. Edison's new process for the magnetic treatment of low-grade iron ores. The illustrations include excellent portraits of Mr. Edison.

**Peterborough.**—Sanction to a further loan of £12,200 for electric lighting extensions has been obtained.

**Perth.**—The municipal electricity works will be formally opened to-morrow (Saturday).

**Poole.**—The Bournemouth and district light electric railway was opened on 22nd inst.

**Presentation.**—Mr. E. H. L. Dickson, assistant at Cheltenham, was last week presented by his colleagues and the staff at the electricity works with a pair of field glasses on the occasion of his leaving to take up a position at Salford. The presentation was made by the Mayor as chairman of the Lighting committee.

**Private Bill Legislation.**—The promoters of the City and North-Eastern Suburban Electric Railway give notice of intention to apply for leave to introduce clauses to authorise certain alterations of the levels of railway No. 1 in their bill, to enable this line to be carried through a tunnel under Hackney Marshes and to authorise the acquisition of land at Leyton Marshes for an electricity generating station.

**Provisional Order Transfer.**—Ambleside District Council give notice of intention to transfer their electric lighting provisional order to the Windermere and District Electricity Supply Co. (Ltd.) for 42 years, reserving the right to purchase at 15 years on payment of an additional 33 per cent. interest on the value of the undertaking, or at any subsequent quinquennial period at a proportionately less interest.

**Ramsgate.**—The extension of the electric tramway from the harbour along the West Cliff to Ellington Park was opened for traffic on Wednesday.

**Reigate.**—The mayor, at a meeting of the Council on the 29th ult., referring to electric lighting matters in this town, made certain statements to which Mr. F. H. Medhurst, the consulting electrical engineer to the Council, takes strong exception and threatens an action for slander. It should be added that the Electric Lighting committee have, by resolution, endorsed the mayor's remarks, Councillor Powell, chairman of the committee, alone dissenting. The correspondence between the mayor and Mr. Medhurst was the subject of discussion at the last meeting of the Council, when Councillor Powell said that his opposition to the resolution endorsing the mayor's remarks arose from the fact that he considered there was no necessity for such a motion being made. He was not aware of the cause of any dissatisfaction with Mr. Medhurst. He hoped the cause of friction, for which he held there were no grounds, would pass away. A report from Mr. Medhurst on the progress of electricity supply was afterwards discussed. Supply in Reigate was commenced on May 6.

**Rotherham.**—The municipal electricity works were opened on Thursday last.

**St. Petersburg.**—The Société d'Eclairage Electrique de St. Petersburg has a connection equivalent to 183,790 10 c.p. lamps. This shows an increase of 68,794 lamps on the year.

**Stoke Newington (London).**—The Electric Lighting committee has been authorised to incur an expenditure of £100 in obtaining expert advice on electric lighting matters.

**Stoke-on-Trent.**—An inquiry has been held into the application of the Council to borrow £1,665 for the purchase of a site for electricity supply and refuse destructor works. There was no opposition.

The preliminary report of the consulting engineers (Mr. W. H. Trentham and Mr. G. R. Peers) on the proposed electric lighting and refuse destructor works has been considered by the Electric Lighting committee, who have been authorised to prepare plans and to submit a complete scheme.

**Submarine Cable Fault through a Fish Bite.**—A fault was discovered in the Eastern Extension Telegraph Company's cable to New Zealand which the c.s. "Recorder" was despatched to repair. It was found that the cable, which rested on the sea bottom, about 300 fathoms deep, had been nearly bitten through, the broken tooth of a huge fish being found embedded in the cable at the bitten point.

**Tonbridge.**—An adjourned inquiry into the application of the Council to borrow £20,400 for electricity works was resumed last week, and evidence in opposition was given.

Mr. A. J. LAWSON, M.I.C.E., said he had for more than 20 years been engaged in electric lighting work, and had installed the electric light at Slam, Bournemouth, Wandsworth, Richmond, and many other places. He had carefully examined the report of the consulting engineer, Mr. Robert Hammond, and found nothing to criticise as to the cost of construction. He did not agree with the cost of running put forward by Mr. Hammond. With a station of the capacity it was proposed to establish at Tonbridge there must be a considerable loss. He held, too, that a great deal sooner than 25 years the machinery would be useless. Mr. Hammond stated that 103,000 units would be required for public lighting, the cost of which would be 2·75. His (Mr. Lawson's) estimate of the cost of the production of that number of units would be, for coal, £312 per annum; per unit for coal consumption it would be 0·75; for wages 1·20; oil and waste of engine room, 0·1; repairs and maintenance, 0·16; rates, rent and taxes, 0·15; depreciation and renewal, 2·18. This made a total of 4·53. A small town like Tonbridge could not borrow money at less than 3½ per cent. The difference between Mr. Hammond and himself with regard to the interest on the sinking fund was ½ per cent. If Mr. Hammond's figures of the cost of production of 2·75 per unit were taken and added to 2·83, for interest and sinking fund, his figures would come 5·58, exclusive of depreciation, as against witness's figures of 5·26. That was his (witness's) estimate of production per unit. The contract did not cover the cost of the accumulators during the 25 years. He considered 10 per cent. should be allocated to the maintenance of those. The whole meter rental was not too much to set aside for depreciation in that direction; 4 per cent. was the all-round figure he would allow for depreciation. He had been engineer to the County of London and Brush Provincial Co., and he was consulting engineer to several companies, including the Charing Cross and Hammersmith underground railway. Mr. R. HARRIS, K.C., who appeared for the Tonbridge Council, said the main difference between Mr. Lawson and Mr. Hammond was on the question of depreciation. Mr. GEO. OFFOR (speaking for the Electrical Power Distribution Co.) said in 1899 his company found that nothing had been done by the Tonbridge Council in connection with their provisional order obtained in 1897, and they therefore decided to come forward and provide a cheap supply of electric current for Tonbridge and district, and had communicated with the Tonbridge Council as far back as September, 1900, offering to supply current at 4d. per unit. He had heard Mr. Lawson's evidence, in which it was stated that current could not be safely supplied at less than 7½d. per unit, but his company were prepared to accept a transfer of the order on the terms they had offered to the Council. At this point the inspector ruled that Mr. Offor had no *locus standi*, and having taken further evidence the inquiry was closed.

**Train Lighting in India.**—The Bombay Electric Co. have secured a contract for the electric lighting of the through carriages (56 in number) of the Rajputana-Malwa Railway mail trains, on the Bombay, Baroda and Central India Railway between Ahmedabad and Delhi, for six months at 1,550 rupees a month.

**Typewriters.**—The Typewriter Co., owners of the well-known "Bar Lock" typewriter, have secured an order from the War Office, in open competition, which is claimed to be the largest order ever placed for typewriters by any Government. A committee was recently appointed to inquire into the merits of the various writing machines used in Government departments, with the result that an order has been placed for 250 "Bar Lock" machines, a record order for type-

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writers. The advantages of the "Bar Lock" machine are that there is no shift key and no lift carriage, and that every separate letter or figure written is immediately visible to the operator.

**Warwick.**—The British Electric Traction Co.'s application for a provisional electric lighting order has been granted by the Board of Trade. The local authority can acquire the undertaking at 28 or 35 years' on giving two years' notice. The company can also at any time within a year transfer the undertaking to the Leamington and Warwick Tramways and Omnibus Co.

**West Bromwich.**—The Municipal electricity supply works were opened on Friday. The official inauguration will take place a month hence.

**West Ham.**—A report has been prepared by the Lighting and Tramways committee on the frequent breakdowns of the electric lighting plant, and the committee state that they are forced to the conclusion that the damage to the plant was maliciously caused. Among specific cases cited by the contractors were the following :—Hemp jammed into the oil-ways, wilful shutting down of stop-valve, forcing of a couple of bolts into the gear-box, and purloining of tools and appliances.

In a report on extensions the borough electrical engineer (Mr. James K. Bock) recommends the erection of a new electricity station at Canning Town, the idea of enlarging the present station at Abbey Mills having been abandoned. The equipment of the new station will include three sets of steam dynamos with a total capacity of 1,500kw. for tramway working, and seven sets with a capacity of 4,800kw. for lighting and power. In his report on the plant to be installed for tramways, Mr. Bock suggests that it would be well to provide sufficient power for 100 cars on the track at one time.

**Weston-super-Mare.**—Electricity supply was formally inaugurated on Friday last.

**Wimbledon.**—The net profit of the electricity department for the year ended March 31 amounted to £14. 9s. 7d.

**Wireless Telegraphy.**—During June experiments with wireless telegraphy are to be made for the first time on vessels in the Norwegian navy. The cruisers "Eidsvold" and "Frithjof" are to be equipped with wireless apparatus for use during the summer manœuvres.

The Administration of the Danish State Telegraphs have for some time past been engaged in wireless experiments, but with only partial success. More recently, however, after some success with Dr. Schlepper's system, the experiments have been resumed, and it has been decided to establish marine stations at several points where subaqueous cables are difficult to lay. The points selected include the islands of Bononhölm and Christianso, in the remote Baltic. Wireless communication is also to be established between a lightship station off Blaavandshuk, on the coast of Finland, and the shore.

**Workhouse and Infirmary Lighting.**—The Marylebone (London) Guardians have instructed Mr. T. W. Baker to prepare a report on electric lighting and the adequacy of the present boiler power at the infirmary.

Prescot Guardians have appointed a committee to consider a proposal to light the workhouse electrically.

Ormskirk Guardians have appointed a committee to consider a proposal to adopt electric lighting.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2, and 3, Salisbury-court, Fleet-street, London :—*

### READY.

Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. United States, 15s.)

**"The Electrician" Electrical Trades' Directory and Handbook for 1901** (corrected to February 4, 1901).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. The latest developments of State and Municipal Telephone enterprise are set out from official sources, as well as the progress of the National Telephone Co.'s service. In the division of "Electric Light, Power and Traction," the valuable Digest of the Law on these subjects by Mr. A. C. Curtis-Hayward, B.A., solicitor, has been much extended ; the full text of the Electric Lighting Acts and the Board of Trade Accounts Forms have been added ; and Sketch Maps and particulars of the Electric "Bulk" areas are also given, together with a coloured sketch map of the Electric Railways and Tramways of the United Kingdom. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to Feb. 11. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 4, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

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"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with ; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net ; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated ; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Armature Winding of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"Temperature Coefficients of 'Conductivity' Copper." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 84·9°F. Printed on strong cardboard, 6d. net.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables ; and the various methods of insulation testing are here collected and discussed.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Wireless Telegraphy : Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour ; price 7s. 6d. ; by post, 7s. 9d. ; abroad, 8s. *New Edition ready early in June.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free ; abroad, 11s.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

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# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Dundee* Town Council require tenders for the overhead equipment of the Seagate route of the city tramways. Specification, &c, can be obtained of Mr. Walter H. Tittensor, city electrical engineer, and tenders must be lodged with Sir Thomas Thornton, LL.D., town clerk, City-chambers, Dundee, by June 5. See advertisement.

*Dundee* Town Council also invite tenders for steel fish bolts with lock nuts, tie bars with nuts and washers, steel joint plates with bolts and lock nuts, and cast steel points and crossings. Tenders by Tuesday, June 4.

*Huddersfield* Corporation invite tenders for five mechanical stokers. Specifications from the borough electrical engineer, St. Andrew's-road, Huddersfield, and tenders, to Mr. F. C. Lloyd, town clerk, Town Hall, by June 4. See advertisement.

*Walthamstow* District Council invite tenders for the supply of electricity meters. Further particulars are given in an advertisement, and copies of specifications, &c., may be obtained from the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W. Tenders to the clerk (Mr. E. J. Gowen) by 5 p.m. June 14.

*Kearsley* District Council invite tenders for taking up roadway and re-paving, laying of rails, points, &c., and all labour required for the construction and completion of certain tramways. Plans, &c., at the office of the surveyor (Mr. Herbert Nuttall), 20, Market-street, Bury, and tenders to the clerk (Mr. T. Alfred Martin), Highfield House, Kearsley, Farnworth, by 1 p.m. June 13. An advertisement contains further particulars.

*Islington* (London) Borough Council Lighting committee require tenders for the painting of arc lamp columns and crutches. Tenders to town clerk by noon June 11.

*Islington* (London) Borough Council Lighting committee are also prepared to receive tenders and to consider offers for "free" or "assisted" wiring in the district. Offers and tenders by noon June 11.

*Bermondsey* (London) Borough Council invite tenders for (*a*) construction of an artesian well and the supply and erection of pumping machinery, (*b*) supply and erection of water-softening plant. Tenders to town clerk, Town Hall, Spa-road, Bermondsey, by noon June 4.

The Electricity committee of *Poplar* (London) Borough Council invite tenders for the supply and erection of a storage battery at their Glaucus-street electricity works. Tenders to town clerk, Council offices, High-street, Poplar, E., by June 4.

*Eastbourne* Corporation invite tenders for the supply and erection of a fuel economiser, feed-water heater, pipe-work, &c., water storage tank, and overhead engine-room travelling crane. Tenders by noon June 8.

*Eastbourne* Electricity committee invite tenders for 400 alternating current electricity meters, and for 200 volt incandescent lamps. Tenders to borough electrical engineer (Mr. J. Kempe Brydges) by noon June 7.

*Central Electric Supply Co. (Ltd.)* require tenders for the supply, delivery, and erection of three overhead travelling cranes for a maximum working load of 20 tons, and one ditto for a working load of 10 tons, to be driven by electric power and hand. Tenders to Mr. F. J. Walker, 19, Carnaby-street, Golden-square, London, W., before 10 a.m. June 12.

*Exeter* City Council invite tenders for the equipment of their new electricity generating station, including boiler and engine-house plant, &c., main and exciter switchboards, cables, instruments, steel-plate coal bunkers and coal conveyors, and feed and condensing water tanks. Tenders to town clerk by June 14.

*Warrington* Corporation invite tenders for the supply, delivery and erection of (*a*) one water-tube boiler and pipe-work, (*b*) one 500kw. high-speed Willans engine with direct-coupled continuous dynamo, (*c*) underground mains, stoneware conduits, &c. Tenders to town clerk by noon June 13.

*Taunton* Corporation require tenders for the construction, supply and erection of (*a*) one 250kw. steam alternator and one 15kw. motor generator, (*b*) switchboard extensions, (*c*) one water-tube boiler, superheater, jet condenser and air pump and piping. Tenders to town clerk by 2 p.m. June 11.

*North-Eastern Railway* invite tenders for telegraph stores for the six months ending Dec. 31 next. Tenders to secretary, York, by noon June 10.

*Manchester* Corporation Tramways committee require electrical fittings for the lighting of the Queen's-road car shed. Tenders (addressed to chairman) by 9 a.m., June 4.

*Rochdale* Corporation invite tenders for the supply and delivery of six specimen electric tramcars. Tenders to town clerk by June 7.

*Farnworth* Urban District Council invite tenders for the overhead equipment of about 5 miles of tramways and for tramway poles. Tenders by June 7.

*Edinburgh* Corporation invite tenders for ash-conveying plant for their Dewar-place electricity works. Tenders to town clerk by June 15.

*Edinburgh* Corporation also invite tenders for the electric lighting installation, &c., of the first portion of the Colinton Mains Fever Hospital. Tenders by 11 a.m. June 12.

*Glasgow* Corporation invite tenders for branch rubber-covered cables. Tenders to town clerk by June 10.

*Glasgow* Corporation also invite tenders for the supply of electricity meters. Tenders to town clerk by June 10.

*Waterford* Electric Lighting committee are prepared to receive proposals as to the electric lighting of the borough. Particulars from the borough surveyor.

*Wakefield* Corporation invite tenders for destructor cells, boiler, water-softening plant, &c. Tenders by June 10.

*Burnley* Electricity committee invite tenders for five injectors and one feed pump. Tenders by June 10.

*Ipswich* Corporation invite tenders for dry-back marine type boilers. Tenders by 10 a.m. June 8.

The *Crown Agents for the Colonies* (on behalf of Uganda Railway committee), Downing-street, London, S.W., invite tenders for galvanised iron telegraph wire. Tenders by June 11.

The *Swedish Telegraph Administration* invite tenders until June 6 for about 10,000 metres of underground and 20,000 metres of overhead electric cables.

## TENDERS RECEIVED AND ACCEPTED.

Aberdeen Town Council have accepted the tender of Messrs. Abernethy & Co. for cast-iron columns for the Dee Village electricity works.

Stoke-on-Trent Guardians have accepted the tender of Messrs. F. W. Smith & Co. for electric motors for driving laundry machinery at £400.

An order has been placed with the Electrical Co. by Manchester Corporation for six three-phase generators of 2,500 H.P. each, and for sub-station motor transformers.

Bristol Electrical committee have accepted the tenders of Messrs. Babcock and Wilcox for pipe work at the Avonbank electricity works; of Messrs. S. Z. de Ferranti (Ltd.) for a power switchboard and feeder panels; and of the British Electric Transformer Mfg. Co. for transformers.

Stirling Town Council have accepted the tender of Messrs. Kelvin and James White for switchboard extension at the electricity supply works at £399. 9s. 3d., and that of Messrs. McDowall, Steven & Co. for arc-lamp pillars, brackets, &c., at £294. 9s.

## BUSINESS NOTICES.

Mr. R. W. Blackwell (Messrs. R. W. Blackwell & Co.) informs us that, in consequence of changes brought about in connection with the Paris office of the firm, he intends to personally assume the direction of this office. Mr. Blackwell further desires us to state that the rumours as to the closing of the Paris office are without any foundation whatever.

Messrs. Fricker and Miller, 82, Victoria-street, London, S.W., have ceased to carry on business as electrical contractors, and have commenced practice as consulting engineers and electricians.

Messrs. R. and H. Lomax (trading as R. Lomax & Co.), electrical engineers, 63, Market-street, Darwen, have dissolved partnership. Debts by Mr. H. Lomax, who continues as Lomax & Co.

From June 1 Messrs. Drake and Gorham's Manchester offices will be removed from 100, King-street to 47, Spring-gardens.

## BANKRUPTCIES, LIQUIDATIONS, &c.

At Exeter last week the first meeting of creditors of H. G. Massingham took place. Mr. Massingham traded in partnership as an electrician, first under the title of Massingham and Mann and lately as Massingham and Lopdell at Torquay:—

The statement of affairs shows gross liabilities £7,827, expected to rank £1,689, estimated assets £319, estimated deficiency £2,378. The alleged causes of failure included "losses in connection with electric lighting contracts." The deficiency account showed total loss from carrying on the Torquay electrical business from July, 1899, to date of receiving order, after deducting from profits the usual trade expenses, including loss upon closing business and the realisation of stock and fixtures, £937, bad debts £42. The official receiver states that the debtor had been in three partnerships in electric lighting businesses at Exeter and Torquay, all of which had been dissolved. That at Exeter with Mr. F. H. Rippon was dissolved about two years ago, the assets being divided and the liabilities paid off. That at Torquay with Mr. Mann was dissolved in July, 1899, when Mr. Mann was paid £700 and retired. A partnership was then entered into between debtor and Mr. C. Lopell, who paid £750 and introduced £500 as his share of the working capital. In December, 1900, Mr. Lopdell retired, and was given acceptances for £1,100 for his share, these acceptances now ranking as liabilities on debtor's estate.

The public examination takes place on June 20.

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A receiving order has been made against Alfred Mavor, electrical engineer. Present address unknown.

The creditors of Jacob Gutmann (trading until the receiving order was made as J. Goodman & Co., electric and gas fittings dealer) are notified that the bankrupt has applied for his discharge. The application will be heard in the London Bankruptcy Court on June 13.

Creditors of Sax, Slatter & Co. (Ltd.) must send particulars of their claims to Mr. A. A. Yeatman, 2, Gresham-buildings, London, E.C., by June 29.

The Du Bois Manufacturing Co. (Ltd.) is to be wound up voluntarily, with Mr. E. S. Torrey, 15, Britannia-street, King's Cross, London, W.C., as liquidator.

The Electrical Inventions and Manufacturing Co. (Ltd.) is to be wound up voluntarily. Mr. C. W. Provis, jun., 3, Mount-street, Manchester, is liquidator.

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**Sales by Auction.**—On Wednesday and Thursday, June 12 and 13, Messrs. Wheatley Kirk, Price & Co. will sell by auction, at the Victoria Foundry, Leeds, the entire contents, consisting of engineering tools, plant, and stores. Some particulars will be found set out in an advertisement, and catalogues will shortly be ready, price 6d., of Mr. F. Riley, Victoria Foundry, Leeds, or of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Messrs. Fuller, Horsey, Sons, and Cassell will sell by auction at Trafalgar Works, Bow Common-lane, London, E., on Tuesday, June 11, at 11 a.m., a quantity of modern machine tools, some particulars of which are set out in an advertisement. Catalogues can be obtained of Messrs. Standring, Marshall & Co., solicitors, 14, Bedford-row, W.C., and of the auctioneers, 11, Billiter-square, London, E.C.

Messrs. Fuller, Horsey, Sons and Cassell will also offer at the above sale, at Bow Common-lane, a small collection of modern machine tools, the property of the General Engineering Co. (Ltd.). Some particulars of this collection are given in an advertisement.

**Electrical Plant for Sale.**—Messrs Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., and Albert-square, Manchester, have high-class electric lighting plant for sale, some particulars of which are set out in an advertisement.

**Drake and Gorham.**—The firm of Drake and Gorham is well known in the electrical industry in this country, and in connection with certain special branches of work has gained a high reputation. Established as far back as 1886, much of the work connected with country house installations and the supply of immense quantities of electric plant, apparatus, accessories, and sundries has been this firm's share of the orders which have followed the growth of the application of electricity to general industrial and domestic purposes. It is not surprising to learn that increase of business and heavy capital demands have induced the partners to seek the advantages of limited liability, and we understand the public will shortly be invited to an issue of capital. Some particulars of the new company will be found on a subsequent page. The firm of Drake and Gorham has probably been more closely associated with the erection of isolated plants than any other firm of contractors in the kingdom, and, notwithstanding the recent development of bulk supply undertakings, Messrs. Drake and Gorham still look forward to a continued demand for isolated installations for lighting and power, as well as the opening up of an enormous field of work in the fitting up of factories and other buildings which the bulk supply schemes will facilitate. The new company is, we understand, to retain the services for a long term of years of both the partners, whose training as mechanical engineers and whose long association with the growing electrical requirements of both large and small consumers has resulted in the creation of a business of considerable magnitude.

**Telephone Cabinets.**—The Patent Collapsible Cabinet Telephone Co. are placing upon the market a telephone cabinet specially designed for telephone users who have no spare office room for cupboard cabinets.

**Mather and Platt Plant.**—The fourth edition of a useful price list, pocket calendar, and tables of practical information is issued by Messrs. Mather and Platt. The illustrations include some excellent examples of the machines for which this firm have a high reputation. The book has been thoroughly revised to date, and the tabular portion considerably enlarged. It is strongly bound for the pocket.

**"Papriwire."**—This is the name given to a new type of insulation applied to bell wires manufactured by the General Electric Co., and which is to take the place of "Excelsior" insulation. The success of impregnated papers for lighting, telephone and telegraph cables, has suggested its adoption for bell wires.

**Electric Driving Plant.**—The works of the Northumberland Shipbuilding Co. have been provided with a complete electric driving plant. Electric current is supplied by the Walker and Wallsend Union Gas Co. The Northumberland Company is stated to be the only shipbuilding company in the kingdom which is entirely supplied with electric current for power and light from a public supply. Current is supplied on the three-phase system, and in order to obviate all risks there are duplicate feeder cables. The current is supplied at 5,500 volts, but this is transformed down to 420 volts. The periodicity is 40. 23 motors are driven under different conditions, some being carried on concrete foundations, some on the machines themselves, some on wall brackets, and one from the roof.

**Automatic Lubricators.**—Messrs. Stern Bros., 57, Gracechurch-street, London, E.C., are placing on the market a new automatic lubricator, which they have styled the "Tic-a-Toc." The lubricator is especially designed for crank pins, eccentrics and all engine and machinery bearings in motion. The throw of the crank pin or eccentric operates a pendulum ratcheted to a worm-connected wheel, forcing the plunger, fast or slow as required, through the grease cup, the speed of the engine or size of bearing being no obstacle.

**Circuit-Breakers.**—Messrs. R. W. Blackwell & Co. are placing upon the market the "I. T. E." combined circuit-breaker and switch, which is claimed to be specially designed for protecting generators working in parallel from the dangers of reverse currents. The time element between the operating point and the actual operation itself is claimed in this apparatus to be as instantaneous as it is possible to arrange mechanically. The circuit-breaker can also be combined with an overload arrangement, which protects the generator in the event of an excessive load or in case of a short-circuit.

**Fire.**—Early on Saturday morning a portion of the Wigg chemical works (Runcorn) of the United Alkali Co. was destroyed by fire. Estimated damage £25,000.

**Theft.**—At Salford Police-court last week three men, named Wilson, Stanley and Cain were convicted of stealing copper wire value £30 from Messrs. Frederick Smith & Co. Wilson had been previously convicted of theft, and was sentenced to four months', and Cain and Stanley to three months' imprisonment.

**National Electrical Contractors' Association.**—We announced last week that a meeting was to be held at the offices of Mr. T. Guthrie, 46, Queen Victoria-street, London, for the purpose of promoting and supporting a scheme for the establishment of a "National Electrical Contractors' Association." Our representative was informed that the meeting was private, but that a statement would be prepared and be communicated to the Press. This statement we have duly received, but there is no evidence that the proposals before the meeting were supported by any firm of standing in the industry, nor have we been able to obtain any list of those present. We give the report as it has reached us from the interim secretary:—

An enthusiastic meeting of the promoters and supporters of this scheme was held at the offices of the secretary, Mr. H. Bland, of Newcastle and West Hartlepool, acting as chairman.

The secretary read apologies for absence from well-known contractors in London and the provinces, all of whom were in hearty sympathy with the movement and promised their support.

The report of the provisional committee appointed at the first meeting was read and approved, after which the chairman delivered a most interesting and exhaustive address, dealing with the needs for such an association and the good work which had already been done by the local associations in existence up and down the country.

The meeting was thrown open to discussion. Encouraging reports were made by representatives from provincial associations, and a number of points affecting the well-being of the association were thoroughly ventilated. The following resolution was carried unanimously, viz.:—

"Having regard to the desirability of forming a national association for the purposes *inter alia* of protecting and consolidating the interests of electrical contractors in Great Britain and Ireland, it is hereby moved that the representatives of local associations and others present at this meeting hereby form themselves into an association to be called the National Electrical Contractors' Association."

A large and influential general committee representative of England, Scotland, and Ireland was appointed, and it will be one of the duties of this committee to use its best influence in forming local associations in centres where they do not already exist, so that the movement may become universal throughout the United Kingdom.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 22 to 29, with the ports of destination:—

*Africa*—Alexandria, £131; Beira, £17; Cape Town, £9,875 (including £9,600 telegraph cable); Durban, £3,098 (including £1,862 telegraph material); East London, £250 (including £228 telegraph material); Port Elizabeth, £74. *Argentina*—Buenos Ayres, £562 (including £497 telegraph material). *Australasia*—Adelaide, £198; Fremantle, £819 (telegraph cable); Melbourne, £2,500 (including £2,158 telegraph cable); Perth, £383; Sydney, £1,116. *Belgium*—Ostend, £188. *Canada*—Halifax, 92cwt. (telegraph material). *China*—Shanghai, £120 (and 75 tons telegraph wire). *Denmark*—Copenhagen, £134 (telegraph wire). *Germany*—Hamburg, £300 (telegraph material). *Holland*—Amsterdam, £90; Rotterdam, £100 (telegraph material). *Hong Kong*, £62. *India*—Calcutta, £1,230; Madras, £10. *Japan*—Nagasaki, £51. *Mauritius*, £13. *Portugal*—Lisbon, £150; Oporto, £15. *Russia*—Odessa, £75; St. Petersburg, £300 (telegraph material). *Siam*—Bangkok, £578. *Straits Settlements*—Singapore, £41. *United States*—New York, £384. *West Indies*—Santa Cruz, £91. Total (for eight days) £22,955, against £14,575 for one week last year (May 23 to 29).

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# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

February 13, 1901.

3,087. A. H. HICKLEY. Liverpool. Improvements in electrical starting and regulating switches.

3,111. B. G. LAMME. London. Improvements in systems of electrical distribution. (Date applied for under Patents Acts, 1883, sec. 103, July 14, 1900, being date of application in United States.)

3,112. B. G. LAMME. London. Improvements in systems of electrical distribution. (Date applied for under Patents Acts, 1883, sec. 103, July 14, 1900, being date of application in United States.)

3,113. B. G. LAMME. London. Improvements in rotary field-magnets for electrical machines. (Date applied for under Patents Act, 1883, sec. 103, July 14, 1900, being date of application in United States.)

3,123. P. C. SEGNY. London. Improved insulating conduit for the conductors of electric tramways.

3,127. S. CRISTOL. Liverpool. Improvements in guards or protectors for trolley wires and other electric conductors.

3,135. F. J. BEAUMONT and W. M. STILL. London. Improvements in means or apparatus for driving dynamos on railway or other vehicles from the axles thereof, and for connecting such dynamos and batteries to lighting, heating or other circuits on such vehicles.

February 14, 1901.

3,164. R. HOYLE and S. WILSON. Manchester. Improvements in electric ignitions for gas engines and motors.

3,177. E. G. PULFORD. Liverpool. Improvements relating to electrical traction system.

3,179. H. J. J. HUMMELL. London. Apparatus for governing the output of dynamos when driven at different speeds.

3,181. F. J. HOWITT and P. R. JACKSON & Co. (LTD.). Manchester. Improvements in or applicable to dynamos and other electro-magnetic machines.

3,190. A. T. SMITH, Junr., and P. R. ALLEN. London. Improvements in apparatus for controlling or breaking electric circuits.

3,192. P. JURIE. London. Improvements in electric furnaces.*

3,206. SIEMENS BROS. & Co. (LTD.) London. Equalising appliances for inter-connected polyphase currents. (Siemens and Halske Aktiengesellschaft, Germany.)*

3,207. SIEMENS BROS. & Co. (LTD.) London. Improvements in telephone installations having a central microphone battery. (Siemens and Halske Aktiengesellschaft, Germany.)*

3,221. W. J. NASH. Liverpool. Improvements in safety appliances for electric trolley wires or cables.

3,225. A. ROSENBERG. London. Portable X-ray apparatus.

3,234. W. MAYBACH. London. Improvements in or relating to electric ignition devices for explosion engines.

February 15, 1901.

3,247. T. W. REDFORD. Bolton. Improvements in or relating to safety guards for overhead electric wires.

3,281. H. E. HART. London. A new or improved light ampere meter for electrical measurements.

3,284. R. J. PATON. London. Improvements in protectors for sparking plugs of petroleum motors with electric ignition.

3,288. F. J. HOWITT and P. R. JACKSON & Co. (LTD.). Manchester. Improvements in or applicable to dynamos and other electro-magnetic machines.*

3,291. G. MIDDLETON. London. An anti-vibration base frame for explosion and other motors dynamos and other mechanism, appliances or apparatus.

3,310. T. B. BROWNE and F. L. MARTINEAU. London. Improvements in and relating to electrical ignition devices for internal combustion engines.

3,313. W. P. THOMPSON. London. Purifying beverages and liquids by means of manganates under influence of the electric current. (Société Mangano Electrique pour la Purification des Eaux et des Boissons, France.)*

3,321. J. M. DAVIDSON. London. Improvements relating to Röntgen-ray apparatus.

February 16, 1901.

3,350. J. T. PEARSON. Burnley. Improvements in and relating to protectors for trolley-wires of overhead-driven electric tramways.

3,353. W. H. COTTAM. Manchester. An improved safety guard to be applied to the trolley wires used for actuating electric tramcars.

3,370. J. LIDDLE. Glasgow. Improvements in battery electrodes. (The Globe Electric Co., United States.)*

3,376. C. A. LEE. London. Improvements in electric arc lamps and electrodes therefor.

3,386. J. COLEY-BROMFIELD and W. H. MILNES. London. Improvements in electrical heat radiators.

3,387. A. E. BARBER. London. Device for automatically breaking circuit of trolley wires.

3,388. W. P. THOMPSON. Liverpool. Improvements in magneto-electric igniters. (J. Beiron, France.)*

3,390. W. T. SMITH. Manchester. Improvements in switches or cutouts for overhead electric wires.

3,391. R. F. YORKE. London. Improvements in secondary batteries.

3,393. J. M. A. STROH. London. Improvements in the diaphragms of phonographs, musical instruments and analogous sound-producing, recording, or transmitting contrivances.

3,397. SIEMENS BROS. & Co. (LTD.), R. DUMAS and C. R. PALAIRET. London. Improvements in commutator brushes.*

3,398. A. W. HANCOCK, J. LEIGHTON and R. HACKING. London. Improvements in or relating to overhead trolley wires for electric traction, overhead electric cables, telephone, telegraph wires, or the like.

3,401. S. O. COWPER-COLES. London. Improvements in apparatus for use in the electro-deposition of metals.

3,402. S. O. COWPER-COLES. London. Improvements in apparatus for use in the electro-deposition of metal upon tubes.

3,406. A. J. BOULT. London. Improvements in electrical apparatus for transmitting linear drawings. (A. Giorgi, Italy.)

3,411. M. PISCA. Improvements relating to electric accumulators.

3,413. H. HIRST and W. WHITE. London. Improvements in and relating to electric motor starting, regulating, controlling switches and like apparatus.

3,416. W. ERUY. London. Improvements relating to the construction of electrodes containing zinc for use in electric batteries and method of producing and employing the same.

3,417. W. ERUY. London. Improvements in galvanic batteries.

February 18, 1901.

3,429. W. GARNETT. Portchester. Improvement in ducts of stoneware, clay, concrete, or other plastic material for carrying electric or other cables for light, power, traction, telegraph, telephones, &c.

3,434. M. MERCIER and W. O. ANDREWS. Manchester. Improvement in electrical switches.

3,438. C. J. SPENCER. Bradford. An apparatus for recording the time an electric car passes a station.

3,450. B. M. DRAKE and J. M. GORHAM. London. Improvements in accumulator plates.

3,451. M. A. CODD. Harrow-on-the-Hill. Improvements in the electrolytic break.

3,468. S. PAULSEN. London. Improvements in or appertaining to electric alarm clocks.

3,481. J. A. FLEMING and MARCONI'S WIRELESS TELEGRAPH Co. (LTD.). London. Improvements in apparatus for wireless telegraphy.

3,487. W. KINGSLAND. London. Improvements in or connected with the carrying of strikers upon motor vehicles for mechanically operating electric switches.

3,488. F. F. WELLINGTON. London. Improvements in or connected with electric ignition apparatus, particularly applicable to explosive engines.

3,491. J. A. RIGNON, T. L. CARBONE, and A. MORENO. London. Improvements in arc lamps.*

3,493. E. JAHR. London. Improvements in the method for obtaining electric currents from the earth.*

3,494. A. COUCH. London. Improvements in electrical glow lamps.*

February 19, 1901.

3,526. H. V. MANGER. London. An electrically lit watch or clock case.*

3,540. C. D. RICARIO. France. Process of simultaneous and separate extraction of hydrogen and oxygen gases from the body-water by electrolysis.

3,554. J. T. ARMSTRONG and A. ORLING. London. Improvements in and connected with apparatus for transmitting and receiving electro-magnetic waves or impulses.

3,563. J. SOULAT. London. Improvements relating to electric-magnetic driving mechanism.

3,570. P. A. NEWTON. London. Improvements in telautographs and methods of telautographic transmission. (The Gray National Telautograph Co., United States.)*

3,576. P. H. F. SPIES and J. NORDEN. London. Improvements in electric switches.*

3,608. A. C. E. RATEAU. London. Improvements in steam regenerative accumulators.*

3,613. A. M. BARNES. London. Improvements in and relating to electric percussive rock drills or the like.

February 20, 1901.

3,636. E. M. HOLLINGSWORTH. St. Helens. Improvements in devices for connecting electrical circuits to earth in case of emergency, chiefly for use with overhead wires.

3,660. A. KÖNIGELÖW and C. PILGRIM. London. New or improved automatic guard for electrical street cars.

3,679. F. H. HEADLEY. London. Improvements in electric switches.

3,686. W. H. F. MURDOCH. London. Improvements in electrical switches.

3,699. A. J. ORME. London. Improvements in trolley heads for use in connection with overhead systems of electrical traction.

3,710. P. J. M. GIRAULT. London. Improvements in or connected with the regulation and starting of single-phase and polyphase alternate current motors with magnetic rotating fields.

February 21, 1901.

3,713. E. H. HOWLETT. Hull. An improvement in electrolytic breaks.

3,744. E. QUARMBY and E. A. NORTH. Huddersfield. Improvements in means for protecting or guarding overhead electric trolley or like electric wires.

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## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900

2,176. ECKSTEIN and ANGOLD. Regulating mechanism for arc lamps.
2,212. PERITZ. Electric arc lamps.
2,260. BREMER. Electric arc lamps.
2,518. ECKSTEIN and COATES. Apparatus for recording, without friction, the indications of electrical and other measuring and indicating devices.
2,783. JOHNSON (Deutsche Gold and Silber Scheide [Anstalt vorm. Roessler and Birger], Carlson). Electrical arc furnaces
3,124. WESTON. Methods of and apparatus for manufacturing coils for use in connection with electrical instruments.
3,264. PERDRISAT. Armatures of electric motors, specially applicable for use in meters for electric currents.
3,683. M. E. REASON, W. PADDISON and H. C. HUGHES (executors of the late H. Reason) and REASON MANUFACTURING Co. (LTD.). Electricity meters.
3,834. STOBER. Electric generators and motors. (Date applied for under International Convention, July 28, 1899.)
4,387. YOUNG. Systems of alternating current electrical distribution. (Date applied for under International Convention, August 8, 1899.)
4,709. NISBETT. Electric cable joint boxes.
4,921. GRANT. Electrical method for securing uniform time in clocks.
5,016. HOLLAND and LAURIE. Porous diaphragms for electrolytic apparatus.
5,767. STANLEY. Construction of carrier for globes or glasses of electric, gas or oil lamps.
5,786. NISBETT. Electric cables.
6,496. SKOPEC and OREL. Means for dropping or cutting out broken overhead conductors on electric railways.
6,615. EDWARDS. Terminals and binding screws for electric batteries and connections.
6,826. DE JANISCH. Switches for electric currents.
6,923. DUSSAUD. Loud speaking telephones.
7,356. SCHATTNER and HARMER. Electrical incandescence lamps.
8,208. BRITISH THOMSON-HOUSTON Co. (LTD.) (Hewlett). High potential electric switches or circuit breakers.
8,668. INTERSTATE ELECTRIC Co. and MELZER. Electric arc lamps.
9,552. BREMER. Electric arc lamps.
10,612. MARTIN, STEWART, BROWN and BOGGS. Arc lamps.
11,547. HILL. Fittings for overhead trolley systems of electric tramways
11,824. BULL. Telegraphy and apparatus connected therewith.
18,472. KINSEY. Phonograph-record carton receptacles.
18,816. CLARKE. Apparatus for indicating phase and frequency relations. in electric alternating current systems.
18,921. BENEDICKS. Electric furnaces.
19,099. MIJERS. Electrodes for accumulators of electricity.
19,251. DE PUYDT. Arc lamps. (Date applied for under International Convention, June 22, 1900.)
19,438. SCHUSTER. Electric arc lamps.
19,512. LAKE (McElroy-Grunow Electric Railway System). Electric circuit breakers or switches.
19,554. LJUNGMAN. Combined telephone and sound telegraph apparatus.
20,186. ABEL (Siemens and Halske Aktiengesellschaft). Electrically and pneumatically-controlled air brakes for railway and like vehicles.
20,995. SERRELL. Poles for electric railways, electric lights, and telephone and telegraph lines.
21,028. BRITISH THOMSON-HOUSTON Co. (LTD.) (Farnsworth). Electric railways on sectional conductor or road-contact systems.
21,029 BRITISH THOMSON-HOUSTON Co. (LTD.) (Haskins). Tachometers.
21,149. MEURANT. Electrolytic process for the precipitation of metals and alloys from their solutions, as also for the deposition of metals or alloys on other metals or alloys, or on other substances.
21,216. JUSTICE (International Acheson Graphite Co.). Method of graphitising electrodes and other carbonaceous articles.
21,217. JUSTICE (Erie Exploration Co.). Electric current regulators.
21,294. BRITISH THOMSON-HOUSTON Co. (LTD.) (Steinmetz). Systems of electrical distribution.
21,486. COTTON, COTTON and REDDELL. Gripping appliances suitable for screwing lamp-shade clamp rings on and off electric incandescence lamp holders.
21,645. CLARKE, CHAPMAN & Co. (LTD.) and FORSTER. Electric switches.
21,701. STERNE (Fowler). Telephony.
21,702. BRITISH THOMSON-HOUSTON Co. (LTD.) (Emmet). Operating dynamo-electric machines.
21,703. BRITISH THOMSON-HOUSTON Co. (LTD.) (Fleming). Systems of electrical distribution and arc lamps therefor.
21,704. BRITISH THOMSON-HOUSTON Co. (LTD.) (Berg.) Systems of electrical distribution.
21,732. SIEMENS BROS & Co. (LTD.) (Siemens and Halske Actiengesellschaft). Method of automatically cutting out main conductors of powerful electrical currents.
21,861. BRITISH THOMSON-HOUSTON Co. (LTD.) (Hewlett). Controlling electric boosters.
21,862. BRITISH THOMSON-HOUSTON Co. (LTD.) (Reist). Methods of securing pole-pieces to electric machines.
21,903. GREEN. Means of holding the inner glass and lower carbons of an electric arc lamp.
21,904. GREEN. Arrangement of electrical resistance especially adapted for electric arc lamps.
21,933. CROMPTON & Co. (LTD.), HODGSON and EWART. Electric arc lamps.
21,991. CLEVELAND. Connections for electrical conductors.
22,010. CLEVELAND. Method of connecting electrical conductors.
22,142. HAGEMANN and POULSEN. Telephone relay.
22,233. KANDÓ. Electric railways, tramways, and the like on a sectional-conductor system.
22,285. BRITISH THOMSON-HOUSTON Co. (LTD.) (Stewart). Current-collectors for electric vehicles.
22,288. BRITISH THOMSON-HOUSTON Co. (LTD.) (Reist). Means for attaching pole-pieces to electric machines.
22,546. BERGMANN. Electrical interrupters for gas engines.
22,591. BARNARD. Magnetic ore separators.
22,605. MÜLLER. Plate-holders for electric accumulators.
22,606. MÜLLER. Process for chemically consolidating the active material of electric accumulators.
22,607. MÜLLER. Electric accumulator cells.

## COMPANIES' MEETINGS AND REPORTS.

### Electrical Power Distribution Co. (Ltd.).

The report of the directors from the formation of the company to March 31 states that the profits amount to £15,001. 2s. 9d., and, after deducting the proportion of general expenses chargeable to revenue, and the expenses incurred in connection with schemes not proceeded with and written off, and £1,271. 5s. 9d. held in reserve in respect of new schemes, there remains a net profit of £13,045. 11s. 2d., which the directors propose should be applied as follows:—Preliminary expenses written off £826. 6s. 2d., reduction of furniture account £55. 16s. 2d., payment of income tax £513. 17s. 8d., dividend at rate of 5 per cent. per annum on ordinary shares £1,320. 2s. 10d., carried forward £10,329. 9s. 4d.

The company was incorporated on June 23, 1898, nominal capital £20,200 in 2,000 ordinary shares of £10 each and 200 deferred shares of £1 each, and in April, 1900, the capital was increased to £300,000 by the creation of 12,980 ordinary and 15,000 preference shares of £10 each. The directors propose to issue at an early date the unissued 15,000 preference £10 shares.

The total amount expended on electric power acts and negotiations in connection with new schemes in course of development was £16,840. 13s. 6d. An Appendix to the report gives particulars of the schemes in which the company is interested. These are, briefly, as under:—

BANBURY.—The E.P.D. Co. has obtained the Banbury electric lighting provisional order, which is to be transferred to the Banbury and District Electric Supply Co. (Ltd.), whose present subscribed capital is £25,000.

COUNTY OF DURHAM.—The County of Durham Electrical Power Distribution Co. (Ltd.) has been formed, with a present subscribed capital of £30,070, to carry out electricity supply undertakings in this county. Provisional orders authorising retail supply to consumers for light, power and other purposes have been obtained for Gateshead, Jarrow and Durham (city), and supply is expected to be available at Gateshead about Aug. 1, at Durham about September, and at Jarrow about November. The construction of the main power station at Gateshead, in connection with the act obtained by the E.P.D. Co. last session for the supply of electric energy in bulk within an area of about 250 sq. miles, is making satisfactory progress, and is supplying current to the various local sections of electric tramways as they are completed.

COUNTY OF KENT.—The E.P.D. Co. owns the Sheerness and the Sevenoaks electric lighting provisional orders, and these are to be transferred to the County of Kent Electric Power Distribution Co., which has a present subscribed capital of £25,000. The British Electric Traction Co. is promoting a light railway order for Sheerness, which, when authorised, will be worked in conjunction with the County of Kent Co.'s electric supply undertakings.

COUNTY OF NORTHAMPTON.—The E.P.D. Co. owns the Wellingborough electric lighting order, which is to be transferred to the County of Northampton Electric Power and Traction Co. (Ltd.), which has a present subscribed capital of £25,000. The British Electric Traction Co. is constructing an electric tramroad system in Wellingborough, Rushden, and neighbouring districts which it is proposed to work conjointly with the County of Northampton Company's undertaking.

COUNTY OF SURREY.—With a present subscribed capital of £25,070 the County of Surrey Electric Power Distribution Co. (Ltd.) has been formed to work provisional orders for the districts of Sutton, Carshalton, and Wallington. It is anticipated that supply under these orders will be commenced this year.

COUNTY OF SUSSEX.—£20,070 has also been subscribed to the capital of the County of Sussex Electrical Power Distribution Co. (Ltd.), to work the provisional order for the borough of Lewes. Current will be available in June.

NORTH METROPOLITAN DISTRICT.—The North Metropolitan Electrical Power Distribution Co. (Ltd.) also has a subscribed capital of £25,070, and will work provisional orders authorising retail supply of current for Barnet, Hertford, and other districts. Current is already available at Barnet, and at Hertford supply is to be inaugurated in the autumn. The E.P.D. Co. obtained an act last session authorising the supply of electrical energy within an area of about 325 sq. miles, including Tottenham on the east to Harrow on the west.

PENARTH.—The works of the Penarth Electric Lighting Co. (Ltd.), whose present subscribed capital is £25,000, are expected to be ready to commence supply in June. This company is working a provisional order for Penarth.

STAINES, EGHAM and CHERTSEY.—The E.P.D. Co. owns a provisional order for this district, which is to be transferred to the Thames Valley Electric Supply Co. (Ltd.), whose present subscribed capital is £25,000.

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WESTON-SUPER-MARE.—The Weston-super-Mare and District Supply Co. (Ltd.) has a present subscribed capital of £25,070, and the company's works are approaching completion. This company owns also an electric tramway provisional order which will be worked in conjunction with the lighting order.

In addition to the above, the Appendix states that other provisional arrangements have been made, and negotiations are pending in regard to other undertakings, which it would be premature and inexpedient at the present moment to describe.

## Telegraph Manufacturing Co. (Ltd.).

The report of the directors for the year ended March 31 states that the profits amounted to £35,183. 2s., and, with £5,825. 8s. 9d. brought forward, there is £41,008. 10s. 9d. available for distribution. Managing director's salary (including a special grant of £1,000) and directors' fees absorb £2,400; duties in connection with the issue of new ordinary shares, £255. 5s.; preference dividend, £4,749. 19s. 10d.; and interim ordinary dividend, £5,000. After placing to depreciation £4,442, and to reserve £6,500, there remains £17,661. 5s. 11., and the directors recommend a further dividend at the rate of 12 per cent. per annum for the half-year (6s. per share) and a bonus of 2 per cent. (2s. per share) on the ordinary shares, tax free, making 12 per cent. for the year, the balance (£7,661. 5s. 11d.) being carried forward.

The new issue of ordinary shares was fully taken up by shareholders, and the premium (£20,000) has been placed to reserve, as well as the special insurance fund of £1,000 formed against claims which might arise under the Workmen's Compensation Act, satisfactory arrangements having now been completed for the insurance of the company's workpeople.

During the past 12 months the business of the company has been carried on under difficulties arising out of the extension of the Helsby factory and the erection of additional machinery, but this work is now practically complete. The directors are convinced that the telephone industry will, in the near future, become a most important branch of the company's business, and as the Liverpool factory is now worked to its utmost capacity, steps are being taken to meet the increasing demand for telephone apparatus.

## Mexico Electric Tramways (Ltd.).

The directors' report for the year ended Dec. 31 states that the net profit of the Compañia de Ferrocarriles del Distrito Federal de Mexico, S.A., was £26,965. 15s. 6d., which enabled the board in Mexico to declare a dividend of 12½ per cent. on the ordinary share capital. The revenue account of the Mexican Electric Tramways (Ltd.) shows a credit balance of £24,544. 17s. 7d. A dividend of 6 per cent. on the preference shares has been declared (absorbing £5,564. 13s. 5d.) and the directors recommend a dividend of 3 per cent. on the ordinary shares (requiring £15,000), the balance (£3,980. 4s. 2d.) being carried forward. During the year the company issued 79,013 6 per cent. cumulative preference shares to provide funds for construction. The service is being conducted as follows:—50 miles by electricity, 10 miles by steam, and 100 miles by animal traction. The extension of the electric service is proceeding.

**METROPOLITAN ELECTRIC RAILWAY CO. OF PARIS.**—At the recent annual general meeting the accounts presented showed the results of the working of the new line from July 19 to Dec. 31. The total traffic receipts were £107,764, and the working expenses £41,741. The proportion of profits paid over to the City of Paris, in accordance with the terms of the concession, was £36,252, so that the net profit from the working of the line was £29,771. A dividend of 7·50fr. per share was declared. The working results for the first four months of 1901 were as follows:—Traffic receipts £107,520, working expenses £45,801, gross profits £61,719, and net profits £18,799. The proportion of working expenses to receipt were below 40 per cent. from the opening day up to December last, in which month they rose to 42 per cent., increasing in January to 44 per cent., and falling again in March and April this year to 40 per cent. To enable the company to increase the length of its trains to seven or eight cars, it is necessary to construct a number of sidings, which the Paris Municipal Council is asked to sanction, The length of line open is rather over 8 miles. The rolling stock at present consists of 41 first and 74 second class carriages and 46 motor carriages. The second line, on the north side of the Seine (via the outer boulevards, between the Etoile and the Place des Nations), is expected to be opened early next year.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BIRKDALE DISTRICT ELECTRIC SUPPLY CO. (LTD.)**—Reg. May 21, capital £30,000 in £5 shares, to carry on the business of electrical engineers and contractors, suppliers of electricity, electricians, manufacturers of and dealers in railway, tramway, electric, and other apparatus, &c., to acquire inventions relating to the propulsion of cars, trucks, and vehicles by electricity or otherwise, and to construct railways and tramways and work the same by electricity or other power. The subscribers are Messrs. J. S. Raworth, Emile Garcke, C. H. Dade, J. V. Kitchener, W. J. Greer, H. Colbourne, and W. L. Madgen.

**DOLTER ELECTRIC TRACTION CO. (LTD.)**—Reg. May 21, capital £100,000 in £1 shares, to acquire inventions, concessions, &c., relating to the production, storage, distribution, and use of electricity, in particular to acquire from the Société d'Exploitation des Brevets Dolter, Paris, the benefit of certain British, Indian, and Colonial patents relating to electric traction or apparatus therefor, and to carry on the business of an electric traction and supply company, and of tramway and railway proprietors, electricians, engineers, suppliers of electricity, &c. The first directors are Emile Garcke, C. S. Drummond, H. N. Lubbock, and Tom O. Callender.

**DRAKE AND GORHAM (LTD.)**—Reg. May 22, capital £125,000 in £1 shares, to acquire and carry on the business of electrical, mechanical, and hydraulic engineers, &c., carried on by Messrs. B. M. Drake and J. M. Gorham at 66, Victoria-street, London, S.W., as Drake and Gorham, with the various tenancy agreements relative to the business and its branches, and also certain patents. The subscribers are B. M. Drake, J. M. Gorham, M. G. Drake, R. P. Sellon, A. Payne (all electrical engineers), J. C. Forster, and A. C. Read. The first directors are Bernard M. Drake, John M. Gorham and two others to be appointed by the subscribers.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27⅛d. per oz. (May 30). Consols (2¾ per cent.) 93⅞—94⅛ for money, 93⅞—93⅝ for account; 2½ per cent. 94—95 (May 30). Consols Pay Day, June 3; Stocks and Shares Continuation Days, June 12 and 26; Ticket Day, June 13; Pay Days, May 31 and June 14; Mining Share Carry-over Days, June 11 and 25.

**REUTER'S TELEGRAM CO. (LTD.)**—At the shareholders' meeting, on Wednesday, the directors' report, set out in our issue of 17th inst., was approved, and the dividends therein recommended declared.

**RUSTON, PROCTOR & CO. (LTD.)**—The report and accounts of the directors, abstracted in our last issue, were adopted at the meeting of shareholders on Wednesday.

**STOCK EXCHANGE NOTICE.**—The Stock Exchange committee has ordered 125,000 ordinary £1 fully paid shares (Nos. 1 to 125,000) of the *Aron Electricity Meter (Ltd.)* to be quoted in the official list.

**SWEDISH TELEPHONE COMPANIES.**—A dividend of 6 per cent. has been declared on the share capital of the Bell Telephone Co. of Stockholm for the past year. Owing to the development of the business the capital is about to be increased.

The Telephone Co. of Stockholm has declared a dividend for 1900 of 6 per cent. It has been decided to transfer the undertaking to the Ericsson Co., the Telephone Manufacturing Co. being dissolved.

**JOHN I. THORNYCROFT & CO. (LTD.)**—Subscriptions are invited to an issue of 160,000 6 per cent. cumulative preference shares of £1 each in this company, which has been formed to take over as a going concern the well-known business of John I. Thornycroft & Co., of Chiswick, which was originally established in 1864. The object of the issue is to pay out the late Mr. John Donaldson's share in the business, to provide additional working capital and to enable Mr. Thornycroft to associate himself with others in the responsibilities of management. The prospectus states that the "orders in hand" include 10 electric locomotives for the City and South London Electric Railway, alterations to rolling stock for the Central London Railway, and work for the London United Tramways. The electrical branch of the business gives every evidence of rapid development.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | May 18 | 670 | + 53 | 50 | 33,170 | + 3,705 |
| *Birmingham Tramways. | ,, 25 | 4,885 | + 331 | 20 | 84,832 | + 1,726 |
| *Blackburn Corporation.. | ,, 24 | 515 | + 8 | 21 | 9,367 | + 972 |
| Blackpool Corporation... | ,, 23 | 438 | + 84 | †8 | 3,470 | + 654 |
| Blackpool and Fleetwood | ,, 25 | 432 | + 18 | 21 | 5,131 | − 393 |
| Bolton Corporation ..... | ,, 26 | 1,440 | + 79 | 8 | 11,804 | + 2,414 |
| Bradford Corporation... | ,, 26 | 930 | + 402 | 8 | 7,774 | + 4,104 |
| Brisbane Trams ..... | Apl. 10 | 2,169 | + 338 | 14 | 28,716 | + 3,391 |
| *Bristol Trams & Carriage | May 24 | 4,681 | +1,512 | 20 | 82,556 | +24,622 |
| *Buenos Ayres & Belgrano | Apl. 28 | 2,770 | + 562 | 17 | 47,642 | + 8,659 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | May 25 | 6,165 | ... | 21 | 130,100 | ... |
| City & South London Ry. | ,, 26 | 1,838 | + 483 | 21 | 41,471 | +15,151 |
| Cork Elec. Trams ..... | ,, 23 | 621 | + 165 | 20 | 8,215 | + 1,078 |
| Dover Corporation ..... | ,, 25 | 201 | − 3 | 8 | 1,662 | + 129 |
| Dublin & Lucan Rly. ... | ,, 25 | 124 | + 13 | 21 | 1,831 | + 136 |
| Dublin United ..... | ,, 24 | 3,853 | + 303 | 21 | 59,186 | − 738 |
| Dublin Southern Dist.... | ,, 24 | 967 | + 143 | 21 | 16,109 | |
| *Dundee Corporation ... | ,, 22 | 720 | + 297 | ... | ... | ... |
| *Glasgow Corporation ... | ,, 25 | 11,836 | +2,212 | 52 | 485,000 | +20,214 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation..... | ,, 25 | 1,589 | + 332 | 47 | 69,392 | +34,718 |
| Liverpool Corporation... | ,, 18 | 9,495 | +1,541 | 20 | 164,587 | +24,208 |
| *Liverpool Overhead Rly | ,, 26 | 1,555 | + 136 | 21 | 32,376 | + 2,719 |
| Perth (W.A.) Elec. Trams | ,, 24 | 815 | + 451 | 47 | 31,507 | ... |
| Portsmouth Corporation | ,, 25 | 543 | − 306 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 26 | 3,572 | +1,251 | 21 | 64,688 | +23,688 |
| Southampton Corporat'n | ,, 23 | 734 | + 329 | ... | ... | ... |

(a) These comparisons are for the corresponding week last year.
* Partly electrical. † Minus 8 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 22. | | Price Wednesday, May 29. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending May 29. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12 0 | Bournemouth and Poole Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7¾ | 8¼ | 7¾ | 8¼ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9 | 8½ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) xd | 7 | 7⅛ | 7 | 7⅛ | 2 6 8 | ... | 7⅛ | 7⅛ |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5⅝ | 5½ | 5⅝ | 3 18 3 | ,, ,, | ... | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5⅝ | 6¼ | 6 | 6⅜ | 4 4 7 | March | ... | ... |
| £180,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | 111 | 110½ |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8¼ | 9¼ | 8⅛ | 9⅛ | 4 4 3 | February and August | ⅝ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 | 13 | 12 | 13 | 4 12 4 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 123 | 127 | 3 19 8 | June and December | ... | |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | 102 | 101½ |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8 | 9 | 4 8 11 | ... | 8¼ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12⅛ | 11⅛ | 12⅛ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 105 | 108 | 105 | 108 | 4 5 1 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5¼ | 5⅜ | 5⅛ | 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/3 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 2 15 5 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 7 6 | ... | 11 13/16 | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 | 104 | 102 | 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1¼ | 1⅝ | 1¼ | 1⅝ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13⅜ | 14⅛ | 4 2 9 | April and October | 14 | 13¼ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13 | 14 | 13 | 14 | ... | ... | 13⅜ | 13⅜ |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 11 5 | ... | ... | ... |
| 8,652 | 10 | 8/0 | Notting Hill Electric Ordinary | 15½ | 16½ | 15⅛ | 16⅛ | 4 13 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅞ | 6⅜ | 5⅞ | 6⅜ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅜ | ⅝ | ⅜ | ⅝ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 14½ | 15½ | 15 | 16 | 4 10 8 | February and August | 15½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8⅝ | 9⅝ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2¼ | 2 | 2¼ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 103,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 12⅝ | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 3⅞ | 4⅛ | 4 | 4¼ | 4 14 2 | April and October | 4⅛ | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 124 | 129 | 4 14 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 96 | 101 | 96 | 101 | 5 0 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2⅜ | 3⅛ | 2⅜ | 3⅛ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4¼ | 4¾ | 4¼ | 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 | 101 | 99 | 101 | ... | ... | 100 | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ | 23¾ | 23½ | 23¾ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅛ | 10½ | 3 14 5 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 | 116 | 114 | 116 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ | 7 | 6¾ | 7 | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 9½ | 10 | 9½ | 10 | 5 0 0 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 99⅝ | 101⅞ | 99⅞ | 101⅞ | 4 9 3 | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 14½ | 15½ | 14½ | 15½ | 5 9 8 | ... | 15 | 14½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 4 | February and August | 12⅝ | 12⅛ |
| £160,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 9 | ... | 122 | 121 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5½ | 5¼ | 5½ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5 | 5⅛ | 5 | 5⅛ | ... | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | 103 | 105½ |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 8 | ... | 98¾ | ... |
| 34,440 | 10 | £/0 | Calcutta Trams. (Nos. 1 to 34,440) | 10½ | 11½ | 10⅜ | 11⅜ | 2 13 2 | ... | ... | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 102 | 104 | 101 | 104 | ... | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | ... | ... |
| 19,980 | 10 | 2/6 | Central London Ordinary | 9⅜ | 10 | 9½ | 10 | 2 15 0 | June and December | 9⅝ | 9½ |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 | 113 | 113 | 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ | 5⅜ | 5¼ | 5⅜ | 4 19 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 100 | 103 | 3 17 10 | ... | ... | ... |
| £865,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 52 | 54 | 51 | 53 | 2 7 7 | February and August | 51½ | 51 |
| 47,500 | 10 | 2/0.10 | Do. Ordinary (Nos. 22,501 to 70,000) | 5 | 5½ | 4¾ | 5¼ | 2 7 0 | ,, ,, | 5 | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1898) | 122 | 127 | 122 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 111 | 116 | 111 | 116 | 3 9 2 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 | 14 | 13 | 14 | 4 5 9 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | £/0 | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tract'n. Pref. | 5¼ | | 5¼ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4¾ | 5¼ | 4¾ | 5¼ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 | 22⅜ | 22 | 22⅜ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15⅜ | 14⅜ | 15⅛ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 8⅜ | 8½ | 8⅜ | 8½ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 18 3 | January and July | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 103 | 105 | 103 | 105 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 3¾ | 3½ | 3¾ | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4¼ | 5 | 4¼ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | £/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 | 13 | 11 | 12 | 1 13 4 | ... | ... | ... |
| 20,000 | 10 | £/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 | 107 | 105 | 107 | 4 4 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (£/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 93 | 96 | 3 2 10 | June and December | 95 | 94 |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 22. | | Price Wednesday, May 29. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending May 29. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowe |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) .... | 99 | 102 | 100 | 103 | 3 19 0 | January and July ..... | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph ..... | 3⅜ | 4½ | 3⅜ | 4½ | ... | June and December .. | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures ..... | 70 | 75 | 73 | 78 | ... | ... | ... | ... |
| £80,720 | Stock | 15/0 | Anglo-American ..... | 53 | 56 | 53 | 56 | 5 11 9 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred ..... | 97 | 99 | 97 | 99 | 6 1 9 | ,, ,, | 98½ | 93 |
| £3,097,640 | Stock | 5/0 | Do. Deferred ..... | 10 | 10½ | 10 | 10½ | 2 7 7 | ,, ,, | 1⅛ | ... |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock ..... | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,020 | Stock | 4% | * Do. 4 per Cent. Debenture Stock ..... | 100 | 102 | 100 | 102 | 3 18 5 | ,, ,, | ... | ... |
| 15,000 | 10 | 4/0 | Cuba Submarine Ordinary ..... | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. ..... | 15 | 16 | 15 | 16 | 6 5 0 | ,, ,, | ... | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary ..... | 3 | 4 | 3 | 4 | 5 0 0 | April and October..... | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference ... | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures ..... | 100⅞ | 104⅞ | 100⅞ | 104⅞ | 4 6 7 | January and July..... | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable ..... | 10 | 10⅛ | 10 | 10⅛ | 6 13 4 | Jan., Apr., July, Oct. | ... | ... |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | 100 | 103 | 4 8 8 | June and December ... | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary ..... [to 1,200) (red.)... | 140 | 145 | 140 | 145 | 4 17 0 | Jan., Apr., July, Oct. | 141 | ... |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock ..... | 91 | 94 | 91 | 94 | 3 14 6 | ,, ,, | 94⅛ | 91½ |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) ..... | 110 | 114 | 110 | 114 | 3 10 2 | May and November ... | ... | ... |
| 300,000 | 10 | 6/6 | Eastern Extension ..... | 13½ | 14 | 13½ | 14 | 5 0 0 | Jan., Apr., July, Oct. | 14 | 13 13/16 |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock..... | 111 | 116 | 111 | 116 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909..... | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) ... | 100⅞ | 103⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November ... | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust ..... | 9⅛ | 10 | 9⅛ | 10 | 5 5 0 | Jan., Apr., July, Oct. | 10 | 9⅞ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference ..... | 14⅞ | 15½ | 14⅞ | 15½ | 3 18 8 | ,, ,, | 15½ | 15 7/16 |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen ..... | 32 | 34 | 32 | 34 | 4 8 3 | January and July..... | ... | ... |
| £82,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos | 100 | 103 | 100 | 103 | 4 8 8 | June and December ... | 130 | ... |
| 17,000 | 25 | 37/6 | Indo-European ..... [1 to 1,200) (red.) | 43 | 47 | 43 | 47 | 5 6 5 | May and November ... | 43½ | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 ... | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) ..... | 100 | 103 | 100 | 103 | 3 18 1 | June and December ... | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's ..... | 7⅞ | 8⅛ | 7⅞ | 8⅛ | 4 14 1 | April and October..... | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust..... | 121 | 123 | 125 | 130 | 4 12 10 | ,, ,, | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph ..... | 2 | 3 | 2 | 3 | 4 9 3 | December and July ... | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.)..... | 98 | 101 | 98 | 101 | 4 19 7 | March and September | 99½ | ... |
| 30,008 | 2½ | ... | West Coast of America..... | ¼ | ¾ | ¼ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures ..... | 100 | 103 | 100 | 103 | 3 18 1 | January and July..... | 100½ | ... |
| 88,321 | 10 | 6d. | West India and Panama ..... | ⅜ | ⅝ | ⅜ | ⅝ | ... | May and November ... | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference ..... | 5 | 6 | 5 | 6 | 10 0 0 | ,, ,, | 5 5/16 | 5 |
| 4,689 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference ..... | 3 | 5 | 3 | 5 | 12 0 0 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures ..... | 103 | 106 | 103 | 106 | 4 14 4 | January and July..... | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zill'n Submarine) ..... | 13⅜ | 14½ | 13⅜ | 14½ | 4 18 3 | Mar., June, Oct., Dec. | 13 5/16 | 13⅜ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) ..... | 102 | 105 | 102 | 105 | 4 15 8 | June and December ... | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) ..... ..... | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) ..... ..... ..... | 3¾ | 4 | 3½ | 4 | 5 0 0 | August ..... ..... | ... | ... |
| 324,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. ..... ..... | 2/3 | 2/9 | 2/3 | 2/9 | 10 18 2 | April and October..... | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary ..... ..... ..... | ½ | ½ | ½ | ½ | 5 0 0 | November ..... | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference ..... ..... | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2 6 | National..... | 3⅜ | 3⅝ | 3½ | 4 | 6 17 6 | Febrdary and August | 3⅝ | 3½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference ... | 10 | 12 | 11½ | 12½ | 4 16 0 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference ... | 10 | 12 | 11½ | 12½ | 4 16 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. ... | 4½ | 4⅝ | 4⅝ | 4¾ | 5 8 1 | ,, ,, | ... | ... |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.)..... | 87 | 90 | 87 | 90 | 3 18 8 | June and December ... | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.)..... | 95 | 98 | 95 | 98 | 4 2 8 | ... | 99½ | 95 |
| 171,504 | 1 | 0/8⅜ | Oriental ..... | ⅞ | 1 | ⅞ | 1 | 6 0 0 | April and October .... | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate ..... | 4½ | 5 | 4½ | 5 | 7 0 0 | July ..... | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref... ... ..... ..... | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December ... | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.)..... | 103 | 106 | 103 | 106 | 4 14 9 | June and December ... | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref..... | ⅝ | ⅝ | ⅝ | ⅝ | 8 0 0 | ... | ... | ... |
| 125,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. ..... ..... | 1 1/16 | 1 3/16 | 1 1/16 | 1 3/16 | 7 7 8 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary ..... ..... ..... | 10 | 11 | 10 | 11 | 6 16 4 | July and February ... | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference ..... ..... | 5⅞ | 6⅛ | 5⅞ | 6⅛ | 4 16 0 | January and July ... | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference ..... ..... | 4⅛ | 4⅜ | 4⅜ | 5⅛ | 5 14 3 | ,, | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering ..... ..... ..... | 1⅜ | 1⅝ | 1⅜ | 1⅝ | 3 8 7 | September ..... ..... | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid ..... ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2⅝ | Do. 5 per Cent. Pref. Non-Cum. ..... ..... | 2⅛ | 2⅜ | 2 | 2¼ | 5 1 1 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid..... ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock ... | 103 | 108 | 103 | 108 | 4 3 2 | March and September | 104 | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock ..... ..... | 101 | 103 | 101 | 103 | 4 7 5 | January and July..... | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. ..... ..... | 14⅛ | 15⅛ | 14⅛ | 15⅛ | 4 16 9 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference..... ..... | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ,, ,, | 5⅞ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.)..... | 109 | 113 | 109 | 113 | 3 19 10 | November and May ... | ... | ... |
| 450,000 | 1 | 0/9⅞ | Castner-Kellner Alkali Co. (fully paid) ..... ..... | ⅞ | 1⅛ | ⅞ | 1⅛ | 7 2 3 | ... | 1 1/16 | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) ... ..... ..... | 94 | 98 | 94 | 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary ..... ..... | ¾ | 1 | ¾ | 1 | 6 10 0 | March ..... ..... ..... | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference ..... .. | ¾ | 1⅛ | ¾ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9⅜ | Crompton and Co. (Nos. 1 to 54,000) ..... ..... | 3⅛ | 4 | 3⅛ | 4 | 5 12 7 | January and July..... | 3 1/16 | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.)... | 101 | 104 | 101 | 104 | 4 17 0 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref..... | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) .. | 1 | 1⅛ | 1 | 1⅛ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid)..... | 2⅛ | 3⅛ | 2⅛ | 3⅛ | 7 11 6 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb.Stock (red.)... | 87 | 89 | 87 | 89 | 4 9 6 | June and December ... | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) . | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 36,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. ..... .. | 5⅛ | 5¾ | 5⅛ | 5⅜ | 7 7 10 | Half-yearly ..... ..... | 5 7/16 | 5⅛ |
| 13,363 | 5 | 1 6⅛ | Do. Cumulative Preference ..... ..... | 5⅛ | 6 | 5⅛ | 6 | ... | ... | 6 1/16 | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) ... . | 104 | 107 | 104 | 107 | 4 4 5 | ... | ... | ... |
| 112,100 | 2 | 1/2⅜ | Electric ConstructionCo. (Limited) ..... ..... | 1⅞ | 2⅛ | 1⅞ | 2⅛ | 5 6 8 | January and July..... | ... | ... |
| 25,000 | 2 | 2/9⅜ | Do. 7 per Cent. Cumulative Preference ..... | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July ..... ..... | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 | 104 | 101 | 104 | 3 16 11 | January and July..... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary ..... ..... ..... | 15⅞ | 16⅛ | 15⅞ | 16⅛ | 6 1 3 | February and August | ... | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... ..... ..... | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb.Stock(red.)... | 107 | 111 | 107 | 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works..... ..... | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | 21 | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. ..... ..... | 35 | 39 | 35 | 39 | 5 7 8 | March and July..... .. | 37⅞ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908..... .. | 102 | 105 | 102 | 105 | 3 16 10 | January and July ..... | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary ..... ..... | 10⅛ | 11⅛ | 10⅛ | 11⅛ | 5 12 6 | ... | 10⅛ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent.Cumulative Preference..... | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary ..... ..... ..... | 10 | 11 | 10 | 11 | 5 9 1 | April and October..... | 10⅛ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. ..... ..... | 6⅛ | 6¾ | 6⅛ | 6⅞ | 4 8 11 | ,, ,, | 6⅞ | 6⅛ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures ... | 105 | 107 | 105 | 107 | 4 0 0 | May and November ... | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,203. [Vol. No. 7. XLVII.] FRIDAY, JUNE 7, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 3d., or 15 cents, or 30c., or 70g/.


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## NOTES.

WE are informed that the system of etheric signalling devised by Sir WILLIAM PREECE has been successfully installed for the purpose of placing Rathlin Island in telegraphic communication with Ballycastle. The first message was sent to HIS MAJESTY THE KING on the 31st ult., and the following message was returned in reply:—"Windsor Castle, May 31, 1901. W. MOORE, Esq., M.P., Ballycastle. The KING thanks you for your telegram, and is very glad to hear that wireless telegraph service from Rathlin Island has been successfully established.—KNOLLYS." The distance over which the signals are transmitted is about 10 miles, as the waves go, and we understand that the lengths of inductive wire employed on either side are 1 and 6 miles respectively, the shorter length being on the island. The telephone was used as the receiver, with Morse signals transmitted by means of a "buzzer"—a more rapid if less sensitive arrangement than the Marconi coherer.

OUR legal intelligence this week includes an interesting matter relating to the rights of road authorities over underground telegraph and telephone lines owned by the Post Office, in cases where the road authority is acting upon statutory powers conferred for purposes other than those normally vested in a road authority. In this particular instance the Richmond Corporation, as a condition of consent to the placing of a Post Office line beneath its streets, sought to impose upon the POSTMASTER-GENERAL the stipulation that at any future date he should alter the position of the wire "at his own expense" in the event of the Corporation requiring the alteration "for the purpose of the better or more convenient exercise by them of powers in connection with the tramways," &c., &c. With the precedent of the City of London Corporation before him, the judge could scarcely have come to any other decision than he did, viz., in favour of the POSTMASTER-GENERAL.

IN another column we print an account of a highly interesting research by Prof. NERNST and Herr v. LIEBEN on a new phonographic principle. The collaborators independently arrived at the idea that the variation in the effective resistance of an electrolytic circuit produced either by the formation of a deposit or the polarisation of the electrode, might be utilised to give a record of alterations of current flow capable of being reproduced by a reversal of the order of procedure. The method is analogous to that used by POULSEN in his magnetic phonograph, but differs in respect of the fact that whereas POULSEN causes merely changes of stress in the substance of his steel strip, the present investors probably produce actual alterations of the amount and condition of the matter itself forming their recording band. In the experiments described in the article referred to above, a platinum band is caused to travel past a wooden wedge kept moist by an electrolyte, and while thus passing is exposed to variations of current induced from a microphone circuit. Some change occurs in the condition of the platinum band which allows the vibrations impressed upon it to be reproduced on reversal of the process. The nature of this change is doubtful. It appears not to be due to polarisation alone, because the reproduced sounds can be made stronger by the use of a current from an external source; evidently this could not enhance the differences between the currents generated at differently polarised points of the band. It would rather appear as if there were an alteration of polarisation capacity, due to a physical change in the surface of the band, even to incipient sponginess. The experiments were extended to the use of various electrolytes and of electrodes other than platinum, and met with varying success. For the details of these and for a discussion of other possible causes for the observed effect the translation of the Paper may be consulted with profitable pleasure. We may congratulate its authors on their thoughtful and stimulating inquiry.

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With reference to the supplying of electrical energy in bulk, there is one difference between the problem that has to be solved in this country and that in the United States which is well brought out by Mr. F. G. Baum in the *Electrical World* for May 18th, in an article on "A Simple Diagram Showing the Regulation of a Transmission System for any Load and any Power Factor." The article deals with the system where both the transmission and distribution are made with alternating currents, using only step-up and step-down transformers. In the simplest case considered the regulation of a three-phase star system has been worked out, in which the power to be delivered over a 15 mile line has been taken at 3,000kw., the pressure at the far end having to be kept at 10,000 volts between the neutral and outside, the periodicity being 60 ∾. The particulars given of the transmission cables are, we believe, in accordance with typical American practice and are as follows:—Distance between wires at corners of a triangle 30in., resistance of line 6 ohms, reactance of line 10 ohms, equivalent resistances of step-up and step-down transformers 2 ohms, equivalent reactances of step-up and step-down transformers 5 ohms, capacity negligible.

The diagram worked out from these particulars shows in a very marked degree the difficulty of regulating the voltage efficiently with overhead cables. A difference of power-factor has in this case a considerably greater effect than change of load, the alteration from no load to full load without change of power-factor being about the same as the change from a power-factor of 0·9 to unity at full load. The diagram shows that at full load and power-factor unity the pressure at the generator has to be 11,000 volts to give 10,000 volts on the distributing system, but with a power-factor 0·9 the pressure would have to be increased to 11,900. This difficulty has been a great source of trouble in the United States, and it is on this account that in a large number of instances motor-generators have been used. In this country, on the contrary, where underground cables are exclusively employed, the reactance of the line will be a matter of considerably less importance, and we see no reason why the variation of pressure should not be kept within reasonable limits.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Bolama | May 20, 1901 |

**Latimer Clark Electrical Library.**—It was officially announced at the annual meeting of the American Institute of Electrical Engineers that Dr. S. S. Wheeler had presented to the Institute the Latimer Clark electrical library, consisting of nearly 7,000 volumes, all relating specifically to electricity.

**Henry Angel Memorial.**—It is proposed to found a prize or scholarship at the City of London College in memory of the late Mr. Henry Angel. Mr. Angel was well known as a teacher and writer on plane and solid geometry. Subscriptions will be received and acknowledged by Mr. P. J. Gillbard, City of London College, White-street, E.C.

**Submarine Telegraph Facilities in China.**—The Eastern Extension and Great Northern Telegraph Companies notify that a duplicate cable between Chefoo and Taku has been laid, lessening the risk of interruption of telegraphic communication with the north of China, and facilitating the transmission of traffic exchange with Taku and beyond.

**Speed Indicator Competition.**—The Great Berlin Tramway Co. offers prizes of 8,000 and 1,500 marks for the best speed indicators suitable for use on their tramways. Particulars of the conditions of the competition, and as to the additional royalty that will be paid by the company to the owner of the successful instrument may be obtained from Die Direktion der Grossen Berliner Strassenbahn, 218, Friedrichstrasse Berlin, S.W.

**Subways for Underground Pipes.**—At a meeting of the Society of Engineers on Monday last, Mr. A. T. Allen read a Paper on "Concrete Subways for Underground Pipes," in which a common system of subways was advocated for all pipes and wires in our large towns. The author gave the cost of some subways constructed in London as £15 per lineal yard, Nottingham £10 per lineal yard, and St. Helens £7. 2s. 4d. per lineal yard.

**Continental Practice in Electric Light Stations.**—Mr. Gerald Stoney at a meeting of the Newcastle-on-Tyne Association of Students of the Institution of Civil Engineers read "A Short Note on Continental Practice in Electric Light Stations," in which he deals with the electric lighting stations at Frankfort-on-the-Main and Elberfeld, both of which were designed by an Englishman (the late Mr. William Lindley), and in both Parsons' steam turbines have been largely used.

**Royal Society.**—Among the Papers down for reading yesterday were:—"On the Electric Response of Inorganic Substances. Preliminary notice," by Prof. J. C. Bose; "On Skin-currents. Part I.—The Frog's Skin," by Dr. Waller, F.R.S.; "The Measurement of Magnetic Hysteresis," by G. F. C. Searle and T. G. Bedford; and (in title only) "The Measurement of Ionic Velocities in Aqueous Solution, and the Existence of Complex Ions," by B. D. Steele.

**Mining Lamps.**—Mr. W. O. Wood, in a Paper read before the North of England Institute of Mining and Mechanical Engineers on April 13th, deals for the most part with the Sussmann lamp, which he has used at the Murton collieries since 1897, 1,000 lamps now being in daily use. The lamp as now made with battery weighs 3¼lb. and has a capacity of 5¼ ampere hours at 2 volts, maintaining the lamp for 8 to 10 hours with one charge. The life of the battery has averaged 10 months.

**New Constitution of the American Institute of Electrical Engineers.**—A new constitution was formally adopted by the American Institute of Electrical Engineers at their annual meeting on May 21st. According to the *Electrical World* of New York, the most important changes introduced in the governing rules are the provisions for state and district organisations, the definition of qualifications for full membership, the addition of the two junior past-presidents to the managing body, the increase of full membership dues, and the method whereby the constitution may be amended in the future.

**Personal.**—Dr. Karl Auer Von Welsbach has been made a baron by the Emperor of Austria in recognition of his inventions and numerous scientific works. Baron Auer is 42 years old.

Amongst the gentlemen forming the delegation from the New York Chamber of Commerce now on a visit to London as the guests of the London Chamber of Commerce is Mr. George G. Ward, vice-president and general manager of the Commercial Cable Co., who was present at the visit of the delegates to the King and Queen at Windsor on Saturday last.

**Long-Distance Transmission of Steam-Generated Power.**—The *Western Electrician* of Chicago for May 11th gives a short account of the power plant of the Cochiti Gold Mining Co., near Bland, N.M., where the power is being transmitted electrically from a coal mine at Madrid, 32 miles away. The water gas for the generating plant is obtained from a river 8 miles from Madrid, and is forced through 4in. pipes to the coal mine by electrically-driven pumps. It is stated that 50 per cent. more work is done at the gold mine at less than a quarter of the former cost when the old steam plant was used and the coal was hauled to the mine.

**Westinghouse Integrating Wattmeters.**—The *London Gazette* of May 31st announces that the Board of Trade approve

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(May 17, 1901) of the pattern and construction of the Shallenberger alternating current integrating wattmeter for the measurement of electrical energy when supplied on the constant potential alternating current system; and also, that they further approve of the means provided for fixing these meters and for connecting them with service lines. The meter, specifications, and instructions were deposited at the Board of Trade by the British Westinghouse Electric and Manufacturing Co.

**Bristol Electric Lighting Staff Dinner.**—A successful dinner of the present and past staff of the Bristol electric lighting station was held on Saturday evening at the Holborn Restaurant, under the chairmanship of Alderman G. Pearson, chairman of the Bristol electric lighting committee, Mr. H. Faraday Proctor, the electrical engineer to the Bristol Corporation, and several of the present and former staff of the works being present. A large number of former assistant engineers at Bristol are now in charge of electricity stations or filling other responsible posts in various parts of the United Kingdom, and it is hoped that this *réunion* will become an annual event.

**Wireless Telegraphy.**—Coastguardsmen who were signalmen of the higher standard are to be trained in wireless telegraphy at Portsmouth, so that they may take charge at the signal stations which have recently been fitted with the Marconi system. It was intended by the Admiralty that the places should be held by naval signal ratings, but these are none too abundant, and the men cannot be spared from their ships.——The first Government installation of Marconi's wireless telegraphy on the coast is being set up at Dover, the site being on the western fortifications overlooking Shakespeare's Cliff, near the coastguard station. The mast is in three sections, and will be 180ft. high when erected. The installation is to be for the service of vessels of the navy to enable them to communicate with the shore.

**Greenwich Observatory.**—Saturday, the 1st inst., was the date for the annual statutory visitation at Greenwich Observatory. The report published in *The Times* states that during the past year the effect of electrical railways and tramways on the magnetic results has been carefully studied. The London County Council propose to adopt for their electrical tramways in the neighbourhood a system of well-insulated returns, and if other companies do the same it would seem that little disturbance is to be feared. The copper dampers on the magnets, which have been in use for 60 years, were recently adopted at the French observatory at St. Maur, where they reduced the oscillations caused by electric tramways to one-tenth of their amount. This was verified at Greenwich by temporarily removing the dampers, the disturbances increasing to ten times their former amount. It is hoped that the employment of higher-conductivity copper will further diminish these disturbances.

**French Cable Schemes.**—Reports of a more or less definite nature as to the submarine cable schemes which the French Government are said to favourably entertain are being discussed in the French press, and a Dalziel telegram states that a French cable from Brest to Dakar, West Coast of Africa, has been definitely decided upon and the work of laying the cable is to be shortly undertaken; also, that several short lines connecting up French posts in the Far East have been decided upon. Plans for a Government controlled "all-French" Atlantic service is said to be under consideration. Another report is to the effect that a network of submarine cables aggregating nearly 10,000 miles in length and estimated to involve an ultimate outlay of £6,000,000 sterling is developing. These reports appear to be a revival of a subject which has already received considerable attention in the French Chamber of Deputies, and the proposed lines have been fully described in our columns from time to time. The well-informed *Times* Paris correspondent considers that these projects will be favourably received by the Chamber and that the necessary moneys will be voted, either in whole or in large part.

**Municipal Trading.**—An interesting letter from the pen of Mr. A. F. Jeffreys, M.P., referring to the case of the Huddersfield Corporation Tramways Bill, mentioned in our leading article this week, appeared in yesterday's *Times*. Mr. Jeffreys, who was chairman of the House of Commons Committee before which the bill came, gives the facts of the case as follows:—

> Powers were sought by the bill to enable the Corporation to make and maintain steam tramways on a large scale outside the borough area, and the Committee, very properly, in my judgment, refused to sanction these powers outside the borough, because Standing Order No. 170A of the House of Commons lays down that no powers are to be given to any local authority to construct, acquire or maintain any tramway beyond the limits of their district, "except under special circumstances," and the Committee did not see any special circumstances in that particular case, and felt, therefore, bound by the standing order. But the House itself debated the subject, and overruled the decision of its Committee, thus setting, as you say, "a Paliamentary precedent likely to be followed in the future"; and, if this be so, the standing orders relating to tramways surely require alteration, otherwise the Committees will find themselves in the dilemma of either obeying the present standing orders (as they are bound to do) or of following the precedent you mention. In April, 1900, I put a question to Mr. Balfour asking whether, in consequence of the Huddersfield case, he proposed to alter these standing orders, but he replied "that no alteration was possible until the Municipal Trading Committee had reported." I agree with you in hoping that the Committee may be re-appointed, and thus enabled to make a report.

**Birmingham Section of the Institution of Electrical Engineers.**—The committee of the Birmingham local section reports that on receipt of a memorial signed by 78 local members of all classes, the council of the Institution of Electrical Engineers granted powers at a meeting on June 25th last year for the formation of a local section of the Institution in Birmingham. The area included by the local section was defined as consisting of the three counties of Warwick, Stafford and Worcester, notices of meetings, however, being sent on application to any member residing within 50 miles of Birmingham. The membership of the local section now stands at 123—21 members, 34 associate members, 46 associates and 22 students. The committee invite offers of Papers from members of the section for the coming session, 1901-2, with a view to the formation of a complete programme in time for issue to members before the first meeting in November. They would remind members that the success of the section will be dependent largely upon the original Papers received, and the members are therefore asked to realise the need of volunteering to contribute Papers—not necessarily sufficiently original or important for inclusion in the *Journal* of the Institution but with the object of promoting discussions on subjects of interest to members. At the meeting on February 27th, the committee at present in office was empowered to act for next session. Mr. G. S. Ram, however, resigned his place on the committee on March 19th on his transfer to London.

**Students of the Institution of Electrical Engineers.**—The report of the committee of the students' section of the Institution of Electrical Engineers for the session 1900-1901 states that during the session 11 ordinary meetings were held, the average attendance at which was 20. At these meetings six Papers were read, in addition to some of the reports presented to the Institution by student-reporters who visited the Paris Exhibition. A list of these reports and also the Papers which were awarded premiums were included in the abstract of the Council's report in our last issue. The visit of the students' section to Manchester and Liverpool from April 16th-19th was taken part in by 32 students, 11 of whom were from London and the majority of the remainder from the neighbourhoods of Manchester and Sheffield. A number of works were visited, and the committee hopes that the success of the experiment will lead to the arrangement of similar visits in future years. The committee also mentions that it has drawn up a code of rules for governing the students' section, which has been unanimously passed at the annual general meeting of the section. The following gentlemen have been elected as Committee for the coming session:—B. H. Morphy and C. W. Wilkinson, Central Technical College; A. H. Bennett, Faraday House; R. L. Longman, P. G. Mitchell and P. Rayner-Smith, Finsbury Technical College; D. R. H. Browne, King's College; G. B. Dyke, University College; F. J. Hiss, jun., and H. D. Symons, non-collegiate.

**The Boston Elevated Railway.**—According to the *Street Railway Review* of Chicago for May 15th, the elevated railway system of Boston was opened to the public on May 2nd, 34 months after the work was commenced. The Sprague

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multiple-unit system of control has been employed. The elevated tracks have been divided into 85 distinct blocks, the block signals being spaced a distance apart corresponding to one minute in schedule running time—that is, it will take a train at least one minute to run through a block. At each block signal there is an automatic tripping device that will instantly set the air brakes on any train attempting to run past a danger signal. In conjunction with the automatic signals there are eight switching towers, one of which contains 35 levers and two with 28 levers each. The apparatus at five of the towers will be operated by compressed air. It is probable that each morning operation will be commenced with two-car trains, increasing in an hour to three-car trains. During the morning and evening rush four-car trains will be run at one-minute intervals. In the middle of the day three-minute intervals will be maintained. Trains will operate at an average speed of 30 miles an hour, including stops, but can be run at 40 miles if necessary. From tests carried out, it has been found practicable to attain an average acceleration of 2 miles per hour per second when passing from rest to full speed. Each car is mounted on two Baldwin trucks, and is equipped with two Westinghouse 150 H.P. motors, both of which are carried on one of the trucks, known as the motor truck, the other truck being merely a trailer. This arrangement of the motor and the distribution of the remaining weights bring about 64 per cent. of the total weight of the car and its equipment upon the four driving wheels. The motor truck has 33in. wheels, the trailer truck 30in. wheels.

**Glasgow Meeting of the Municipal Electrical Association.**—The sixth annual convention of the Municipal Electrical Association will be held in Glasgow and Edinburgh from June 19th to 22nd inclusive. The programme is as follows:—On Wednesday the 19th, at 9.45 a.m., at the Institution of Engineers and Shipbuilders in Scotland, 207, Bath-street, the Lord Provost of Glasgow will welcome the Association, and the president, Mr. W. A. Chamen, will deliver his address. Subsequently two Papers will be read and discussed:—(1) "Uninsulated Returns in a Tramway System," by Mr. J. H. Rider; (2) "Street Electric Lighting," by Bailie W. Maclay. At 2 p.m. the Glasgow Corporation will entertain the Association at a private luncheon. Works will be visited during the afternoon and the annual Association Dinner will be held in the evening at the Windsor Hotel. Thursday the 20th will be spent in Edinburgh. At 10 a.m. a meeting will be held in the Freemason's Hall, 96, George-street, when the following Papers will be read and discussed:—(1) "Braking Apparatus for Electric Cars," by Mr. A. L. C. Fell; (2) "The Equitable Allocation of Costs in Combined Lighting and Traction Stations," by Mr. W. H. Tittensor. At 1.30 p.m. the Association will be entertained by the Edinburgh Corporation at a private luncheon. The works about Edinburgh will be visited during the afternoon and evening. Returning to Glasgow on Friday, a meeting will be held at 10 a.m. at the same address as that on Wednesday, and the following Papers will be read and discussed:—(1) "Refuse Destructors in Combination with Electric Power Stations," by Mr. J. S. Highfield; (2) "Coal and Ash Conveying Gear," by Mr. R. A. Chattock. Works will be visited during the afternoon, and in the evening the annual general business meeting will be held at 8 o'clock. This meeting will be followed by a final extraordinary general meeting for the purpose, among other things, of passing the following resolution:—"That the assets and liabilities of this Association be transferred to and accepted by the Incorporated Municipal Electrical Association as from the present date." On Saturday visits are to be made to the works of Messrs. Babcock and Wilcox, at South Renfrew, after which a trip on the Clyde will be taken by the members. Further particulars are obtainable of the secretary, whose temporary address after the 12th inst. will be "Windsor Hotel, Glasgow." We are requested to announce that visitors are cordially welcome to the convention, and can obtain the necessary tickets on application to the secretary.

**Gravity Cells for Alkali Production.**—In the issue of the *Zeitschrift für Elektrochemie* for May 2nd Adolph publishes the results of laboratory experiments relating to the "bell" or "gravity" method of producing caustic alkalies and chlorine by electrolysis. The principle of this method consists in the use of a bell jar as anode chamber in the cell, and in the absence of diaphragms. The current passing between the anode and cathode thus travels round the lower or free edge of the bell with a minimum loss of E.M.F., and while the chlorine gas collects in the upper part of the bell the sodium or potassium hydrate formed at the cathode descends by gravity to the bottom of the containing vessel, and can be removed by a syphon or other similar arrangement. Using this form of apparatus with platinum anodes and a 25 per cent. solution of potassium chloride as electrolyte, Adolph obtained current efficiencies of 99·86 and 99·15 per cent. in experimental trials lasting 3½ and 7 hours respectively. With carbon anodes the current efficiencies were not so high, and only reached 92·97 and 92·68 per cent., with solutions of similar concentration, during experimental trials lasting 24 hours. The difference in the results is partly due to the increased time during which diffusion of the two layers in the electrolyte occurred, and partly to the more rapid formation of oxychlorine compounds when carbon is used as anode material. In order to ascertain whether the losses arising from diffusion could not be prevented, Adolph carried out a third series of experiments with a cell designed for continuous operation, the chlorine solution being fed continuously into the upper portion of the "bell" or anode chamber, and the solution of hydrate being removed in equivalent volume from the floor of the containing vessel, so that the levels remained unaltered. Working in this way with a flow of 1 litre of solution per day, Adolph obtained an average current efficiency, as regards hydrate production, of 82·1 per cent. in an experiment lasting seven days. These results are important, and are worthy of consideration by those engaged in the practical application of the electrolytic methods to alkali manufacture. The difficulty with this method has hitherto been to minimise the losses due to diffusion of the hydrate into the anode compartments of the cell. As Adolph points out, these losses increase rapidly with increase of temperature; and the saving effected by a reduced E.M.F. is more than swallowed up by the waste of energy involved in the electrolysis of hydrate and in the formation of chlorate or hypochlorite at the anode. The conditions which the recent investigation of Adolph have proved requisite in order to obtain satisfactory results with the "bell" method are: (1) Maintenance of a definite relation between the heights of the anode and cathode in the inner and outer portions of the cell; (2) a low temperature; (3) regularity of flow of fresh electrolyte into the anode chamber, and adjustment of this to the work of the cell; (4) maintenance of as great a difference as feasible between the strength of the inlet and exit solutions. It is possible that the failure of the Richardson and Holland process at St. Helens was brought about by the non-recognition of one or more of these conditions essential to success; and that with the initiation of further trials upon an industrial scale gravity processes may be proved to have practical value. The advantages arising from the absence of diaphragms and simplicity of cell construction are self-evident. It is significant that Hausserman in a recent report upon the electrolytic alkali industry, has stated that at Aussig, in Austria, alkalies and bleach are being produced by a gravity process at the rate of 8 tons per day with a current efficiency of 87·5 per cent. If this statement be correct the mercury processes will not hold undisputed sway in the electrolytic alkali industry.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TUESDAY, June 11th.**

INCORPORATED GAS INSTITUTE.

*10 a.m.* Annual General Meeting at the Royal United Service Institution, Whitehall.

**WEDNESDAY, June 12th.**

INCORPORATED GAS INSTITUTE.

*10 a.m.* Annual General Meeting. Second Day.

**THURSDAY, June 13th.**

INCORPORATED GAS INSTITUTE.

*10 a.m.* Annual General Meeting. Third Day.

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House, W.

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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Velocity of Different Ions.*—Previous researches undertaken by D. Child have shown that when a discharge passes between a flame and a neighbouring metallic plate, the quantity discharged varies nearly in proportion to the square of the difference of potential and inversely as the cube of the distance. The velocity of the positive ions varies from 2·85cm. to 1·45cm. per second for a potential gradient of 1 volt per centimetre, and that of the negative ions from 4·66cm. to 2·03cm. per second. These experiments, showing an average of 25 per cent. excess of velocity of negative over positive ions, are in striking contrast to the measurements made with the electric arc, where the positive ions exceed the negative ions in velocity by 100 per cent. Zeleny's method of measuring the velocities of X-ray ions was applied by the author to the arc, and the positive ions again showed double the velocity of the negative ones. The author has since investigated an arc between mercury electrodes through mercury vapour, where no second substance intervenes. The greatest potential gradient was then at the anode, so that the positive ions move fastest. The author makes the interesting proposition that whenever gases are ionised the negative ions move most rapidly, but whenever metallic vapours are ionised the positive ions move most rapidly. This would be an important generalisation.

[D. Child, *Phys. Zeitschr.*, May 18, 1901.]

*Electric Oscillation Experiment.*—H. Pellat describes an experiment which appears somewhat paradoxical at first, but which is easily explained by electric oscillations. Two condensers of very unequal capacities, say a battery of six large jars and a small Leyden jar, are placed in connection by means of a commutator mounted on ebonite columns, so as to be able to deal with high potentials. All the armatures, or at least three of them, are insulated. Two discharging rods are attached to the small condenser, and they show a spark when the difference of potential reaches a sufficient value. If now the condensers are charged so as to give them only half the charge necessary for producing sparks, or even a little less, and the connections are reversed, the spark passes between the rods. Since the reversal makes the positive coating of one condenser communicate with the negative coating of another, the difference of potential should diminish. Nevertheless, the discharge shows that at a certain moment the difference of potential between the coatings of the small condenser must have doubled at a certain moment. This is of practical importance as showing that reversal of connections may produce dangerous potentials. The author gives a full explanation based upon the current theory of electric oscillations.

[H. Pellat, *Comptes Rendus*, May 13, 1901.]

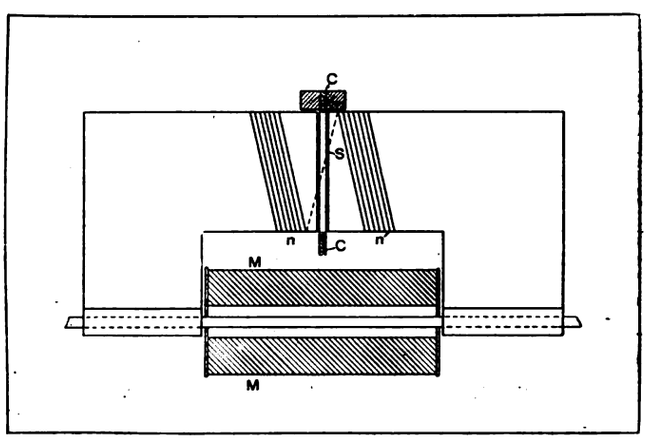
*A Perfectly Astatic Galvanometer.*—M. Lippmann describes a galvanometer which is quite independent of the magnetic field of the earth. The principle is the following: A magnetic needle is suspended by a cocoon fibre and allowed to settle in the magnetic meridian. The poles project into coils whose axis is oriented in the same way, and which are traversed by the current to be measured. Hence the needle is displaced in the direction of its own length, and as the earth's magnetic field does not tend to displace a needle in the direction of its own length, that field is without influence upon the displacement, and is as good as non-existent. The needle is, therefore, perfectly astatic. Its suspension is attached to one arm of a torsion balance, which gives the resistance to the displacement. That resistance can be made as small as desired, and the sensitiveness of the apparatus can be thus increased indefinitely. In a galvanometer devised by Becquerel the needle is attached to the arm of an ordinary balance, and sucked into a coil in the same manner. But it is obvious that the substitution of a torsion balance for an ordinary balance greatly increases the sensitiveness. The author obtained the best effects by using a thick and heavy needle strongly magnetised. He gives the mathematical theory of the instrument.

[Lippmann, *Comptes Rendus*, May 13, 1901.]

*Permeability of Nickel Steels.*—René Paillot has employed the "isthmus" method for measuring the permeability of nickel steels in intense magnetic fields. Truncated pole-pieces, with a semi-angle of 60° 30′, were attached to a Du Bois electro-magnet, and gave a uniform field over a space 0·33cm. long and 0·6cm. wide. Bars of the metal to be tested, 0·32cm. in diameter, were suddenly withdrawn from between the pole pieces, and the inductions measured by a ballistic galvanometer. The first series of measurements was made with samples of "irreversible steel" containing 24·1 per cent. of nickel and 0·3 per cent. of carbon. It was shown that there is a distinct increase of permeability in raising the field intensity from 20,000 to 30,000 units. On the other hand, two samples of "reversible steel" containing some 27 per cent. of nickel retained a constant permeability while the field varied from 4,000 to 30,000 units. This is quite in accordance with Guillaume's predictions. When the steel, besides the addition of nickel, contained also small quantities of chromium or manganese, the permeability showed a decided diminution of permeability with increasing field intensity.

[R. Paillot, *Comptes Rendus*, May 13, 1901.]

*Yoke for Measuring Hysteresis.*—Hopkinson's bar and yoke method of studying the magnetic hysteresis in iron necessitates either breaking the continuity of the magnetic circuit




in the specimen to be examined or using the "step-up" method. The difficulties presented by a large air-gap are overcome in a yoke designed by D. B. Brace and described by Z. Crook. It is divided into two equal parts (see diagram). The two halves are mounted on a solid base, and so arranged that the slot S may be varied in width or be completely closed up at pleasure. Uusually, however, the width is reduced to one or two tenths of a millimetre. It was found that even within these narrow limits it was possible to use a test coil, C, of sufficient number of turns to give accurate readings for weak fields. The magnetising solenoid M consisted of 1,000 turns of copper wire. To equalise the induction in the yoke and the rod, compensating coils, $n$, $n'$, of a few turns of wire were used.

[Z. Crook, *Am. J. Science*, May, 1901.]

**A Steam-Driven 22,000-Volt Transmission Plant.**—The plant of the United Electric Gas and Power Co. at Santa Monica, Cal., is described in the *American Electrician* for June. Five steam plants in different towns have been replaced by the one plant, with a saving of about 50 per cent. in the cost of fuel and labour. The largest distance over which current is supplied is 35 miles. The current is generated at 2,200 volts, 60 ~ per sec., and transformed up to 22,000 volts. As in all steam plants in Southern California, crude oil is burned for fuel.

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# WIGAN CORPORATION ELECTRIC SUPPLY AND TRAMWAY WORKS.

During the past few weeks the long contemplated electrical scheme of the Wigan Corporation attained a stage which has allowed of the starting of the permanent station and the inauguration of a short length of electric tramway. In this we have the small beginning of what promises to grow to a large and important municipal undertaking. Prior to the starting of the tramway and the permanent station, electric supply for lighting and motors was temporarily provided by means of an 80 H.P. overtype Robey engine and boiler driving a small dynamo built by the General Electric Co. (1900), Ltd., and used in connection with a battery of 130 E.P.S. cells. This battery, which was at that time used on the 230 volt two-wire mains, now serves as one-half of the 460 volt battery across the outers of the three-wire circuits. The new station, as shown by the plan, Fig. 1, is conveniently situated beside the Leeds and Liverpool canal, and it is within but a short distance of the centre of the town. Wigan is a populous and busy Lancashire town that offers as favourable opportunities as any town of its size for the development of electric supply and tramways. The Corporation will be able to cater for their own demand for efficient street lighting as well as for the abundant demand for motors in factories and small workshops; but, as regards the tramways, things are not yet quite in the hands of the local authority. There has been a tramway system in Wigan for some time past, but it is owned by a company and it is not worked electrically. Unless negotiations upon a commercial basis can be concluded the local authority is not yet in a position to acquire these tramways. On the other hand, there are many parts in and around Wigan which might usefully be served by tramways, though at present without them, and upon this new ground the Corporation has commenced its experiment in electric traction, beginning in a small way with only some 2 miles of single-track route with turnouts. Extensions, however, are in immediate contemplation.

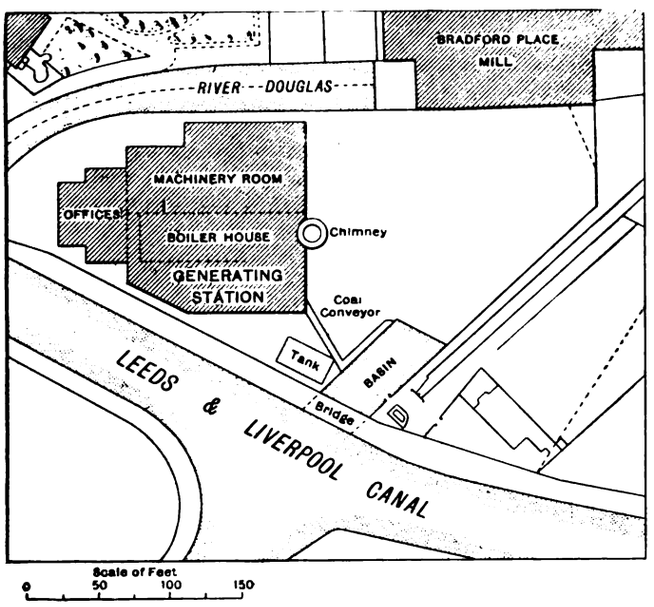


FIG. 1.—PLAN SHOWING SITUATION OF WORKS.

The power-station is a substantial brick structure providing ample accommodation for both present and future needs for some time to come. A general view of the machinery room, so far as it has at present been equipped with plant, is shown in Fig. 2, and it will be noticed that the ample floor-space would admit of much greater concentration of machinery upon occasion. There is also a considerable amount of available unused space at the end of the hall. The arrangements for the switchboard are also shown in Fig. 2, a lofty gallery at one end of the machinery room giving a commanding view of the machinery, and providing space for further extensions of the switchboard. Otherwise an admirable design, this arrangement introduces some little inconvenience and delay in passing from the switch gallery to the floor, owing to the winding stairways. An overhead hand traveller, built by the Bedford Engineering Co., traverses the entire length of the room.

The equipment of the machinery room is entirely on the continuous-current system, with boosters and balancers, for feeding on the two-wire system and distributing on the three-wire system, with battery regulation. There are at present four generating sets, each consisting of a Willans steam-engine direct-coupled to a Byng-Hawkins dynamo. Each set is designed for use either on the supply feeders or on the tramway. Two of the sets are built to deliver 300 amperes each at 500 volts for lighting, or 215 amperes at 560 volts for traction; these sets run at 380 revolutions. The two larger sets are wound for the same voltages respectively, and give 420 amperes for lighting or 300 amperes for traction; the speed of these is 350 revolutions. The spare floor-space would accommodate four more of these larger sets. The

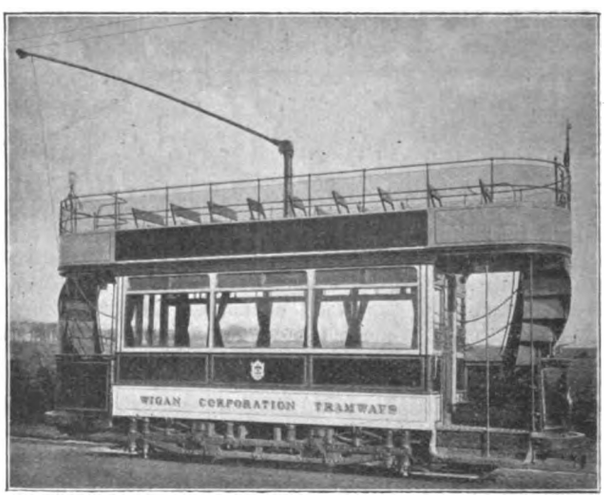


FIG. 7.—ELECTRIC TRAMCAR AT WIGAN.

machinery room also contains two balancing sets, built by the General Electric Company, who were the principal contractors for the equipment of the station. These are also shown in Fig. 2. Other balancers are placed in sub-stations in various parts of the town. The capacity of each of these machines is 50 amperes at 230 volts. At present five sub-stations have been thus equipped. In the machinery room, beneath the switch gallery, three motor-driven boosters have been installed, as shown in Fig. 3. The switchboard and auxiliary switch arrangement have been carried out by Messrs. Dorman and Smith, to the designs of Mr. H. Collings Bishop, the Corporation electrical engineer. A view of the main board is shown in Fig. 4. One of the broad features of the switchboard is that it is entirely on the two-wire system, and is arranged so that all the supply feeders are placed direct on general 'bus bars at the same voltage, regulation being effected on each feeder by means of the boosters. Separate 'bus bars are, of course, used for the tramway feeders.

Within the boiler house, Fig. 5, which adjoins the machinery room along the left side of Fig. 2, there are four Babcock-Wilcox boilers, with spare space for two boilees of the same size. All the boilers are stoked by means of motor-driven chain-grate stokers. The arrangement of the steam piping, which was erected by Messrs. Crompton & Co., is shown in Figs. 2 and 6. A pump room adjoining the boiler house is equipped with three Weir feed pumps and three vertical

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compound circulating pumps by the same makers. Among the other items in the steam and water arrangements are a Berryman feed-heater, a Green economiser and Körting ejector condensers. There has also been erected in a separate house near the main building a water-softening plant on the Archbutt Deeley system. This has been erected by Messrs. Mather and Platt, and is capable of softening 6,000 gallons of water per hour.

and are of their well-known type. There are at present eight feeders, five of which are for the general supply and three for the tramway. All the feeders are drawn into Doulton earthenware conduits. The cast-iron boxes for the distributors were made by Messrs. Picksley, Sims & Co., of Leigh.

We have already mentioned that the existing electric tramway is independent of the general town tramway system, and compulsory surrender of the latter cannot be enforced by

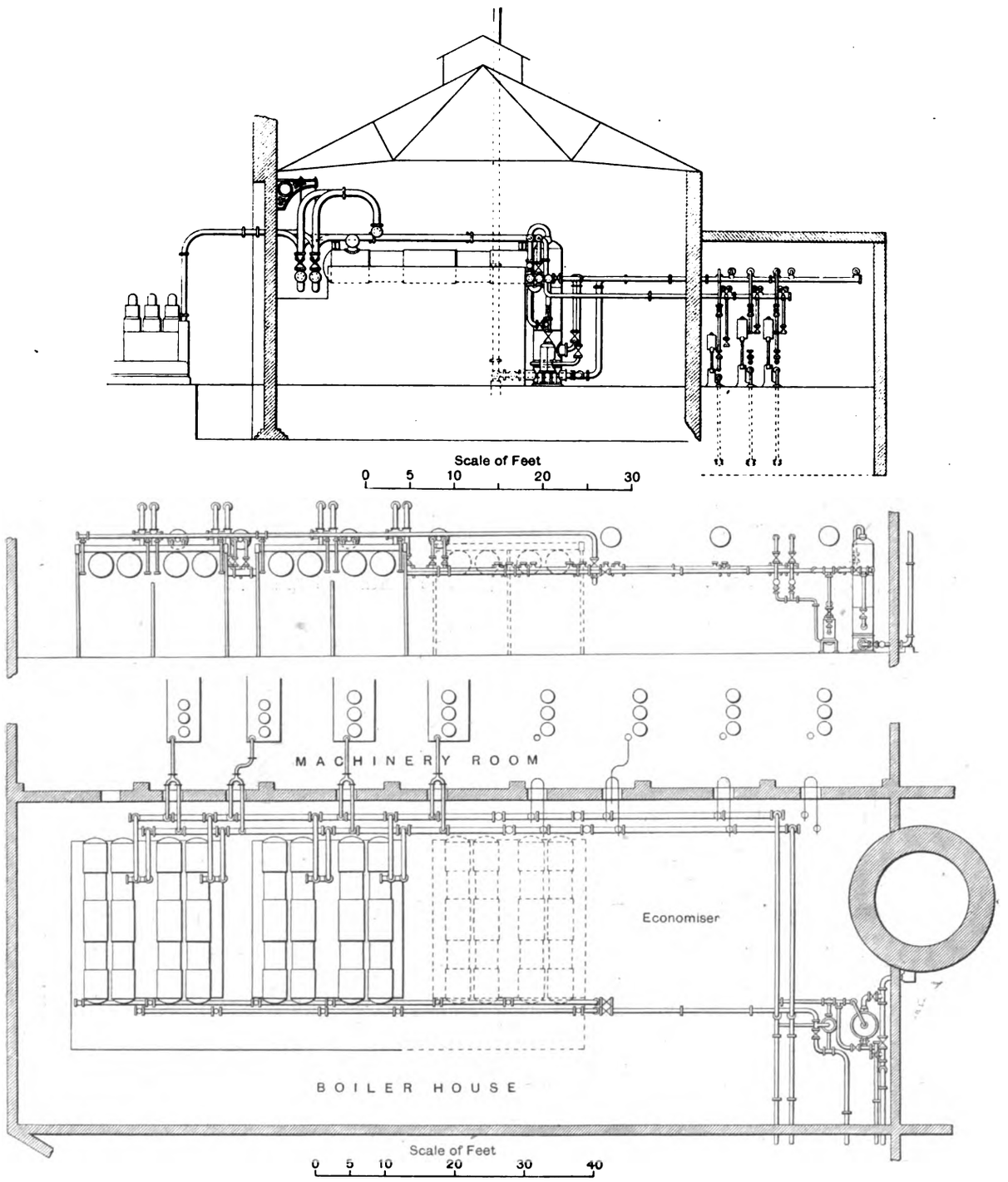


FIG. 6.—ARRANGEMENT OF BOILERS AND STEAM PIPING.

Adjoining the side of the machinery room remote from the boilers the battery room has been erected. Here are installed 280 E.P.S. cells coupled in series in a single battery without a third-wire connection. Each cell consists of 15 plates in a lead-lined wooden box, and has a capacity of 75 amperes discharge for 10 hours or 300 amperes for one hour.

Leaving the station, we may first notice that the mains have been supplied throughout by Messrs. W. T. Glover & Co., the Corporation for some 14 years to come. Efforts have been made to effect a purchase on another basis, but have thus far been unsuccessful. The gauge of the new line is 3ft. 6in., and the track has been laid out by Mr. W. Bolton, the borough engineer, and equipped on the overhead system by Mr. Bishop and his staff. The rails were supplied by the Barrow Hematite Steel Co., and the well-known firm of Messrs. Askham Bros. and Wilson have, as usual, supplied



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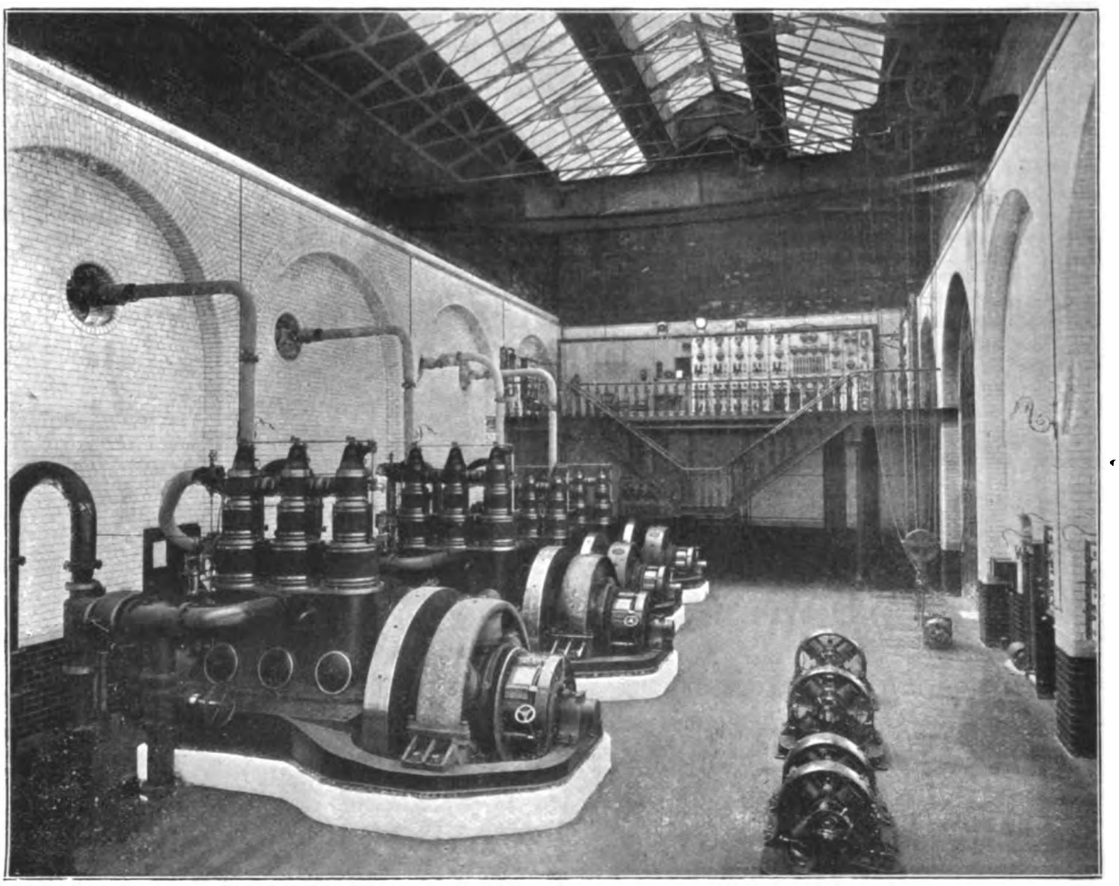

FIG. 2.—WIGAN: MACHINERY ROOM, SHOWING SWITCHBOARD GALLERY.

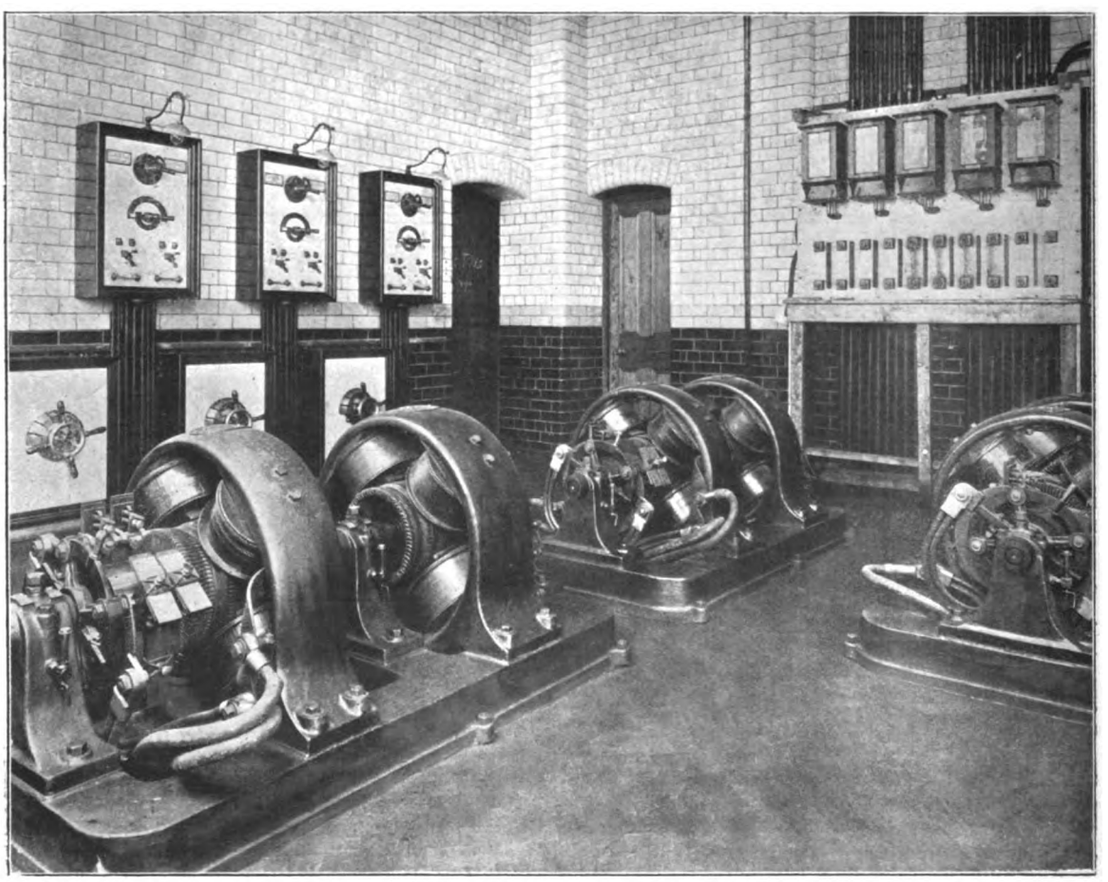

FIG 3.—WIGAN: VIEW OF BOOSTERS AND REGULATING GEAR.

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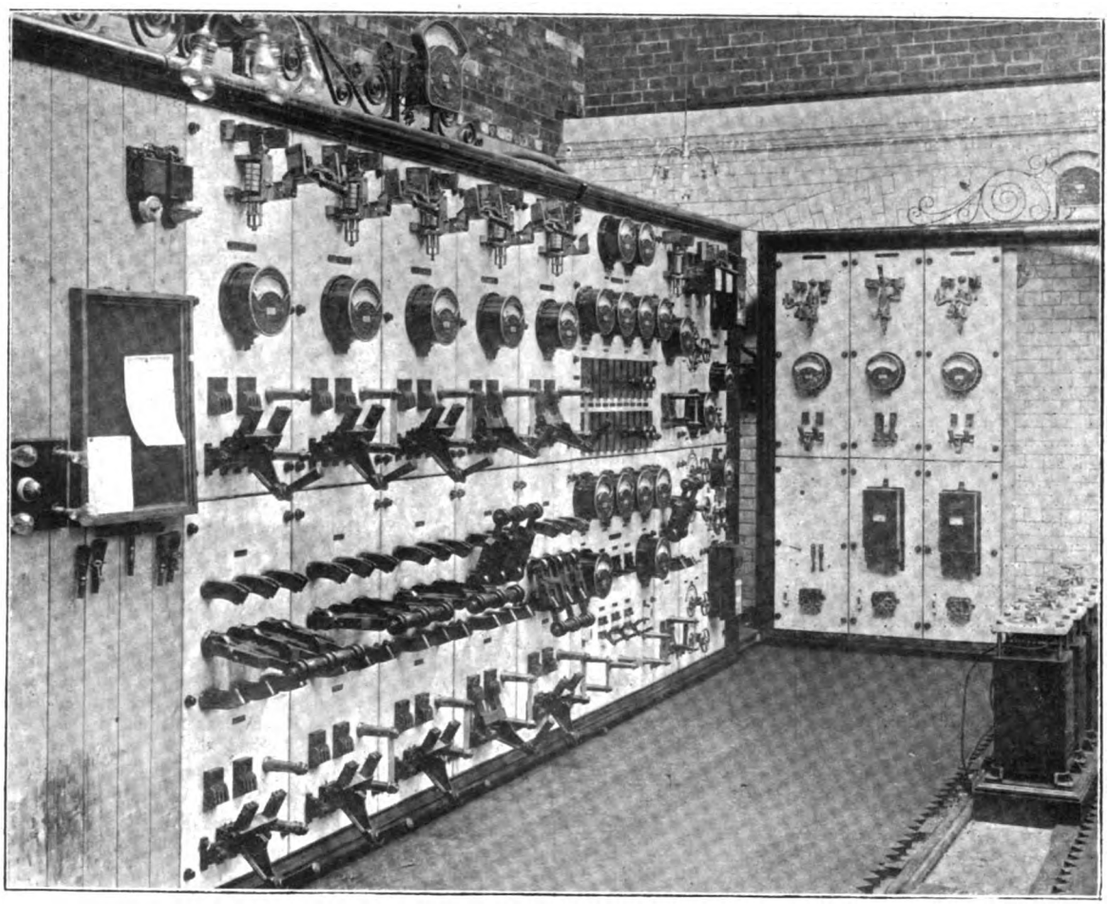

FIG. 4.—WIGAN: VIEW OF THE MAIN SWITCHBOARD.

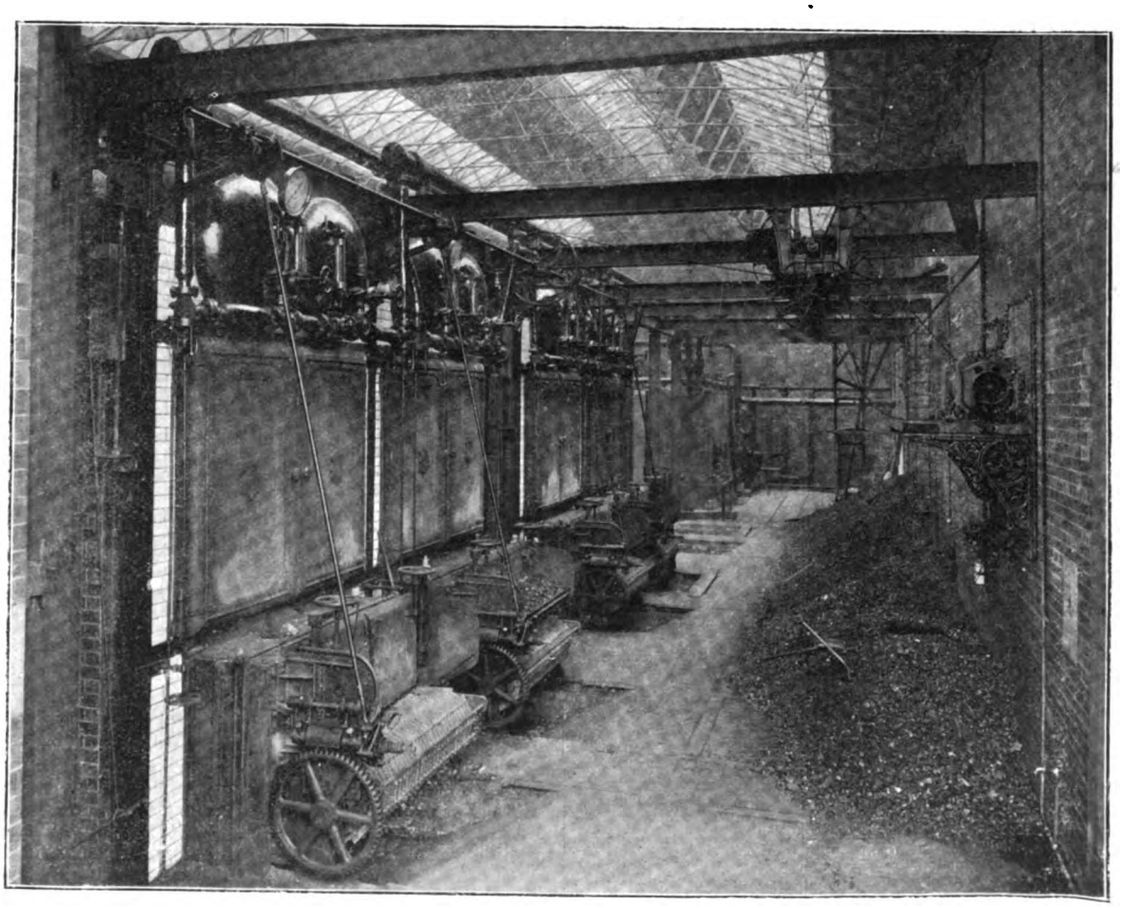

FIG. 5.—WIGAN: INTERIOR OF BOILER HOUSE.

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all the points, crossings, &c., for the line. Messrs. R. W. Blackwell & Co. supplied the trolley equipment, which has been effectively put up by the electrical engineer's staff. Not more than two or three cars are required for this short line at present, but other cars are being built, and there is ample space for these in the well-constructed car shed near the terminus of the line. These cars have been furnished by Messrs. Dick Kerr & Co., and were built and equipped at the Preston works. Fig. 7 illustrates one of these cars, from which it will be seen that the rigid-truck double-deck type has been favoured, as being the better suited to the narrow streets and sharp curves of Wigan.

We give below a list of the contractors, sub-contractors, and manufacturers associated with this interesting piece of engineering work, and in conclusion we wish to express our thanks to Mr. H. Collings Bishop for the assistance he kindly rendered in the preparation of this article :—

| | |
|---|---|
| Equipment of power station ..... | General Electric Co. (1900), Ltd. |
| Engines ..... | Willans and Robinson. |
| Boilers, &c. ..... | Babcock and Wilcox. |
| Coal conveyer ..... | Chain Belt Engineering Co. |
| Water softener ..... | Mather and Platt. |
| Feed and condensing pumps ..... | G. and J. Weir. |
| Condenser ..... | Körting Bros. |
| Steam pipes, &c. ..... | Crompton & Co. |
| Switchboard, &c. ..... | Dorman and Smith. |
| Accumulators ..... | Electrical Power Storage Co. |
| Cables ..... | W. T. Glover & Co. |
| Trolley details ..... | R. W. Blackwell & Co. |
| Trolley cars ..... | Dick Kerr & Co. |
| Track rails ..... | Barrow Hematite Steel Co. |
| Points, crossings, &c. ..... | Askham Bros. and Wilson. |
| Bracket arm hangers ..... | Bergtheil and Young. |

## THE ELECTRICAL EQUIPMENT OF THE NEW YORK ELEVATED RAILWAY.*

The most important single factor in the history of New York city transportation has undoubtedly been the present Manhattan elevated railway. Commencing operations in 1878, its four longitudinal lines on Second, Third, Sixth and Ninth Avenues, the two latter lines being the same above Fifty-third-street, were completed in 1880. On February 3, 1899, Mr. G. J. Gould, president of the company, announced to the stockholders that the company proposed to make the change from steam to electricity, and asked for their sanction to this as well as to the issue of $18,000,000 in additional stock for the proposed improvement. This was granted at a special meeting of the stockholders held on February 28, 1899. It will be seen that two years have not elapsed between the announcement of the decision to make the change and the almost practical completion of the plans, power station and track equipment. When completed, the Manhattan plant will supply current to 75 miles of track, aggregating over 70,000 amperes, at 625 volts at the period of maximum load. The power house is located on the East River between Seventy-fourth and Seventy-fifth streets, where the current is generated at 11,000 volts and transmitted at this pressure to seven sub-stations (see Fig. 1), where it is transformed to a voltage of 390, and by means of rotary converters is converted to direct current at 625 volts. The generating station is designed for a maximum capacity of 100,000 H.P., which may, however, be extended to 150,000 H.P. by constructing an addition on a part of the plot left unoccupied.

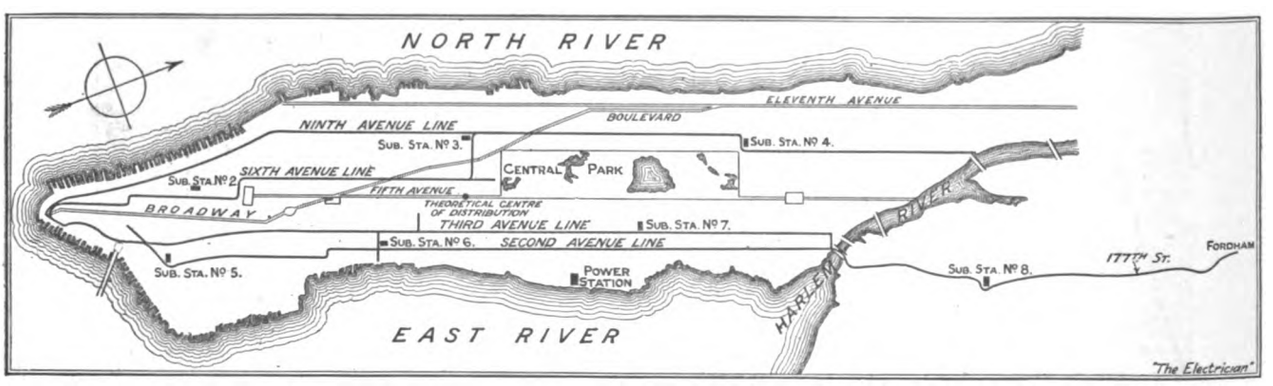


FIG. 1.—MAP OF THE NEW YORK ELEVATED RAILWAY SYSTEM.

As will be seen by referring to Fig. 2, the building is divided by a longitudinal wall into two parts, forming a boiler house 104ft. wide and a generator house 96ft. 6in. wide. The length of the building is 395ft. on Seventy-fourth-street and 413ft. on Seventy-fifth-street. The boiler house contains a basement, two boiler floors, and coal pockets located immediately under the roof. The height from the basement to the top of the monitor is 128ft. The basement is divided into three compartments by two longitudinal walls, in the central one of which are located the pumps, the ashes being handled from the compartments on either side. The coal pocket has a capacity of 15,000 tons.

There are four chimneys, each 17ft. inside diameter and 270ft. high above the basement floor. These chimneys are built of "Custodis" brick, perforated with rectangular holes about 1in. square in the direction of the height of the stack, thus making the cell walls about 1in. thick. These holes serve to bond the bricks in the nature of tenon joints by flushing the mortar into them. The four chimneys contain 30,000 cubic ft. of concrete and 204,000 cubic ft. of brickwork.

A bridge 20ft. wide and 12ft. high extends from the front of the boiler house, at an elevation of 60ft. above the street, to a coal and ash tower, built at the water's edge, in which is located a coal crane. The tower contains a line of ash storage pockets extending along its length for 65ft., from which the ashes will be dumped into barges by gravity, being guided by aprons folding up against the face of the tower when not in use.

The coal will be discharged from barges at the dock and delivered into the bunkers, situated above the boilers, at the rate of 150 tons per hour by means of Mead coal conveying apparatus. In its passage the coal is passed through crushers and weighing hoppers. After leaving the furnaces, the ashes pass through chutes to the basement and are conveyed to an ash pit at the river end of the building by means of dump cars, hauled by an electric locomotive. From the ash pit the ashes are carried to storage bins on the river front by a bucket conveyor.

The boiler equipment consists of 64 Babcock and Wilcox horizontal water-tube boilers of 500 H.P. each, arranged in batteries of two boilers each in four lines. The boilers are capable of sustaining safely 200lb. working steam pressure, and are fitted with Roney mechanical stokers capable of burning either hard or soft coal, either separately or mixed. It is interesting to note that to handle this boiler plant by flat grates and hand firing would require a force of about 270 men, which the employment of mechanical stokers reduces to 90 men.

Sixteen Sturtevant blowers will be used for furnishing forced draught. These are installed as an emergency provision for such contingencies as a sudden increase in load, unusually low barometer, combined with bad coal, neglect or bad judgment on the part of the fireman, or accident to some part of the plant requiring forcing of the remaining units. Two blowers will be located on each boiler floor, one opposite each chimney, and each blower will supply two batteries of boilers. The blowers are 9ft. in diameter, 4½ft. wide, and will be driven by a direct-connected alternating-current motor running at 180 revs. per min.—alternating current motors being employed in this instance for the reason that the blowers will never be called for when the main generators are not in operation.

Sixteen Green economisers are employed, each serving two batteries of boilers. The use of economisers in this plant is more than usually advantageous from the fact that all the auxiliary machinery is electrically driven; there is, therefore, no waste steam which could be utilised in auxiliary heaters for raising the temperature of the feed water. Eight triplex single-acting Gould's boiler-

* This article has been compiled from the *Street Railway Journal* and the *Electrical World* of New York.

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feed pumps will be electrically driven by means of 500 volt direct-current motors.

The engines are being constructed by the E. P. Allis Company and will differ considerably from the types heretofore used in railway power plants. They are of the compound horizontal and vertical cross-compound type, and each unit consists of two compound engines working at either end of a generator shaft. The high-pressure cylinder, which is horizontal, is 44in. in diameter, and the low-pressure or vertical cylinder is 88in. in diameter, the stroke being 60in. and the speed 75 revs. per min. The normal

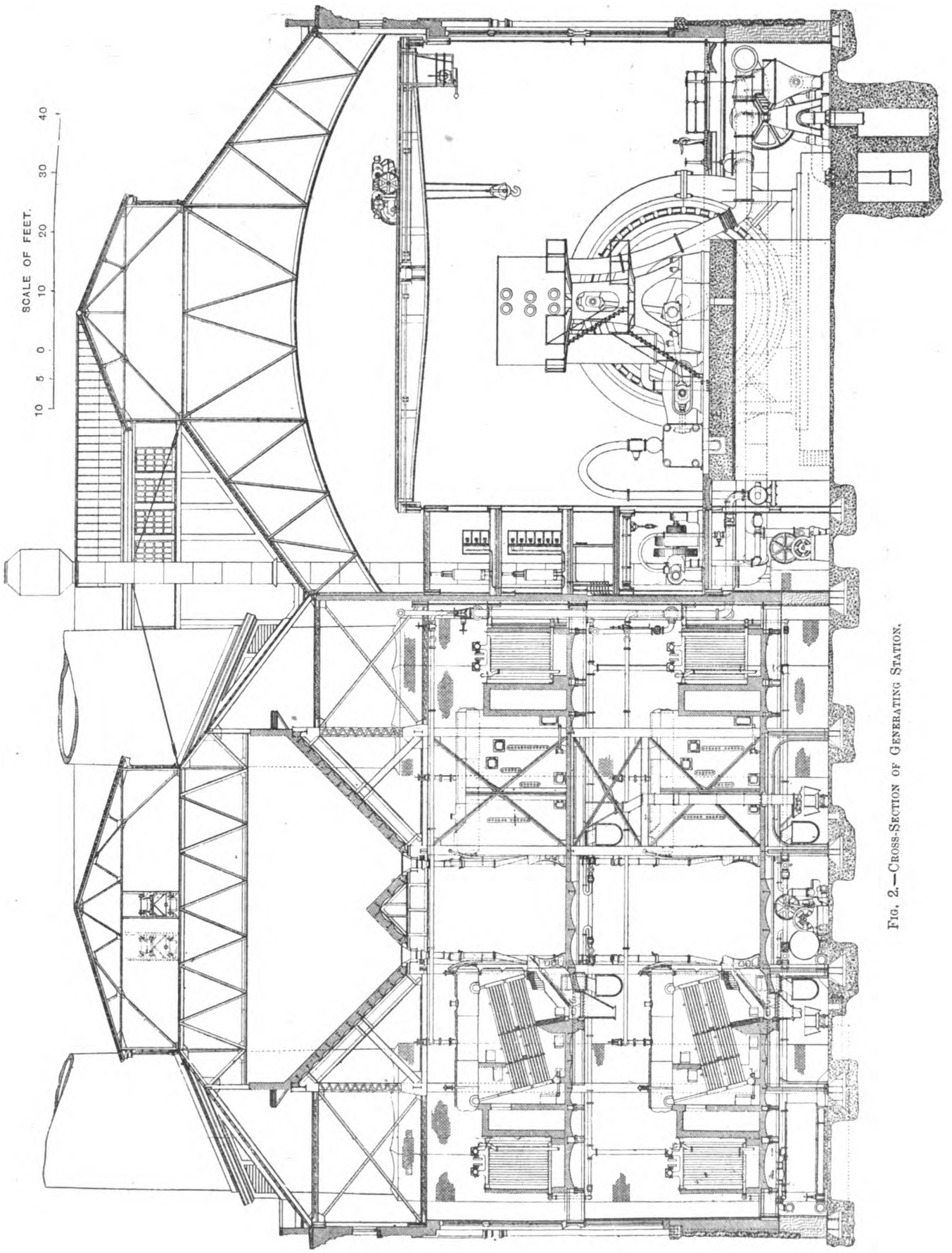


FIG. 2.—CROSS-SECTION OF GENERATING STATION.

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rating corresponds to 8,000 H.P. and the maximum to 10,000 H.P. The eight engine foundations are approximately 40ft. square and 21ft. high, and have an archway through the middle 4½ft. wide.

Under one side of the engine room are condensing tunnels which are of concrete in a rectangular excavation of bed-rock extending 20ft. below the engine room floor. The intake tunnel is 8½ft. wide from the rear of the building to the front, from which point it increases to a width of 14ft. at the river, where the screen chamber is placed. The outlet tunnel is 5ft. wide. The Worthington condensers to be used are in several particulars of unusual design. Owing to the present uncertain state of the art as regards the extraction of cylinder oil from the water of condensation, and the possibility of radical improvements in this direction, it was decided that the installation should consist of jet condensers, so arranged that each can be changed or modified into a surface condenser hereafter, and at a minimum expense. One of the condensers is shown in Fig 3. The air pumps are of the vertical triplex type, driven by a geared direct current motor at 30 revs. per min. when operating in connection with the jet condensers. By changing the ratio of the gearing they may be run at 10 or 15 revs. per min.

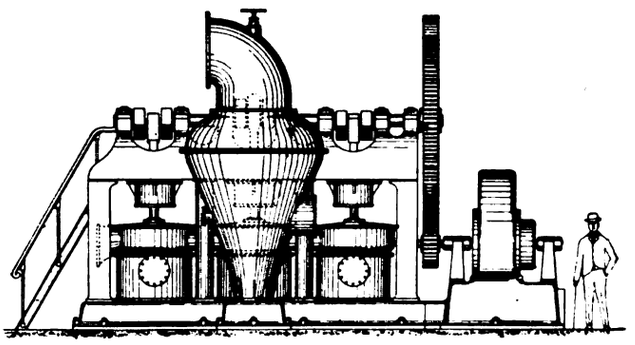

FIG. 3.—JET CONDENSER.

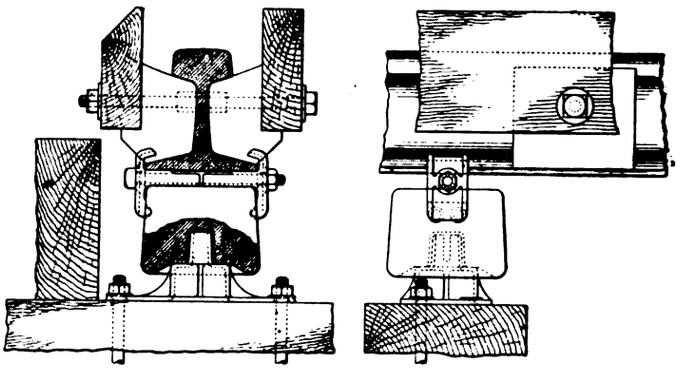

FIG. 4.—METHOD OF INSULATING THE THIRD RAIL

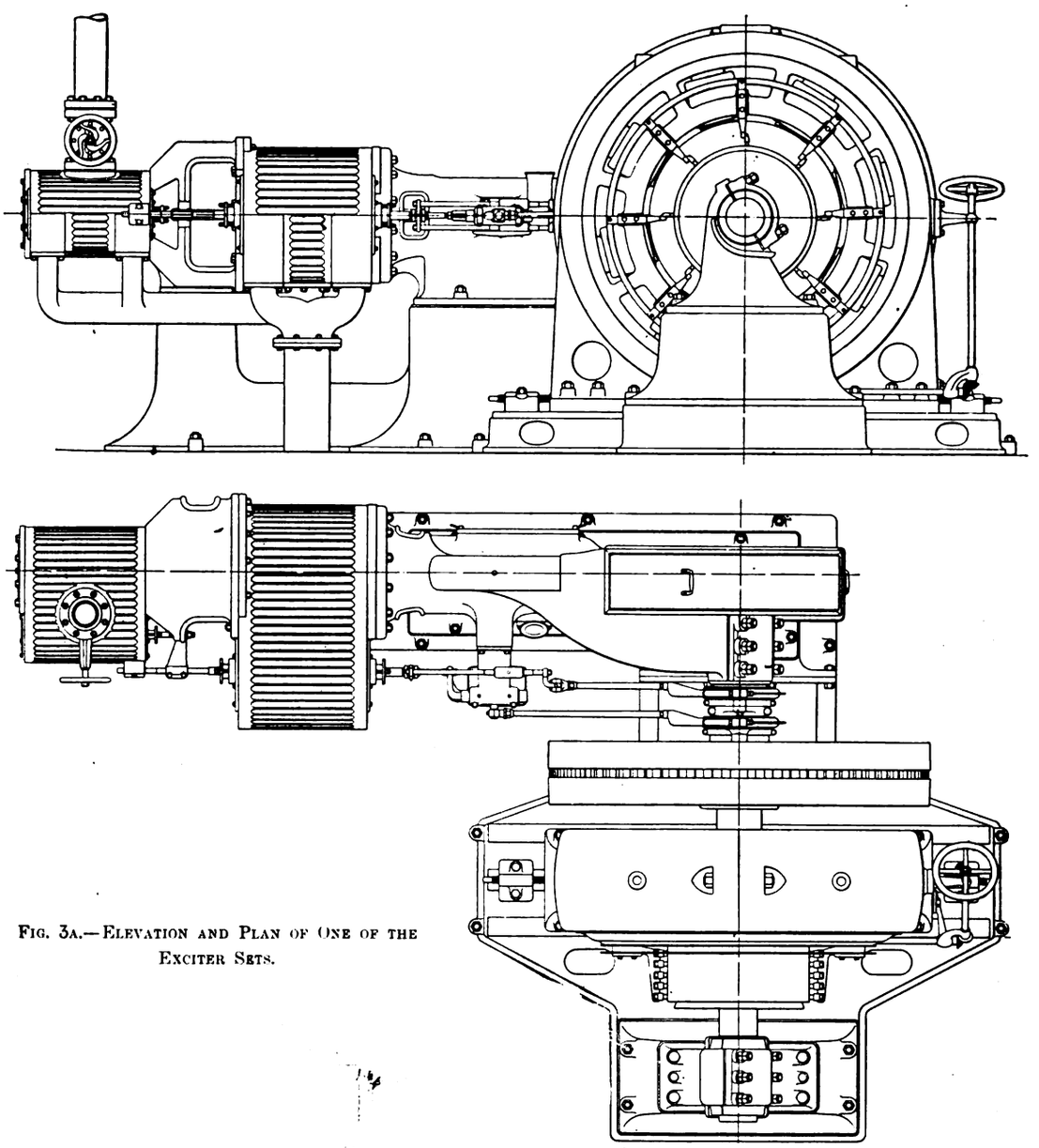

FIG. 3A.—ELEVATION AND PLAN OF ONE OF THE EXCITER SETS.

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when operating in connection with a surface condenser. The circulation of water through a surface condenser will be by means of a centrifugal circulating pump to be directly connected to the free or

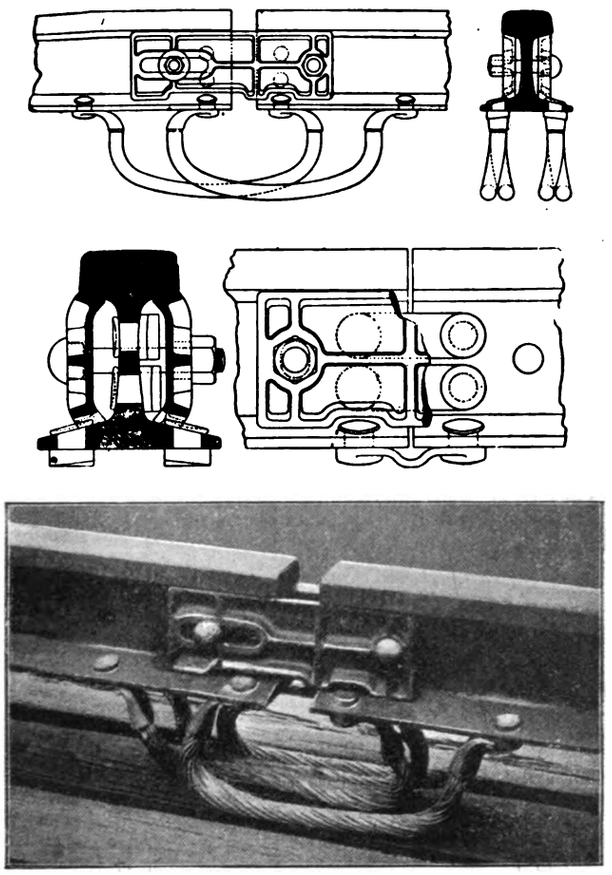

FIG. 5.—METHODS OF BONDING.

outer edge of the electric motor. Whenever it may be decided, therefore, to change this system to a surface condensing system, this may be accomplished by the mere addition of the necessary apparatus, the only portion of the present condensing system to be discarded being the condensing chamber of the jet condenser.

Feed water will be obtained from the city mains, but a centrifugal motor-driven pump will be installed to supply river water to the boilers in case the city water is shut off for any cause. In the latter case salt water will, of course, be supplied, but the occasions when it will be necessary to resort to this measure will be very rare, as storage and surge tanks will provide a supply of fresh water sufficient to run the boilers for four hours at their maximum load. There are eight surge tanks, corresponding to the eight units, which receive the condensation from the steam pipes and re-heaters of the engines, and all the water used in the water-jackets around the engine bearings.

The steam piping consists of eight sections, each section connecting four batteries of boilers to one engine. Eight boilers are arranged in a group opposite an engine, and there is thus secured the shortest distance for the steam to travel. A steam reservoir 36in. in diameter and 24ft. long is installed at each engine, from which a steam pipe runs to each of the two high-pressure cylinders of the engine. The steam reservoirs all connect together through headers. The design of this piping permits of alteration or repairs without any interruption in the operation of the plant. A 42in. exhaust pipe is placed in the basement on the south side of the engine-room, and in the centre of the building a branch runs below the engine-room floor, and is connected to a riser ending in an exhaust head above the roof.

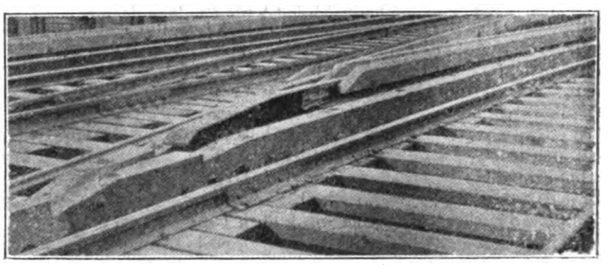

FIG. 7.—END OF AN INCLINE.

The engine room is supplied with a 50-ton electric travelling crane and two small cranes, the latter for the purpose of handling the exciter engines and generators.

The engines driving the four exciters of this plant are of the tandem-compound piston-valve type, made by the Harrisburg Foundry and Machine Works, and have a nominal rating when running at 150lb. steam pressure, condensing, of 300 H.P. at 200 revs. per min. They are direct-connected to 200kw. Westinghouse multipolar generators, shown in Fig. 3A.

As stated above, all auxiliary machinery is electrically driven. For the purpose of starting the plant when the main engines are for any reason temporarily stopped, auxiliaries which are required to operate before the main engine can be started are provided with electric motors wound for 500 volts direct current. The current from the main generators being alternating, it is transformed for this purpose by means of transformers and rotary converters. A small storage battery is provided for the power station

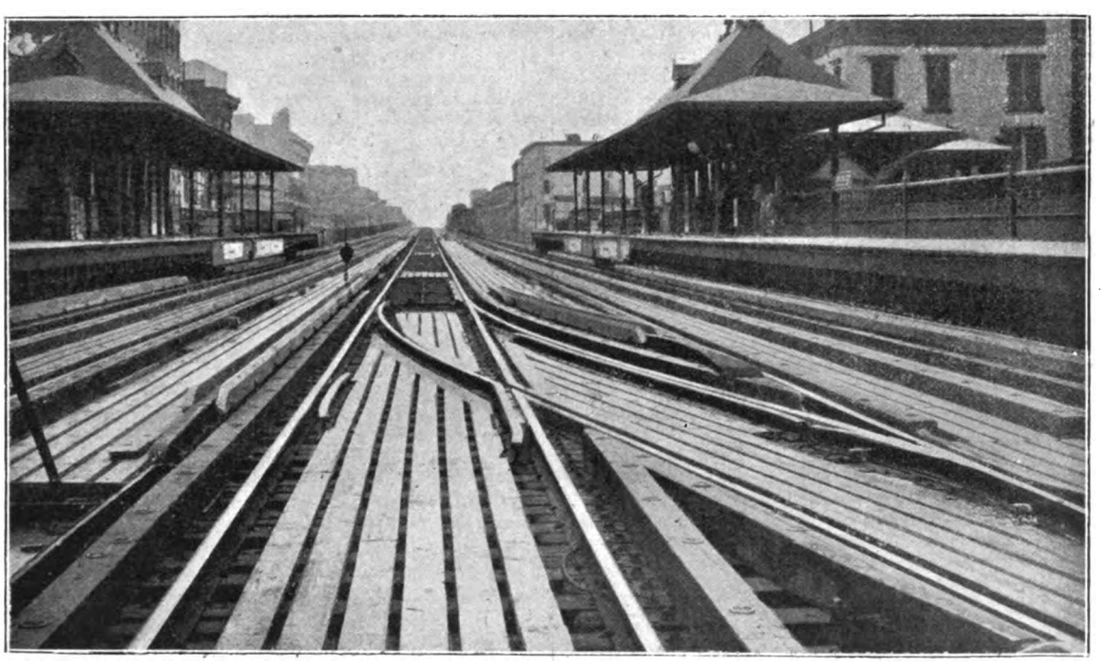

FIG. 6.—GENERAL VIEW OF TRACK SHOWING CROSS-OVER.

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from which the electric auxiliaries can be driven should the main engines be shut down.

The lighting of the power station, sub-stations, passenger car stations, yards and miscellaneous buildings will require the use of 15,000 incandescent lamps and 250 arc lamps. Since the current generated in the power station has a frequency of 25 ∿ per sec, it is necessary to provide apparatus for transforming this frequency to 60 ∿ per sec. in order that both arc and incandescent lamps can be operated on the same circuit. This will be done by the use of motor-generator sets located in the power house and in the several sub-stations. Each motor generator set will consist of a 25-cycle 400 volt three-phase induction motor driving a three-phase alternator generating current at 60 cycles and 2,300 volts.

Each sub-station is made an independent centre of distribution for the lighting load in its vicinity and distributes to the transformers along the line through triple conductor lead-covered cables. Two hundred transformers in two sizes, 3·2kw. and 6·4kw., will be used to reduce the voltage from 2,300 to 110 volts for incandescent lamps. About 100 16 c.p. incandescent lamps will be used at each station. The third rail used on the Manhattan Railway weighs 100lb. per yard, and is rolled in 60ft. lengths. Each section is the standard section of the Lackawanna Iron and Steel Co. An investigation as to the composition of iron giving the best conductivity resulted in the adoption of the following formula:—Carbon, 0·073 per cent.; manganese, 0·341 per cent.; sulphur, 0·073 per cent.; phosphorus, 0·069 per cent. While the use of this formula gives a rail so soft as to be unfit for ordinary railway service, its conductivity is only about one-eighth that of copper, while the conductivity of the traffic rail used by the Manhattan Company is only from one-tenth to one-twelfth that of copper. The third rail has a cross-sectional area equivalent to about 1,560,000 circular mils of copper. Where the length of the track between stations does not exceed 6,500ft., and with car trains running on a 15 miles per hour schedule at one-minute headway, the third rail alone is sufficient to maintain at the end of a section the voltage to within about 10 per cent. of the sub-station voltage under average load conditions. The method of insulating the third rail from the track ties is shown in Fig. 4. A casting bolted to the tie supports an insulating block, to which the rail is secured by a clip. The design of the rail clips is such as to allow the rail to expand lengthwise, and a sufficient clearance is provided to prevent undue strain on the insulators from deflection in the structure girders and jarring of the ties.

In order to provide for the expansion of the third rail it is divided into sections of five-rail lengths of 300ft. each. These 300ft. sections are securely anchored at the centre by sectional anchor clips, and the ends are connected by means of expansion bonds and expansion splice-bars, as shown in the right of Fig. 5. The method of bonding the intermediate rails is the second joint shown on Fig. 5. The cross-sectional area of copper in all of the third-rail bonds is 1,750,000 circular mils, or a little in excess to the equivalent section of the rail. The third rails for two and three-track structures are cross-bonded at 300ft. intervals with cable of 250,000 circular mils section. As will be seen by reference to Fig. 4, there are wooden guard-pieces secured to each side of the rail. These guards extend 2in. above the rail, and act as a safeguard against accidental shocks and burns to employés and also to prevent fallen wire from causing short circuit between the third rail and the traffic rails or other ground connection.

At crossings and turnouts the continuity of the third rail has obviously to be broken. This necessitates the use of various forms of inclines to guide the contact-shoe up and down from the third-rail ends. Some of these inclines are illustrated in accompanying Figs. 6 and 7. Great care is taken to maintain connection with at least one of the four contact-shoes on the motor car while passing turnouts or other special work. Electrical connection between third rail at turnouts is made by cables supported on insulators below the ties.

*(To be continued.)*

## TESTS ON A 500KW. PARSONS TURBO-ALTERNATOR.*

BY PROF. J. A. EWING, F.R.S., M.INST.C.E.

At the request of Messrs. C. A. Parsons & Co. I have made a series of trials of a 500kw. steam turbo-alternator, at the works of the Cambridge Electric Supply Co. This machine was supplied by Messrs. Parsons to the Cambridge Company, and was erected at the company's station in January, 1900. During the last year it has been doing a large part of the duty of the station. The machine was tested in its place in the station, and under the same conditions in all respects as those which hold in its regular work. The tests are, therefore, specially important as showing the behaviour of one of these turbine dynamos under the conditions of daily use, and after it has been in use for a considerable time. The Cambridge Supply Company were good enough to afford all possible facilities for carrying out the trials.

The station log, to which the company's manager and engineer gave me access, shows that the machine began to run on Jan. 20, 1900. By the end of January it had run for 97 hours. In February and March it ran almost daily, taking the heaviest part of the daily load. From the middle of April to September it did duty only from time to time, these being months of light load. In October it ran almost daily. In November a sister machine of the same power was installed, and from that time the two machines were employed to take the load on alternate days.

The machine is a compound turbine of the parallel flow type, running at about 2,700 revs. per min. and governed electrically to give constant volts, with its shaft directly coupled to the armature of a four-pole alternator, generating 250 amperes at 2,000 volts. The exciter armature is on a prolongation of the same shaft. Steam was supplied at 150lb. per sq. inch from a pair of Lancashire boilers, through about 140ft. of a steam pipe for the most part 6in. in diameter. The steam was not superheated, and there was no separator, but water which collected in a pocket under a vertical limb of the steam pipe leading to the engine was from time to time blown off. This, however, was insufficient to keep the steam dry, for the velocity of steam in the pipe was too great to allow much of the moisture to be deposited in the pocket. Evidence that the steam was, in fact, wet on admission to the turbine was given when an indicator was applied to record the variation of pressure in each of the successive blasts by which the steam was admitted. This wetness would, of course, affect unfavourably the results of the tests. The turbine is furnished with a surface condenser, and drives its own air-pump and circulating pump (the latter lifting water 12ft.), by means of a shaft carrying a screw wheel which is driven by a worm on the main turbine shaft. The measured consumption of steam therefore includes what is required to drive these auxiliaries. The discharge from the air-pump was delivered, for the purpose of the test, through a two-way valve into tanks which were filled alternately. The discharge into each was continued until the tank was filled up to an overflow lip in a narrow neck, and the valve was then thrown over, to fill the other tank, any overflow from the lip being collected in a can and emptied into the other tank. The time at which each tank in turn was filled was noted, to the nearest second, and the times were taken continuously from tank to tank during each run in the trials.

To measure the output of the machine a Kelvin watt balance was employed, which at the conclusion of the trial was sealed up and sent by messenger to Glasgow to have its constant re-determined by the makers, Messrs. Kelvin and White. They reported that a small correction in the original constant had become necessary. The corrected constant determined in this way has been used in the reduction of the results. During each trial the readings of this wattmeter were taken regularly every 2½ min. Readings were also taken of a Kelvin electrostatic voltmeter and an ampere-meter. The results of these were in good general agreement with those of the wattmeter, but it is the readings of the wattmeter which have been accepted as authoritative.

The tanks were calibrated by me after the trials by weighing each, with its contents, on a standard platform balance. When filled to the overflow lip with water at 75°F. the weight of the contents was:—

| | |
|---|---|
| Tank No. 1 | 371·51b. |
| Tank No. 2 | 369·71b. |
| Mean | 370·61b. |

The machine was loaded for the purpose of the tests by discharging its current between iron plates in the river Cam. By varying the immersion of one of the plates the load was caused to vary, in successive trials, from 586kw. (an overload of one-sixth) down to zero. Preliminary trials at 535kw. and 300kw. were made on Jan. 8, when the staff of observers, which consisted of my assistants, Messrs. Inglis, Peake, Peel and Sheldrick, with Mr. Wynne, of the Electric Supply Company, were familiarised with their duties. On Jan. 9 the complete series of trials was made without a break, the load being varied from one trial to the next without stopping the machine. On that day, Jan. 9, the machine started at 7:40 a.m., and a load of 520kw. was applied at 8:10 a.m. The test was continued under this load until 10 a.m. The following figures relate to the last 30 tanks during the hour from 9 to 10:—

| Time of filling 10 tanks (3,706lb. of steam). | Mean output in kw. |
|---|---|
| 17min. 2sec. | 514 |
| 17min. 5sec. | 517 |
| 17min. 8sec. | 518 |

Taking the last 10 tanks (after the machine had warmed to its work), the air-pump discharge is 3.706lb. in 0·2856 hours, or 12,970lb. per hour. This is at the rate of 12,970/518, or 25·01b. of steam per electrical unit of effective output. The load was then increased to 586kw., and 20 tanks of air-pump discharge were measured. The time per tank (ranging from 1min. 35sec. to 1min. 32sec.) was sufficient, but not much more than sufficient, to let one tank empty

* A report on trials of a 500kw. steam turbo-alternator at the works of the Cambridge Electric Supply Co.

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while the other was filling. The following are the times for each 10 tanks, with the output :—

| Time of filling 10 tanks. (3,706lb. of steam.) | Lb. per hour. | Mean output in kw. |
|---|---|---|
| 15min. 27sec. | 14,390 | 587 |
| 15min. 35sec. | 14,260 | 584 |

The mean for the whole of this run is 14,320lb. per hour, with an output of 588kw., or 24·4lb. per electrical unit of effective output. The load was then reduced to 273½kw., and 15 tanks were measured, taking 43min. 7sec.; this is at the rate of 7,730lb. per hour, or 28·3lb. per electrical unit of effective output. The load was then further reduced to 160½kw. and 10 tanks were measured, taking 41min. 50sec.; this is at the rate of 5,320lb. per hour, or 33·1lb. per electrical unit. Finally, the load was reduced to zero, the exciter, however, being kept at work so that the volts of the dynamo were maintained. It then took 24min. 12sec. to fill two tanks, which corresponds to a consumption of 1,850lb. per hour. In the preliminary trial of the previous day, with an output of 535kw., the consumption of steam was at the rate of 13,350lb. per hour, and with an output of 300kw. the consumption of steam was at the rate of 8,270lb. per hour.

The following are collected results, as to the consumption of steam at various grades of output, including the preliminary as well as the final trials :—

| Trial No. | | Effective electrical output in kw. | Consumption of steam. Lb. per hr. | Lb. per unit |
|---|---|---|---|---|
| Trials of Jan. 9 ... | 1 | 518 | 12,970 | 25·0 |
| | 2 | 586 | 14,320 | 24·4 |
| | 3 | 273½ | 7,730 | 28·3 |
| | 4 | 160½ | 5,320 | 33·1 |
| | 5 | 0 | 1,850 | — |
| Preliminary trials of Jan. 8 ..... | A | 535 | 13,350 | 25·0 |
| | B | 300 | 8,270 | 27·6 |

The relation of the consumption of steam in pounds per hour to the output in kilowatts is shown in the accompanying curve. It will be observed that the points representing the various trials lie well on a smooth line which is nearly straight. By measurement from the lines so drawn the following figures are obtained :—

| Output in kilowatts. | Consumption of steam. Lb. per hour. | Lb. per unit. |
|---|---|---|
| 600 | 14,600 | 24·3 |
| 500 | 12,500 | 25·0 |
| 400 | 10,400 | 26·0 |
| 300 | 8,300 | 27·7 |
| 200 | 6,140 | 30·7 |
| 100 | 4,020 | 40·2 |
| 75 | 3,550 | 47·7 |
| 50 | 2,840 | 56·8 |
| 0 | 1,850 | — |

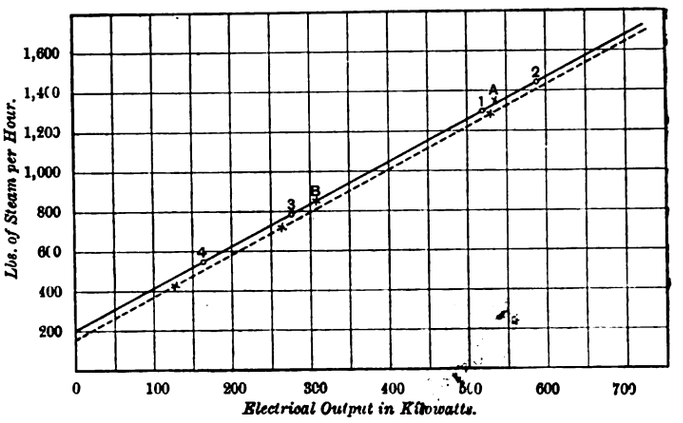
These figures give most satisfactory evidence that the machine working under the conditions of every day use retains its character as a highly efficient electrical generator. The efficiency is well maintained when the load is reduced even to one-fourth or less of its normal amount. Particulars of the pressures, temperatures, &c., in the various trials are given in the table below. The figures stated are, in each case, means taken from logs which were kept throughout the trials.

At the end of the trials on Jan. 9, after the machine had been running under load for five hours, the temperature of the armature was taken and was found to be 118°F. The temperature of the engine room was 77°F. The following copy of tests of the same machine made in Newcastle at the makers' works by the Cambridge Company's engineer, before the machine was delivered, has been supplied to me.

*500kw. Cambridge Machine, No. 723.—Tests made Oct. 27, 1899, by Cambridge Electric Supply Co.'s Engineer.*

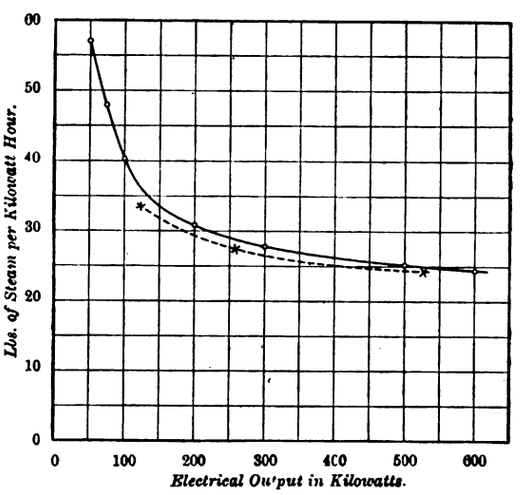
| | | | |
|---|---|---|---|
| Boiler pressure | 139 | 145 | 140 |
| Vacuum | 24½" | 26⅝" | 27⅝" |
| Barometer | 29·6 | 29·6 | 29·6 |
| Water, pounds per hour | 12,675 | 7,029 | 4,180 |
| Average kilowatts | 526·4 | 256·1 | 124 |
| ,, volts | 2,015 | 2,115 | 2,015 |
| ,, speed | 2,750 | 2,750 | 2,700 |
| Pounds per kilowatt hour | 24·1 | 27·5 | 33·7 |

I am informed that these tests were made with dry steam, and the engine was not driving its own pumps. Considering the altered




——— Test at Cambridge, Turbo driving air and circulating pumps.
..... Test at Newcastle, Turbo without driving air and circulating pumps.

Trials of a 500kw. Steam Turbo-Alternator, January, 1901.




——— Test at Cambridge, Turbo driving air and circulating pumps.
..... Test at Newcastle, Turbo without driving air and circulating pumps.

Trials of a 500kw. Steam Turbo-Alternator, January, 1901.

conditions in these two respects, I am of the opinion that the results of the present trials show that there has been no deterioration due to wear.

It was unfortunately impossible at Cambridge to conform to the identical conditions of the makers' tests and to run the turbine

| No. of Trial. | 1. | 2. | 3. | 4. | 5. | A. | B. |
|---|---|---|---|---|---|---|---|
| Electrical output in kilowatts | 518 | 585 | 273½ | 160½ | — | 535 | 300 |
| Volts at terminals of generator | 2,100 | 2,150 | 2,250 | 2,290 | 2,280 | 2,120 | 2,110 |
| Speed in revolutions per minute | 2,670 | 2,740 | 2,630 | 2,590 | 2,580 | 2,880 | 2,800 |
| Air-pump discharge, pounds per hour | 12,970 | 14,320 | 7,730 | 5,320 | 1,850 | 13,350 | 8,270 |
| ,, ,, pounds per kilowatt per hour | 25·0 | 24·4 | 28·3 | 33·1 | — | 25·0 | 27·6 |
| Pressure at stop-valve, pounds per square inch | 148 | 145 | 151 | 151 | 121 | 145 | 150 |
| Vacuum in condenser, inches | 27·8 | 27·9 | 28·2 | 28·3 | 28·3 | 26·6 | 27·6 |
| ,, turbine cylinder, inches | 25·7 | 25·4 | 27·2 | 27·8 | 28·1 | 25·1 | 26·2 |
| Temperature of air-pump discharge °F. | 74 | 76 | 57½ | 56 | 54 | 90 | 68 |
| ,, circulating water, inlet °F. | 40 | 40 | 38 | 39 | 36 | 41 | 39 |
| ,, ,, outlet °F. | 71 | 72½ | 60 | 57 | 46 | 91 | 71 |
| Barometer, inches | 29·93 | | | | | 29·99 | |



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without driving the combined pumps. The original consumption guaranteed by the makers was to include that absorbed by the pumps, and in dispensing with this the makers reduced their guarantee at full load by 1lb. of steam per kilowatt.

The turbo-alternator to which the above tests relate was built from designs made in 1897. Since that date a new type has been supplied, and tests made by Mr. Hamilton Kilgour for the Cheltenham Corporation, and Mr. F. G. Holden for the Scarborough Electric Supply Co., of two sets of 500kw. output are given below. The difference in favour of the former is due to its being of a higher speed, viz., for 100 periodicity against 80 periodicity in the latter case.

| —— | Cheltenham Corporation tests, by Mr. H. Kilgour. | | Scarborough, Mr. F. G. Holden. | |
|---|---|---|---|---|
| Machine number..... .. | 772 | 772 | 770 | 770 |
| Stop valve pressure ..... | 130 | 129 | 126 | 127 |
| Vacuum ..... | 26·7 | 27·2 | 26·8 | 27·65 |
| Load in kilowatts ..... | 553·17 | 275·8 | 529 | 258 |
| Water per hour ..... | 21·7 | 26·2 | 22·7 | 26·4 |
| Volts ..... | 2,120 | 2,000 | 1,990 | 2,000 |
| Speed ..... | 3,000 | 3,030 | 2,400 | 2,500 |
| Superheat ..... | Nil | Nil | Nil | Nil |

## ON TEST-ROOM METHODS OF ALTERNATE CURRENT MEASUREMENT.*

BY ALBERT CAMPBELL, B.A.

The object of this Paper is to describe a number of methods of measurement, some of which are capable of fairly general application, while others are only of use in special cases. Many of these methods are novel, I believe, and most of the others are not well known.

*Section A. Transformer Methods of Measuring Current, Voltage, and Power.*—With alternating currents, however, the measurement of extreme values of voltage and current is not so easy as with continuous currents, and it is for this purpose that transformer methods are specially valuable. In the first method (which is fairly well known) the whole current to be measured goes through the primary coil of a transformer the secondary of which is connected to an ammeter. In Method 2 the current passes through a low non-inductive resistance $r_1$, giving a small voltage drop, which is transformed up so as to give readings on an electrostatic voltmeter. As to Method 1, some years ago I investigated† the conditions by which the ratio of current transformation can be kept sufficiently constant and independent of frequency. I found that it was necessary to have (*a*) an air-core transformer, or one with a well-closed iron circuit; (*b*) relatively low resistance and high inductance in the secondary circuit.

*Method 2.*—It is to Method 2, however, that I wish to draw special attention at present. Here the measuring instrument being electrostatic is unaffected by variations in frequency, and, if of good type, has a very high degree of accuracy. [If a reflecting electrostatic voltmeter be set up in a fixed position, and a scale for it (say, at 2 metres' distance) be drawn by calibration with a potentiometer and direct current, an accuracy of at least 2 in 1,000 is attainable over a large part of the range. In most of the measurements in this part of the Paper I have used such a voltmeter.] For currents from 5 amperes and upwards the resistance $r_1$ should be so small that not more than 0·5, or at most 1 volt, is lost in it. If the voltmeter reads to about 120 volts this necessitates a high transformation ratio, at least 1 : 100, in the transformer. To keep the voltmeter readings proportional to the current I find it best to use a transformer with (*a*) a well-closed iron circuit, (*b*) a highly inductive primary coil of very low resistance (*i.e.*, large time-constant).

It is difficult to thoroughly carry out condition (*b*) without employing a considerable weight of either iron or copper, but very fair accuracy may be attained with a quite small transformer, as the following instance will show. The core consisted of annular iron stampings of total weight about 1·5 kg; the primary coil had 100 turns of No. 16 wire, the secondary 10,000 turns of No. 40; $r_1$ had a resistance of 1 ohm and the resistance of the primary coil was 0·107 ohm. The divergences of the observed ratio $V_2 : C_1$ from the value 10 are shown in Table I. The primary current at 1 volt (86 ∿ per sec.) was 0·17 ampere. By inserting known resistances in the primary circuit the curve in Fig. 1 was obtained, and thus it was proved that these divergences are (practically) entirely due to the ohmic drop of volts in the primary. If such a transformer is to be used on a circuit of nearly constant frequency the ratio of the windings can be altered slightly so as to give an error almost

**Table I.**

| Frequency. ∿ per sec. | Error in ratio. |
|---|---|
| 39 | −1·9 per cent. |
| 86 | −0·8 „ |

negligible, or a few extra ends may be brought out to suit various frequencies. Perhaps an easier plan is to have a small range of adjustment on one of the parallel wires forming the low resistance $r_1$.

It is possible, however, to compensate for changes of frequency by Method 2*a*, shown in Fig. 2. Here the total current C, after passing through the small resistance $r_1$, passes through a turn or two on a very small compensating transformer *t*, whose secondary is connected

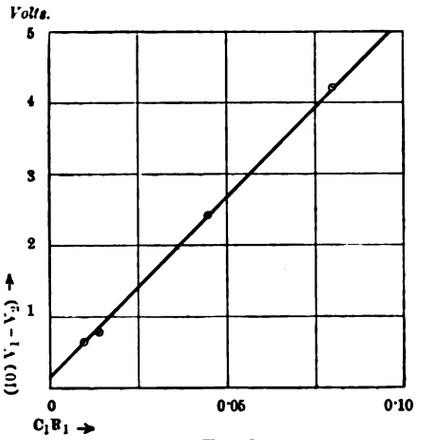


FIG. 1.

(reversed) in series with the secondary of T and the voltmeter. As the frequency is raised, the transformer *t* subtracts more and more from the voltmeter reading and thus compensation can be secured.

The advantages of Method 2 are that with one voltmeter and a set of low resistances a very wide range of currents can be measured; also no disturbing inductance is introduced into the main circuit.

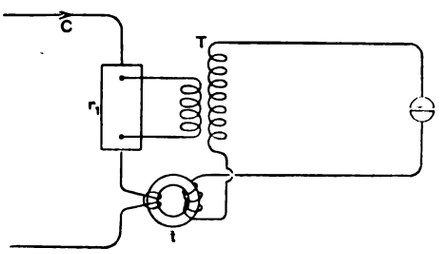


FIG. 2.

It will be noticed that a transformer of high ratio like that described above gives a means of measuring small voltages with very small expenditure of current, but it is mainly to its use in conjunction with a low resistance that I would draw attention.

*Measurement of Power.*—For the measurement of power (or energy) transformers are often of great assistance, and in several well-known types of watt-hour meter they are employed with success. Under

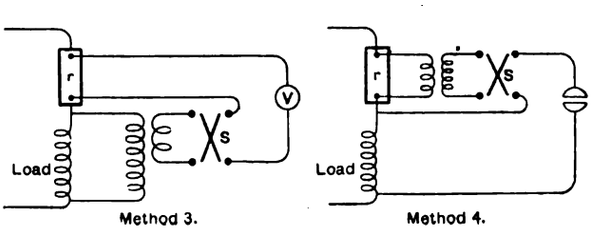


FIG. 3.

this head I shall content myself with mentioning two methods (3 and 4) shown in Fig. 3, the first due to Mr. M. B. Field and the second published recently by myself. In both of these a small resistance *r* is placed in series with the load, and S is a reversing switch. In Method 3 the voltage on the load is transformed down and added and substracted from that on *r*, giving resultants P and Q, measured on a hot-wire voltmeter. In method 4 the voltage drop

* Abstract of a Paper read before the Institution of Electrical Engineers, April 18.

† *Phil. Mag.*, p. 271, September, 1896.

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on $r$ is transformed up, and the resultants P and Q (similarly obtained) are measured on an electrostatic voltmeter. For both methods watts $= (P^2 - Q^2)/4mr$, where $m$ is the ratio of the transformer.

*Method* 4 can be used with fair accuracy to measure power with power factors down to 0·1 or even lower. For this the resistance of the primary of the transformer must be made very small, so that the secondary voltage may be almost exactly in opposite power phase to the primary P.D. (The small angular deficiency may be measured by Method 6 below.) For example, with 50 volts on the load and 50 volts from the transformer, a power factor of 0·1 would give $P - Q = 7$ volts, *i.e.*, the error of reading could be below 2 per cent. even on a voltmeter reading to 100 volts.

*Method* 5.—The three-voltmeter method as usually employed has several disadvantages; these are mainly due to the fact that, in order to get good readings, the auxiliary resistance must use up a considerable fraction of the total available voltage, and, what may be worse, tends to alter the wave-forms in the circuit. In the two-voltmeter methods (3 and 4) this is avoided; there is, however, a simpler modification of the three-voltmeter method which also gets over the difficulty. This is shown in Fig. 4,* where $r$ is a relatively small

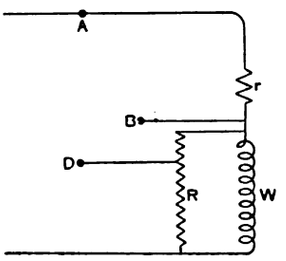


FIG. 4.

resistance, and R a very high resistance in parallel with the load W. A convenient fraction (1/nth) is picked off R by B, D and the three-voltmeter method is applied to A, B, and D. The result multiplied by $n$ gives the power taken by W. In another modification the resistance R is put across both $r$ and W, but a more complicated formula is then required.

*Method* 6.—*Measurement of Power-Phase Differences close to* 180 *deg.*—Let the effective voltages be V and X. (1) Let V be nearly equal to X, and let the small difference V − X be measured by an electrostatic voltmeter and a quick change-over key. Then Q, the small effective resultant of V and X, is found either by a low-reading voltmeter or by the help of a phase turner, or a transformer of high ratio, and an ordinary range electrostatic voltmeter. Then, as will be seen from Fig. 6,

$$\text{Sin } \phi \doteq \frac{M}{X} = \frac{\sqrt{Q^2 - (V - X)^2}}{X}.$$

(2) If V is not nearly equal to X let a high resistance be put across the greater (say V) and $V^1$ a fraction of it picked off as nearly as possible equal X. $V^1$ and X are then combined as in (1). [The transformer must not be used here for measuring Q.]

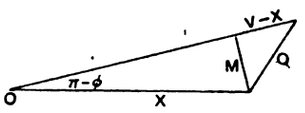


FIG. 5.

I have found the above method useful for measuring approximately the power lag between the primary and secondary (open) potential differences in transformers.

In one case, for example, the lag was found to be (180deg.—0·15deg.). Similarly, the lag between two independent voltages very nearly in phase may be measured by reversing one of them and proceeding as above.

*Section B. The Testing of Watt-hour Meters.* I. *Real Non-inductive Loads.*—When sufficient power is available (at the proper frequency), the tests are usually easy, the chief difficulty sometimes being to find the gearing ratio between the quickest moving part and the dials, for some of the makers cannot be persuaded to mark this clearly on the meter.† Some meters are so much affected by inductance in the load that the introduction even of a small Kelvin balance (to measure the current) is undesirable. The want of a non-inductive ammeter in this and other cases led me, seven or eight years ago, to devise and make a thermal ammeter which, although I exhibit it now only as a curiosity, has some points of interest about it. It consists (Fig. 6) of a form of differential air thermometer in which the bulbs are replaced at each side by thin-walled metal tubes $T_1$ and $T_2$ of small diameter (1mm. to 2mm.); each of these is connected with a small aneroid chamber of extremely small internal volume. These chambers act against one another, and their differential action is magnified by ordinary aneroid mechanism, as shown in the figure. The current to be measured is passed along the tube $T_1$ (or a set of tubes electrically in parallel), while the tube $T_2$ in the same enclosure acts as compensator. The use of the thin hot tube acting as its own air chamber is to give the maximum quickness in attaining steady readings. To compensate for the decrease in the expansibility of the air as the temperature rises, the hot tube was made of a material having a considerable resistance-temperature coefficient. Such a hot-tube ammeter, though non-inductive, dead-beat, and low in resistance, was scarcely accurate enough for careful testing work, but I think the principle is worth recording here.

II. *Inductive Loads.*—As several types of energy-meter suitable for measuring inductive loads are now in common use, it is often necessary to test with inductive loads going down to power factors of 0·6 to 0·7. I have used the following method (7) for some years past, and have found it convenient and accurate.

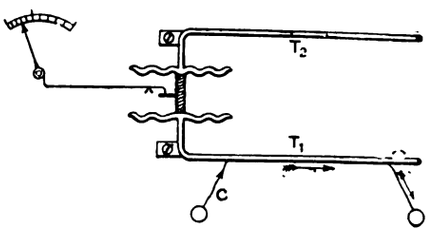


FIG. 6.

*Method* 7.—This is shown in Fig. 7, in which M is the watt-hour meter under test. The load consists of a non-inductive resistance, L, in series (through mercury pools) with an inductive part consisting of a Kelvin balance and a set of copper coils, N, wound inductively. In order to be able to make sudden measurements of the resistance of this inductive portion, mercury cups are so arranged that it can be quickly switched over into connection with a direct-current circuit, and the resistance measured by reading current and P.D. on a Weston instrument. While the meter is running, the current C is read on the balance, and by the help of the switch K the voltage V on L and the total voltage U are read on the electrostatic voltmeter Es.

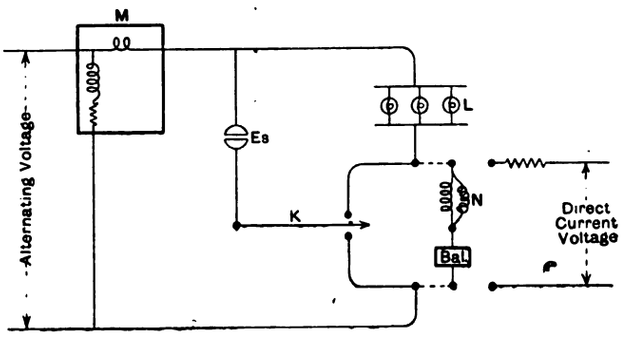


FIG. 7.

If $r$ = mean resistance of the inductive part, then

$$\text{Power} = CV + C^2r,$$

and

$$\text{Power factor} = W/CU.$$

In practice $r$ is made as small as possible, so that a small error in $C^2r$ has a very small effect upon the value of W, while the CV part can be measured with extreme accuracy. The coils which make up N must have no iron near them, eddy currents must be avoided, and mutual induction must be guarded against, except where two of the coils are identical in winding, in which case their impedance in parallel can be conveniently varied by varying their relative positions. The method is also suitable for testing wattmeters.

*Method* 8.—I have sometimes found it convenient to use a somewhat different method by which the measurement of resistance is rendered unnecessary. This consists simply in measuring $w$, the power in the highly inductive part, by the three-voltmeter method (or by an ordinary wattmeter), the total power being $CV + w$. Since $w$ can be made to be only a small part of the whole power, this is accurate enough and the coils N may here have iron cores.

*(To be concluded.)*

* Mr. Addenbrooke uses a similar method in his electrostatic wattmeter.

† The Board of Trade might reasonably insisist on this being done, I think.

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# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

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## "THE TIMES" AND MUNICIPAL TRADING.

Our leading daily paper has, in a clear and straightforward manner, declared war with the present system of municipal trading and the parliamentary precedent and legislation from which it is evolved,—the "particularism in this country, descended from the days of sharp provincial distinctions and jealousies, which Parliament rather fosters than checks." The above is a passage from a leading article in last Saturday's *Times*, entirely endorsing the views and arguments put forward in a four-column article on "Electricity and Municipal Trading" contributed to the same issue of this newspaper. The writer of the latter article not only shows that he possesses a thorough knowledge of the law relating to municipal trading, and more especially to electric lighting, traction and power distribution, but he has evidently also had practical experience of the manner in which municipal trading has modified the natural tendency of these industries, and of the preferential treatment accorded throughout to municipal traders who are in competition with private enterprise. But although written more or less in a partisan spirit, the article treats the subject from a broad point of view; it is, as our contemporary says, carefully reasoned, and it states the facts of the case in a temperate manner—more temperate, indeed, than our contemporary's leading article, which opens with a reference to "the obstacles placed in the way of the extended use of electricity for lighting, traction and motive power generally, by the combined effects of muddled legislation and of the prevalent craze for municipal trading."

Commencing with electric light, the writer of the article points out the natural desire on the part of Parliament, when this method of illumination was introduced as a novelty, to apply to it the theory which had been acted upon in dealing with gas, for even in 1888 Parliament was, perhaps excusably, ignorant of the fact that the conditions for the most economical generation, and the limits of the area of supply, were different in the two cases. Nor did our legislators foresee the widespread applications that would take place of electricity to traction and power distribution, with the natural result that large stations would be required for the wholesale and economic conversion of the chemical energy of coal into electrical energy for all purposes. Thus the Electric Lighting Act of 1883 commenced the series of mistakes by giving a deliberate preference to local authorities in the obtaining of electric lighting provisional orders, laying down in the first section of this act the necessity of obtaining the consent of the local authority as a preliminary to obtaining powers for electrical supply. If the local authority refused this consent, the Board of Trade might over-rule this refusal; but by the simple expedient of applying for a provisional order themselves, local

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authorities have been enabled to keep out electricity supply companies if they desired it and yet defer for some years a consideration of the question whether they should actually supply electricity themselves or transfer their provisional order to a company on favourable terms. Lord CROSS's Joint Committee of both Houses of Parliament, appointed in 1898 to consider several questions arising out of the Electric Lighting Acts, recommended that this veto of the local authority should be dispensed with, and that, as a substitute, the local authority should be entitled to a hearing before the Board of Trade previous to the award of the provisional order. No legislation has given effect to this wise recommendation, however.

Coming next to tramways, the article does not compare the 21 years' purchase clause of the Tramways Act of 1870, which has remained unmodified, with the 42 years' purchase in the case of electric lighting, but merely points out that the same arguments apply to the local veto in the case of urban tramways as in the case of electric lighting. The question of inter-urban tramways is enlarged upon, however, and the writer asks how far it is right and proper that municipalities should be the owners of tramway systems extending far beyond the boundaries of their own areas. As a corporation thus would become an ordinary trader, trading outside its own area, without even the excuse that this was essential in order to keep its streets from being profaned by the non-municipal pick-axe, is it right that it should be allowed to bind over the property of the ratepayers as security for a speculative business carried on among people who are not ratepayers? If there is a profit, it is not apparent how it can be equitably disposed of, and if there is a loss it has to be made good out of the rates which thus would subsidise an unremunerative business carried on largely for the benefit of non-ratepayers. Two Scottish acts, although they both apply to tramways wholly within the municipal boundary, meet this difficulty to some extent. They are the Aberdeen and Dundee Corporation Tramways Acts of 1898, and their provisions in this respect are epitomised as follows:—

> Each year a statement and balance-sheet of the tramway accounts has to be put before the Corporation along with an estimate of the probable expenditure for the coming year, and thereupon the Corporation must fix the tolls and charges for that coming year (not exceeding, of course, the charges allowed by the Act), so that the revenue may meet the expenditure. Should the revenue exceed the expenditure, the excess must be carried to a reserve account to be used in meeting contingencies; and should there be a deficiency on the year's working it must be provided for in the estimate for the following year by drawing from the reserve account, or by varying charges, or by reducing working expenses, or be carried to a suspense account and reduced gradually over a period of not more than five years.

A very similar clause was inserted in the Rochdale Corporation (Tramways) Act last year, but in the large proportion of tramways acts, including all the purely urban English ones, this principle is not recognised. Next, the Huddersfield Corporation Tramways Bill of last session is referred to. This involved large extensions outside the municipal boundaries, and in committee it was decided that these extensions should be excluded until the Committee of the two Houses appointed to report on municipal trading had presented its report. When the bill came back to the House of Commons, however, it was sent back to the Committee to have the parts relating to these extensions re-inserted, because the appointment of the Municipal Trading Committee was alleged not to be intended to affect this question. It may be mentioned, by the way, that the same issue of *The Times* contains a forcibly-worded letter from Mr. B. L. COHEN, M.P., lamenting that the Municipal Trading Committee would probably not be re-appointed this session in spite of the facts that it recommended its re-appointment and that the evidence already taken showed that private enterprise could discharge more cheaply and effectively many of the services which municipal traders are so anxious to undertake. The letter points out also that legitimate municipal duties would be carried out more satisfactorily if the municipalities would confine themselves to the discharge of those duties—already heavy and numerous enough—with which the Legislature has entrusted them.

The article which we are reviewing next proceeds to consider the attitude of the local authorities towards the power bills, a matter which we have repeatedly alluded to in our columns recently, and concludes by drawing attention to an aspect of municipal trading that has hitherto almost escaped observation. A statute called the Public Authorities Protection Act was passed in 1893, with the object of discouraging unnecessary or vindictive legislation against a public authority. An action against a person "for any act done in pursuance or execution, or intended execution, of any Act of Parliament or of any public duty or authority, or in respect of any alleged neglect or default in the execution of any such act, duty or authority" must be commenced within six months of the act complained of, and if unsuccessful carries costs as between solicitor and client. A similar action against an ordinary person may be brought six years instead of six months after the event, and only carries the ordinary costs, the defendant having to pay his solicitor whether successful or unsuccessful. From the interpretation of the Act it seems that railway, tramway or electric lighting companies, although they hold powers granted by Act of Parliament, are not endowed with this immunity, but only the public authorities.

Thus a long indictment of the law relating to municipal trading is put before the general reader. "One section or another," says *The Times* in its editorial review of the question, "is always calling out for the remedy of some defect, and a patch of some kind is always being applied, without much regard to the nature of its immediate predecessor, and without any serious attempt to organise the whole subject upon scientific principles." The most recent "patch" of this kind, for instance, was a local government act whose chief feature was the conversion of certain vestrymen into aldermen. This may possibly encourage better men than formerly to interest themselves in local affairs, but it does nothing to promote industrial progress. Entirely new legislation is required, and, so far as the electrical industry is concerned, the antiquated Tramway Act of 1870 and the Electric Lighting Act of 1888 should be superseded by something more suited to our present needs. It is shameful that a new industry such as electrical engineering is still governed by acts based on the condition of affairs 30 and 13 years ago.

## OBITUARY.

### JOHN VIRIAMU JONES.

We deeply regret to announce the death, on Sunday last, of Prof. J. Viriamu Jones, Principal and Professor of Physics at the University College of South Wales, Cardiff. Prof. Jones succumbed to a long illness, and at the time of his death was staying at Geneva. His decease removes from the ranks of physicists one of their most able and scientific workers, one who combined an exact and profound thoughtfulness with a remarkably high degree of practical skill in the execution of his ideas. His master-work in the evaluation of the ohm by absolute measurement illustrates this precision and incisiveness of his method, whether of thought or of executive skill.

John Viriamu Jones was born at Pontreporth, near Swansea, in 1856. In 1872 he passed the matriculation examination of the University of London, being placed first in the Honours division. He then entered University College, London, and

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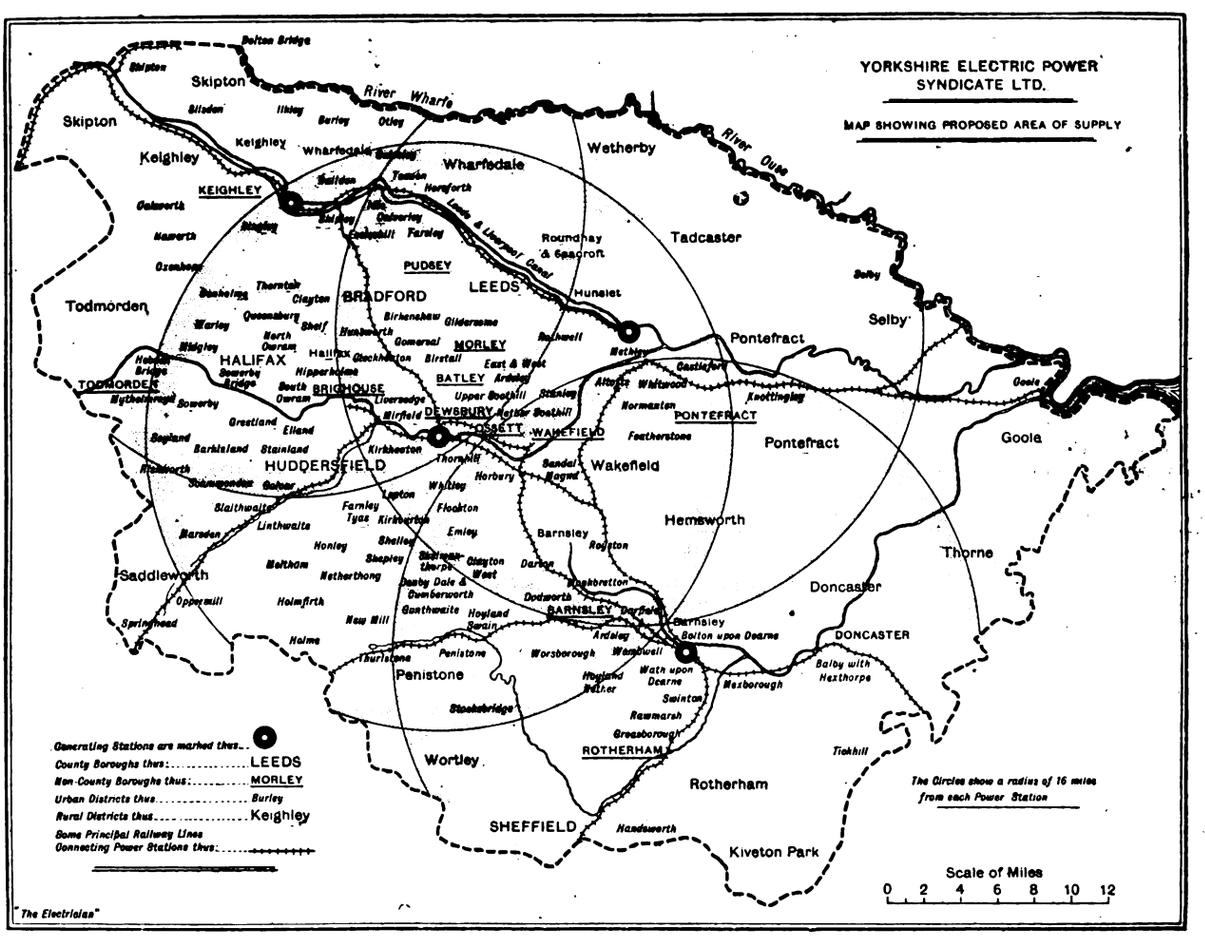
graduated Bachelor of Science in 1875, taking the University scholarship in geology. In 1874 he obtained a Brackenbury scholarship in Natural Science at Balliol College, Oxford; in 1877, a First Class in Mathematical Honours in Moderations; in 1879, a First Class in the Final Honour School of Mathematics; and in 1880, a First Class in the Final Honour School of Natural Science. In 1880 he was appointed demonstrator in the Clarendon Laboratory, Oxford, under Prof. Clifton; in 1881 he became Principal and Professor of Mathematics and Physics in the Firth College, Sheffield; and in 1883 he was elected Principal and Professor of Physics in the newly-founded University College of South Wales and Monmouthshire at Cardiff. Prof. Viriamu Jones is the author of several Papers, contributed to the *Transactions* of the Royal Society, the Physical Society, and the British Association, among which the more important relate to the absolute measurement of electrical resistance and to points connected with it. He was a Fellow of the Royal Society, a Fellow of University College, London, a member of the Royal Institution, a member of the Council of the Physical Society, and a member of the British Association Committee for the Determination of Electrical Standards. He has been closely connected with the rapid development of university and technical education in South Wales and Monmouthshire. He was the first Vice-Chancellor of the University of Wales and vice-chairman of the Welsh Central Board for Intermediate Education.

## ELECTRIC POWER SCHEMES IN 1901.

### III.—Yorkshire Electric Power Syndicate's Scheme.

The area to which this scheme relates is shown on the accompanying map, which bears a close relationship to the map of the Derbyshire and Nottinghamshire Electric Power Co.'s scheme on p. 210 of our issue last week. Comparison will show that the northern boundary of the Derbyshire area is largely identical with the southern boundary of the Yorkshire area. The directors of this scheme are Messrs. A. G. Lupton (chairman), R. Armitage, A. C. Briggs, M. Crowther, R. Hudson, C. L. Mason and F. Priestman. The engineers are Messrs. Gibbings and Baker and Messrs. Pressland and Sturgeon. The share capital is fixed at £3,000,000, with borrowing powers of £1,000,000. Within the area of 1,800 sq. miles there is a population of about 2¼ millions; and the area includes 17 municipal and county boroughs, 119 urban districts and 22 rural districts. Four generating stations, each supplying over about 8 miles radius, are to be erected, on sites indicated on the map. As announced in our issue of the 24th ult., p. 187, Sir William Houldsworth's Committee have passed the preamble of the bill embodying this scheme.




## A NEW PHONOGRAPHIC PRINCIPLE.*

BY W. NERNST AND R. VON LIEBEN.

As is well known, the Poulsen phonograph has in recent times excited well-deserved attention, not only because of its absolutely pure reproduction of human speech, but above all because of the originality of the idea on which the apparatus is based. Instead of employing, as Edison did, soft masses to fix the tones by means of mechanical deformations produced by the sound waves, Poulsen uses the magnetic effect of the microphone current upon a magnetically-deformable substance—steel. It is evident that one can, in general, employ on the phonographic principle any process which will produce a lasting change proportional to the corresponding action of the voice. One might conceive an electrification of insulators (which would be, so to speak, an electrostatic analogue to the Poulsen electromagnetic apparatus), a photo-chemical process, &c. The electro-chemist will, in the first instance, however, bethink himself of the permanent change which an electric current produces in an electrode, *i.e.*, galvanic polarisation. The following experiment may therefore be made (Fig. 1):—An endless belt of platinum runs over two rollers, and is continuously moved by a motor and

* From the *Zeitschrift für Elektrochemie.*

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polarised by a microphone current. As a necessary condition is that the variable polarisations produced by the current variations must be separate from one another in position, the platinum belt must move with considerable speed on the one hand, but on the other hand, the contact surface between the belt and the electrolyte must be as small as possible. The latter condition is sufficiently fulfilled if one employs as an electrolyte a wooden wedge which is saturated with a conducting liquid held in a glass trough provided with an electrode. In the figure, M is a microphone which is connected in the primary circuit of a transformer, in which circuit are also five accumulator cells. S is the secondary coil of the transformer. For receiving the record the throw-over switch W connects the apparatus with S, and for reproduction connects it to the telephone T. B is a battery of variable pressure which can, if required, be connected in the circuit. The experiment succeeded completely. One heard a more or less clear reproduction which could be repeated several times before the volume of sound had noticeably diminished.* However, the quite unexpected result was easily remarked that for reproduction it is necessary to have a current in the telephone circuit, and that, at least within certain limits, reproduction is louder the stronger the current is. To regulate this current a variable E.M.F. can be connected into the secondary circuit. Evidently this phenomenon is not compatible with the idea that the currents reproducing the sounds in the telephone are nothing but discharge currents from a polarised electrode. Such a discharge would naturally have to occur when no permanent current was flowing, and the superposed permanent current would have no influence on it. The assumption that the variation in resistance or contact resistances of the polarised platinum belt caused the effect would certainly agree with the above-described behaviour. For these would naturally require a current to make the variations in resistance active, and the volume of sound would necessarily, as had been observed, increase with the value of the constant current.

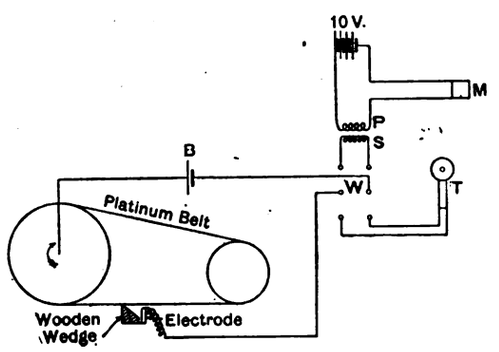


FIG. 1.

The following observations, however, make this explanation questionable. It is difficult to assume that hydrogen or oxygen polarisation on platinum would cause noticeable variations in resistance. Besides, a very strong action is also noticed in employing a solution of silver-potassium cyanide and a moving strip of silver (see the following communication), in which any variation in resistance is certainly not to be expected. We would put forward the following explanation as most probable:—Variations of the microphone currents cause a superficial disintegration of the metal electrode passing through the electrolyte. According to the amount of this disintegration, which would naturally be accompanied by a change in the polarisation capacity, variations in the constant current would occur on reproduction, which would be reproduced as sounds in the telephone. Although, as already remarked, in some cases a really clear and sufficiently loud reproduction of spoken words occurs, we believe, nevertheless, that the above-described arrangement would not afford any practical utility on account of its frequently uncertain behaviour, and also for other reasons.

### ADDITIONAL NOTES BY HERR ROBERT VON LIEBEN.

As a continuation of the experiments contained in the above article, I have tested other metals than the above-mentioned platinum in their applications to an electro-chemical phonograph. The frequent tearing of the platinum belt, in consequence of the continual bending, disturbed the observations, as did also the joint in the belt. So it was necessary to try another arrangement. The following showed itself suitable:—

A copper disc, about 2mm. thick and 450mm. diameter, screwed between two strong cast-iron plates, rotates on a pivot bearing. Parallel to the cast-iron plates a second driving disc, also of cast-iron, is keyed. This is driven by an indiarubber friction pulley at the end of the shaft of a small electromotor. By moving the electromotor on slide bars at right angles to the axis of the copper disc, the friction pulley can be made to drive the cast-iron disc either near its centre or its periphery, so that different speeds can be given to the copper disc. The edge of the copper disc is carefully turned up, and current may be led to it directly through the pivot bearing. The other electrode is in a small glass trough, measuring about 20 × 5 × 10mm., in which also is the wooden wedge (beech or cane) which is saturated with the electrolyte. It was found advantageous to connect the trough with a weak spring, so that the point of the wooden wedge is gently pressed against the periphery of the copper disc. The latter is about 3mm. wide, and the width of the contact of the wedge about ½mm. The smallest speed which could be employed for clear reproduction was about 60 revs. per min., and the purity of the tone increases as the speed increases. There was easily room for one or two words on the periphery of the disc. In order to prevent disturbing noises it was necessary to insert a pad of blotting-paper or similar material, soaked in the electrolyte, which pressed gently against the periphery of the disc. This prevented the crystallisation of the film of electrolyte, as it passed through the air, without moistening the periphery too much.

Fig. 2 shows diagrammatically the connections employed, these being almost exactly as in the previous experiment. A resistance

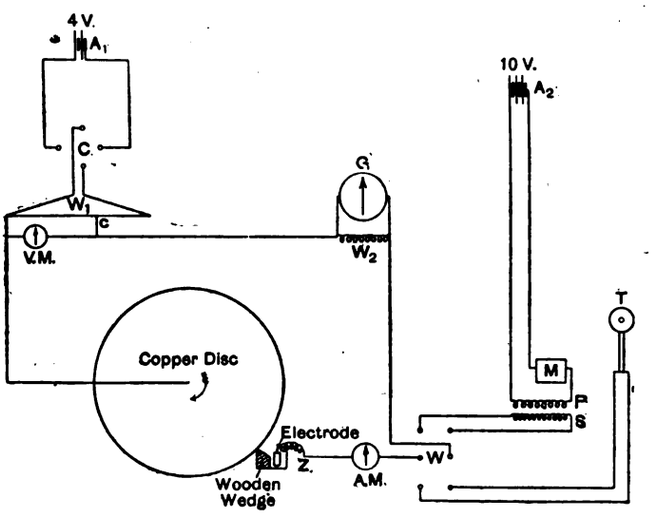


FIG. 2.

$W_1$ is added, however, with a sliding contact $c$, which enables the E.M.F. of the trough to be compensated so that the null instrument G indicates no current. In making the record the current takes the following path:—From the accumulator battery $A_1$ it flows to the switch C, a part going through the resistance $W_1$ and the voltmeter VM, and part through the periphery of the copper disc, and thence through the saturated wooden wedge to the electrode. From here, through the ammeter AM, the mercury contacts W, then through the secondary coil S, again through the contacts W to the null instrument G, the sliding contact $c$, the switch C and back to the battery. If the sound is to be reproduced, the connection to the mercury contacts is changed so that the current flows through the telephone T. While recording, the battery $A_2$ sends current through the microphone M and the primary coil P. Induction currents are therefore produced in S which are superposed on the constant current of the battery A and vary its value. The ratio of transformation P to S is not unimportant. As the result of trials the best was found to be 1:80. Many experiments were not made with regard to this, but there must be a certain best ratio. The resistance of the microphone and telephone was taken as small as possible. It was found to be a decided disadvantage to connect the microphone directly into the circuit of the battery A, as, on account of the disturbing noises which take place with a high current density at the contact surface of the wooden wedge (due to interruptions through bubbles of gas, &c.), this would necessitate too small a value for the current in the microphone for it to work well. The most noteworthy experiments are briefly given below, and observations are added which may have some bearing on the theory of the phenomenon.

I. *Solution:* $CuSO_4$ (simple normal). 4 volts employed for record and reproduction.

(*a*) *Neutral Solution.*—Cathode: Copper periphery. Anode: Copper electrode. Reproduced six to eight times with clearness, after which record disappeared.

* The above-described experiment had been already made by me in June of last year; without knowing of this, Herr von Lieben suggested to me soon afterwards the making of a phonograph based on the variations in resistance which could be produced by the electrolytic deposit of films of oxide or the like on metal electrodes. Thereupon we continued the investigation together.—W. NERNST.

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(*b*) *Acid* solution acidulated with $H_2SO_4$. Cathode: Copper periphery. Anode: Copper electrode. Reproduced once or twice weakly. (In this case the scraping off of metallic copper was a disturbing influence.)

(*c*) *Alkaline* solution (precipitated with KOH). Reproduction better and louder, sometimes about 30 or 40 times. (Reproduction was successful in this case with very small pressures, copper voltameter.)

(*d*) With the solutions (*a*), (*b*) and (*c*) the current was reversed, the pressure being 4 volts (so that the copper periphery was directly oxidised electrically). The reproduction was much worse than expected, each word only being repeated three to four times.

*Remarks on I.* (*a*), (*b*), (*c*).—In all cases finely-divided copper is deposited, which is quickly oxidised in air. In the acid solution it is dissolved again, while in the alkaline solution it remains.

II. *Solution:* $ZnSO_4$ (triple normal). 4 volts employed for record and reproduction.

(*a*) *Neutral* solution.—1. Cathode: Copper periphery. Anode: Copper electrode. Reproduced six to eight times clearly, but not loud. (Here also no reproduction was observable without a battery current.)

2. Anode: Copper periphery. Cathode: Copper electrode. Reproduced worse than (*a*) 1 and record disappears quicker.

(*b*) *Acid* solution (acidulated with $H_2SO_4$).—1. Cathode: Copper periphery. Anode: Copper electrode. Reproduced once or twice badly.

2. Anode: Copper periphery. Cathode: Copper electrode. Reproduced as in (*b*) 1.

(*c*) *Alkaline* solution (precipitated by KOH).—1. Cathode: Copper periphery. Anode: Copper electrode. Reproduced *very loud and clearly*, frequently 200 to 300 times without apparent diminution in intensity. The cause of the sound becoming unclear and finally disappearing was in this case (as in the other experiments) due to an alteration (widening) of the contact surface of the wooden wedge. Frequently, by removing the gelatinous $Zn(OH)_2$ which had collected on the wedge, one could cause the telephone to speak clearly again. If the deposit was left for a long time on the wedge, he sound waves were finally wiped away by the superposed deposit.

2. Anode: Copper periphery. Cathode: Copper electrode. Reproduced 10 to 12 times, and often more frequently, but very indistinctly.

*Remarks on II.* (*a*) 1, (*b*) 1, (*c*) 1.—This series of experiments is not a true one, as in addition to the zinc, copper must also be deposited, so that it is partly covered by the series of experiments I.

III.—Solution of zincate (made by precipitating $ZnSO_4$ with KOH, and dissolving the precipitate in excess of KOH).

(1) Cathode: Copper periphery. Anode: Zinc electrode. Reproduced loudly and distinctly, frequently *several hundred times.* In taking the record the back pressure of the electrolytic trough was compensated, and a battery current was employed for reproduction. It was successful with currents in both directions, but was considerably better when the copper periphery was the cathode.

(2) Anode: Copper periphery. Cathode: Zinc electrode. Reproduction much worse and ceased after a short time.

The record was successful with 1 to 2 volts pressure (from the compensated zero point) and was about equally good with either direction of current, only the reproduction was always better when the periphery was the cathode. On increasing the superposed pressure reproduction was much louder, and certainly not in proportion to the rise in pressure (but more probably to the square of the latter). Above 4 volts considerable disturbing noises (gas bubbles) usually set in. The current passing was about 1·2 milliamperes at 1 volt.

*Remarks on III.—Experiment* 1. After some time, with the copper periphery as cathode, a falling-off in the reproduction was noticeable. This may be explained by a secondary action causing the zinc to be coated itself with copper which is somewhat oxidised. Thus, in a short time, one has copper on the periphery opposed to CuO and Cu on the small electrode, which explains the drop in pressure. (The electrolytic deposition of zinc on the periphery is of no importance on account of the large surface of the latter and the small quantity of zinc deposited.) In addition, the resistance of the trough increases on account of the oxidisation of the electrode. If 2 volts are put on at the beginning (while copper and zinc are still clear) one obtains 3 volts (*i.e.*, 2 volts + 1 Daniell). In a short time, however, the pressure drops to 2 volts, and with the drop of pressure is a corresponding falling-off of the strength of the effect. By reversing the current, it is easy to free the zinc electrode from copper and to deoxidise it, so that in a short time the original strong action is resumed.

*Experiment* 2.—In this case (copper periphery as anode) the copper of the periphery goes into solution, and in addition the periphery becomes oxidised, which makes the worse reproduction more plausible.

IV. *Solution*: $KAgCy_2$ dissolved in $H_2O$.—1. Cathode: Silver periphery (produced by silvering the copper periphery). Anode: Silver electrode. Reproduction not so loud as in III., but uncommonly clear with a pure silver electrode (oxidation later), several hundred times without becoming noticeably weaker.

The record was made without a battery current.

Successful reproduction was obtained with either direction of current, but was best with the periphery as cathode. The reproducing action falls off quickly, however, when the electrode becomes slightly oxidised. By reversing the current in this case also the electrode can be deoxidised, and the good results are once more obtained.

2. Anode: Silver periphery. Cathode: Silver electrode. Reproduction notably worse than IV. 1; scarcely clear once or twice.

In the case of IV. 1 the record could be made equally well with either direction of current, but in this case one direction (silver periphery cathode) was better for the reproduction.

The increase of applied pressure does not improve the reproduction very considerably. The best result was obtained at 4 to 5 volts.

At 1 volt the current passing was only 0·4 milliampere, while in former experiments it was frequently 10 or 12 times as high.

*Remarks on IV.—Experiment* 1. The current passing dropped uncommonly quickly, perhaps because of the increased resistance which the oxidation of the electrode occasioned.

*Experiment 2.* It appears worthy of notice that the reproduction with the direction of current in which silver is dissolved was much worse than when silver was deposited on the periphery. As a considerable oxidation of the silver periphery in the air is very improbable, any change in the contact resistance does not appear likely.

V. *Solution*: KI in $H_2O$ (five times normal).—1. Cathode: Silver periphery. Anode: Platinum electrode. Reproduction (with the same currents as IV. 2 above) much less loud and clear, and at the same time inconstant. Also a strong roaring sets in at higher pressures, which may be accounted for by the liberation of hydrogen. This almost completely prevents anything else from being heard.

2. Anode: Silver periphery. Cathode: Platinum electrode. Reproduction, often 10 or 12 times, much clearer and louder than V. 1.

The record in the case of V. 1 and 2 is as before about equally good with current in either direction with the best pressure of about 2 volts. High pressure causes too much disturbing noise. The duration and purity of the reproduction was very small. At 1 volt the current flowing was about 4 to 5 milliamperes.

*Remarks on V.—Experiment* 1.—The evolution of hydrogen has a very disturbing effect on account of the roar it produces. The noise seems to be particularly produced by the liberation and non-adhesion of the hydrogen, in antithesis to the iodine, which combines first with the silver. In general, the deposition of smoothly and well adhering metals gives favourable results, while all gassy depositions are unfavourable. Hence the advantage of the direction of current in which the periphery is the cathode.

As the platinum (in this experiment) is not attacked, neither the pressure nor the resistance of the trough changes.

As the AgI formed cannot be so quickly dissolved (only minimum quantities come into question here, however), considerable changes in resistance were to be expected. But as the reproduction effects were appreciably lowered here, it seems that the mere changes in resistance do not play the most important part in the reproduction.

*General Remarks.*—The above experiments lead to the conclusion that an explanation of the phenomena by pure polarisation effects is untenable, and that the effects are also not in all cases consistent with the assumption of changes in the contact resistance. Prof. Nernst has kindly called my attention to a third possibility, to which I will allude briefly: it is the variation in friction at polarised electrodes, noted by Edison and others.* It would be conceivable that in our case also the friction between the copper periphery and the electrode, varied in amount by the polarisation, could give rise to a corresponing variation of the *section* of the drop forming contact between the wedge and the periphery, by which the reproduction might be explained as well. This is merely put forward as a surmise, however, as the variation in friction has hitherto only been observed at electrodes polarised by gases, while many of the above experiments indicate no evolution of gas at all. All things considered, therefore, the explanation already put forward as possible in the first note seems the most likely one—namely, the change in the polarieation capacity. Of course, the possibility is by no means excluded that several effects may be superposed in these experiments.

In conclusion, the most convenient method of obliterating the sound-waves recorded on the periphery may be indicated. For this purpose a pad soaked in acid and pressed against the periphery was used with success. It was found better to connect this pad with one pole by means of an additional electrode, by which means a wide electrolytic deposit is obtained, analogous to a coarse brush, which covers up the fine variations. However, the most certain and quickest method is to obliterate with very fine emery paper.

* G. Arons, *Wied. Ann.* 41 473 (1890).

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## LIGHT RAILWAY SCHEMES.

During the past month 26 applications for Light Railway orders were lodged with the Light Railway Commissioners, and in only four of these was steam specified as the motive power. Below we give particulars of the electrical schemes, as well as particulars of the applications since the passing of the Light Railways Act in 1896 :—

| — | 1901. | 1900. | | 1899. | | 1898. | | 1897. | | 1896 |
|---|---|---|---|---|---|---|---|---|---|---|
| | May. | Nov. | May. | Nov. | May. | Nov. | May. | Nov. | May. | Nov. |
| Total applications. | 26 | 27 | 24 | 43 | 40 | 54 | 35 | 30 | 28 | 28 |
| Electric schemes. | 22 | 19 | 17 | 32 | 21 | 32 | 18 | 16 | 10 | 14 |

| Title. | Promoters. | Mileage. | Gauge. | Agents. |
|---|---|---|---|---|
| | | | Ft. In. | |
| Canterbury, Herne Bay, and Whitstable | O. W. Bowen and W. J. Kershaw | 16 | 3 6 | J. D. Tetley. |
| County of Middlesex (extensions) No. 1 | Middlesex County Council | 10½ | 4 8½ | Sir R. Nicholson. |
| County of Middlesex (extensions) No. 2 | Middlesex County Council | 11¾ | 4 8½ | Sir R. Nicholson. |
| County of Middlesex (extensions) No. 3 | Middlesex County Council | 25½ | 4 8½ | Sir R. Nicholson. |
| County of Middlesex (extensions) No. 4 | Middlesex County Council | 30¾ | 4 8½ | Sir R. Nicholson. |
| Crewe | British Electric Traction Co. (Ltd.) | 6¼ | 4 8½ | Sydney Morse. |
| London United Tramways (Light Railway Extensions) | London United Tramways Co. (Ltd.) | 21¾ | 4 8½ | Sherwood & Co. |
| Preston and Norwich | Auxiliary & Light Railways & Tramways Co. (Ltd.) | 24 | 4 8½ | Tahourdins & Hitchcock |
| Preston and Lytham | E. Bois, G. Hunter and E. Osborne | 12¼ | 4 8½ | Tahourdins & Hitchcock. |
| Rotherham and Laughton | T. Morrison and W. Binns | 8 | 4 8½ | Baker, Lees & Co. |
| Southend, Burnham and Bradwell | Railways & Gen. Construction & Maintenance Co. | 20½ | 4 8½ | Spencer, Gridland & Co. |
| South Shields, Sunderland and District | British Electric Traction Co. (Ltd.) | 8¼ | 4 8½ | Sydney Morse. |
| Spen Valley and Morley (extensions) | British Electric Traction Co. (Ltd.) | 3¼ | 4 8½ | Sydney Morse. |
| Tottenham, Walthamstow, and Epping Forest | Metropolitan Tram. and Omnibus Co. (Ltd.) | 10 | 4 8½ | H. C. Godfray. |
| Turton, Tottington, Ramsbottom, and Rawtenstall | Lancashire Light Railways Co. (Ltd.) | 18½ | 4 8½ | Sharpe & Co. |
| Wakefield (extensions) | J. Fell, J. J. Gittings, E. Horton & W. J. Kershaw. | 6½ | 4 8½ | Wm. Webb & Co. |
| Woolwich, Eltham and District | Auxiliary & Light Railways & Tramways Co. (Ltd.) | 4½ | 4 8½ | Tahourdins & Hitchcock. |

## AN INSTRUMENT FOR MEASURING THE PERMEABILITY OF IRON AND STEEL.*

BY C. G. LAMB, M.A., B.SC., AND MILES WALKER, B A.

The instrument described in this Paper has been designed to meet the demand for a simple, cheap and reliable piece of apparatus for measuring the permeability of iron and steel. The authors have tried to construct an instrument which would be extremely simple to use, and whose calibration should be dependent on such principles as should render it incapable of alteration with time and with some-

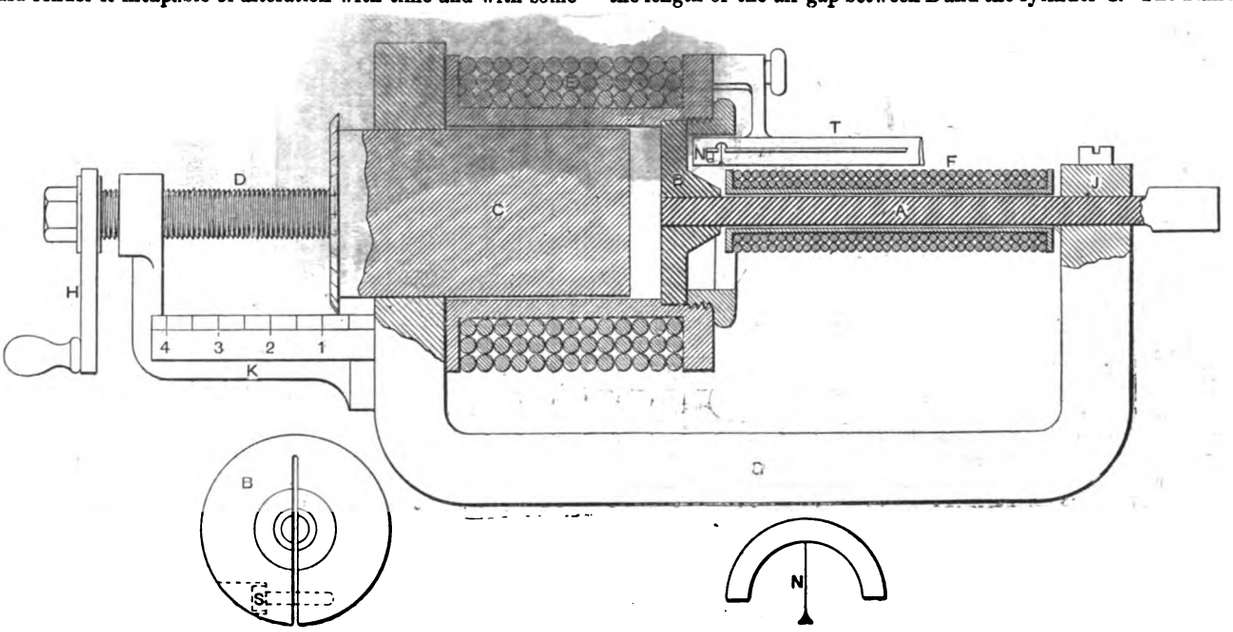


FIG. 1.

what careless usage. The principle adopted is that of balancing the reluctance of an air-gap against that of the specimen under test by means of altering the length of the air-gap. Since the reluctance of such an air-gap of given dimensions is invariable, the accuracy of an instrument based on this principle depends only on the accuracy with which the dimensions of the air-gap can be measured and the delicacy with which the point of balance can be ascertained. In order to fulfil both these conditions the instrument, as first used, is made as shown in Fig. 1. The specimen to be tested consists of a bar, turned up to a definite diameter (which we have taken as ⅜in.) and about 7in. long. One end of this fits into an iron head, B, provided with a hole of the right size to receive the specimen. Any slight looseness in the fit is taken up by the screw *s*, which draws together the two halves of the head, this being almost severed by a saw cut. Surrounding the specimen is a magnetising coil F, and the head B fits into a recess turned in another magnetising coil E, which is wound on the adjustable air-gap. The other end of the specimen is fixed to the yoke-piece G by the block J and two set screws. Opposite the end of the head B is the flat face of an iron cylinder C, which is 2in. in diameter and 3½in. long. This slides freely, but with a good fit, through a hole in the yoke G, and can be moved parallel to its own axis by a screw D fixed rigidly to it, and working in a boss on the bracket K (fixed to the yoke G) by means of the handle H. This enables the operator very gradually to alter the length of the air-gap between B and the cylinder C. The number of turns and fractions of a turn made by the screw are read on the scale and graduated head shown in the figure.

In the instrument described, the coils E and F are wound with the same number of turns and are placed in series in such a manner that the magneto-motive forces on air-gap and specimen (which are in this case equal) act in the *same* direction—that is, they assist in creating the magnetic flux, the path of which lies through the specimen A, across the air-gap, along the cylinder C, and back by the yoke G to A. If the air-gap be so adjusted in length that its reluctance is equal to that of the specimen, then, since the magneto-motive forces are the same for both, the flux of magnetism through each must be the same—that is to say, the whole of the lines of force coming from the specimen A must cross the air-gap, and none will escape from the back face of B. If, however, the reluctance

* Paper read before the Institution of Electrical Engineers on May 2.



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of A be greater or less than that of the air-gap, the whole of the head B will be magnetised positively or negatively as the case may be. Its state may be indicated by means of a suspended magnetic needle placed in proximity to it. The needle used as an index is shown at N. It consists of a small curved steel bar pivoted on a jewel and needle point, and carrying an aluminium pointer. The latter is protected from air currents by means of a brass tube T, provided with two windows to observe the position of the index. These windows are covered with a slip of mica pushed into the tube. The whole arrangement can be detached at will by a thumb-screw.

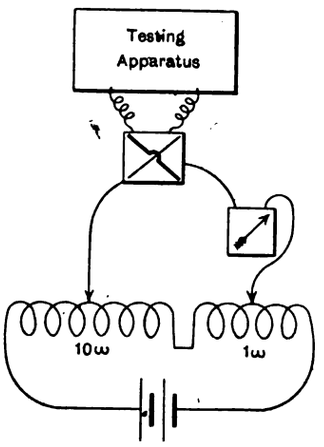


FIG. 2.

Although the instrument described above has an equal number of turns on both specimen and air-gap, this is not essential, and we can easily show that any ratio can be used. Consider a circuit made up of an air-gap with $T_1$ turns of wire on it, and a specimen with $T_2$ turns of wire, and let it be a perfect circuit—that is, let no flux issue from it into the surrounding air. Let $\rho_1$ and $\rho_2$ be the respective reluctances. When a current of A amperes is passing round the coil, and the same flux F is passing round the whole circuit (neglecting for the time any reluctance in the rest of the circuit) we must have

$$\rho_1 F = \frac{4\pi}{10} A T_1 \text{ and } \rho_2 F = \frac{4\pi}{10} A T_2, \text{ or } \frac{\rho_1}{\rho_2} = \frac{T_1}{T_2}.$$

Hence, by merely altering the ratio of the turns on the air-gap and specimen we can balance the reluctance of the specimens with different lengths of air-gap. This may be of advantage when we wish to measure the reluctance of specimens in the neighbourhood of their maximum permeability, or at very high inductions.

The operation of testing a specimen after it is turned to the right diameter is as follows:—It is placed inside the coil F, and one end is inserted into the head B, which is then placed in the recess provided in the coil E, and fixed there by a thumb-screw as shown in the figure. The block H is then fixed in position, and the coils E and F being properly connected, are put in series with a reversing key, an adjustable resistance, an ammeter, and a few accumulator cells. For the purpose of more finely adjusting the current we often prefer to connect the apparatus up as shown in Fig. 2. The battery is placed in series with two resistances, conveniently about 10 ohms and 1 ohm, and the contact arms of these resistances are used to carry the current to the rest of the circuit; in fact, the current is supplied by a potential slide. This disposition of course entails some waste of current, but the advantage of being able very gradually to alter the current by small steps from zero to a maximum more than compensates for this disadvantage. This method will be found most convenient for all magnetic testing work. The amperemeter used is a Weston instrument reading to 1·5 amperes, but we have marked a second scale on it whose readings give directly the magnetising force H applied to the specimen, allowance having been made, in a manner afterwards briefly to be described, for the loss of magnetomotive force in the joints and yoke of the instrument. It is advisable before beginning a test to wipe out any magnetism that may be left in the instrument from a previous test by applying a fairly large magnetising force (say H=50), and reduce this through a series of reversals to zero. The alternative method of connection enables this to be done with great convenience and accuracy. The current is then adjusted until the amperemeter reads a definite value, say H=5. The index needle will now be found hard over to one side, and if the current be reversed it will go hard over to the other side. The handle is then turned to lengthen or shorten the air-gap until the needle points to a central position. It is well to reverse the current once or twice before taking the final position of the handle so as to establish well the cycle for that particular magnetising force. The reading of the scale is then taken, and the calibration curves supplied with the instrument give the permeability or its reciprocal without any calculation. It is found that the movement of the needle enables the adjustment of the right length of a gap to be made with the greatest precision. An alteration of about $\frac{1}{1000}$th of an inch is sufficient to disturb the balance. The degree of sensitiveness has been attained by having a strongly magnetised needle placed close to the head B, and controlled by a magnet so as to be just in stable equilibrium. A magnetised needle suspended parallel and near to a vertical iron plate is unstable, in the absence of outside controlling force, and the function of the magnet is to make the position just stable. It is adjusted in position to put the needle in its central position when the process of demagnetisation has been gone through, and before the test is actually commenced. In order that the readings of the instrument should be the same on reversal of the current, is is of course necessary that this process of demagnetisation should have been so carried out as to leave the circuit *completely* devoid of magnetism. This is not, in general, possible, and in practice great accuracy in the demagnetisation is not required. All that is necessary is to take readings for both directions of the current, and the mean of these is the true reading. This also greatly diminishes any effect of hysteresis in the yoke. It will be seen from Tables I. and II., which give the readings in a few tests made on Lowmoor iron and mild steel, that at fairly high inductions the two readings differ but little; at low readings the demagnetisation adjustment is more important. In obtaining the readings given in Table I. some care was taken in this respect, and in adjusting the needle exactly central by the control magnet; in the case of Table II. no special care was taken, and yet the readings were found to be quite reliable.

The scale-readings are found to be perfectly consistent for one specimen, and the important question arises whether the calibration

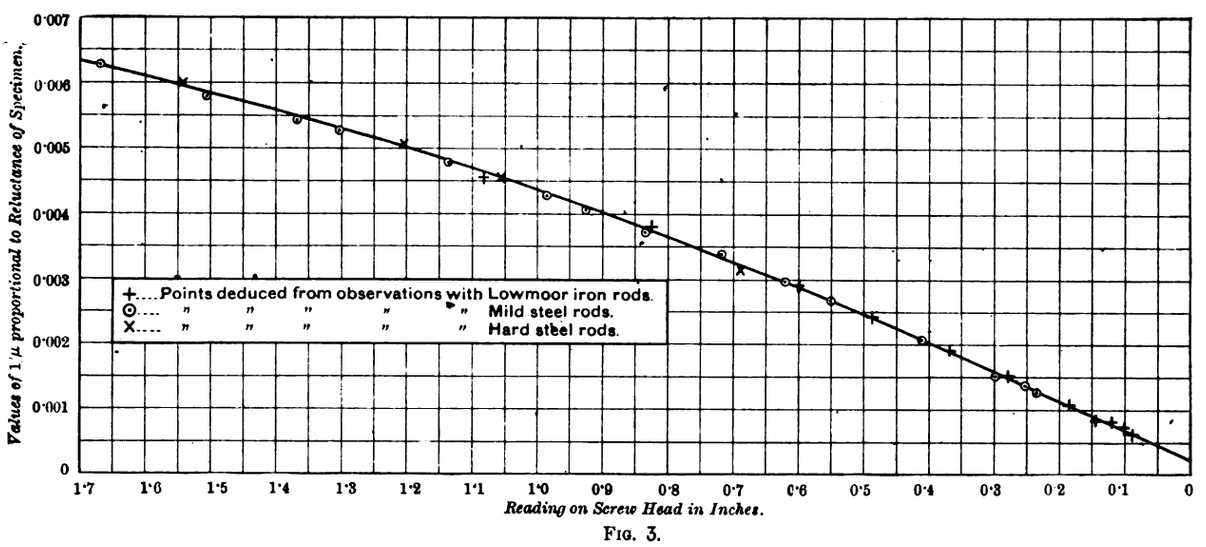
0·007
0·006
0·005
0·004
0·003
0·002
0·001
0
Values of 1/μ proportional to Reluctance of Specimen.
+....Points deduced from observations with Lowmoor iron rods.
⊙.... " " " " " Mild steel rods.
X.... " " " " " Hard steel rods.
1·7 1·6 1·5 1·4 1·3 1·2 1·1 1·0 0·9 0·8 0·7 0·6 0·5 0·4 0·3 0·2 0·1 0
Reading on Screw Head in Inches.

FIG. 3.

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curve is the same for specimens differing widely in permeability. The answer to that question is thoroughly satisfactory. Throughout the most important part of the magnetic curve, namely, the part dealing with the permeability at fairly high inductions, the readings of the instrument can be taken to measure the permeability within a fraction of 1 per cent. This was tested by obtaining the B-H curves of different specimens of material (viz., Lowmoor iron, mild steel, and hard steel) by Prof. J. A. Ewing's double-yoke method.* and calibrating the instrument in the method described below. Since the dimensions of the specimen and gap are determinate and fixed, it would evidently be possible to engrave the cylinder so as to give the permeability (or its inverse) directly, but we found it convenient, in the first place, to read from an arbitrary scale of inches and 1,000ths, and connect with these quantities by calibration curves shown in Figs. 3 and 4. Tested by means of these specimens no distinction could be made between the values obtained with the different specimens within the limits of error of other measurements made in the observation. With regard to tests at low stages of the curve, it is doubtful if the use of small specimens is of much value for commercial purposes, since the behaviour of the iron under these low forces is so dependent on small accidents in its history that we can never be sure that the specimen represents the bulk. Should the permeability under these conditions be required the best method would be to build up an instrument from the material under test, and measure its permeability directly by a ballistic method. It is, hence, not a matter of great importance that at low inductions the end joints introduce an error varying with the material under test. The nature of this error may be considered as follows :—The joints and yoke introduce a certain reluctance, and to drive the flux through this requires a magneto-motive force which is approximately proportional to the flux. It was found, for instance, that for an induction per square centimentre of 15,000 in a specimen of Lowmoor iron about 9 ampere turns were required to overcome the joint and

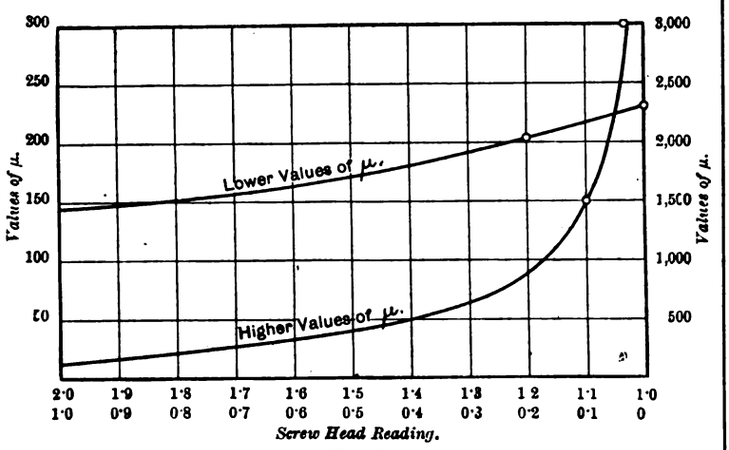


FIG. 4.

yoke resistance ; the total ampere turns on the specimen was 298, so that 3 per cent. of the magneto-motive force was required for the joints and yoke. In a specimen of mild steel at the same flux-density the total ampere turns required was 350, so that the percentage expended on the yoke and joints was 2·7. In the graduation of the ampere meter we made an allowance of 2·85 per cent. at this part of the scale for the loss of ampere turns in the joint and yoke, so that the error at this point in reading H for either soft iron or mild steel was only of the order 0·15 per cent. At lower densities the effect of the joints is somewhat more important.

*Details of the Calibration of the Instrument.*—The calibration of the instrument was carried out in the following manner :—Three pieces of Lowmoor iron were sawn off from the same bar and turned to gauge. They were not annealed, since in some previously used specimens that had been carefully annealed a question had arisen as to a change with time of the condition of the specimens. These were then tested in pairs by Ewing's double-yoke method. Two of the specimens were found in this way to agree very nearly indeed throughout the whole curve of magnetisation, while the third differed slightly in the early stages. One of the former pair was taken as standard, and was tested very carefully by the double-yoke method with the other as its return path. The ballistic galvanometer used to measure B was one of Crompton's midget type of D'Arsonvals. To eliminate any slight irregularity in the law of the instrument it was calibrated relatively throughout its scale by successive throws from a standard air coil, the current being measured on a Weston ammeter previously calibrated by a potentiometer. In the double-yoke method the reluctance of the joints can be very accurately determined, and this enables a good estimate of the joint reluctance

* Ewing on "Magnetic Testing of Iron and Steel," *Proc.* Inst. C.E., Vol. CXXI., part 4.

**Table I.**—*Lowmoor Iron.*

| Current in coil in amperes. | H | B | $\frac{1}{\mu} \times 10^{-3}$ | Length of air-gap in inches. Readings with current in each direction. | | Mean reading. |
|---|---|---|---|---|---|---|
| 0·03 | 1·42 | 1,180 | 1·20 | 0·204 | 0·205 | 0·205 |
| 0·04 | 1·88 | 2,100 | 0·89 | 0·129 | 0·139 | 0·135 |
| 0·05 | 2·32 | 3,400 | 0·68 | 0·097 | 0·103 | 0·100 |
| 0·06 | 2·78 | 4,500 | 0·62 | 0·089 | 0·091 | 0·090 |
| 0·08 | 3·68 | 6,450 | 0·57 | 0·079 | 0·083 | 0·081 |
| 0·10 | 4·58 | 7,950 | 0·58 | 0 080 | 0·082 | 0·081 |
| 0·15 | 6·95 | 10,550 | 0·66 | 0·098 | 0·101 | 0·100 |
| 0·20 | 9·35 | 12,000 | 0·78 | 0·123 | 0·123 | 0·123 |
| 0·30 | 14·30 | 13,750 | 1·04 | 0·183 | 0·185 | 0·184 |
| 0·40 | 19·20 | 14,620 | 1·31 | 0·230 | 0·235 | 0·233 |
| 0·50 | 24·20 | 15,210 | 1·60 | 0·300 | 0·300 | 0·300 |
| 0·60 | 29·50 | 15,600 | 1·90 | 0·363 | 0·363 | 0·363 |
| 0·80 | 39·20 | 16,050 | 2·45 | 0·500 | 0·500 | 0·500 |
| 1·00 | 49·20 | 16,350 | 3 03 | 0·643 | 0·643 | 0·643 |
| 1·10 | 55·00 | 16,600 | 3·33 | 0·710 | 0·720 | 0·715 |
| 1·15 | 56·50 | 16,660 | 3·38 | 0·750 | 0·750 | 0·750 |
| 1·20 | 59·20 | 16,700 | 3·55 | 0·780 | 0·790 | 0·785 |
| 1·30 | 64·20 | 16,800 | 3·84 | 0·851 | 0·867 | 0·859 |
| 1·40 | 69·10 | 16,950 | 4·10 | 0·935 | 0·945 | 0·940 |

**Table II.**—*Mild Steel.*

| Current in coil in amperes. | H | B | $\frac{1}{\mu} \times 10^{-3}$ | Length of air-gap in inches. Readings with current in each direction. | | Mean reading. |
|---|---|---|---|---|---|---|
| 0·04 | 1·97 | 388 | 5·08 | 1·065 | 1·120 | 1·093 |
| 0·06 | 2·95 | 738 | 4·00 | 0·766 | 0·914 | 0·840 |
| 0·08 | 3·92 | 1,340 | 2·93 | 0·576 | 0·617 | 0·597 |
| 0·10 | 4·86 | 2,235 | 2·17 | 0·385 | 0·425 | 0·410 |
| 0·15 | 7·17 | 5,280 | 1·36 | 0·245 | 0·245 | 0·245 |
| 0·20 | 9·50 | 7,550 | 1·26 | 0·228 | 0·227 | 0·228 |
| 0·30 | 14·30 | 10,550 | 1·35 | 0 253 | 0·246 | 0·250 |
| 0·40 | 19·30 | 12,310 | 1·56 | 0·300 | 0·292 | 0·296 |
| 0·60 | 29·10 | 14,120 | 2·03 | 0·420 | 0·412 | 0·416 |
| 0·80 | 39·10 | 15,020 | 2·60 | 0·552 | 0·548 | 0·550 |
| 1·00 | 49·10 | 15,650 | 3·14 | 0·692 | 0·685 | 0·689 |
| 1·20 | 59·10 | 16,000 | 3·70 | 0·836 | 0·828 | 0·832 |
| 1·40 | 69·10 | 16,350 | 4·23 | 0·984 | 0·981 | 0·983 |
| 1·60 | 79·10 | 16,600 | 4·77 | 1·136 | 1·133 | 1·135 |
| 1·80 | 89·00 | 16,900 | 5·27 | 1·308 | 1·302 | 1·305 |
| 2·00 | 99·00 | 17,100 | 5·79 | 1·518 | 1·504 | 1·511 |

to be made in one instrument when the standard specimen was put in place. There are then two methods of arriving at the value of H in the specimen when any measured current is passing round the magnetic coil. The first method, which was most accurate at high flux-densities when a large change in H makes but a small change in B, is to take the total magneto-motive force produced by the magnetising coil and to deduct the known small magneto-motive force required for the joints, &c., and divide by the effective length of the specimen. The second method, which was relied on at lower flux-densities, where the joint effect might be expected to be most variable in relation to the reluctance of the specimen, is to measure B in the sample by means of a search coil, and deduce the corresponding value of H from the calibration curve of the specimen. The two methods agree well between themselves at these points where they can be both applied. In this way a curve was made connecting the current in the magnetising coil of the instrument, and the value of H applied to the specimen when the instrument is properly balanced. By means of this curve a second scale was marked on the Weston ammeter, on which the H can be directly read off. The correction is the same for any instrument made of the same dimensions, and hence has only to be determined once for all for any set. The readings of the screw head were now taken for various values of H, and a curve was plotted with length of air-gap as abscissa and 1 $\mu$ as ordinate. This curve is given in Fig. 3. It will be seen that this curve begins with a straight line part pointing a little beyond the zero point, which means that with zero air-gap there is still some reluctance due to joints and yoke. As the air-gap is lengthened the reluctance is at first increased proportionately ; but, as the gap gets longer, still the field spreads more sideways and a more than proportional increase in length is required to produce the same result in air-gap reluctance. A calculation of the reluctance of the air-gap when quite short gives a value agreeing exactly with the reluctance of the specimen as determined by the double-yoke method.

After this curve had been obtained for Lowmoor iron a similar test was carried out with rods of mild steel, and it was found that the curve connecting air-gap length and 1$\mu$ (see Fig. 3) was the same as that for the Lowmoor iron. Two specimens of hard steel were then similarly dealt with, and the curve was further extended by



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this means. The calibration of the instrument as a measurer of $\mu$ was then drawn in the following way :—The first part of Fig. 3 was taken as linear, and the reciprocals of the ordinates of this curve were taken as the ordinates of Fig. 4 ; the rest of the curve was plotted by taking the reciprocals of the curve in Fig. 3. For many purposes, however, the curve in Fig. 3 is itself the more useful.

DISCUSSION.

Mr. SYDNEY EVERSHED said the last time an instrument of this sort was brought before the Institution was at the Society of Arts some years ago by Prof. Ewing. In this, the induction passing through the sample, was measured by the force necessary to remove it from two poles. He had ventured at that time to make some rather unfavourable criticism on Prof. Ewing's instrument, and he felt now that he was to some extent justified, because this present instrument, also coming from Cambridge, was a very much better one ; in fact, it seemed to him to be the first that was based on the correct principle of comparing the reluctance of the unknown with the reluctance of such a very definite thing as an air-gap. He congratulated the authors upon the happy and simple way they had carried out the idea, but he would like to suggest that other methods of comparing the reluctance of an air-gap might be tried with advantage. In particular he would suggest that two plates of iron might be moved so as to keep the air-gap constant. This might prove of some advantage, because it would have a straight-line law over a much longer range. He had only used this type of air-gap with electromagnets, where it had the great advantage that the attraction could be calculated. The reason for this was that the induction which came out from one part of the core went round the leakage part, so to speak, and did not go geometrically through the air-gap. All that part was constant when there were two surfaces moving in parallel planes. He only suggested this as a possible way in which this very ingenious instrument could have its range enormously extended. He could not say that he himself had ever done anything in the direction of making an instrument for measuring the reluctance of iron. He had been more interested in measuring the qualities of magnetic steel, and he must confess to having failed in devising any sort of instrument which would be fit for commercial purposes. All these instruments seem to fail in one respect—viz., they only tested samples of the iron or steel and not the bars themselves. It would be a great help if there was an instrument which tested the iron or steel in bulk, and although this had been referred to by Mr. Mordey in the discussion on Mr. Ewing's Paper, he wished to enforce the point in the hope that Messrs. Lamb and Walker might be able to bring forward another instrument which would do for iron in bulk what this one did for samples.

Mr. W. B. ESSON asked if the instrument was on the market. It seemed from the Paper that it was necessary to rig up apparatus in the laboratory. What engineers wanted was something contained in a small box with battery complete, from which, by turning a handle, you could get the reading direct.

Mr. C. G. LAMB said that Mr. Evershed's point as to range had been considered, but it was very difficult to make an instrument of that sort. It might be possible to do so later on. In this case, however, the range could be extended, as was pointed out in the Paper, to any two or three ratios by using a different number of windings. The question of testing castings in bulk was one of the most important that could possibly be mentioned. He had seen in shops abroad any number of castings which more resembled sponges than anything else, but this could not be told until they were machined. All instruments for this purpose had proved to be impracticable, and although an extremely difficult problem, it was one which must be seriously gone into if they wished to save money. As regards Mr. Esson's question if the apparatus were yet on the market, he said it was not, but a little later on he would tell him where it could be obtained. He thought the handle at the end of the instrument would draw Mr. Esson, because that was a thing to appeal to the engineering mind. Mr. Esson, however, seemed to have a small idea of the complexity of measuring permeability. At least two things must be read. The instrument did not claim to have the great accuracy obtained by Prof. Ewing, but he did claim that it was very much simpler and more convenient in operation.

Mr. ROBERT HAMMOND said that for many years he had been closely connected with the manufacture of iron and steel, and this Paper had directed his thoughts to the many mixtures that had to go into the blast furnace and the Siemens-Martin furnace for the manufacture of steel. He had often been struck with the small amount of attention that had been given to the fact of how varied must be almost every brand of steel that issued even from the same works. Those concerned would know how varied the ore was when taken from the earth, even from the same mine. For years he had had a grade passing through his hands from the Bilbao district, and very rarely indeed was one consignment identical in quality with another. Then came the coke difficulty, and this varied as to the quantity of sulphur and so on that it contained, with the result that the finished steel also varied. What he wished to emphasise was the immense importance of the authors of this Paper turning their attention to testing iron in bulk, and not to be contented with an instrument which tested only a small sample, because the practical man, like Mr. Esson, wanted to constantly apply the bulk test, even though the material came from the same works. This instrument was in the right direction.

**Consumption of Copper in Germany.**—In a recent consular report it is estimated that 40,000 tons of copper were used in making electrical conductors and machinery out of a total of 72,000 tons imported or mined in Germany.

## THE NEW EDISON STORAGE BATTERY.

Dr. A. E. Kennelly read a Paper before the American Institute of Electrical Engineers, on May 21, on the subject of a new storage battery, invented by Mr. Edison, in which the elements are iron and a superoxide of nickel, believed to have the formula $NiO_2$. As electrolyte a 20 per cent. solution of potassium hydroxide is employed. The initial voltage of discharge after recent charge of 1·5¼ volts, and the mean voltage of full discharge is 1·1 volts. The fall of voltage is rapid till 1·2 volts is reached, then gradual to 1·1 volts, when the fall becomes very rapid. A normal discharge rate is 60 milliamperes per square inch of active element (positive or negative) can be maintained, and the storage capacity is 14 watt hours per pound of the total weight of the cell. The mean normal discharge is 4 watts per pound of the total weight for 3½ hours, but it can be discharged in one hour at a rate of 12 watts per pound. Charging and discharging rates are alike, and the cell may be charged at a relatively high rate in one hour, with no apparent detriment beyond a somewhat lowered efficiency for that charge.

The positive and negative plates are mechanically alike, and can scarcely be distinguished by the eye. They differ only in the chemical contents of their pockets. Each plate is formed of a comparatively thin sheet of steel, 0·024in. in thickness, out of which rectangular holes are stamped, so as to leave a grid. Each recess is filled with a pocket or box containing the active material, and they project slightly beyond the surface of the steel grid. They are perforated with numerous small holes to admit the electrolyte, but entirely conceal the contained active material from view.

The active material is made in the form of rectangular briquettes and one such briquette is lodged in each pocket of the plate. Each briquette is placed in a shallow, closely-fitting nickel-plated box of thin perforated crucible steel, cut from a long strip of that material 0·002in. thick. A cover of the same material is then laid over it, so that the briquette is closely enveloped by the sides and walls of its perforated steel box. The boxes are then placed in the openings or holes in the nickel-plated steel grid, and closely fit the same. The assembled plate is then placed in a hydraulic press, and subjected to a pressure of about 100 tons. This pressure not only tightly closes the boxes, but it also forces their metal sides over the adjacent sides of the recesses in the steel grid, thus clamping the whole mass into a single solid and rigid steel plate, with the hollow pockets full of active material. The nickel-plating of both grids and boxes aids in securing good permanent electric connections between them. The finished plate has a grid thickness of 0·024in. and a pocket thickness of 0·1in. The positive briquettes are made by mixing a finely-divided compound of iron with a nearly equal volume of thin flakes of graphite. The graphite assists the conductivity of the briquettes. The graphite is divided into very thin laminæ, and these are passed through sieves so as to leave a size of flake that is much larger than the area of the perforation in the steel windows. The mixture is then pressed into briquettes in a mould, under a hydraulic pressure of about two tons per sqaure inch. The negative briquette is made by similarly mixing a finely divided compound of nickel with a nearly equal bulk of fine flakes of graphite and solidifying the mixture in a mould. A suitable number of positive and negative plates are assembled together, being separated from one another only by a thin sheet of perforated hard rubber. The assembled plates are placed in a vessel or external containing cell of sheet steel containing the potash solution.

In charging, the current deoxidises the iron compound to spongy metallic iron oxidising the nickel compound to the hyperoxide of nickel $NiO_2$ On discharge, the current partially reduces the nickel superoxide $NiO_2$ while oxidising the spongy iron.

In the case of the lead storage cell, theoretically, for every 445 grammes of active material on both plates, 196 grammes of sulphuric acid are required to effect the combination, or 44 per cent. by weight of the active elements, and in practice it is usual to allow a weight of sulphuric acid nearly equal to half the weight of the elements, or about one-quarter of the total weight of the cell. In the new Edison cell, on the other hand, the theoretical action of the potash solution is merely to provide the proper channel through which the oxygen ions may travel in one direction or the other—positive plate to negative plate in charge, and negative plate to positive plate in discharge. Consequently, the amount of solution needs only to be sufficient to fulfil mechanical requirements. It is believed that the weight of solution will in practice be only about 20 per cent. of the plate weight or about 14 per cent. of the cell weight.

The cell may be fully discharged to the practical zero point of electromotive force without detriment. In fact, a cell has not only been completely discharged, but recharged in the reverse or wrong direction, and after bringing it back to its originally charged state by proper restoration of the direction of charging current, the storage capacity remained unaffected. It would seem, therefore, that the cell should be capable of withstanding much abuse. Mr. Edison states that "the negative plate (nickel) either charged or discharged, can be removed from a working cell and dried in the air for a week without appreciably injuring it, and when the plate is finally re-

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placed in the cell its charge is practically undiminished." The positive (iron) plate, if similarly removed from the cell will be likewise uninjured, but it soon loses its charge by the oxidization of the spongy iron with accompanying liberation of heat and appreciable rise of temperature extending over a period of several hours. On replacing the electrode, however, in the cell the storage capacity is unaffected on recharge.

As regards cost, Mr. Edison believes that after factory facilities now in course of preparation have been completed, he will be able to furnish the cells at a price per kilowatt-hour not greater than the prevailing price of lead cells.

Dr. Keith pointed out the danger of local action between the carbon and steel, and he pointed out that the chemical reactions were complicated, as did several other speakers.

Mr. C. J. Read, in the discussion, pointed out that several chemical reactions must take place in succession. He considered that it might lead to an indirect process of obtaining electrical energy from carbon by restoring the discharged plates to their original condition by reducing the oxide in a furnace. He had made a rough calculation of the relative capacities of the lead and Edison cells. In the case of the former there would be theoretically a total capacity of 44 ampere-hours to the pound of active material, and in the Edison cell the capacity would be about 160 ampere-hours. As in in this cell also both electrodes would remain conductors he considered that a higher percentage of the total active material might be used.

Dr. Kennelly, in reply, stated the graphite seemed to be normally inert. The voltage fall of the cell was due to superficial action on the briquette, and not to local action. The complete chemical formula of the so-called nickel super-oxide and iron oxide was not known.

## CORRESPONDENCE.

### POLYPHASE EQUIPMENT OF FACTORIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the appendix to the interesting Paper by Mr. Wyld on the above subject, which you publish in your last issue, we observe that a somewhat interesting polyphase installation is omitted from the list of the 16 factories which are at present thus operated in this country. We think perhaps, therefore, it may interest your readers to know that the case we allude to is the Anglo-Swiss Condensed Milk Co.'s new factory at Kensal-road, W., where there are two 40 H.P. direct-driven generators operating the whole of the works by motors, all of the Brown-Boveri three-phase type, as well as supplying the whole of the lights. The generators are worked in parallel and are regulated by means of Chapman voltage regulators. A storage battery is used to run the lights when the machinery is not running, the battery being charged by means of a motor-generator.

We may mention that this installation was carried out by us as well as one-third of the other three-phase installations enumerated by Mr. Wyld.—Yours, &c.,

London, June 4. GEIPEL AND LANGE.

## LEGAL INTELLIGENCE.

### Postmaster-General v. Richmond (Surrey) Corporation.

At Wandsworth (London) County Court, on Tuesday, the presiding judge (the Hon. A. Russell) heard a summons taken out by the Postmaster-General against the Richmond Corporation as to a difference which has arisen in respect of the placing of a telegraph line in a certain street within the Corporation's district. The Postmaster-General has required the Corporation to give consent to his placing the said line under ground, and the Corporation have attached to their consent a stipulation which the Postmaster-General objects to—that the Postmaster-General's line is to be altered whenever required at the request of the Corporation at his expense, in order for the better or more convenient exercise by the Corporation of their powers in connection with tramways, gas, water, electric light and power, sewers or other similar purposes.

Sir ROBERT HUNTER, solicitor to the Post Office, pointed out that the powers held by the companies whose rights were taken over by the Post Office in 1870 had all been transferred to the Postmaster-General. It was admitted that in the present case the Richmond Corporation were the road authority. On Nov. 2 last the Postmaster-General asked the Corporation's sanction to lay certain pipes along roads specified. After considerable correspondence the Corporation gave their consent, subject to the Postmaster-General consenting to move the pipes at his own expense when such alterations became necessary, in the view of the Corporation, by reason of the exercise by the Corporation of their various powers over the roads. The reason why the Postmaster-General objected to that condition was that he considered the Corporation were going beyond the conditions which they, as road authority, were competent to impose, and also because he considered that, in effect, such a condition overruled the provisions of the Telegraph Act, 1878, which had been passed for the express purpose of protecting the works of the Postmaster-General from alteration, except at the expense of the undertakings who required such alterations to be made. The only case in which that could not apply was that of sewers, and as to that Sir Robert pointed out that an authority acting as a sewer authority could not exercise powers as a road authority. The case of the Postmaster-General *v.* the Corporation of London before the Railway Commissioners was put in. That was a case, said Sir Robert, in which the City Corporation refused consent to the Postmaster-General to lay telephone wires as he was afterwards going to lease them to the National Telephone Co. The Commissioners decided in favour of the Postmaster-General. The important point settled by that case was that the objections which the road authority had a right to make must be raised in their capacity as a road authority, and not in any other capacity. In the case of the Corporation of Tunbridge Wells against Baird the House of Lords drew this distinction very sharply. Finally, he urged that it was not equitable, Parliament having voted money to the Postmaster-General to enter into competition with the National Telephone Co., that he should be put to the unnecessary expense which the Richmond Corporation's condition would involve.

Mr. MORTEN (for Richmond Corporation) said there was no technical question raised in this case. All Richmond wanted decided was whether they had acted legally in their contention. He contended that under sec. 5 of the Telegraph Act of 1863 the Corporation was entitled to make the condition they had imposed.

Mr. BRIERLEY, borough surveyor, said that many of the streets through which it was proposed by the Post Office to lay the pipes were very narrow—in one case only 22ft.

Mr. MORTEN said the suggestion put forward by the Postmaster-General was that the authority having control of the streets could only impose a condition which concerned them as a road authority. He held that the rights and duties of such an authority had not been touched by the cases cited by Sir Robert Hunter. It was idle to suggest that the use of roads was confined to the driving over them of vehicles; it went much beyond that, and he held that such matters as electric light and electric tramways, amongst others, were of much greater importance to the public than telephones. He thought the objection of the Postmaster-General only really went to the question of expense.

Sir ROBERT HUNTER said the Postmaster-General could raise no objection to alterations where necessary, but he could and did object that such alterations should be effected at the expense of his department. The Postmaster-General would, of course, be bound to make an alteration in his works in cases where it was rendered necessary by an undertaking carried out by special Act of Parliament.

Mr. MORTEN said obviously the only authority to determine whether alterations were necessary was the body having supervision of the roads. It therefore became solely a question as to who ought to bear the cost. Richmond Corporation had got an electric lighting provisional order, and had leased it to a company who were actually supplying current. They, therefore, desired to protect the ratepayers from having to pay for what should be paid for by the Post Office.

After consideration, the learned judge gave his award in favour of the Postmaster-General, ordering each party to pay their own costs.

### Gwynne and Another v. Medical Electro-Thermic Generator Co. (Ltd.) and Another.

In the King's Bench on Wednesday the trial of this action came before the Lord Chief Justice and a special jury. The plaintiffs were Mrs. Agnes Gwynne and her husband, Mr. John Gwynne, who sued the Medical Electro-Thermic Generator Co. (Ltd.), and Mr. Arthur Edwin Greville, both of 2, Staple Inn, London, to recover damages for personal injuries said to have been caused by the defendants or their servants while administering an electric bath to Mrs. Gwynne. Defendant company were proprietors of an electro-medical generator, and the defendant Greville was managing director of the company and inventor of the apparatus. The defendant company pleaded that there had been no negligence on their part, and that there had been contributory negligence by the female plaintiff. The defendant Greville pleaded in addition that there was no cause of action against him.

Mr. MACASKIE, K.C., said plaintiffs claimed damages for a most lamentable mischief which happened to Mrs. Gwynne during the course of the administration of a newly-invented bath to which she was subjected, with her consent, on April 17, 1899. The peculiarity of the company's treatment was the application of immense heat to portions of the human body, which for that purpose were enveloped in a bath or cylinder. He believed in some cases the heat applied rose as high as 400°F. The heat was developed by means of electricity. In April, 1899, Mrs. Gwynne was suffering from an obscure form of spinal disease, which had now been ascertained to be curvature of the spine and softening of the spinal cord. Eminent surgeons, including Dr. Broadbent, had been consulted, and by the advice of her doctor she made a trial of defendants' system. Two baths were taken, in which only the patient's legs were treated, without any evil effects, but on the occasion of the third bath, when the whole of the lower portion of the patient's body was dealt with, the defendants did not supply the proper wrappings, and in consequence of their representative (the son of Mr. Greville) not making proper inquiries, Mrs. Gwynne sustained severe burns, which laid her up for some time and

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caused her great suffering. In the course of the correspondence it was suggested that the defendants' representative was not allowed to examine the manner in which Mrs. Gwynne had been prepared for the bath by means of towels; but the plaintiffs' case was that he should have inquired and satisfied himself definitely before he turned the electric current on. Instead of doing that he only asked if she was comfortable or all right.

The apparatus having been brought into court,

His LORDSHIP asked at what voltage the electric current was applied.

Mr. MACASKIE: I think at about 104 volts. Counsel then read the evidence of Mrs. Agnes S. Gwynne, taken on commission, to the effect that in February, 1899, she came to London. She then had a slight cold, and called in her doctor. He advised her to take electric baths. Her husband disapproved, but she had two baths against her husband's wishes. She had the first on March 28, 1999, when one of Mr. Greville's men and a nurse were present. The bath was satisfactory. She had a second bath a day or two afterwards at which the defendant, Mr. Greville, was present, and a nurse. Pads were sent, and stockings. She had a third bath on April 7, 1899. She had no pads, but she had lint stockings on, and towels down the sides of her legs. She asked Mr. Greville, junior, if she was all right, and he said she was. Some few minutes afterwards the electricity was turned on, and it became so hot that she could not endure it. The bath lasted from 15 to 20 minutes. At the end of the bath Mr. Greville, junior, asked her if she was satisfied. She thought she said she was all right. She felt very bad after Mr. Greville left and went to bed. She remained ill for three months and never left her bed. The blisters which ensued were very painful. She now felt the effects of the burns.

Dr. A. FINDLATER gave it as his opinion that Mrs. Gwynne had suffered considerable injury to her general health by the treatment.

Dr. BLASSON said he had advised Mrs. Gwynne to take a course of the baths. He had a high opinion of those baths. If the padding had been properly done, he believed the bath would have been as successful as the two previous baths which Mrs. Gwynne had had. He corroborated the evidence of the last witness.

Prof. VICTOR HORSLEY, F.R.S., said he examined Mrs. Gwynne about three months after the last bath. She suffered from a spinal disease of some standing, but he considered the bath had depressed her condition and caused her suffering.

The proceedings were at this point adjourned till yesterday (Thursday)

### Cuba Submarine Telegraph Co. (Ltd.) v. West India and Panama Telegraph Co. (Ltd.).

A difficulty having arisen as to the drawing up of the order of the Appeal Court in the recent proceedings before Lord Justices Rigby, Collins and Romer, the matter was mentioned in the Court of Appeal on Wednesday, and the points of issue are to be argued before their lordships on a later date.

### British Electric Works Co. (Ltd.).

Mr. Justice Wright, on Wednesday, granted a stay of proceedings in the petition of Samuel Walker (Ltd.) for the winding-up of this company, as a proposed scheme of reconstruction is not quite completed. The matter was ordered to stand over for one month.

### Keighley Fleece Mills Co. (Ltd ).

At Bradford (Yorks.) County Court, on Tuesday, Judge Bompas, K.C., heard a petition for the alteration of the memorandum of association of this company according to special resolutions duly passed.

Mr. WATSON, who appeared for the petitioners, said the proposed alteration having been approved by the shareholders he had now only to satisfy the Court that the alterations were such as came within the meaning of the 1890 Act. As to the objection of the Keighley Corporation, he submitted that that body had no *locus standi*, as not being persons interested within the meaning of the act. The company was incorporated in 1865, and its purpose was the manufacture and sale of gas and the supply of motive power. As an illuminant gas was being superseded by electricity, and the company desired to be able to use its powers in regard to the supply of electricity just as it had done in regard to gas.

Mr. WRIGHT, for Keighley Corporation, claimed a *locus standi* on the ground that that body were creditors, and also that they were interested persons as being threatened with competition.

The JUDGE held that the Corporation had a *locus standi*, and, after hearing arguments, granted the petition of the company, as he found that its object could be effected without the sanction of the Court if it only took the more expensive and elaborate process of winding-up and forming a new company.

### Legal Fixtures.

The following are causes with an electrical interest entered for hearing at the Royal Courts of Justice during the present Trinity Sittings:—

SUPREME COURT OF JUDICATURE.—COURT OF APPEAL.

CHANCERY DIVISION.—*General Appeals.*

Chamberlain and Hookham (Ltd.) *v.* the Mayor, &c., of Bradford. (Appeal of plaintiffs from order of Mr. Justice Farwell dismissing action for infringement of electricity meter patent, dated May 25, 1900, and motion to adduce further evidence.) (By order.)

The Mayor, &c., of Wolverhampton *v.* the British Electric Traction Co. (Ltd.). (Appeal of defendants from order as to compensation for non-performance of contract to sell tramways, dated Dec. 20, 1900.)

In *re* the Madras Electric Tramways Co. (Ltd.) Electric Construction Co. (Ltd.) *v.* Cooper. (Appeal of plaintiffs from order (as to priority of debenture charges) of Justices Cozens-Hardy and Wright, dated March 1, 1901.)

KING'S BENCH.—*Final Appeals.*

The British Electric Traction Co. (Ltd.) *v.* the Commissioners of Inland Revenue (Revenue side). (Appeal of respondents from judgment of Justices Kennedy and Phillimore (as to stamp duty on an indenture giving authority to lease tramways), dated November 27, 1900.)

Lane *v.* Elliott Bros. Appeal of defendants from judgment of Mr. Justice Ridley, dated January 17, 1901.

Maxwell *v.* the British Thomson-Houston Co. (Ltd.), Blackwell & Co., third parties (Crown side). (Appeal of defendants from judgment of Mr. Justice Kennedy (as to liability of sub-contractor), dated March 27, 1901, with special jury, Leeds.)

Gibbs *v.* Chloride Electrical Storage Syndicate (Ltd.). (Appeal of defendants from judgment of Mr. Justice Bigham (in action for balance of price of goods sold and delivered), dated April 2, 1901, without a jury, Middlesex.)

*Before Mr. Justice Wright.*—Companies (winding-up) petitions.

British Electric Works Co. (Ltd.). (Petition of Samuel Walker, (Ltd.)

*Before Mr. Justice Cozens-Hardy.*—Causes for trial with witnesses.

The National Society for the Distribution of Electricity by Secondary Generators (Ltd.) *v.* Gibbs. (Action and counterclaim.)

The Charing Cross and Strand Electricity Supply Corporation (Ltd.) *v.* Johnson and Hooper (Ltd.). (Action.)

*Before Mr. Justice Buckley.* (Causes for trial with witnesses.)

Sawyer *v.* Continental Water and Electrical Power Syndicate (Ltd.). (In liquidation.) (Action.)

*Before Mr. Justice Joyce.* (Causes for trial with witnesses.)

British Motor Co. (Ltd.) *v.* Ford. (Action.) (Not before July 10.)

The Motor Carriage Supply Co. (Ltd.) *v.* British and Colonial Motor Car Co. (Ltd.). (Counterclaim for trial.)

KING'S BENCH DIVISION.

*Special Paper.*

In *re* an Arbitration between the Brush Electrical Engineering Co. and the Governor of Malta.

*Special Jury Actions.*

Gwynne and another *v.* Medical Electrothermic Generator Co. (Ltd.) and another. (Personal injury.)

*Non-Juries.*

Berrenberg *v.* Berrenberg Electric Lamp Syndicate (Ltd.) (Wrongful dismissal.

Philp *v.* National Telegraph Co. (Ltd.). (Injunction.)

National Telegraph Co. (Ltd.) *v.* Exchange Telegraph Co. (Ltd.). (Injunction.)

Laing, Wharton & Down (Ltd.) *v.* W. T. Henley's Telegraph Works Co. (Ltd.). (Contract.)

Metallurgical Engineering Co. (Ltd.) and another *v.* The English Electro Metallurgical Co. (Ltd.). (Contract.)

Marks and another *v.* The Crystal Palace Electric Supply Co. (Ltd.). (Issue.)

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The governing body of the Battersea Polytechnic, London, S.W., require an instructor in electric wiring and a student-demonstrator in mechanical and electrical engineering. Particulars from the secretary. See also advertisement.

The Indian Government require the services of an electrical engineer as professor on the staff of the Civil Engineering College, Sibpur. Some particulars are given in an advertisement, and applications have to be sent in to the Secretary, Public Department, India Office, London, by June 29.

A meter inspector is required at Bradford. Applications to city electrical engineer, Mr. R. A. Chattock. See advertisement.

Bristol Electricity committee have a vacancy for a charge engineer. Applications to city engineer (Mr. H. Faraday Proctor), Temple Back, Bristol. See advertisement.

Glasgow Corporation require experienced men for telephone instrument fitting and switchboard construction. Applications to the general manager of telephone department (Mr. A. R. Bennett), Castle Chambers, Renfield-street, Glasgow. See advertisement.

The Brush Company, 49, Queen Victoria-street, London, E.C, require an instructor at their Falcon Works, Loughborough. See advertisement.

Messrs. Drake and Gorham (Ltd.), 66, Victoria-street, London, S.W., require a superintendent of the sales department of the Jandus Arc Lamp Co. See advertisement.

Lecturers in Physics and Electrical Engineering, Mechanical and Civil Engineering and Chemistry are required for the Sunderland Technical College. Applications by June 28.

Telegraphists are wanted for the Cape Government postal telegraph service. See advertisement.

A testing-house assistant is required by a firm of electrical engineers. See advertisement.

A demonstrator in engineering is required at the Municipal Technical Institute, West Ham. Appliations to Principal by June 12.

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The Council of the Harris Institute, Preston, require a lecturer in mechanical engineering, and assistant lecturers in mathematics and physics and chemistry. Applications by June 17.

Mr. John V. Moinet, mains engineer at Tunbridge Wells, has been appointed (out of 35 candidates) mains engineer to the Reading Electric Supply Co.

Mr. W. A. Kemm, late assistant electrical engineer at Canterbury, has been appointed assistant electrical engineer to the Battersea Borough Council at £175 per annum.

**Alfreton.**—The Board of Trade have intimated that they cannot give their reasons for refusing the Council's application for a provisional electric lighting order.

**Argostili (Greece).**—In the month of June, 1900, electric lighting superseded the old petroleum lighting of this town, the station having been put down by the Hellenic Electric Lighting Co., to which the Continental Thomson-Houston Co. has transferred its concession. The boilers at the station are of British make, the remainder of the steam and electric plant and apparatus and the lamps being of Swiss and French manufacture. The cables were made at Milan. Under the concession the municipality pays £1,200 a year for the public lighting by 300 16 c.p. lamps lighted 2,450 hours per annum. The concession is for 60 years, and on its expiry the station and plant become the property of the local authority. The number of 16 c.p. lights taken by private consumers is between 600 and 700, all the Government establishments being lighted electrically. The charge for lighting has been fixed at a little under ½d. per hour per 16 c.p. lamp, the company undertaking the work of installation at fixed charges.

**Barnstaple.**—The Council have decided to proceed with the electric lighting scheme prepared by Mr. W. H. Trentham, who has been instructed to draw up plans and estimates. Application has also been made for a loan.

**Barrow-in-Furness.**—The second annual report of the Electric Lighting committee states that the revenue amounted to £3,755, compared with £2,630 for the first year. The gross profit was £886, an increase of £128. Mains have been laid in six out of the eight wards of the town and are shortly to be laid to Walney. There has been a satisfactory increase in the number of motor connections, and the cost of production has been decreased in spite of the high price of coal.

**Beckenham.**—An inquiry was held on Wednesday into the application of the Council to borrow £20,000 for electric lighting extensions. There was no opposition.

**Belfast.**—The Gas and Electric committee recommend that the price of electric current for power and heating be reduced after June 30 from 1½d. to 1d. per unit after the first hour's maximum demand. There is the equivalent of 82,205 8 c.p. lamps connected, and applications are in hand for 10,389 further.

**Bendigo (Victoria).**—A system of electric tramways is being constructed in this district. The work is being executed under the supervision of Mr. B. H. Deakin, of the Electric Supply Co. of Victoria.

**Berlin.**—The Municipal Council have granted 20,000m. for preparation of plans for an underground railway from north to south of the city.

**Birkenhead.**—The Electricity committee have decided to apply for a further loan of £40,000 to meet charges and expenses incurred in excess of amount already sanctioned to be borrowed (£2,430), to provide additional generating plant at Bentinck-street works (£11,270), to provide generating plant to supply the South End of the borough (£5,800), for feeder and distribution mains for the Rock Ferry district (£8,000), for distributing mains in other parts of the borough (£7,500), for service mains and connections, terminal boxes, &c. (£3,000), and for arc-lamp mains, lamp pillars, lamps and switch pillars (2,000).

The salary of the borough electrical engineer (Mr. Wm. Bates) has been increased from £300 to £500 per annum.

Application is to be made to the Board of Trade for authority to supply electric energy to the district of Higher and Lower Bebington and Brenton.

The Tramways committee are putting on 15 additional cars at a cost of £13,000, and providing further generating plant at £7,500.

**Brescia (Italy).**—A concession has been granted for the utilisation of the waters of the river Caffaro in this province. From 8,000 H.P. to 10,000 H.P. will be developed. Electric traction is to be adopted on the railway from Caffaro to Brescia, for which current will be supplied from the works to be erected by the concessionnaire, and any surplus power available is to be utilised in works to be erected for the production by electrolysis of caustic soda.

**Canary Islands.**—An electric railway from Santa Cruz to Laguna, for which a concession for 60 years from the Spanish Government was secured by a Belgian syndicate, is now complete, and has started running. Laguna is the second town of importance in the islands, and has about 13,000 inhabitants. The electric line is likely to be carried on to Oratava, a famous health resort on the northern side of the islands. The capital expenditure for the first part of the scheme, now completed, has been £64,000. The machinery, plant, apparatus, and materials for the permanent way and electrical equipment have been supplied by Belgium and Italy.

**Carnarvon.**—The Council are to have the advice of Sir William Preece gratuitously in connection with their proposed application for a provisional order.

**Chorley.**—Sanction to a loan of £21,300 for electricity supply works and £7,646 for a refuse destructor has been obtained. The Lancashire Electric Power Co. are to be asked for their terms for a supply of current in bulk.

**Cirencester.**—The Council are recommended to apply for an electric lighting order.

**City and Guilds of London Institute.**—The annual report of the council of this Institute, which was presented at the annual general meeting last month, contains an interesting account of the past year's work. The present forms the 21st annual report of the council, and reference is made to the efforts to obtain a separate faculty of engineering in the University of London and to the favourable consideration given to these efforts which have enabled the Institute to accept the position of a "school of the University" in the faculty of engineering for the Central Technical College. The Institute has contributed its quota to those who have died in the service of their country in South Africa in the persons of Messrs. W. Berry (killed in action) and F. C. Weakley, who died of enteric. These gentlemen were both past students of the Institute. Three students have returned and resumed their studies, and one has been appointed assistant to the electrical adviser to the Government of Cape Colony. Ten other students have left for the front and one of the electrical assistants at Finsbury College has recently volunteered. The number of students in regular attendance at the various courses of study shows in most cases a satisfactory increase, that for the electrical engineering course being 95, only once exceeded—in the session 1894-1895. The number of students receiving instruction in the electrical engineering department has increased from 211 in 1898-1899 to 237 last session. A list of 46 matriculated third-year students, to whom the diploma of Associate of the City and Guilds Institute has been awarded, accompanies the report. A steady increase in the total number of day students attending the Finsbury College is recorded, and the rapid development of electric traction in this country is credited with attracting an increased number of students to the electrical department. During the session 29 certificates were awarded in the electrical engineering courses at Finsbury out of a total of 101 day students. The evening classes were also well attended. It is noted that the action of the Telegraph Department of the Post Office in giving extra increments of salary to those of its servants who obtain a certificate in telegraphy or telephony as well as electricity and magnetism has stimulated attendance at the classes.

**Deptford (London).**—The Electricity committee are considering the advisability of obtaining a provisional order, and the proposed application by the City of London Electric Lighting Co. is to be opposed.

**Eccles.**—The Council have decided to engage Mr. C. H. Wordingham to prepare a report on the extension of the electricity works, and particularly as to the supply of electric current for traction.

**Exhibition of Practical Work.**—There will be an exhibition of practical work executed by candidates at the City and Guilds of London Institute's Technological and Manual Training examinations, 1901, at the Imperial Institute (North Gallery) on Tuesday, June 18, at 3:30 p.m. Lord Avebury will preside.

**Glasgow.**—The traffic receipts of the tramways department for the year ended May 31 amounted to £484,871 6s. 11d., compared with £464,786. 15s. 2d. for the previous year, £433,128. 0s. 6d. for 1898-9, £389,216. 9s. 6d. for 1897-8, £365,761. 3s. 10d. for 1896-7, and £328,827. 8s. 8d. for 1895-6, the first complete year's working by the Corporation.

The Corporation electrical engineer (Mr. W. A. Chamen) has submitted a supplementary statement in connection with the proposed scale of charges for electric current. Referring to the three alternative scales for 1901-1902, set out in his report of May 6 (*The Electrician*, May 17, p. 155), Mr. Chamen says that the third scale, which was put forward by himself, consisted of an increase in price to all consumers, those charged under the demand indicator system (the greater part of the consumers) paying 7d. per unit for the first 365 hours' use per annum of their maximum demand, and 1d. per unit after. This scale was arrived at by taking the returns of current consumed by the various classes of consumers for the year, and putting on such a price as would bring out a revenue of £81,858, the estimated sum required to meet all working expenses, interest, and sinking fund for the year. If applied to the past year's returns, this scale would bring in about £80,970. The Corporation, however, stand committed to further capital expenditure, which would increase the interest and

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sinking fund by about £10,000, so that the sum required for the year ending May 31, 1902, would be at least £92,000, even if only 6,000,000 units were sold. The Electricity committee, with only two dissentients, came to the conclusion that it was unsound policy to reduce the initial price to one-hour consumers below the present rate of 6d. per unit, though they did not wish to increase it, and that they would be more certain to obtain a largely increased revenue through encouraging the sale of electricity to long-hour consumers by reducing the price to them. The actual average cost of about 6,000,000 units sold to private consumers during the past year would be, say, 3·18d. per unit. If, with the estimated expenditure of £92,000 for the current year, only the same quantity of electricity were sold, the average cost would be 3·68d. per unit. But should the sale of electricity increase by 50 per cent., as it had done for the past two years, the only additional cost would be for coal, and that would be, at the most, some £6,000 for an extra 3,000,000 units, or a total expenditure of, say, £98,000 for the 9,000,000 units, an average cost of 2·61d. per unit. The committee therefore consider that every effort should be made to sell 9,000,000 units during the year, and to that end the price should be 6d. per unit for the first 365 hours of maximum demand and 1d. after, and the rates for domestic consumers, theatres, halls, &c., 3½d. per unit; for churches 3d., and for power 1½d. The revenue produced on 6,000,000 units would be only about £72,000, but if the output sold increased to 9,000,000 units, and the proportions of the various classes of consumers remain as at present, a result which seemed probable, the revenue would be about £104,000 and the expenses about £98,000, leaving £6,000 to the good, and giving an average revenue of 2.77d. per unit sold. Mr. Chamen fully agrees with the recommendation of the committee.

In a report presented to the Tramways committee on Friday, Mr. John Young, the general manager, refers to the trouble experienced with the Allis engines. It appears that this trouble arose chiefly in connection with the lubricating arrangements, but which, in Mr. Young's view, was not of a serious nature. It could, he considers, have been prevented by a little extra care and foresight. Owing to their being unable to have the use of the first Allis engine, Messrs. D. Stewart & Co. had been asked to keep their auxiliary engines working since April 27, and by assistance from the Springburn power station they had been able, although with some difficulty, to maintain a service of electric cars on the routes converging on the exhibition. On some days the Stewart engines had operated no less than 80 cars, but this was a strain which they had been compelled to reduce, and they were now running only 65 off those engines. Their troubles would be overcome when they had the use of the first Allis engine, which could operate 200 cars or more, leaving the second Allis engine as a reserve. Their first Musgrave engine was promised in June, but unless a great change were made in the rate of progress he did not think this delivery could be effected. When they were in possession of the engines on order they would be able to work 400 cars, still holding the third engine in reserve. In connection with the cranes supplied by the Clayton Company Mr. Young states that these have been unsatisfactory from the first, and still give trouble. They were only having such repairs as were necessary to keep them working and to enable the erecting engineers to proceed. The Clay Cross Co., who had in hand a contract for economisers, had not yet completed their first set of apparatus, and he could not say when they would have the use of it.

Referring to the speed of the electric cars and the regrettable accidents which had occurred, Mr. Young states there has been a great deal of exaggeration in this connection. He had enjoined special carefulness on the part of their working staff, and with care and consideration from the travelling public, he hoped such accidents would become infrequent. As to the blame for these accidents he was able to say that, with a few exceptions, the evidence adduced had exonerated the motormen from blame.

**Greenwich (London).**—The Borough Council intimate that they will oppose the proposed application of the City of London Electric Lighting Co. for a provisional order for the district.

**Hereford.**—The Electric Lighting committee reports that the result of the first year's working of the electricity undertaking exceeded anticipations, as the profit had been sufficient to pay interest and to almost discharge the sinking fund instalment, the deficit being only £85. The salary of the borough electrical engineer (Mr. F. G. Poulton) has been increased to £200 per annum.

**Ilkeston.**—The Council have applied for an extension of time to construct the tramways authorised by their Tramways Order of 1899.

**Lagos.**—All the principal thoroughfares of this West African town are now well lighted by means of 250 c.p. incandescent lamps, which are kept burning from sunset to sunrise. All the principal Government buildings are electrically lighted, and now that the generating station is completed it is anticipated that arrangements for supplying current to private consumers will be made.

The subject of establishing a tramway along the main thoroughfare at Lagos—from Carter Bridge along the Marina—is being considered.

The telephone system established here is a very efficient one. New offices have been erected, and a new station at Lafiaji has been connected up to the service during 1900. The lines have been put underground.

**Leith.**—The salary of the burgh electrical engineer (Mr. J. Gray Scott) has been increased by £50 per annum.

**Liverpool.**—An inquiry was held on Wednesday into the application of the Corporation to borrow £300,000 for electric lighting extensions. The town clerk (Mr. Pickmere) stated that when the Corporation purchased the undertaking of the Liverpool Electric Power Co. in 1896 they had power to borrow £500,000, of which £400,000 was paid in buying out the shareholders. The Corporation obtained power to borrow £56,000 in 1897, and £44,000 in 1899. Sanction to a further loan of £300,000 was given in 1900. The output of electrical energy by the company in 1896 was 1,362,511 units; in 1900, under the Corporation, it was 11,500,000 units; the estimate for 1901 was 20,000,000. In 1897 the Corporation purchased the tramways, and had now nearly 100 miles of electric tramways in operation. The number of consumers of electric current at the date of the purchase was 1,300, and last year was 3,450; the equivalent number of 16 c.p. lamps being 52,490, and last year 158,000; H.P. 6,240, last year 22,000; price charged for current for lighting 7½d. per unit, last year 4d.; for power 5d., last year 2d. up to 3,000 units per quarter, and 1½d. per unit after. The present loan of £300,000 was to enable the Corporation to continue this work. The demand for current was very largely increasing, and the amount now proposed to be borrowed would serve for only about 12 months. Technical details were supplied by the city electrical engineer, Mr. A. Bromley Holmes. There was no opposition.

**Llandudno.**—The Great Orme's Head electric railway will be opened about the beginning of August by Sir George Newnes, M.P.

**Manchester.**—The Cheetham and Hightown electric tramway route was formally opened yesterday (Thursday) by the Lord Mayor.

**Municipal Telephony.**—West Hartlepool Town Council have decided to apply to the Postmaster-General for a licence to establish a municipal telephone exchange.

**Oldham.**—The salary of the borough electrical engineer (Mr. S. W. Newington) has been increased from £250 to £275 per annum.

**Paignton.**—The Council have had to decline Mr. Paris Singer's offer to erect electricity works owing to difficulties about borrowing.

**Portsmouth.**—The Admiralty propose to introduce electric cranes in some of the shops.

**St. Helens.**—The net profit on the electricity undertaking for the past year amounted to £1,219. 12s. 4d. After paying off deficit on the previous year, there is a net profit of £553. 13s. 9d., which is to be carried to reserve. Application to borrow £10,000 for additional plant for traction and £16,500 for lighting has been made.

**Sheffield.**—There was a net profit of £4,048. 13s. 10½d. on the last 15 months' working of the electric lighting department. The total income was £41,939. 5s. 9½d., or £18,597 over 1899. The cost of generation and distribution, management, &c., was £15,985. 16s. 9d. The gross profit on the tramway undertaking for the past year was £48,657. 6s. 10d., and the net profit £21,817. 17s. 2d. During 1900-1 over 34 million passengers were carried, against about 19 millions in the previous year.

**Stockton-on-Tees.**—Application has been made for sanction to a loan of £27,500 for electric lighting extensions. During the ensuing year only about £4,000 or £5,000 will be expended. At present the equivalent of 7,238 8 c.p. lamps are connected, and there are applications which will bring the total to 8,814. The capacity of the plant at the station is only equal to 11,600 lights.

**Sudbury.**—A local company, with a capital of £10,000, is being formed by Mr. A. Slatter for the purpose of establishing electricity works.

**Sunderland.**—The borough electrical engineer (Mr. J. F. C. Snell), in his annual report, states that there was a profit of £1,257 on the working of the electricity department during the past year.

**Teignmouth.**—A provisional electric lighting order was obtained in 1899, and as the Board of Trade have intimated that they have no power to extend the period the Gas committee on Tuesday recommended the Council to take no further steps in the matter. The chairman of the committee (Mr. Bird) said that they had no power to sell their rights, and consequently the only course was to drop the scheme. The recommendation was adopted.

**Trowbridge.**—Mr. D. Stevenson has been appointed consulting electrical engineer to the Council.

**Wigan.**—The second section of the electric tramways, from Market-street to near the boundary of Standish, was officially inspected on Thursday last.

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**Worcester.**—The Council on Monday adopted the Electricity committee's recommendation to authorise the completion of the plans of the machinery and plant at the new generating station in Tybridge-street, and to apply for sanction to a loan of £30,450.

**Workhouse Lighting.**—Hartlepool Guardians are making inquiries into the cost of lighting their workhouse electrically.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Extension of Time.*—Exeter City Council have extended the time for the delivery of tenders for the equipment of their new electricity generating station, including boiler and engine-house plant, &c., main and exciter switchboards, cables, instruments, steel-plate coal bunkers and coal conveyors and feed and condensing water tanks from June 14 to the 28th. This contract was advertised in our issue of May 10.

*Mansfield* Corporation invite tenders for the supply and erection of boiler and engine house plant, Körting condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains and arc lamps, posts and accessories for public lighting, mains and workshop equipment. Further particulars are given in an advertisement. Specifications from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W. Tenders to town clerk (Mr. J. Harrop White), Mansfield, by 4 p.m. July 12.

*West Ham* Borough Council invite tenders for three 500kw. continuous-current tramway generators coupled direct to three 850 I.H.P. steam engines, and 11 water-tube boilers. Specifications from the borough electrical engineer (Mr. James K. Bock), Abbey Mills, West Ham, after 11th inst., and tenders to town clerk (Mr. Fred E. Hilleary) by 4 p.m. 25th inst. An advertisement contains further particulars.

*West Ham* (London) Borough Council also invite tenders for the construction of three transformer chambers. Tenders by 4 p.m. 11th inst.

*Wigan* Electricity committee invite tenders for one complete direct reading potentiometer, one ditto photometer, tramcar spare wheels and pit-jack, car body lifting jack and one complete Thomson's balance. Particulars from the borough electrical and tramways engineer (Mr. H. Collings Bishop), Bradford-place, Wigan, to whom tenders by 12th inst. See also advertisement.

*Wigan* Electric Light and Tramway committee invite tenders for 12 double-deck single truck electric cars. Specifications from the borough electrical and tramways engineer (Mr. H. Collings Bishop), to whom tenders by June 18. See advertisement.

*Erith* Urban District Council require tenders for generating station plant, mains, conduits, arc lamps and posts, &c., some particulars of which will be found set out in an advertisement. Specifications, &c., can be obtained from Mr. Chas. H. Fry, clerk to the Council, Council Offices, Erith, Kent, and further information from Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C., to whose plans and specifications the works are to be carried out. Tenders have to be sent to Mr. Fry before 12 noon of June 24.

*Cleckheaton* District Council invite tenders for the supply and erection of engines and dynamos. Further particulars are given in an advertisement, and specifications, &c., may be inspected at the office of the consulting engineers (Messrs. Gibbings and Baker), Piccadilly Mansions, 17, Shaftesbury-avenue, London, W., and Old Bank Chambers, Cheapside, Bradford, and may be obtained from the clerk (Mr. J. Armitage), Town Hall, Cleckheaton. Tenders by June 22.

*Bermondsey* (London) Borough Council invite tenders for electricity meters, demand indicators, and main fuses. An advertisement contains further particulars, and specifications, &c., can be obtained at the Town Hall, Spa-road, Bermondsey, or can be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders to the town clerk (Mr. Frederick Ryall) by noon of July 1.

*Sutton Coldfield* Corporation require direct current meters and cut-outs. Specifications may be seen at (but not obtained from) the offices of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen Street-place, London, E.C., and tenders to the town clerk (Mr. Thos. V. Holbeche) by noon 15th inst. See advertisement.

*Llandudno* District Council advertise elsewhere for tenders for the supply and delivery of 1,673 yards of 0·25 triple concentric feeder cable, paper insulation. Specifications from the electrical engineer (Mr. Harold Morton), and tenders to the clerk of the Council (Mr. Alfred Conolly) by June 17.

*Kearsley* District Council invite tenders for taking up roadway and re-paving, laying of rails, points, &c., and all labour required for the construction and completion of certain tramways. Tenders to clerk by 1 p.m. June 13.

*Islington* (London) Borough Council Lighting committee require tenders for the painting of arc lamp columns and crutches; also offers for "free" or "assisted" wiring in the district. Tenders to town clerk by noon June 11.

*Central Electric Supply Co.* require three overhead travelling cranes for a maximum working load of 20 tons, and one for a working load of 10 tons, to be driven by electric power and hand. Tenders to Mr. F. J. Walker, 19, Carnaby-st., London, W., before 10 a.m. June 12.

*Warrington* Corporation invite tenders for one water-tube boiler and pipe-work, one 500kw. high-speed Willans engine with direct-coupled continuous dynamo, underground mains, stoneware conduits, &c. Tenders to town clerk by noon June 13.

*Taunton* Corporation require tenders for one 250kw. steam alternator and one 15kw. motor generator, switchboard extensions, one water-tube boiler, superheater, jet condenser and air pump and piping. Tenders to town clerk by 2 p.m. June 11.

*Edinburgh* Corporation invite tenders for ash-conveying plant for Dewar-place electricity works. Tenders to town clerk by June 15.

*Edinburgh* Corporation also invite tenders for the electric lighting installation, &c., of the first portion of the Colinton Mains Fever Hospital. Tenders by 11 a.m. June 12.

*Marylebone* (London) Guardians require tenders for wiring the new able-bodied block of their workhouse. Tenders to clerk, Northumberland-street, W., by 17th inst.

*Walthamstow* District Council require electricity meters. Tenders to clerk by 5 p.m. June 14.

*Exeter* City Council invite tenders for the equipment of their new electricity generating station. Tenders to town clerk by June 14.

*Barking* Council invite tenders for condensing plant. Tenders by 19th inst.

*Peterborough* Corporation require a Lancashire boiler and a 120kw. steam dynamo. Tenders by 14th inst.

*Oldham* Corporation require tenders for foundations, &c., for a new generating station. Tenders by June 11.

*Norwegian State Railways Administration* invite tenders until 26th inst. for 37,600 kilog. galvanised iron wire (4mm.), 9,300 ditto (3mm.), 12,800 insulators, 9,000 insulator-holders, and 3,600 top covers. Offices, 8, Stanersgade, Christiania.

*Belgian State Railway Authorities* invite tenders for two 30kw. dynamos for the Jumet-Brulotte power station.

*Villanueva de Cordoba* (Spain) Municipal Council invite tenders until 10th inst. for the electric lighting of the town for six years.

Tenders are invited by the municipalities of *Kertch* and *Mariupol* (Russia) for electric lighting and electric tramway installations. We understand that plans and conditions have been transmitted to the Commercial Department, Foreign Office, London, where they can be inspected.

Tenders are invited until July 26 by the Ministry of Agriculture, Industry, Commerce, and Public Works, *Madrid*, for a 60 years' concession for an electric tramway from the Santuario de la Yedra to Baeza, and also for a concession for an electric tramway from Cadiz to San Fernando, with a branch to Carraca. Tenders by July 30.

The Municipal Council of *Rieza* (Spain) invite tenders until July 9 for the public lighting of the town for 20 years. About 70 10 c.p. lamps will be required.

The Municipal Council of *Alcalá de Guadaira* (Spain) invite tenders for the electric lighting of the town for 20 years. About 210 10 c.p. incandescents will be required.

### TENDERS RECEIVED AND ACCEPTED.

The Electrical Co., 122-124, Charing Cross-road, London, W.C., have received an order from Messrs. Browett, Lindley & Co. for one direct and three-phase current dynamo, with one armature 600kw. on either side, for the Trafford Park electric light and power station.

Middlesbrough Corporation has accepted the following tenders in connection with the extensions to the municipal electricity works, subject to sanction for loan :—

Holdsworth & Sons (30ft. by 8ft. 6in. Lancashire boiler and accessories), £915. 10s.

Witting Bros. (300kw. high-speed steam generator—Browett engine and Kolben dynamo—and pipework), £3,564.

Crompton & Co. (ejector condenser with circulating pumps), £557.

British Insulated Wire Co. (cables, troughing, trenching and boxes), £737. 19s. 2d.

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Manchester Tramways committee have accepted the tender of Babcock and Wilcox for 24 boilers, each capable of evaporating 12,000lb. of water per hour, for the Stuart-street power station.

Bristol Corporation have recently let the following contracts :—

*Avonbank Electricity Works.*

E. Nuttall, foundations, retaining walls, culverts.
R. Wilkins, buildings.
Babcock and Wilcox, boilers.
Babcock and Wilcox, coal conveyor and elevator.
Babcock and Wilcox, steam and other piping.
Ed. Bennis & Co., coal discharging plant.
Bumsted and Chandler, induced draught plant.
G. and J. Weir, steam, electric, feed and general service pumps.
Doulton & Co., water softening plant.
Higginbottom and Mannock, electric travelling crane.
Siemens Bros. & Co., steam alternators (Willans engines).
Siemens Bros. & Co., steam dynamos (Willans engines).
W. H. Allen, Son & Co., condensing plant.

*Temple Back Electricity Works.*

S. Z. De Ferranti (Ltd.), low tension switchboard.

*General.*

British Elect. Trans. Mfg. Co., London, alternating current transformers.
E. Nuttall, underground sub-stations.

Newcastle-on-Tyne New Tramways committee have let the following contracts :—

Messrs. Dick, Kerr & Co., for balance of steel rails required for the completion of the tramways, at £6. 8s. 9d. per ton, and for fish plates £12. 10s. per ton. About 1,000 tons required.

The contract for the erection of a pumping station at the power house was given to Mr. J. F. Miller at £2,668 ; and for laying the pipes, connections, &c., to Mr. Simpson at £1,681.

The tender of the Electrical Power Storage Co. for the erection of a storage battery at £2,117. 3s., and that of Messrs. J. H. Holmes & Co. for a booster at £380 were also accepted.

Contracts for the alteration of the old tramway stables, to make them suitable for car-sheds, were let to Messrs. J. R. Veitch & Co., at £5,178. 14s. 1d. for the Haymarket stables, and at £3,646. 18s. 11d. for those at Gosforth.

Oldham Town Council have accepted the tender of Messrs. Dick, Kerr & Co. for steel tramway rails.

Messrs. C. A. Parsons & Co. have recently obtained an order for a turbine engine for Milan capable of driving a 2,000kw. Brown-Boveri dynamo. Delivery within ten weeks of order.

Shoreditch (London) Borough Council have accepted the tender of the Renewable Lamp Co. for the supply of incandescent lamps for the 12 months ending March 31, 1902, and that of W. T. Henley's Telegraph Works Co. for cable for extensions during the next nine months at £10,516. 5s.

Stockton-on-Tees Town Council have accepted the tender of Messrs. J. & H. McLaren for a steam dynamo at £3,450.

Wigan Corporation have accepted the tender of Messrs Walter Scott (Ltd.) for steel tramway rails, and that of Messrs. Askham Bros. and Wilson for iron tie-bars, points, &c.

## BUSINESS NOTICES.

Messrs. Julius Sax & Co. (Ltd.) notify the completion of their arrangements for the removal of their offices and stores from Camberwell to 51, Rupert-street, Coventry-street, London, W., where a stock of electric bells and telephone requisites will be kept as well as electric lighting materials. A list of high-voltage electric light accessories will shortly be ready. Messrs. Julius Sax & Co. desire it to be known that they are the parent firm of this name, having been established in 1855, and that they have no connection whatever with the firm of Sax, Slatter & Co. (Ltd.), now in liquidation. The firm's new telephone number is 3266 Gerrard.

Messrs. Crompton & Co. (Ltd.) notify that their head offices will be removed from Mansion House Buildings to Salisbury House, London Wall, London, E.C., as from June 10.

We are informed that, owing to the re-arrangement of the staff of the Edison and Swan Co., Mr. A. W. Hill will, after an uninterrupted service of 20 years, sever his connection with the company. Mr. Hill joined the staff of the American Edison Co. before the formation of the English company, and was superintendent at Holborn Viaduct central station for the Edison and Swan Co., with charge of the erection and maintenance of all the installation work in London undertaken by the company. He has held the position of works foreman and engineer at Ponder's End for the past 10½ years.

Messrs. Johnson and Phillips call attention to the addition at their extensive works at Charlton of a mechanical rubber department fitted with the latest machinery driven electrically.

Messrs. C. J. Whistler-Hanson, A.I.E.E., and Mr. C. H. Watkins have joined interests and established the Precision Engineering Co., electrical and mechanical engineers, metal stampers, &c., at 5, Clerkenwell-green, London, E.C.

## BANKRUPTCIES, LIQUIDATIONS, &c.

J. E. Liardet, engineer, 16, Hyde Park-gate, London, W., has been adjudicated bankrupt.

A meeting of Paris Singer (Ltd.) will be held at 28, Bedford-row, London, W.C., to receive an account of the winding-up. Mr. S. H. Baldrey is liquidator.

In the bankruptcy of Alfred Mavor (present address unknown), the first meeting of creditors will take place on 11th inst, and the public examination on July 12, both at Bankruptcy Buildings, London, W.C.

At a meeting on Tuesday of the creditors of G. F. Cook, electrical engineer, Charles-street Bradford, it was decided to leave the estate in the hands of the Official Receiver (Mr. J. Arthur Binns).

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**Sales by Auction.**—Messrs. Wheatley Kirk, Price & Co. are instructed by the sole surviving executor of the well-known firm of Messrs. Smith, Beacock and Tannett to sell by public auction piecemeal at the works premises, Victoria Foundry, Water-lane, Leeds, on 12th and 13th inst., at 10 for 11 prompt, the entire contents of the works. An advertisement contains further particulars, and catalogues may be obtained (price 6d.) on application to Mr. F. Riley at the works, or of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Messrs. Fuller, Horsey, Sons, and Cassell will sell by auction at Trafalgar Works, Bow Common-lane, London, E., on Tuesday, June 11, at 11 a.m., a quantity of modern machine tools, some particulars of which are set out in an advertisement. Catalogues can be obtained of Messrs. Standring, Marshall & Co., solicitors, 14, Bedford-row, W.C., and of the auctioneers, 11, Billiter-square, London, E.C.

Messrs. Fuller, Horsey, Sons and Cassell will also offer at the above sale, at Bow Common-lane, a small collection of modern machine tools, the property of the General Engineering Co. (Ltd.). Some particulars of this collection are given in an advertisement.

**Plant for Sale.**—Messrs. Wheatley Kirk, Price & Co. have received instructions from the Edison and Swan Co. to sell by public auction at an early date, at the Broadheath Engineering Works, Broadheath, near Manchester, some finished stock, plant, machinery, tools, &c. An advertisement contains further particulars. Further information from the auctioneers, Albert-chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

An advertisement contains particulars of an E C.C. dynamo coupled direct with a 50 H P. vertical compound engine which are for sale. Applications to Mr. H. A. Couchman, Messrs. Bass & Co., Burton-on-Trent.

**Plant Wanted.**—Electric light plant is required for 1,000 16 c.p. lamps. See advertisement.

**Fire.**—A fire occurred on Monday afternoon at the electrical engineering works of Messrs. Johnson and Phillips, Charlton, resulting in a building of one floor, 100ft. by 40ft., being partly burnt out and considerable damage to buildings, plant and stock. No delay whatever will occur in the execution of orders, as the firm are able to utilise other portions of their extensive premises at Charlton for carrying on the work.

**Theft.**—At Glasgow Criminal Court last week, Edward Paterson was convicted of having resetted 47ft. of electric cable, 21cwt. 65lb. of lead, 812lb. of copper wire, a connector, and a quantity of insulating material, value about £63, the property of the Glasgow Corporation electricity department, and 9cwt. 2lb. of electric cable, value about £28, the property of the National Conduit Co. A sentence of 15 months' imprisonment was passed.

**General Electric Apparatus.**—Section M of the main catalogue of the General Electric Co. is now ready. The list is devoted to instruments.

A list of "Freezor" electric fans and small power motors for continuous and alternating currents is also just issued.

**Mavor and Coulson Plant Catalogue.**—An excellent catalogue of generating plant manufactured by Messrs. Mavor and Coulson, 47, King-street, Mile End, Glasgow, has just been issued, the illustrations showing some good views of generating sets coupled to various makes of engines. The list is noticeable for some useful instructions for cable jointing, &c.

**"P.P.P." Plant.**—A well-illustrated list of generating plant and apparatus manufactured by Messrs. D. Bruce Peebles & Co., of Edinburgh, is issued, and gives particulars of a large range of dynamos and motors installed in the chief central stations of the kingdom as well as in numerous works where electric driving has been established. In all over 50,000 E H.P. generated by "P.P.P." dynamos is at the present moment running in the lighting and tramway power stations of the United Kingdom and the colonies, and motors of this make have been put in for a great variety of purposes. The illustrations include views of the chief machine shops at the Tay Works, Bonnington, and a good group of combined "P.P.P." sets

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with Willans, Belliss and "Sentinel" engines. The group of sections of which the main list is made up includes motors, generators, dynamos, balancers, crane motors and controllers, motor-driven pumps and fans, plating dynamos and a short list a geared motors.

**"Kelly's Directory of Engineers and Iron and Metal Trades."**—The ninth edition of the very comprehensive and useful Directory of Engineers and the Iron and Metal Trades, published by Kelly's Directories, Ltd. (price 30s.), is to hand. The scope of the work embraces all metal and engineering trades and colliery proprietors in the United Kingdom, and, as can usually be said for the bulky tomes sent out by Messrs. Kelly, the work has, on the whole, been admirably done. Those who know the labour and detail necessary in the compilation of these publications can readily pardon such blunders as are almost inevitable in such a work. Only praise can be awarded the system adopted in rendering the book of the utmost service, and the information given readily get-at-able. The towns in the English counties are set out in alphabetical order, and a "local" list follows of the traders in each particular branch covered by the title of the book. London and its suburbs, Scotland and Wales are similarly treated, followed by Ireland, the Channel Islands and the Isle of Man. So far as we have tested the accuracy of the directory it has answered expectations, and will be found of the greatest service to those seeking to reach the engineering and metal trades of the country.

**"B.B." Continuous-Current Machinery.**—A useful, well-illustrated list of continuous-current dynamos and motors is just issued by Messrs. Richardsons, Westgarth & Co., of Hartlepool.

**Electric Lighting Boards.**—We are informed that at a recent meeting of the shareholders of this company it was announced that the American rights of the "E. L. B." system have been disposed of, the negotiations for the sale having been conducted by Miss Amy Ashton Bence, secretary of the company, who has recently visited New York for the purpose. It is further announced that a demonstration of recent improvements in the system is shortly to take place.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from May 30 to June 4, with the ports of destination:—

*Aden*—£108,520 (telegraph cable). *Africa*—Alexandria, £42 (telegraph wire); Cape Town, £33 (including £21 telegraph material), Durban, £821. *Argentina*—Buenos Ayres, £1,326 (including £916 telegraph material). *Australasia*—Adelaide, £2,271 (including £2,200 telegraph wire); Brisbane, £36; Fremantle, £1,989 (including £21 telegraph material); Melbourne, £1,774 (including £1,308 telegraph cable); Sydney, £2,429 (including £770 telegraph wire); Wellington, £2,976. *Belgium*—Ostend, £15. *Burma*—Rangoon, £57. *Canada*—Halifax, £3,000 (telegraph cable); Montreal £100. *Ceylon*—Colombo, £179. *Chili*—Valparaiso, £167. *China*—Shanghai, £55. *Denmark*—Copenhagen, £186 (telegraph material). *Germany*—Bremen, £20; Hamburg, £430 (including £380 telegraph material). *Gibraltar*, £775 (including £60 telegraph apparatus). *Holland*—Amsterdam, £117; Flushing, £39; Rotterdam, £241 (telegraph material). *Hong Kong*, £32. *India*—Bombay, £357 (including £82 telegraph cable); Calcutta, £967 (including £22 telegraph material). *Japan*—Hiogo, £32; Nagasaki, £40; Yokohama, £392; Yokosaka, £6,342 (including £3,754 telegraph cables). *Malta*, £192. *Mauritius*, £20. *Norway*—Christchurch, £100 (telegraph wire). *Peru*—Callao, £1,021 (telegraph material). *Russia*—Archangel, £239; Kure, £1,088 (telegraph cable); St. Petersburg, £500 (telegraph material). *Siam*—Bangkok, £1,646 (telegraph cable). *Spain*—Vigo, £58 (telegraph material). *Straits Settlements*—Singapore, £456 (including £407 telegraph apparatus). *Sweden*—Stockholm, £86 (telegraph wire). Total (for six days) £141,166, against £13,683 for eight days last year (May 30 to June 6).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

February 21, 1901.

3,753. J. D F. Andrews. London. Improvements in connections for electric conductors.

3,793. H. W. Webb. London. A new or improved compound or material for insulating electrical wires.

3,794. H. W. Webb. London. A new or improved die or mandrel and mounting therefor, for facilitating the uniform coating of electrical wires with insulating material in a viscid state.

February 22, 1901.

3,796. W. Aitken. London. Improvements in surface contact electric traction systems.

3,799. R. C. Quin. Blackpool. An improved method and apparatus for the prevention of accidents from trolley wires.

3,803. G. Smith and H. H. Hall. Manchester. Improvements in electrically illuminated letters for signboards.

3,823. R. Ames. London. Improvements in and connected with conduits for electric wires and cables.

3,832. C. C. Garrard and The Nernst Electric Light (Ltd.). London. Improved steadying resistance for Nernst lamps.

3,833. B. M. Drake, C. C. Garrard, E. G. Sheppard, M. Solomon and The Nernst Electric Light (Ltd.). London. Improvements in Nernst lamps.

3,834. P. J. M. Girault. London. Improved means for starting electromotors with rotating fields.

3,860. E. G. Sheppard, M. Solomon and Nernst Electric Light (Ltd.). London. Improvements in electro-magnets.

February 23, 1901.

3,881. C. F. Elliott. Liverpool. Improvement relating to overhead conductor electrical traction systems.

3,929. E. Andreas. London. Improvements in or relating to electric lamps.

3,930. O. Lugo and J. A. Barratt. London. Improvement in the art of telephony.

3,935. F. Jones. Liverpool. Improvements in or in connection with the laying of underground conductors for distribution of electrica energy.

February 25, 1901.

3,964. A. G. New. Woking. Improvements in electric igniters for internal combustion engines and the like.

3,965. A. G. New. Woking. Improvements in automatic and safety subsidiary devices for controlling electrically-propelled vehicles and the like.

3,967. A. Dickinson and T. Preece. Leeds. Improvements in dynamo electric generators and electric motors.

3,972. E. A. Clarkmont and J. Stratton. Manchester. Improvements in machines or mechanism employed in the manufacture of pipes or tubes or for covering telegraph and telephone cables and wires with lead or other metallic substance for electric purposes.*

3,992. H. W. Cobb. London. Improvements in electrical accumulators.

4,005. T. F. Walker and T. S. Walker. London. Improvements in or relating to electrical ship log apparatus.

4,007. C. D. Abel. London. Improvements in telephonic apparatus for central stations. (Siemens and Halske Aktien Gesellschaft, Germany.)*

4,017. A. A. Vogelsang. London. Improvements in the electrolytic bleaching of cotton and other textile materials, and in apparatus for use in connection therewith.*

4,033. H. J. Haddon. London. Improvements in controlling apparatus for electric lifts. (A. Stigler, Italy.)

February 26, 1901.

4,042. S. Cowper-Coles. London. Improvements in and connected with the production of electrotypes.

4,050. L. P. Perkins and H. Humphreys. Manchester. Improvements in electrical switches.

4,088. C. J. R. Le Mesurier. London. A safety device for overhead systems of street electric transmission of power.

4,098. W. Hume. London. Improvements in railway electric signalling apparatus.*

4,114. S. H. Heywood. Manchester. Improvements in or applicable to the trolley systems of electrical traction.

4,122. G. E. Gaiffe and G. A. G. Contremoulins. London. Improvements in make-and-break switches or interrupters for electric circuits.

4,123. C. W. Hildred and H. C. Walker. London. Improvements in and relating to slack-cable safety gears for electrically-operated lifts, elevators and the like.

4,149. J. H. Spangler. London. Improvements in electrically-operated switches.*

February 27, 1901.

4,215. H. H. Lake. London. Improvements relating to electric switches. (The "Telephonfabrik Aktiengellschaft vorm. J. Berliner," Germany.)

4,243. J. W. Beauchamp. Liverpool. Improvements in electrical circuit breaking and making devices.

February 28, 1901.

4,259. J. Kelly. Birmingham. The preparation and use of calcium compounds for the electro depositions of metals other than calcium.

4,290. British Thomson-Houston Co. (Ltd.). London. Improvements in mica insulation for electrical apparatus. (Charles F. Peterson, United States.)*

4,305. R. W. Derbyshire. London. An improved tidal motor for generating and transmitting energy.

4,330. H. J. Dowsing. London. Improvements in the connections or contacts of incandescent electric lamps for lighting and heating.

March 1, 1901.

4,337. J. B. Mackenzie. Bradford. A new or improved stopping-place indicator for electric cars and electric railways.

4,366. C. R. Bellamy, W. J. Turner and D. R. W. Hardman. Liverpool. Improvements in safety devices for the trolley poles of electric cars.

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4,382. C. C. HEWETT. London. An improved method of breaking the electric circuit in the overhead wires of electric tramways, railways and the like, and apparatus therefor.
4,388. J. COURTIER. London. Improvements in devices for producing, by the electric volatilisation of metal wires, flashes for use in photography.*
4,401. T. K. BELLIS. London. An electric heater for liquids.
4,422. C. A. HUSSEY and S. G. CLARKE. London. Improvements in electric primary batteries.*
4,429. F. M. CHAPLET. London. Improvements in or relating to electric storage batteries or accumulators.

March 2, 1901.

4,487. J. BUSH and M. T. MEDWAY. London. An improved magnetic brake for motors, for electric lifts and other purposes.
4,489. A. A. VOGELSANG. London. Improvements in electrolytic cells and in electrodes therefor.*
4,491. F. B. LACY. London. Improved electrical remedial appliance.
4,494. W. P. THOMPSON. London. Improved process for making electrodes for accumulators. (Akkumulatoren und Electricitäts-Werke Aktiengesellschaft, formerly W. A. Boese & Co., Germany.)*
4,501. G. W. COXSON. Birmingham. Improvements in electric switches.
4,508. H. J. H. PICKARD and J. S. EVANS. London. Improvements in accumulator plates.*
4,509. H. J. H. PICKARD and J. S. EVANS. London. Improved composition of paste for filling the cells of reticulated accumulator plates.*
4,519. C. F. HENGST. London. Improved construction of rail for electric and other railways or tramways.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

25,591. GUARINI. Apparatus for wireless telegraphy. (Date applied for under International Convention, May 27, 1899.)

1900.

1,133. BOULT (Sauvalle). Incandescent electric lamps.
3,390. DUNDAS and KERSHAW. Typewriting, type-setting, or analogous machines and telegraphic apparatus.
3,588. DE MARE. Device for finding the electric poles.
3,886. HEAPHY. Fire alarm thermostats.
3,917. LORWA. Electricity meters.
3,949. COLLINGE and COLLARD. Electrical speed indicator.
3,992. WISE (Actien Gesellschaft Electricitätswerke vorm, O. L. Kummer & Co.). Voltmeters.
4,168. CERBOTANI and SILBERMANN. Devices for rapidly transmitting impulses of current.
4,198. DE LAMPRECHT. Time apparatus for making and breaking telephonic and telegraphic circuits.
4,383. LINCOLN. Electric controlling apparatus.
4,461. GLOVER. Electric cables or conductors.
4,503. HIRST and COLLINGS. Self-locking elbow joint for electrical fittings.
4,561. COTHIAS. Bearings and lubricants applicable to electric trolleys and other electrically-conducting bearings.
4,570. VAUGHAN and FOSTER. Overhead travelling electric cranes.
4,680. MÜLLER. Electric accumulators.
4,685. WRIGHT and REASON MANUFACTURING CO. (LTD.). Electricity meters.
4,706. LIGHTFOOT. Electric switches, principally for high voltage circuits, and also applicable to switch lampholders.
4,803. FESSENDEN. Electric incandescent lamps. (Date applied for under International Convention, Aug. 25, 1899.)
4,842. WOOD. Electric fire-damp detector or indicator.
4,926. HOWARD. Automatic time switches.
5,137. GALE. Incandescent electric lamps.
5,187. LAMKIN. Automatic telephone call recorder.
5,191. WESTINGHOUSE BRAKE CO. (LTD.) (Newell). Electric heating systems for cars.
5,389. SHORCRAFT and GARDINER. Electrically-operated railway signals.
5,429. OPPENHEIMER (Actiengesellschaft Mix and Genest). Granulated carbon microphones.
5,430. OPPENHEIMER (Actiengesellschaft Mix and Genest). Cable suspenders for multiple switchboards or similar apparatus.
5,561. ROUGÉ and FAGET. Transformer of alternating currents into continuous currents of equal or different tension). (Date applied for under International Convention, Sept. 27, 1899.)
5,562. ROUGÉ and FAGET. Apparatus for transforming single and multiphase alternating currents into continuous currents and inversely. (Date applied for under International Convention, Nov. 14, 1899.)
5,650. THOMPSON (Voltohm Electrical Co.). Method and apparatus for determining the size and position of bodies by means of Röntgen rays.
5,860. SCOTT. Electrical apparatus for hoisting or other intermittent work.
6,209. BREWER (Knudson). Joints and electric bonds for street mains or pipes.
6,301. BEST. Means for electrically igniting miners' safety lamps.
6,499. LEHFELDT. Electric meter depending on electrolytic transport of mercury.
6,568. RAAB. Heaters of conductors of the second class in electric incandescent lamps.
6,569. RAAB. Heating of conductors of the second class in electric incandescent lamps.
6,727. HALFORD. Electric contacts.
6,731. WISE (Goldstein and Latimer). Combined telephone exchange and alarm systems.
6,768. ISBILLS. Construction of vehicle or car wheels and electric motors therefor.
6,931. LORRAIN (Bedell). Transmission and distribution of electricity.
7,062. RICCI. Variable speed gear for mechanically or electrically propelled vehicles.
7,070. KNEALE and HARTLEY. Telephones.
7,200. THOMSON (McLaughlin). Electric belts for the electric treatment of the human body.
7,272. BAKER. Carbon electrodes.
7,285. PARSONS, BELFIELD and CHAPMAN. Electric railways operated on the conduit system.
7,355. CERPAUX. Microphones.

# COMPANIES' MEETINGS AND REPORTS.

## Electrical Power Distribution Co. (Ltd.).

The fourth ordinary general meeting of this Company was held on Tuesday, Mr. WM. L. MADGEN, M.I.E.E. (managing director), presiding.

The CHAIRMAN, in moving the adoption of the directors' report and accounts, said: I regret Mr. Garcke is indisposed, and he has asked me to take his place to-day. You have the report before you, and will see the profits amount to £15,001. 2s. 9d., and after deducting the proportion of general expenses chargeable to revenue, and the expenses incurred in connection with schemes not proceeded with and written off, and a sum of £1,271. 5s. 9d. held in reserve in respect of new schemes in course of development, there remains a net profit of £13,045. 11s. 2d., which we propose should be applied in writing off preliminary expenses, £826. 6s. 2d., that the furniture account shall be written down, £513 paid as income tax, and a dividend paid at the rate of 5 per cent. per annum on the ordinary shares for nine months or from the date on which the calls and instalments were paid. That leaves the large sum of £10,329 to be carried forward. We have a very large amount of unfinished work in hand, and feel that it would be judicious while it is in an uncompleted state to carry forward the sum in question. The first item on the credit side of the balance-sheet is "Expenditure on power bills and negotiations in connection with new schemes in course of development, less amount reserved, £16,840." We feel that that amount is fully justified by the value of these schemes which we have in process of development. No part of the work actually carried out is included in this item. It represents undertakings which are in course of development and negotiations which are in progress with a view to being, at a later stage, put into a practical shape—the stage at which the works will themselves be constructed and be available for revenue purposes. This sum of £16,840 represents the net cost of these power bills and of the negotiations in progress, and, of course, nothing at all has been added to that amount in taking it into the balance-sheet. I submit that we have so far met with a very fair measure of success. In the session of last year four electrical power bills, for the distribution of electrical energy under economical conditions over large sections of country, were passed by Parliament. Of those four bills this Company secured two and, I think, for exceptionally favourable districts—the county of Durham, one of the greatest industrial areas of our country, and the other for the North Metropolitan district, which has exhibited during past years an enormous increase of population in the residential districts, and in more recent years has shown a tendency to industrial development along the valley of the Lea. In addition we secured rights for electricity supply in numerous other districts. These latter undertakings are not in themselves so large, and will not offer us so great a scope for investment as the power bills themselves, but they are in some cases the nucleus of what may be equally large undertakings later on. After the power bill for the county of Durham had received the Royal Assent the work was immediately put in hand, and last month we successfully inaugurated the main power station at Gateshead under that bill. Our friends, the British Electric Traction Co., have in that district the beginning of a very extensive system of electric tramways, and the first business undertaken by our main station there has been to supply those tramways with electrical energy. The general electricity supply for the town of Gateshead and the neighbouring districts is making very rapid progress, and we are led to believe that our confidence in the suitability of that district for general electrical power purposes would be fully justified. Consumers are taking the supply very readily. With regard to the North Metropolitan scheme, that will be commenced with two power stations, both on the river Lea, where facilities for coal and water supply are probably the best in the north of London, and where the amenities of the district will not be interfered with by the consumption of coal on a large scale. Progress was made with the work in this district with just as little delay as we permitted ourselves in the county of Durham, and during the present month the first of the two main power stations for north London will be inaugurated at Hertford. Of the other stations referred to in the appendix to the report, one of the most interesting is that of Weston-super-Mare. The electricity supply for that town was inaugurated during the past month, and we started there with a very satisfactory number of customers, and the number is steadily increasing week by week. The Weston-super-Mare company have a concession for a system of electric tramways for the town, and the construction of these lines, which will be worked in association with our electricity supply, will be commenced during the coming autumn. Most of the other stations referred to in the report will be completed during the present year, and from all the indications which reach

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us from those districts we confidently believe that a satisfactory and profitable business will be done. I now move the adoption of the report.

Mr. R. PERCY SELLON, seconded the resolution, which was agreed to.

The retiring directors, Mr. Emile Garcke and Mr. John S. Raworth were then re-elected, and the Directors remuneration at £300 approved. After the appointment of Messrs. Wright and Wake as auditors, the meeting was made extraordinary, and resolutions were passed amending the articles of association in accordance with the new Act.

A vote of thanks to the Chairman, Directors and Staff terminated the proceedings.

## Metropolitan District Railway Co.

A special general meeting of the proprietors of this company was held yesterday, Mr. JAMES STAATS FORBES, chairman of the company, presiding. The meeting was called to consider the resolution for approving a bill to empower the District Company to convert their lines to electric traction, and to effect an agreement between the Metropolitan District Railway Co. and the Metropolitan District Traction Co. (Ltd.).

Among those present at the meeting was Mr. C. T. Yerkes, the United States railway magnate, but he took no part in the proceedings.

The CHAIRMAN said that the adoption of electric traction was held to be the only remedy for the trouble which had overtaken the company's operations, and the question was how, with the company's credit standing as it did, they were to meet the necessary charges which conversion to electric traction involved. In endeavouring to find ways and means the directors had met with gentlemen of reputation and ability and with—what was more mportant still—financial means. These gentlemen had become by purchase owners of a controlling percentage of the Metropolitan District Railway Co.'s share capital, and were, in fact, masters of the situation. They had had great experience of electric traction, and had assured him that they could carry out the proposed conversion. They had from time to time shown their belief in the ultimate success of the project by taking up about half the ordinary capital and were ready to find the necessary funds for the work which was required to be carried out. The agreement which had been prepared, and which was now submitted to the meeting, had been the subject of earnest consideration by the directors and all concerned. Under this agreement it was proposed:—(1) to build a generating station at the lowest possible cost consistent with efficiency, and this station would be hiredor leased by the Metropolitan District Traction Co. (Ltd.), to the Metropolitan District Railway Co. (2) This would be followed by the conversion of the line to electric traction, and for this work the combination, which had at its head Mr. C. T. Yerkes, would take all the funds that the Metropolitan District Railway Co. had to dispose of. They had power to raise £500,000 ordinary stock, and this carried with it power to create £166,000 debenture stock. The Traction Company would take the ordinary stock at 25 per cent. and the 4 per cent. debentures at par. When it came to be remembered that the conversion to electric traction was to be carried out without any serious interference with the working of the line the chairman felt that the proposal was one which would commend itself to the proprietors; and the chief benefit to be secured by those who were financing the Traction Company and undertaking this great risk was the increasing value of the stock they had taken over by the improvements which they were thus bringing about by the proposed changes. This really meant nothing more than a reasonable interest on their outlay, as they would find the money for the generating station and any other money required to carry out the electrification of the line under contract at 5 per cent. The proposal before the proprietors had the unanimous recommendation of the directors as offering the best possible way out of the difficulties with which they were surrounded. He concluded by moving the resolution, which was seconded by the deputy-chairman (Mr. L. H. Isaacs).

After lengthy discussion, in which a number of proprietors supported and opposed the proposed arrangement,

Mr. PERKS, M.P., said there was great urgency for the passing of the proposed bill, as he might point out that a measure was now being put forward for the construction of a parallel line of railway along Fleet-street and the Strand which would have the effect of still further cutting into their receipts. He had himself not a penny interest in the new Traction Company which was undertaking the conversion of the line to electric traction, but he was a large holder of District Railway Co.'s stock, and it was for that reason that he had taken an active part in the proposals now before the proprietors.

Replying upon the discussion, the CHAIRMAN said that the cost of the generating station was estimated at £400,000, and it would take two years to erect and equip it. The agreement which had been entered into would only become binding on the Metropolitan District Railway Co. when the Traction Company was organised. The proprietors would remember that they had been spending 52 per cent. of their receipts in working expenses, whereas the electric working of the line could, it was said, be effected at 35 per cent. of the receipts, and the difference would mean £70,000 per annum. Taking a less sanguine view, and putting the working expenses at 40 to 45 per cent., there would still be an enormous saving effected in the working, and, in addition, there would be a much greater number of trains running over the lines and earning revenue. While all connected with the Metropolitan District Railway Co. were anxious to work in harmony with the Metropolitan Railway Co. in this matter, he was not prepared to recommend them to sacrifice their own interests. Amalgamation with the Metropolitan Company could not now be effected after the changes which had taken place. The resolution was then put to the meeting and carried unanimously.

At an extraordinary meeting which followed, resolutions authorising the exercise of certain powers conferred on the District Railway Co. by the Whitechapel and Bow Railway Act (1900), and the Brompton and Piccadilly Circus Railway (Extensions) Act (1899) were approved.

## India Rubber, Gutta Percha and Telegraph Works Co. (Ltd.).

A half-yearly general meeting of this company was held on Tuesday, Major L. DARWIN presiding.

The SECRETARY (Mr. T. J. Lloyd) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, in the unavoidable absence of Mr. Marsham, Mr. Scott, our senior director, has asked me to take the chair. You are aware that the object of the half-yearly meeting of the company is to obtain your approval of the payment of an interim dividend. It is usual on these occasions for the board to take advantage of the opportunity, and to give you some information as to the progress of the company's business during the preceding six months. Since December last, I am glad to say that, with the exception of gutta percha, the prices of raw material have eased, and we have been able to sell our manufactures at lower prices than had ruled for the previous 18 months. These reductions have, however, not been considerable. As a result of this and of a general slackness in trade, our turnover does not compare favourably with the similar period of last year. Within the last two months an improvement has taken place, and should this be maintained, the board hope to meet the shareholders in December with a statement of affairs showing much the same results as we laid before you six months ago. We have just completed the laying, for the Commercial Cable Co., of a cable between Weston-super-Mare and Waterville in Ireland, and our steamer "Buccaneer" has just terminated her charter to the Western Telegraph Co. Owing to the continued state of unrest in South Africa your agency in Durban and your agency in Bulawayo have not yet been able to do any profitable work, but your board hope that when hostilities cease we shall be fully prepared to take advantage of every opening for business which may present itself. From the remarks made at the beginning of my observations you will have gathered that the price of gutta percha has not fallen, and I am afraid that these remarks may cause a false impression. The market prices of the different grades of gutta percha are, as a matter of fact, lower than they were recently, but the quality of these grades is below the usual standards, with the net result that buyers get less useful material for the money they pay than was formerly the case. I now move the adoption of the report and accounts.

The resolution was carried unanimously.

The CHAIRMAN then announced that during the period under review the board had sustained a very great loss by the retirement of Mr. Matthew Gray and Mr. Silver. Only those who had been on the board could thoroughly appreciate what a great loss their retirement was to the company. The loss was mitigated, however, because under the recent rules which have been passed by this company they had been able to appoint these gentlemen extraordinary directors. The directors appointed Mr. George Henderson, an old shareholder of the company and a son of the former chairman, and Mr. Charles Moore to fill the two vacancies.

A vote of thanks to the chairman and directors was passed, and the proceedings terminated.

**BAKER-STREET AND WATERLOO RAILWAY.**—A report of the liquidators of the London and Globe Finance Corporation states that this corporation's holding in the Baker-street and Waterloo Railway Co. amounted to over £700,000, and negotiations have been carried on with a view to the disposal of this interest for £500,000; but at the date of the report no definite arrangement had been come to. Meantime Messrs. Perry & Co., the contractors for the construction of the line, have continuously carried on the works, and a considerable portion of the tunnelling between Baker-street and Waterloo has been completed, the payments for work done being provided by the railway company. The proposed purchasers of the line, in addition to the provision of £500,000 for the holding of the London and Globe Corporation, will become responsible for the completion of the line from Baker-street to Waterloo, together with the extensions from Paddington to Baker-street, and from Waterloo to the Elephant and Castle, a total liability of over £2,000,000. The liquidators point out that the magnitude of these financial operations involve considerable loss of time in their negotiation, and that another difficulty has arisen in regard to possible liability falling upon the purchasers in connection with vibration. The liquidators express the opinion that the London and Globe interest in the railway will be transferred sooner or later, as there are several purchasers prepared to come in, but at prices much less favourable to the interests of the creditors and shareholders.

**BARCELONA TRAMWAYS CO. (LTD.)**—The report for the year ended Dec. 31 states that the traffic receipts from electric traction amounted to £85,589. 4s. 7d. and from mule traction to £13,157. 14s. Sundry receipts brought this amount to £99,872. 2s. 8d. The working expenses amounted to £69,728. 16s. 10d., leaving a gross profit of £30,143. 5s. 10d. After deducting loss on exchange (£9,234. 13s. 2d.) and adding £1,211. 14s. 9d. brought from 1899, there was a net profit of £22,120. 7s. 5d. After paying debenture interest (£10,264. 10s.), preference dividend (£5,000) and other expenses, £317. 10s. 8d. is carried forward. The directors regret that no dividend can be recommended on the ordinary shares. The receipts from mule traction (which was not entirely superseded by electricity until Oct. 4 last) were absorbed by working expenses. The grant of a concession for working the Ensanche Company's tramway system by electricity is now only subject to certain formalities, and when those are settled the directors hope to enter into a lease or working agreement to the mutual advantage of both companies. A new concession to be worked by electricity has also been obtained for an extension of about 1½ miles of one of the company's principal lines, and the work of construction will be taken in hand without delay.

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**CASTNER-KELLNER ALKALI CO. (LTD.)**—At the meeting last week the chairman (Mr. W. Mather, M.P.) said the absorption of the business of the Aluminium Company had been completed. The reasons for the reduced earnings of the year were due to increased price of coal and other raw materials, which had reduced by £11,000 the net profits; but this notwithstanding, an interim dividend at the rate of 8 per cent. per annum had been paid in October last. At that time the company were making and delivering their largest product (bleaching powder) to the utmost capacity of the works, and prices were promising. Towards the end of the year prices of bleaching powder hardened considerably, but with the turn of the year an extraordinary change occurred in the alkali trade. Practically, there was a collapse, and, although prices remained high, stagnation of orders set in and had continued, and, as a consequence, there had also been a decrease in the sales of caustic soda. The new works at Weston Point had been completed, the delay having minimised the benefits anticipated from amalgamation with the Aluminium Company. Sodium was largely used in connection with the manufacture of cyanide, and until operations were resumed at the Transvaal mines the present depression would continue. He considered the position of the company a sound one, and reminded the shareholders that in previous years the dividend had been maintained at 8 per cent.

**MEXICO ELECTRIC TRAMWAYS (LTD.)**.—At the meeting on Wednesday the chairman (Col. Sir C Euan-Smith, K.C.B.) said the company had had to contend with great difficulties during nearly the whole of the past year. At present their tramway system was in a state of transition; some of it was worked by electricity, a small portion by steam and a large portion was still operated by animal traction. It was not possible that, until electric traction was established throughout the whole area covered by their concession, they could gauge with absolute accuracy the future limits of success that awaited the completed of their enterprise. The local board in Mexico was showing active and energetic interest in the undertaking, and their thanks were especially due to Mr Clegg, the general manager, Mr. Worswick, the chief engineer, and, in fact, the entire body of officials and members of the local board, for their untiring efforts to ensure ultimate success. The relaying of the track, the extension of the electrical system, the erection of power houses and other buildings, and the provision of the required rolling stock was all being proceeded with in a satisfactory manner. Since the commencement of 1901 the board had concluded a most advantageous arrangement, which had the effect of leasing the whole lines of the Ferrocarriles Co. to the Mexican Electric Tramways (Ltd.), under which name the operations of their company would henceforth be conducted in Mexico.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**HAM, BAKER & CO. (LTD.)**—Reg. June 1, capital £40,000 in £1 shares (20,000 preference), to acquire business carried on by Ham, Baker & Co., and to carry on the business of mechanical and electrical engineers, manufacturers of electric and steam motors and machinery, &c. The first directors are F. G. S. Ham, W. E. Baker and C. M. Sansom.

**J. STENNER & CO. (LTD.)**—Reg. May 25, capital £15,000 in £5 shares, to take over and carry on business as manufacturing electrical engineers, metal workers, ironmongers, &c., at Tiverton, Devon. The first directors are Joseph Stenner (chairman), W. C. Webber and J. Stenner, jun.

**JOHN I. THORNYCROFT & CO. (LTD.)**—Reg. May 22, capital £260,000 in £1 shares (160,000 6 per cent. cumulative preference), to acquire business of John I. Thornycroft & Co., at Chiswick. First directors are W. Beardmore, J. I. Thornycroft and Sir W. C. H. Domville, Bart.

**W. & C. TIPPLE (LTD.)**—Reg. May 23, capital £20,000 in £1 shares (500 preference), to acquire and carry on business of wholesale and retail ironmongers, engineers, dealers in electrical and engineers' requisites, &c. The first directors are C. and C. H. Tipple.

**T. C. WELDING & CO. (LTD.)**—Reg. May 25, capital £1,000 in £1 shares, to take over and carry on business at Liverpool as manufacturers of and dealers in electric fittings and apparatus, railway brakes, conplings and connections, mechanical and electrical engineers, wire drawers and makers, metallurgists, &c.

**NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)**—The annual return to March 14 gives the capital as £50,000 in 10 "A" and 49,990 "B" shares of £1 each, of which 10 "A" and 36,922 "B" have been taken up. £1 has been called up and paid on each share. Mortgages and charges, £28,400. Since date of above return, 900 "B" shares have been allotted.

**SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)**—The annual return to March 1 gives the capital as £100,000 in £5 shares, 12,000 of which have been taken up. £60,000 has been received. Mortgages and charges, £58 000.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3½ per cent. (June 6, 1901). Price of silver 27 7/16d. per oz. (June 6). Consols (2¾ per cent.) 93⅜—93½ for money, 93½—93⅝ for account; 2½ per cent. 94—94½ (June 6). Consols Pay Day, July 3; Stocks and Shares Continuation Days, June 12 and 26; Ticket Days, June 13 and 27; Pay Days, June 14 and 28; Mining Share Carry-over Days, June 11 and 25.

**BRITISH WESTINGHOUSE ELECTRIC AND MFG. CO. (LTD.)**—It is announced that the Hon. R. C. Parsons has retired from the position of chairman of the executive committee and director, and that Mr. George Westinghouse, of Pittsburg (U.S.A.), has been elected chairman of the board.

**CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)**—A dividend of 10 per cent. per annum has been declared on the ordinary shares for the half-year ended March 31, making 8 per cent. for the year.

**CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)**—On Friday last the shareholders approved a resolution authorising the directors to raise moneys to the maximum of £500,000 for the purposes of the City undertaking of the company.

**COMMERCIAL CABLE CO.**—A quarterly dividend of 1¾ per cent. has been declared payable July 1 out of the net earnings of the company.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—The following particulars of the revenue of this company for the March quarter have been issued:—Sale of current, &c., £91,611. 12s. 7d.; working expenses, £45,728. 1s. 5d.; leaving available for interest on debenture stocks and loans, depreciation, special charges and dividends, £45,883. 11s. 2d.

**DRAKE AND GORHAM (LTD).**—Applications for an issue of 85,000 ordinary shares of £1 each at par in this company have been made during the week. Some particulars relating to the firm of Drake and Gorham were given in our last issue (page 235).

**ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)**—Subject to audit, the directors recommend the payment of the following dividends, &c., for the year ended May 31:—Ordinary shares: 5s. per share (2s. per share paid on account in December) and a bonus of 2s. per share, making together a present distribution of 5s. per share, equal to 7s. per share, or 35 per cent., for the year. Founders' shares: £50 per share.

**GENERAL ELECTRIC CO. (1900) (LTD.)**—The transfer books of the preference shares of this company will be closed from the 14th to 29th inst. inclusive.

**MUNICIPAL LOAN.**—The Portsmouth Town Council have decided to create new three per cent. redeemable stock, to an amount not exceeding £610,000, for the purchase of the local tramways and the electrical equipment of the lines. The stock is to be issued immediately at 95.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed June 19 as special settling day in the further issue of 30,000 6 per cent. cumulative preference £10 shares (issued at £1. 10s. premium and £7. 10s. paid, of which £6 is capital and £1. 10s. is premium), Nos. 160,001 to 190,000, of the *British Electric Traction Co. (Ltd.)*, and has ordered the further issue of 2,074 ordinary £10 fully-paid shares (Nos. 120,001 to 122,074) of the same company to be quoted in the official list. The committee has also been asked to allow £50,000 4 per cent. debenture stock of the *Oxford Electric Co. (Ltd.)* to be quoted in the official list.

**TELEGRAPH MANUFACTURING CO. (LTD.)**—The ordinary general meeting of this company will be held at the Law Association's rooms, Cook-street, Liverpool, at 3 p.m. this day (Friday). The transfer books of the ordinary shares are closed to the 11th inst.

**WESTERN UNION TELEGRAPH CO.**—The usual quarterly dividend of 1¼ per cent. is declared.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | May 25 | 685 | + 13 | 51 | 33,856 | + 3,719 |
| *Birmingham Tramways. | June 1 | 5,647 | +1,146 | 21 | 90,479 | + 2,872 |
| *Blackburn Corporation.. | May 31 | 663 | + 211 | 22 | 10,031 | + 1,188 |
| Blackpool Corporation... | „ 30 | 1 862 | +1,407 | †9 | 5,333 | + 2,062 |
| Blackpool and Fleetwood | June 1 | 1,863 | +1,492 | 22 | 6,993 | + 1,098 |
| Bolton Corporation ..... | „ 2 | 1,852 | + 516 | 9 | 13,656 | + 2,930 |
| Bradford Corporation... | „ 3 | 1,431 | + 969 | 9 | 9,205 | + 5,073 |
| Brisbane Trams ..... | Apl. 17 | 1,933 | + 56 | 15 | 30,649 | + 3,447 |
| *Bristol Trams & Carriage | May 31 | 6,597 | +3,550 | 21 | 89,153 | +28,172 |
| *Buenos Ayres & Belgrano | „ 5 | 2,728 | + 325 | 18 | 50,370 | + 8,984 |
| Carlisle Trams. Co. ..... | June 1 | 216 | ... | 22 | 3,086 | ... |
| Central London Railway | „ 1 | 6,368 | ... | 22 | 136,265 | ... |
| City & South London Ry. | „ 2 | 1,815 | + 381 | 22 | 43,286 | +15,532 |
| Cork Elec. Trams ..... | May 30 | 585 | + 129 | 21 | 8,800 | + 1,207 |
| Dover Corporation ..... | June 1 | 289 | + 81 | 9 | 1,952 | + 418 |
| Dublin & Lucan Rly. ... | „ 1 | 172 | + 64 | 22 | 2,003 | + 200 |
| Dublin United ..... | May 31 | 4,109 | + 642 | 22 | 63,295 | + 99 |
| Dublin Southern Dist.... | „ 31 | 1,011 | + 154 | 22 | 17,120 | |
| *Dundee Corporation ... | „ 29 | 701 | + 280 | ... | ... | ... |
| *Glasgow Corporation ... | June 1 | 11,382 | +1,920 | 52 | 484,870 | +20,083 |
| Halifax Corporation..... | „ 2 | 1,682 | + 648 | ... | ... | ... |
| *Huddersfield Corpn. .... | „ 1 | 1,179 | + 506 | 9 | 6,843 | + 1,840 |
| Hull Corporation..... | „ 1 | 1,965 | + 841 | 48 | 71,358 | +35,559 |
| Liverpool Corporation... | May 25 | 9,378 | +1,165 | 21 | 173,965 | +25,373 |
| *Liverpool Overhead Rly. | June 2 | 2,079 | + 727 | 22 | 34,455 | + 3,446 |
| Perth (W.A.) Elec. Trams | May 31 | 772 | + 348 | 48 | 32,279 | ... |
| Portsmouth Corporation | ... | ... | ... | ... | ... | ... |
| *Sheffield Tramways ..... | June 3 | 4,590 | +2,309 | 22 | 69,278 | +25,997 |
| Southampton Corporat'n | ... | ... | ... | ... | ... | ... |

(a) These comparisons are for the corresponding week last year.
* Partly electrical. † Minus 8 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 29. | | Price Wednesday, June 5. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending June 5. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Hl'ekh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 | 75 | 70 | 75 | ... | ... | 73½ | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | 10½ | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅜ | 8⅛ | 7⅜ | 8⅛ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅝ | 9 | 8⅝ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7 | 7⅛ | 7 | 7⅛ | 2 6 8 | ... | 7 1/16 | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 8⅛ | 5⅛ | 5⅛ | 5⅛ | 3 18 3 | ,, ,, | 5 3/16 | 5⅛ |
| 24,000 | 5 | 2/0 | Chelsea Electricity Supply Ordinary | 6 | 6⅛ | 6 | 6⅛ | 4 4 7 | March | 6⅛ | ... |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 9⅛ | 9½ | 4 4 3 | February and August | 8⅞ | 8⅛ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 | 13 | 12 | 13 | 4 12 4 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 126 | 127 | 126 | 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8¼ | 9 | 4 4 3 | ... | 8 1/16 | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11⅜ | 12⅜ | 11⅛ | 13⅛ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 105 | 108 | 105 | 108 | 4 5 1 | ... | 108⅛ | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 2 16 5 | ... | 8⅛ | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11 | 12 | 11½ | 12½ | 4 4 0 | ... | 12 | 1 ⅛ |
| 16,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6⅝ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 105 | 102 | 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 | 104 | 102 | 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £380,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 99 | 101 | 3 19 8 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 12½ | 14½ | 14 | 15 | 4 0 0 | April and October | 14½ | 14 |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13 | 14 | 14 | 15 | ... | ... | 14½ | 14 |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | 111 | ... |
| £180,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 11 5 | ... | 9 ⅜ | ... |
| 8,652 | 10 | 9/0 | Notting Hill Electric Ordinary | 15½ | 16½ | 15½ | 16½ | 4 13 4 | March | ... | ... |
| 14,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6⅛ | 5⅝ | 6⅛ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅜ | ½ | ⅜ | ½ | 10 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 103 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 60,000 | 5 | 2/6 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 5 | February and August | 15⅜ | ... |
| 20,000 | 5 | 2/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 90 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2⅝ | 3⅛ | 2⅝ | 3⅛ | ... | ... | ... | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 12⅜ | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4⅛ | 4 | 4⅛ | 4 14 2 | April and October | 4 3/8 | 4 3/16 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 124 | 129 | 4 14 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,000 | 100 | 5% | Do. 5% Debentures | 96 | 101 | 99 | 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ | 3⅛ | 2⅝ | 3⅛ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4⅛ | 4⅝ | 4⅛ | 4⅝ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 | 101 | 99 | 101 | ... | ... | 99⅝ | 99⅜ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23⅜ | 23⅝ | 23⅜ | 23½ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅜ | 11 | 3 14 5 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 | 116 | 114 | 116 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6¾ | 7 | 6¾ | 7 | ... | ... | ... | ... |
| 12,500 | 10 | 5/0 | Do. 5% Preference | 9⅜ | 10 | 9⅜ | 10 | 5 0 0 | May and November | ... | ... |
| £240,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 93⅞ | 101⅞ | 93⅞ | 101⅞ | 4 9 3 | ... | ... | ... |
| 62,074 | 10 | 6/0 | British Elec. Trac. Ord. | 14½ | 15½ | 14½ | 15½ | 5 9 8 | ... | 15⅝ | 14½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 8 | February and August | 12⅝ | ... |
| £160,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 9 | ... | 121½ | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5 | 5⅛ | 5 | 5⅛ | ... | ... | 5 1/8 | ... |
| £230,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 8 | ... | 98⅛ | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) | 10⅜ | 11⅛ | 10⅛ | 11⅛ | 2 14 2 | ... | 10⅜ | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 102 | 104 | 103 | 105 | ... | ... | 104⅜ | 1 8⅛ |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅜ | 1⅝ | 1⅜ | 1⅝ | ... | ... | 1⅝ | ... |
| 19,980 | 10 | 2/6 | Central London Ordinary | 9⅛ | 10 | 9⅜ | 10 | 2 15 0 | June and December | ... | ... |
| £696,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 113 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 4 17 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 100 | 103 | 3 17 10 | ... | ... | ... |
| £884,000 | Stock | 4½% | City and South London Railway Con. Ordinary | 51 | 53 | 51 | 53 | 2 7 7 | February and August | ... | ... |
| 47,500 | 10 | 2/0 | Do. Ordinary (Nos. 22,501 to 70,000) | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 2 7 0 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 131 | 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 | 127 | 122 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 111 | 116 | 111 | 116 | 3 9 2 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 | 14 | 13 | 14 | 4 5 9 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 4½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5⅛ | | 5⅛ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4⅞ | 5⅛ | 4⅞ | 5⅛ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 | 22½ | 22 | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 | 114 | 113 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,500 | 10 | 2½% | Liverpool Overhead Railway Ordinary | 8¼ | 8½ | 8¼ | 8½ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 13 3 | January and July | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fully pd) | 103 | 105 | 104 | 103 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y 5% Str'rl'g 5% Mort. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3½ | 3⅝ | 3 | 3⅛ | 5 14 4 | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4⅝ | 5 | 4⅝ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | ,, ,, | ... | ... |
| 12,234 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 | 12 | 11 | 12 | 1 13 4 | ... | 12 | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 | 107 | 105 | 107 | 4 4 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 8% | Waterloo and City Ordinary | 93 | 96 | 93 | 96 | 3 2 10 | June and December | 94⅛ | 93½ |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, May 29. | Price Wednesday, June 5. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending June 5. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 100 103 | 100 103 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ 4⅛ | 3⅜ 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 73 78 | 78 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 53 56 | 54 57 | 5 10 7 | Feb., May, Aug., Nov. | 53 | ... |
| £3,097,640 | Stock | £0/0 | Do. Preferred | 97 99 | 98 100 | 6 1 3 | ,, ,, | 99⅜ | 98½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 10⅛ | 10⅛ 11 | 2 5 6 | ,, ,, | 11 3/16 | 10⅜ |
| 13,333,300 | £100 | £1¼ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,023 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 5 | ,, ,, | 103½ | ... |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 8 | 7 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 16 | 15 16 | 6 5 0 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ 104⅞ | 100⅞ 104⅞ | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 10⅛ | 10½ 10⅝ | 6 10 10 | Jan., Apr., July, Oct. | 10 11/16 | 10⅛ |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 140 145 | 140 145 | 4 17 0 | Jan., Apr., July, Oct. | 142 | 141½ |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 94 | 91 94 | 3 14 6 | ,, ,, | 93½ | 91½ |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 114 | 110 114 | 3 10 2 | May and November | 111⅝ | ... |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ 14 | 13½ 14¼ | 4 18 3 | Jan., Apr., July, Oct. | 14⅜ | 13⅜ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 116 | 111 116 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 103 | 100 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100⅞ 103⅞ | 100⅞ 103⅞ | 3 17 10 | May and November | 100½ | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust | 9½ 10 | 9⅝ 10⅛ | 5 2 5 | Jan., Apr., July, Oct. | 10 1/16 | 9⅝ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ 15½ | 14⅝ 15½ | 3 18 8 | ,, ,, | 15 | 1 ⅛ |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen | 32 34 | 31 33 | 4 10 11 | January and July | ... | ... |
| £82,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos. | 100 103 | 100 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red.) | 43 47 | 43 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 1 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's xd | 7½ 8½ | 7 8 | 5 0 0 | April and October | 7⅝ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 130 | 125 130 | 4 12 10 | ,, ,, | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2 3 | 2 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 101 | 98 101 | 4 19 7 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ ⅜ | ¼ ⅜ | ... | ... | ¼ | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 100 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅜ ⅝ | ⅜ ⅝ | ... | May and November | ... | ... |
| 34,563 | 10 | 5/0 | Do. 5 per Cent. 1st Preference | 5 6 | 5 6 | 10 0 0 | ,, ,, | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | 12 0 0 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 14 4 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zill'n Submarine) | 13¾ 14¼ | 13¾ 14¼ | 4 18 3 | Mar., June, Oct., Dec. | 14⅛ | 13 3/16 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1905) | 102 105 | 102 105 | 4 15 8 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅛ 4 | 3⅛ 4 | 5 0 0 | August | ... | ... |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/3 2/9 | 2/3 2/9 | 10 18 2 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ ¼ | ⅛ ¼ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3¾ 4 | 3⅝ 3⅞ | 7 11 9 | February and August | 3⅞ | 3⅝ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11⅛ 12⅛ | 11⅛ 12⅛ | 4 16 0 | ,, ,, | 12⅛ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11⅛ 12⅛ | 11⅛ 12⅛ | 4 16 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅜ 4⅝ | 4¼ 4⅜ | 5 11 1 | ,, ,, | 4 3/8 | 4 |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 87 90 | 87 90 | 3 18 8 | June and December | 89 | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 8 | ... | 95 | 95½ |
| 171,504 | 1 | 0/3½ | Oriental | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4¼ 5 | 5 5½ | 6 7 3 | July | 5 | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ 5¼ | 4¾ 5¼ | 4 15 3 | June and December | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 106 | 103 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅝ ¾ | ⅝ ¾ | 8 0 0 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ... | 13/16 15/16 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | 11/16 13/16 | 11/16 13/16 | 7 7 8 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 11 | 9½ 10½ | 7 2 10 | July and February | 10⅝ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5⅞ 6¼ | 5⅞ 6¼ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅞ 5¼ | 4⅞ 5¼ | 5 14 3 | ,, | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ 1⅝ | 1⅜ 1⅝ | 3 8 7 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2¼ | 2⅜ 2⅝ | 5 1 1 | ,, | 2⅜ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 104 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. xd & bonus | 14½ 15½ | 14 15 | 5 0 0 | ,, ,, | 13 | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | ,, ,, | 5⅝ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 113 | 109 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) xd | ⅝ 1⅛ | ¾ 1 | 5 0 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 98 | 94 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1⅛ | 5 15 7 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1⅛ | ¾ 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅜ 4 | 3⅜ 4 | 5 12 7 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 101 104 | 101 104 | 4 17 0 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1 1⅛ | 1 1⅛ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2½ 3½ | 2 3 | 8 16 6 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 89 | 87 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 98 | 94 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5⅛ 5⅜ | 5⅛ 5⅜ | 7 7 10 | Half-yearly | 5⅛ | 5⅜ |
| 13,363 | 5 | 1/6½ | Do. Cumulative Preference | 5⅜ 6 | 5⅜ 6 | ... | ... | 5⅜ | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) xd | 104 107 | 104 107 | 4 4 5 | ... | 103 | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1⅝ 2⅛ | 1⅝ 2⅛ | 5 6 8 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅛ 3 | 2⅛ 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 100 103 | 3 19 0 | January and July | 103 | ... |
| 18,000 | 10 | ... | General Electric (1900) Ltd. 5% Cum. Pref. | ... | 9¾ 10½ | ... | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures xd | ... | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 15/0 | Henley's Telegraph Works Ordinary | 15½ 16½ | 15½ 16½ | 6 1 3 | February and August | 16⅛ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 6 | 5⅛ 6 | 3 15 0 | ,, ,, | 5 1/16 | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 111 | 107 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 13 0 | ,, ,, | 21⅜ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 35 39 | 35 39 | 5 7 8 | March and July | ... | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1900 | 102 105 | 102 105 | 3 16 10 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11⅜ | 5 12 6 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ 6 | 5⅜ 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 1 | April and October | 10⅛ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 6¾ | 6½ 6¾ | 4 8 11 | ,, ,, | 6⅝ | 6 1/16 |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures xd | 105 107 | 104 105 | 4 0 2 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,204. [New Series. Vol. XLVII.] FRIDAY, JUNE 14, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

MR. MORDEY'S report on the condition of electricity supply in Newcastle-upon-Tyne, an abstract of which we publish in another column, raises an important question with regard to the attitude of local authorities towards the extensions of the systems of companies working within their areas. In Newcastle, Mr. MORDEY points out, there may be ultimately nine distinct sets of cables and five supply stations, of which one is outside the municipal area and another would probably also be extra-urban. When, in 20 years' time, therefore, the companies' provisional orders expire the Corporation would find such a multiplicity of systems pressures, and frequencies rather troublesome; and moreover, although they would be able to acquire the mains and the stations within the town at a cheap price, they could not compel the sale to them of the extra-urban stations from which, in all probability, the main part of the supply would then be derived. This same question will crop up from time to time in all company supply districts in which the generating station is placed outside of the supply area; but it would assuredly be acting unfairly to place any impediment in the way of the companies improving their systems on the most economical lines, merely for the purpose of enabling the local authorities to make a better bargain in the future. On the other hand, it may be that the eagerness of large supply companies to transmit their electrical energy "in bulk" from large generating works outside the area covered by their provisional order, is not attributable to their desire merely for better coal and condensing facilities.

SOME remarkable further developments are recorded in our Contemporary Science Notes this week of Dr. RUHMER's researches with the photographophone, an instrument which he has devised for the purpose of photographically recording and reproducing sound. Since Baron MÜNCHHAUSEN's extravagant story of the frozen sound which was reproduced when the ice melted, there have been many serious efforts on scientific lines to actualise that absurdity, and another instance is thus afforded of the anticipation by fiction of genuine scientific discovery. The ordinary forms of phonograph and graphophone, and the more recent telegraphone, accomplish the desired end practically, but do not reveal the details of the process by which the result is attained. Dr. RUHMER's photographophone secures a more scientifically useful result, inasmuch as it allows of close and definite examination of the detailed sound records. Not merely is the sound recorded and reproduced, but the complex sound waves are photographed seriatim, and can, therefore, be analysed and comparatively studied.

Two earlier instruments have already accomplished this, though in a less perfect degree. We refer to KÖNIG's manometric analyser and to Prof. GRAHAM BELL's phonautograph, the former of which made a record that was both transient and inaccurately shaped, while the ingenious instrument devised by BELL, although making a fairly accurate trace of the sound waves on smoked glass, was incapable of being used for reproduction of the actual sound. From a purely graphical point of view, however, the phonautograph was superior to Dr. RUHMER's photographophone, the one showing the complex sound waves in Cartesian curves, the other indicating them merely by the irregularity of tint or shade in a photographic strip. The earlier instrument, on the other hand, suffers from defects due to inertia, while the employment by Dr. RUHMER of the practically inertialess machinery of a ray of light effectively eliminates that source of error. For the analysis of the finer elements in a complex sound, such as human speech or a musical chord, the damping and distorting effect of inertia is peculiarly fatal, so that in this respect Dr. RUHMER has gained decided advantage over earlier workers in the same field.

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THE field of research that may be surveyed by means of the photographophone is extensive and rich. Little has been done of late in acoustical research, the attractions of subtler physics having distracted scientists from the coarser and more obvious vibrations and phenomena of sound. We have even heard it said that acoustics is a worked-out mine. There are no worked-out mines in Nature, nor any that do not yield payable ore. Dr. RUHMER proposes to himself the fascinating problem of the analysis and synthesis of human speech. Another "level" in the acoustic mine which has scarcely been explored is the physical basis of harmony, relative to the physical character of complex sound waves which are dissonant as compared with the character of those which are consonant. Indeed, the whole psychological "theory" of music should be amenable to elaborate physical explanation, not merely by correlating numbers corresponding to pure fundamental tones, but by the far more satisfactory method of comparing the actual records of complex sounds, including all the natural harmonics that make them so rich and grateful to the ear.

INSULAR prejudice is salutary within certain limits, but prejudice against foreign-made machinery, and especially against foreign two and three-phase plant, may occasionally be carried too far. In Swansea last week, when tenders for two-phase motor alternators were under consideration, the Electric Lighting committee discussed the report of their consulting engineer (Mr. MANVILLE), which recommended the acceptance of the tender of the International Electric Co. of Liège. The amount of this tender—the lowest of 14—was £1,470, the lowest English one being £580 higher. Mr. CAWTHRA, the resident engineer, objected to the acceptance of this tender on the ground that his experience with foreign-made machinery at Swansea had been unsatisfactory hitherto. He added, as his main argument, that nine-tenths of the foreign machinery "has its own standard, and that when nuts, bolts, &c., are destroyed three or four weeks may elapse before duplicates can be obtained from the Continent." As a matter of fact, a large number of the leading Continental makers adopt the Whitworth screw thread, which is standard in this country and America; and even those who do not could supply small replacement parts in far less time than three or four weeks, just because they have their own standards. The way to combat foreign competition in a particular type of machinery is to allow the introduction of the foreign products until we can manufacture them as well and cheaply ourselves, just as Germany and Belgium have done with regard to English machinery in the mechanical engineering and iron industry. An unconditional damning of all foreign-made machinery is now too conservative a method to advance our industrial progress in view of the high state of perfection to which electrical engineering has been brought abroad.

| Cable Interruptions. | Date of Interruption |
|---|---|
| Latakia—Cyprus ..... | June 21, 1899 |
| Pará—Maranham ..... | Mar. 2, 1900 |
| Cayenne—Pinheiros ..... | April 21, 1901 |
| Bolama ..... | May 20, 1901 |
| Gibraltar—Tangier..... | June 11, 1901 |

**Edison Storage Battery Company.**—Mr. Edison has formed a company to manufacture the new storage battery described in our last issue. The capital is $1,000,000.

**City and Guilds of London Institute.**—Particulars of the courses of instruction, &c., given at the Institute's Central Technical College, Exhibition-road, and at the Technical College, Finsbury, are set out in an advertisement on another page.

**University College of North Wales, Bangor.**—In October a systematic course of instruction in "Electric Measurement and Practical Electricity" for students proposing to enter the profession of electrical engineering will be commenced. Some particulars will be found set out in an advertisement.

**Memorial to the late Mr. G. J. Symons.**—It has been decided that the memorial to the late Mr. G. J. Symons, F.R.S., should take the form of a gold medal, to be awarded biennially for distinguished work done in connection with meteorological science, irrespective of sex or nationality. The sum subscribed amounted to over £700.

**The Breakdown on the Manchester Tramways.**—There was a stoppage on the tramways at Manchester for about 20 minutes on the 2nd inst. It was due to an overhead line in the car shed becoming earthed, which blew the circuit breakers, and was not, as has been asserted in certain daily papers, due to a breakdown at the generating station.

**The Automobile Club.**—Last week over 100 representatives of County Councils were driven in motor vehicles from London to Richmond Park where they were received and entertained by the general council and committee of the Automobile Club at Sheen House. The object of the gathering was to show councillors how completely under control automobiles are, and how indifferent horses are to their existence.

**Cable Communications Committee.**—On Monday and Tuesday meetings of this Committee were held, Lord Balfour presiding. Evidence was tendered by the Secretary of State for India (Lord George Hamilton), Mr. W. Andrews, Mr. T. W. Stratford-Andrews and Sir W. R. Brooke, K.C.I.E. (representing the Indo-European Telegraph Co.), and Mr. W. S. Andrews and Mr. R. T. Brown (representing the West India and Panama Telegraph Co.)

**Electrically-Worked Bridge over the Weaver.**—We learn from the *Liverpool Post* that on the 6th. inst. a new bridge worked by electric power was most successfully operated for the first time at Winnington, Northwich. The bridge was designed by and built under the supervision of Mr. Saner, engineer to the River Weaver Commissioners. It crosses a portion of the river and gives access to the loading wharf of Messrs. Brunner, Mond & Co., chemical manufacturers. The bridge is 90ft. long, 10ft. wide, weighs 50 tons, and is worked by a 6½ H.P. motor.

**Royal Society.**—At the meeting of the Royal Society yesterday Prof. James Dewar, F.R.S., delivered the Bakerian lecture on "The Nadir of Temperature and Allied Problems:—(1) Physical Properties of Liquid and Solid Hydrogen; (2) Separation of Free Hydrogen and other Gases from Air; (3) Electric Resistance Thermometry at the Boiling Point of Hydrogen; (4) Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen; (5) Pyro-Electricity, Phosphorescence, &c."——At the annual meeting held on Thursday last week the 15 gentlemen proposed as new fellows, a list of whom appeared in our note of May 10th, were duly elected.

**Amalgamation of Four Engine Building Firms.**—According to the *Street Railway Review* of Chicago for May 15th, the Allis-Chalmers Engine Building Co. has been organised with £2,500,000 preferred stock and £4,000,000 common stock, and on April 27th consolidated four of the most prominent engine-building companies in the States, *i.e.*, the E. P. Allis Co., of Milwaukee; the Frazer and Chalmers Co., of Chicago and London; the Gates Iron Co., of Chicago; and the Dickson Manufacturing Co., of Scranton and Wilkesbarre. It is stated that the works of the Dickson company at Scranton will be operated as a separate concern for the present.

**Glasgow University Jubilee Celebrations.**—The proceedings connected with the celebration of the ninth jubilee of the Glasgow University commenced on the 11th inst. In addition

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to those from the colleges of England, Wales and Scotland, there were representatives from the Universities at Amsterdam, Calcutta, California, Cape of Good Hope, Christiania, Copenhagen, Leyden, Madras, Massachussets, Montreal, Nancy, Ontario, Punjab and Toronto. The Royal society was represented by Lord Kelvin, Lord Lister and Sir. J. D. Hooker, the Institution of Electrical Engineers by Prof. Ayrton and Mr. R. K. Gray, the British Association by Sir William Turner, Sir William Roberts-Austen and Dr. D. H. Scott, the Institution of Civil Engineers by Sir John Wolfe Barry, Prof. Kennedy, Mr. G. F. Deacon, Mr. J. I. Thornycroft and Dr. J. H. T. Tudsbery, the Physical Society by Prof. Silvanus P. Thompson, and the Royal Institution by Sir James Crichton-Browne and Prof. Dewar.

**Conversion of the Tramway System on Broadway, New York, from Cable to Electric Conduit.**—According to the *Electrical World* of New York, electric trams ran along Broadway, New York, for the first time on Monday, May 27th., the cable system operating for the last time during the previous week. Under the surface of Broadway there were between 4,000 and 5,000 moving parts, all of which were removed before the conductor-bars for electrical traction could be put in place. This included hundreds of wheels and three great terminal wheels 12ft. in diameter. As these wheels were built into the road and were set before the track was laid, it was necessary to break them up in the pits into pieces small enough to be removed through the openings. The 3,500 small sheave wheels on which the cable rested along the straight runs of the road also had to be removed through the manholes. About 200 electrical connections had to be made, 8,000 plugs removed and between 36,000 and 40,000 bolts set before the current was turned on; and none of this work could be done until the cable, which aggregated in length 117,000ft. and weighed about 8½lb. a foot, had been removed.

**Edinburgh Chair of Natural Philosophy.**—The *Glasgow Herald* publishes the following list of candidates for the Chair of Natural Philosophy in Edinburgh University, vacant through the resignation of Prof. Tait:—

Dr. J. C. Beattie, D.Sc., Professor of Applied Mathematics and Physics, South African College, Cape Town; Dr. G. H. Bryan, Sc.D., F.R.S., Professor of Pure and Applied Mathematics, University College, North Wales; Dr. Charles Chree, F.R.S., Superintendent of the Observatory Department, National Physical Laboratory, Richmond; Dr. Cargill G. Knott, D.Sc., Lecturer in Applied Mathematics, University of Edinburgh; Dr. J. P. Kuenen, Ph.D., Professor of Physics in University College, Dundee; Dr. Charles H. Lees, D.Sc., Lecturer in Physics and Assistant-Director of the Physical Laboratories in the Owens College, Manchester; Mr. David B. Mair, Examiner in the Civil Service Commission, London; Mr. J. A. M'Clelland, Professor of Natural Philosophy in University College, Dublin; Dr. James Gordon MacGregor, D.Sc., F.R.S., &c., Monro Professor of Physics, Dalhousie University, Halifax, U.S.; Prof. Karl Pearson, F.R.S., Professor of Applied Mathematics in University College, London; Mr. G. F. C. Searle, Demonstrator in Experimental Physics and University Lecturer in Physics in Cambridge University; Mr. George W. Walker, Fellow of Trinity College, Cambridge; Mr. Gilbert T. Walker, Lecturer and Director of Studies in Mathematics, Trinity College, Cambridge; Mr. C. T. R. Wilson, F.R.S., Fellow of Sydney Sussex College, Lecturer and Demonstrator of Experimental Physics in Cambridge University.

**Visit of the Institution of Electrical Engineers to Germany.**—We are informed that, in the unavoidable absence of the President, Mr. Alexander Siemens (Past President) will, at the unanimous request of the Council, assume the leadership of the Institution party throughout the visit to Germany. Members are reminded that their applications for tickets should be forwarded before Saturday, June 15th.——The following are among the Papers already announced for the annual meeting of the Verband Deutscher Elektrotechniker at Dresden from June 27th to 30th, to attend which is part of the programme of the Institution of Electrical Engineers' visit to Germany:—"Fast-speed and Heavy Electric Railways," by Herr M. Schliemann; "A Process for Increasing the Capacity of Accumulators," by Prof. Dr. C. Heim; "The Dresden Municipal Electrical Power Works," by Herr Menz; "On the Determination of the Form Factor of Power Machines," by Dr. R. Franke; "On the Transformer Properties of the Continuous Current Armature," by Herr Friedrich Eichberg; "On the Allgemeine Elektricitäts-Gesellschaft's new Installation Material for Overhead Lines," by Herr Bönninghofen; "The Weissmann System of Lighting," by Prof. Dr. K. Feussner; "Lifting Magnets for Straight and Circular Motions," by Herr F. R. Dietze.

**Obituary.**—We very much regret to have to record the death, on Monday last, of Lord Wantage. He will be remembered by the public principally as one of the founders of the Volunteer movement, but in the electrical profession he has a special claim to recognition as a pioneer of electric lighting in London. In 1885 the historical Grosvenor Gallery station was started by Lord Wantage and his brother, Sir Coutts Lindsay. In 1887 the company changed its name from Sir Coutts Lindsay & Co. (Ltd.) to the London Electric Supply Corporation (Ltd.). When next year it was advisable to issue preference shares, Lord Wantage took ordinary shares in place of the £150,000 worth of 4 per cent. debentures that he held. After the disastrous breakdown of 1890 he again advanced about £100,000, for which he accepted debentures. The affairs of the company went from bad to worse, so that Lord Wantage found it necessary in July, 1894, to foreclose; but, instead of winding up the company and seizing the whole concern, as most business men would have done, he carried on the undertaking for three years, appointing Mr. R. Stewart Bain receiver and manager. In 1898, when the company was prospering, he allowed the shareholders to come in on equal terms with himself, receiving £100,000 in debentures out of a total of £200,000.

**Perth Electricity Works.**—On June 8th., the new electricity works at Perth were formally opened by the Lord Provost. The buildings, erected to the plans of Mr. R. M'Killop, burgh surveyor, comprise an engine room 115ft. by 38ft., a boiler house 115ft. by 42ft., and an accumulator room 48ft. by 31ft., together with the necessary offices, stores, &c. The buildings are of red brick, the chimney shaft being 150ft. high and 7ft. internal diameter. Three Babcock and Wilcox boilers have been installed, each capable of evaporating 6,000lb. of water at 200lb. pressure, and there is a 192-tube Green economiser in the flue. There are two feed pumps each capable of supplying 2,000 gallons of water per hour, one being driven by steam and the other by an electric motor. One 100 H.P. and two 260 H.P. Willans engines have so far been fixed, driving Bruce Peebles multipolar compound dynamos, designed for either lighting or traction. A Carruthers surface condenser, capable of dealing with 18,000lb. of exhaust steam, has been provided, the cooling water being obtained from the river Tay. There is one Bruce Peebles 21kw. booster and balancer and a battery of E.P.S. cells having a discharge rate of 200 amperes for three hours. Callenders' vulcanised bitumen cables have been laid on the solid system, there being about 5,700yd. of feeders and pilot wires, and 7,250yd. of distributors. Sixty-seven 5 ampere enclosed lamps have been fixed for public lighting, and on each post are two incandescent lamps for use after 11 p.m. The Wright maximum demand system is employed, the rates being 7d. and 3d. The whole of the work was carried out to the specifications and under the superintendance of Mr. W. C. C. Hawtayne. The resident engineer is Mr. J. Lambert.

**Mr. Carnegie's Gift to the Universities of Scotland.**—Mr. Carnegie, in a preamble to the deed in which he transfers to trustees bonds of the United States Steel Corporation of the aggregate value of 2 million pounds, bearing interest at 5 per cent. per annum, redeemable in 50 years, states that he is creating the trust for improving and extending the opportunities for scientific study and research in the Universities of Scotland. The trustees are: The Earl of Elgin (chairman), the Earl of Rosebery, Lord Balfour of Burleigh, Lord Kelvin, Lord Reay, Lord Kinnear, Sir Henry Campbell-Bannerman, Mr. A. J. Balfour, M.P., Mr. Bryce, M.P., Mr. Morley, M.P., Sir Robert Pullar, Sir Henry E. Roscoe, Mr. Haldane, M.P., and Mr. Shaw, M.P. The following are also appointed trustees ex officio: The Secretary for Scotland, the Lord Provost of the City of Edinburgh, the Lord Provost of the City of Glasgow, the Provost of Dunfermline. The four universities are to be represented by one trustee each, to be chosen by the University Courts. The trust deed is followed by a constitution which provides that the admini-

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stration of the trust shall be conducted by an executive committee of nine members:—

(*a*) One half of the net annual income is to be applied towards the improvement and expansion of the universities of Scotland in the faculties of science and medicine; also for improving and extending the opportunities for scientific study and research, and for increasing the facilities for acquiring a knowledge of history, economics, English literature, and modern languages, and such other subjects cognate to a technical or commercial education as can be brought within the scope of the university curriculum by the erection of buildings, laboratories, class-rooms, museums, or libraries, the providing of efficient apparatus, books, and equipment, the institution and endowment of professorships and lectureships, including post-graduate lectureships and scholarships.

(*b*) The other half of the income, or such part thereof as in each year may be found requisite, is to be devoted to the payment of the whole or part of the ordinary class fees exigible by the universities from students of Scottish birth or extraction, and of 16 years of age or upwards, or scholars who have given two years' attendance after the age of 14 years at State-aided schools in Scotland, or at such other schools and institution in Scotland as are under the inspection of the Scotch Education Department. The students must have passed in the subject matter of the class for which payment of fees is desired an examination qualifying for admission to the study of that subject at the Universities with the view to graduation in any of the faculties. If the committee, after due inquiry, are satisfied that any student has shown exceptional merit at the University, and may advantageously be afforded assistance beyond the payment of ordinary class fees, they are to have power to extend such assistance, either in money or other privileges, upon such conditions and under such regulations as they may prescribe. In the case of schools or institutions in Scotland established to provide technical or commercial education, the committee may recognise classes which, though outside the present range of the University curriculum, can be accepted as doing work of a University level, and may allow them and the students thereof to participate under both (*a*) and (*b*) to such an extent as the committee may from time to time determine.

(*c*) Any surplus income which may remain after satisfying the requirements under (*a*) and (*b*) is to be at the disposal of the committee, who may expend it (1) in establishing or assisting to establish courses of lectures in convenient centres by professors or lecturers of the Universities or extra-mural colleges or schools in science and the subjects before mentioned, or (2) for the benefit of evening classes of students engaged in industrial or professional education during the day, or (3) in any other way the trustees may think proper towards furthering the usefulness of the universities in connection with the purposes expressed in the trust-deed and constitution.

If in any year the full income of the trust cannot be used, the committee may pay such sums as they think fit into a reserve fund, to be ultimately applied to those purposes. The benefit of the trust is to be available to students of both sexes. The trustees are to have full power by a majority of two-thirds of their number to modify the conditions under which the funds may be applied, so as to secure that these shall always be applied in the manner best adapted to meet the purposes of the donor, as is expressed in the constitution, according to changed conditions of the time.

**Experiments with Sound Signals.**—*The Times* of the 3rd inst. gives an interesting account of some elaborate experiments which are being undertaken by the Trinity House Corporation on this subject. Twenty-five years ago, says our contemporary, the Trinity House Corporation, with the advice and assistance of Prof. Tyndall, carried out some interesting experiments at the South Foreland in regard to the use of sound for signalling to the mariner, to warn him of his proximity to danger at times when fog or other kinds of thick weather prevented his seeing the land or sea-marks by day or the guiding or warning lights at night. The scientific aspect of the question is fully given in the late editions of "Tyndall on Sound," and the practical results obtained have been shown in the large increase in the number of fog signal stations around our coasts and the adoption of certain instruments for producing sounds which had not previously been employed in this country. With the lapse of time and the growth of the coast fog signal system new knowledge has been gained and new developments have taken place, and it has become necessary to test by practical and comparative experiments the value of certain theoretical improvements which have from time to time been introduced, and to endeavour to determine some moot points which have arisen in connection with the general question. Accordingly, a special committee of the Elder Brethren of Trinity House was appointed, the deputy-master being chairman, with whom were associated Lord Rayleigh, as scientific adviser, and the engineers of the three lighthouse boards, to consider the present position of the subject and to carry out such experiments as they might regard as necessary. St. Catherine's Point, in the Isle of Wight, was selected for the trials. Here there is a lighthouse with a powerful electric arc light, produced by steam power, which also serves for compressing air into receivers for sounding a permanent fog signal. At this station the committee have now been carrying on their work during the past two or three weeks, observations being made at sea each day by members of the committee on board the Trinity yacht "Irene." One important question upon which the committee have been engaged is that of the relative merits of sirens as sound-producing instruments, as compared with reeds. It does not seem probable that the vibrations set up by means of a reed can possibly be so powerful as those produced by means of a siren, and it will be interesting to learn the results of the committee's observations on this point. The form of the trumpet or sound projector is also receiving considerable attention, Lord Rayleigh himself having certain theoretical views on the point which he desires to have practically tested. The relative merits of notes of different pitch, in regard to their capability of penetrating the atmosphere under unfavourable conditions, is another branch of the inquiry which is being followed up by the committee, and some useful information on this point may result from the experiments. The question of the most effective and economical utilisation of power for operating sound signals is also receiving much consideration. It is obvious that there must be limitations in respect of the size of instruments and the development of power for working them. Other matters for inquiry and experimental test are questions connected with the best site for a land sound signal, regard being had to the nature of the coast line and the neighbouring physical features; also how a sea area which is to be guarded can be most efficiently covered by the sound of the signal. The various forms of siren and reed vibrators have come into the trials, with the view of deciding which form, size, and description of vibrator is best adapted for producing the sounds; and questions respecting pressure, air consumed and length of blast, are also being dealt with. The investigations ought to yield some very interesting results, which it is hoped will in due course be published.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), June 14th.**

PHYSICAL SOCIETY.

*5:0 p.m.* Ordinary Meeting at Burlington House. Agenda: (1) "On Herr Jahn's Measurements of the Electromotive Force of Concentration Cells," by Dr. R. A. Lehfeldt. (2) Exhibition of a set of specimens of Jena glass, by Prof. S. P. Thompson, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

*9 p.m.* Annual Conversazione at the Natural History Museum, South Kensington.

**WEDNESDAY, June 19th.**

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

*9:45 a.m.* Opening of the Sixth Annual Convention at the Institution of Engineers and Shipbuilders in Scotland, 207, Bath-street, Glasgow. Mr. W. A. Chamen will deliver his Inaugural Address, after which the following Papers will be read:—(1) "Uninsulated Returns in a Tramway System," by J. H. Rider. (2) "Street Electric Lighting," by Bailie W. Maclay.

*7 p.m.* The Association Dinner at the Windsor Hotel, St. Vincent-street, Glasgow.

**THURSDAY, June 20th.**

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House, W.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

*10 a.m.* Second day of Annual Convention. Meeting in the Freemasons' Hall, 96, George-street, Edinburgh. Papers to be read and discussed:—(1) "Braking Apparatus for Electric Cars," by A. L. C. Fell. (2) "The Equitable Allocation of Costs in Combined Lighting and Traction Stations," by W. H. Tittensor.

**FRIDAY, June 21st.**

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

*10 a.m.* Third day of Annual Convention. Meeting at 207, Bath-street, Glasgow, when the following Papers will be read:—(1) "Refuse Destructors in Combination with Electric Power Stations," by J. S. Highfield. (2) "Coal and Ash-Conveying Gear," by R. A. Chattock.

*8 p.m.* Annual General Business Meeting at 207, Bath-street, Glasgow. A final Extraordinary General Meeting of the Municipal Electrical Association will follow.

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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Dark Cathode Space.*—In most investigations of the distribution of potentials in discharge tubes, it is assumed that the potential is constant over any plane normal to the axis of the tube. Mebius has shown that the equipotential surfaces are concave with respect to the anode. A. Wehnelt has studied this question by a new apparatus, by means of which the potential at any point, whether axial or eccentric, may be determined. The device is simple. The cathode is attached to a flexible coil of wire, and may be moved to any position in the cylindrical tubes by means of a magnet. A side tube contains a probe, which, again, may be brought to any distance from the axis of the tube by means of a similar magnetic arrangement. The results obtained show that, as in the case of the anode, the equipotential surfaces are concave with respect to the cathode. The curve of potential is continuous in every case, and sharp bends, as found by Graham, must be attributed to faults in the method. The curve of potentials, like that of temperatures, is of the $e^{-kx}$ form. The author makes a distinction between "free" and "influenced" cathodes, the latter being those which are influenced by the proximity of the tube walls. There is, however, no essential difference in the potential curves of the two types.

[A. Wehnelt, *Phys. Zeitschr.*, June 1, 1901.]

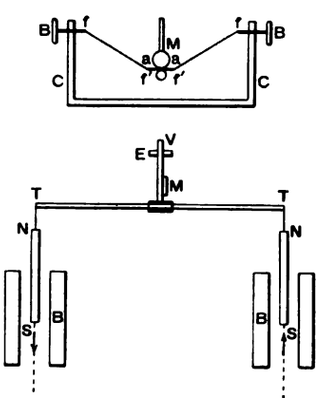
*Discharge by Flame Gases.*—On the occasion of an announcement of the destruction of gaseous conductivity by smoking liquids, K. von Wesendonck stated that the conductivity of flame gases depended largely upon the state of the surface of the metallic electrodes to be discharged. The same author has since accumulated further evidence of the importance of the electrode surface, without, however, succeeding in throwing much light upon its nature. A brass plate will show a "fatigue" of its discharge when exposed to sal-ammoniac fumes. This fatigue is not, however, due to the formation of a non-conducting surface layer, as its exposure to acid vapours often has the effect of eliminating the fatigue. Even the influence of water does not seem to be a determining one, since fatigue sets in both when the electrode is moistened and when it is well dried. It is known that ultra-violet light produces some effect upon the surface of the negative electrode, and the author suggests that flame gases may have a peculiar radiation of their own which produces the change of surface conditions described. This recalls the explanation hazarded by J. Chunder Bose. The author also calls attention to the observation of Villari that a charge of electricity of one kind in the interior of a paraffin tube de-röntgenises gases passing through the tube.

[K. von Wesendonck, *Phys. Zeitschr.*, June 1, 1901.]

*Electromagnetic Properties of the Ether.*—As an attempt to clear up the obscurities attached to Maxwell's theory concerning electrostatic phenomena, L. Graetz has formulated a theory which he claims to be free from contradictions, either in itself or with experiments. He assumes the ether to be an elastic solid, and therefore attributes to it the same properties as Fresnel and Neumann did. In ponderable matter the ether experiences an influence which is manifested as a force as soon as there is a displacement in the ether. The force exerted by the molecule upon the ether is manifested in a local change of the density of the ether, while the ether retaliates by displacing the molecule from its normal position. Those parts of a material body in which such a displacement exists permanently are the ions. This action and reaction between the ether and the molecules leads to Maxwell's equations. The so-called magnetic polarisations, or displacements, are determined by the torsion of the ether elements, while the electric forces, all except some electrostatic ones, are the velocities of the ether particles. The magnetic energy of a body is the potential energy of the ether contained in it. The electric energy consists of two parts, one of which is the kinetic energy of the ether, whereas the other is the potential energy of ponderable matter. "True" magnetism, assumed to be zero in Maxwell's theory, has no meaning whatever. The magnetic properties of iron may be brought in as special molecular torsions. The so-called true electricity consists of the amount of ether contained by a given volume in excess or defect of the normal amount. A current consists in the transformation of rectilinear motions of molecules into heat vibrations. The conception that the ether surrounding every molecule is attached to it implies that a totally independent relative motion of ether and matter is impossible.

[L. Graetz, *Ann. der Physik*, No. 6, 1901.]

*Electric Balance.*—The perfectly astatic galvanometer described by Lippmann (see *The Electrician*, June 7, p. 245) has led V. Crémieu to construct a balance on a similar principle, which can be used as a galvanometer, an electrodynamometer, or an absolute electrometer. Between the two branches of a brass frame *cc* is suspended an aluminium plate *da* by a cocoon thread *ff'*. An aluminium tube TVT, bearing a movable nut E, is attached to the aluminium plate so that it is normal to the plane of the cocoon threads. The whole represents a balance without knife edge. The moving parts are very light, weighing only 0·8 grammes. The nut E serves to regulate the sensitiveness, and the mirror M to indicate the deflections. Two cylindrical permanent magnets NS are suspended at TT by cocoon fibres. They can travel along the axis of the coils BB. With a period of 8 seconds, the balance indicates a displacement of 12mm. at 1 metre distance for a current of $10^{-9}$ ampere. The




balance is well damped and perfectly astatic. On replacing the magnets by coils carrying currents an electrodynamometer is obtained. An electrometer may be made by mounting a plate and guard ring on one arm.

[V. Crémieu, *Comptes Rendus*, May 28, 1901.]

*The Photographophone.*—E. Ruhmer has considerably improved his photographophone, and achieved some very notable successes with it. The vibrating flame of an arc lamp is photographed on a kinematograph film, and the sound vibrations are thus translated into dark and bright stripes on the film. The light is concentrated upon the sensitive film by means of a cylindrical lens. When the impression of the voice has thus been taken the film is developed and fixed in the usual way. To reproduce the sound the film is moved past an ordinary projection lamp, and a sensitive selenium cell provided with telephones and a dry battery is placed behind it. The changes in the illumination of the selenium cell produce changes in the current corresponding to the original sound vibrations. The velocity of the film is 2 or 3 metres per second, but even with 20cm. per second good photophonograms are obtained. From one negative any number of positive films may be obtained, and either the negatives or positives may be used for reproduction. The inventor hopes to record pictures and sounds on the same film. An interesting development proposed is the synthesis of human speech from its elements, obtained from the photophonograms, or from an artificial film suitably shaded.

[E. Ruhmer, *Phys. Zeitschr.*, May 25, 1901.]

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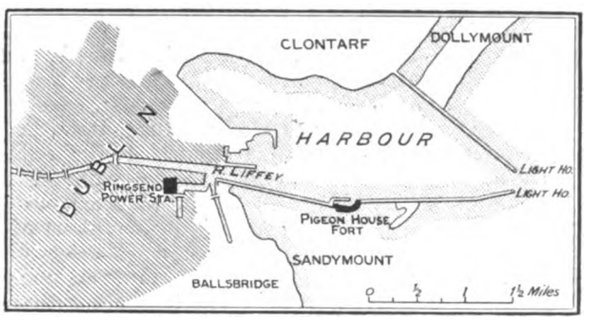
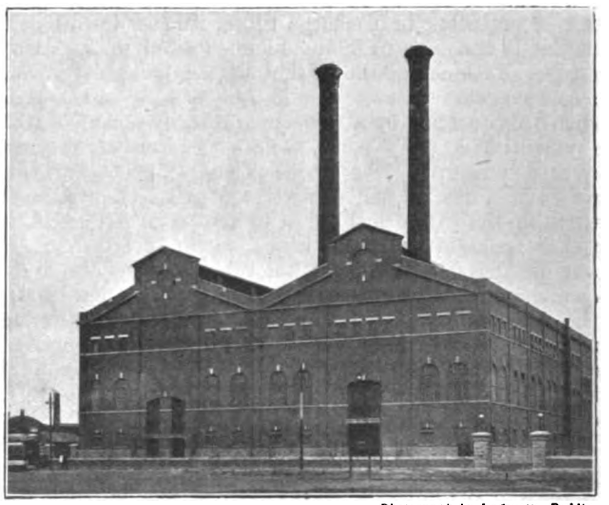
## ELECTRIC POWER STATIONS AT DUBLIN.

The history of electrical enterprise in Dublin is well known to our readers. Profoundly interesting and instructive from many points of view, it has chapters recording remarkable engineering progress, but not a few pages that relate to incidents of a less happy nature. We do not intend, however, to review past events, but, by the aid of the accompanying illustrations, to glance at the present condition of affairs. So much has been said and argued




SKETCH MAP OF DUBLIN HARBOUR, SHOWING SITES OF POWER STATIONS.

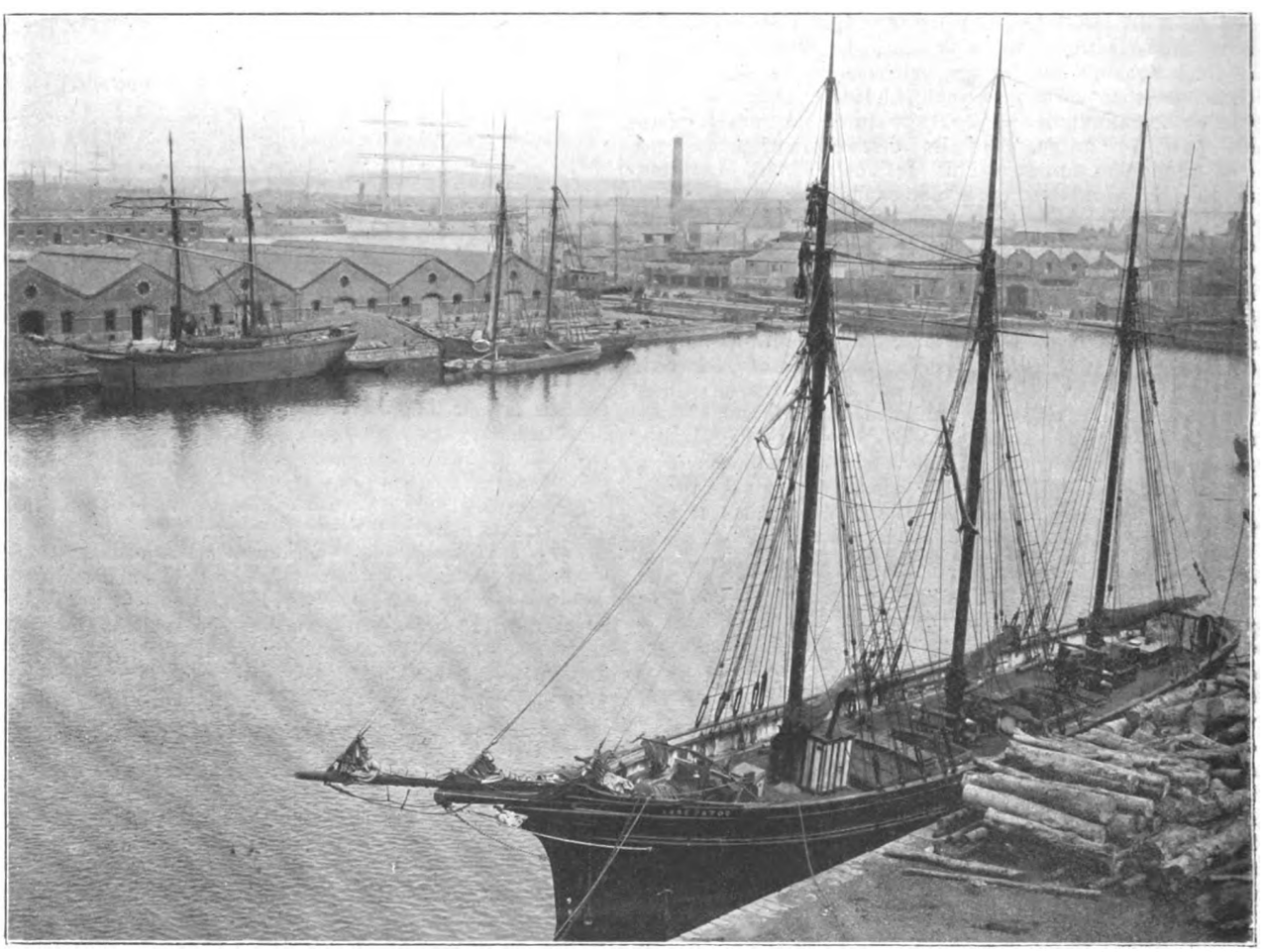
as to the advantages or otherwise of the famous Pigeon House Fort as the site for a municipal electric supply station that a photographic view of it in its present state should possess some interest. One of the annexed views, which are from photographs taken for us by Messrs. Lafayette, of Dublin, shows the Pigeon House Fort as viewed from the breakwater on which it stands. From the sketch map the exact position on this lengthy breakwater is made more clear. It will be seen that the site of the proposed municipal electricity works is somewhat "out to sea," being about



*Photograph by Lafayette, Dublin.*

EXTERIOR OF RINGSEND POWER STATION. FRONT VIEW.

1½ miles out on a breakwater over 3 miles in length. On one side of it is the open sea, on the other side the water of the outer harbour. "Water facilities," we believe, constitute one of the chief merits of the Pigeon House site in the eyes of its advocates—there is no lack of (salt) water, as our readers must perceive. It is also to be observed that the landward end of this breakwater is somewhat removed from the central part



*Photograph by Lafayette, Dublin.*

VIEW FROM THE ROOF OF THE RINGSEND TRAMWAY POWER STATION.

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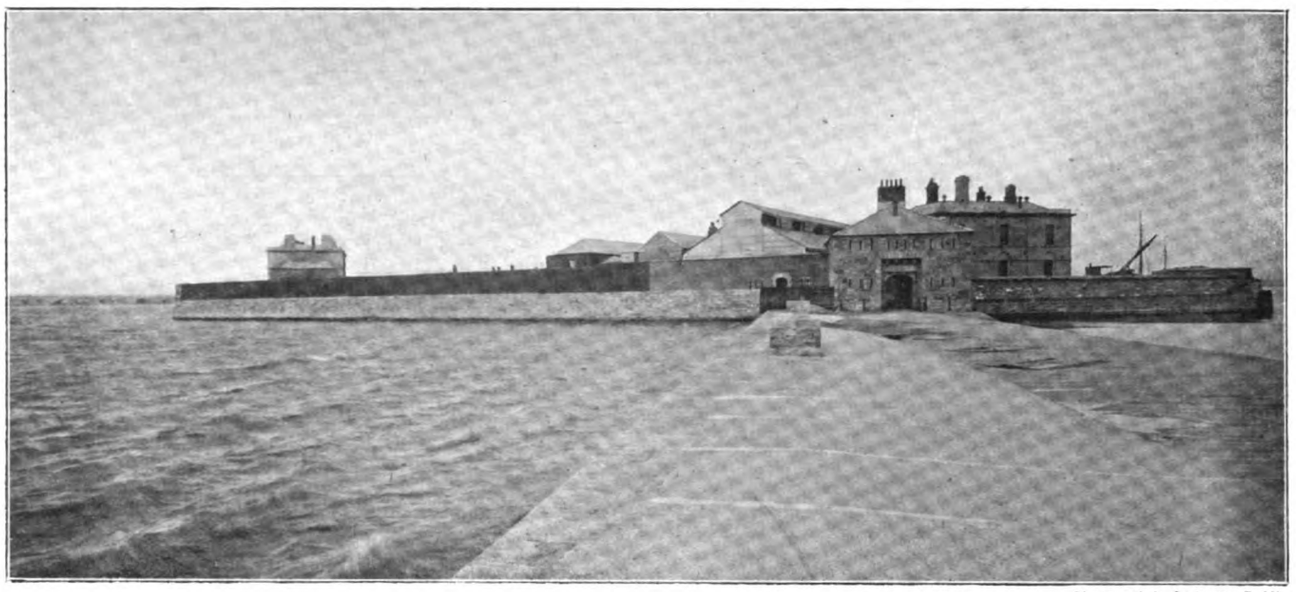
of Dublin. Few station engineers, we imagine, would regard it as advantageous to have to lay the first mile-and-a-half of all their feeders along a breakwater. Coal facilities are also a desideratum in a power station, and the Corporation of Dublin will be able to berth their coal vessels alongside their works almost if not quite as conveniently as is now being done by the tramway company at their large power station on the mainland, at Ringsend. Our readers will judge of the coal and water facilities of the Ringsend tramway station from the picturesque view of the harbour taken from the roof. The remaining illustration shows the front of the Ringsend station, and may serve to indicate that these works possess land facilities as well as water facilities. It is useful to be able to get coal by land sometimes, and it is also advantageous—other things being equal—to have the power-station near to the area of supply, whether for lighting or traction. In conclusion, we express the hope that these illustrations will serve to propound to our readers the riddle which puzzles so many—namely, as to what induced the Corporation of Dublin to adopt such a site for its electricity works.



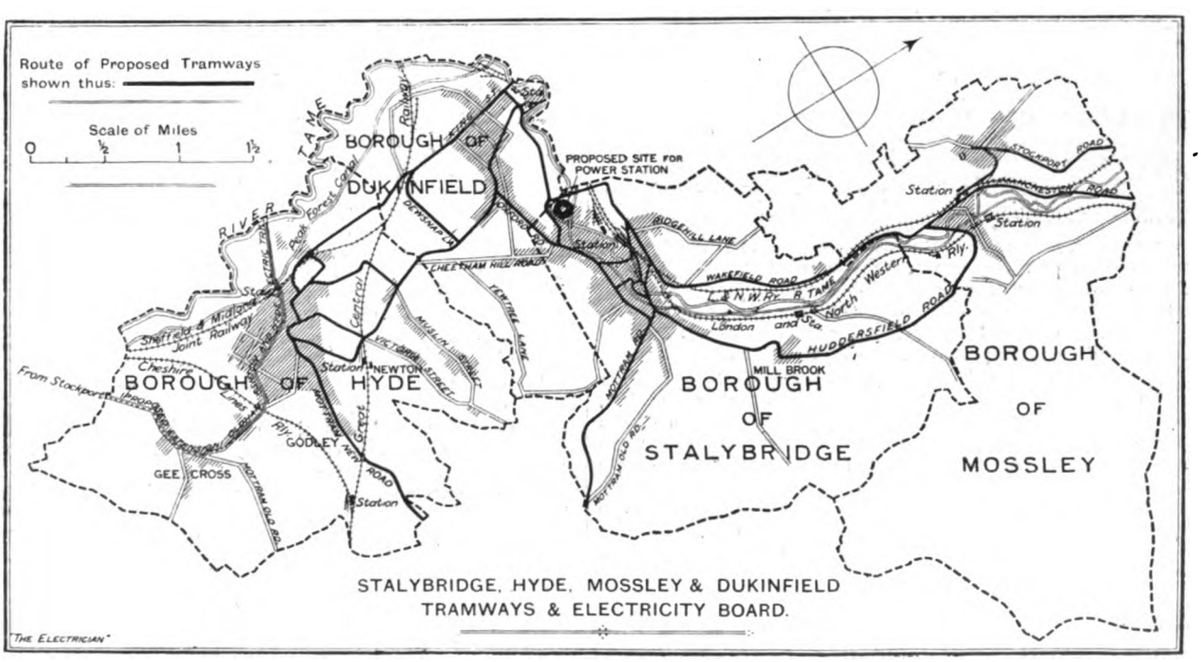
Photograph by Lafayette, Dublin.

THE PIGEON HOUSE FORT. SITE OF THE MUNICIPAL ELECTRICITY WORKS.

## ELECTRIC POWER SCHEMES IN 1901.

### IV.—Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board's Scheme.

An exceptional interest attaches to this scheme, for it is the first of the electric power schemes to be promoted by a syndicate of local authorities. It is some time since we suggested that if local authorities were resolved to keep the business of electric generation and supply in their own hands, the wiser course for the smaller local authorities would be to combine with their neighbours in constructing and running joint works. This is what has been done by the local authorities within the area shown on our map. The proposed scheme of this combination of municipalities is to supply electricity for lighting and power, and to work the tramways indicated on the map. There is to be one power station, generating three-phase

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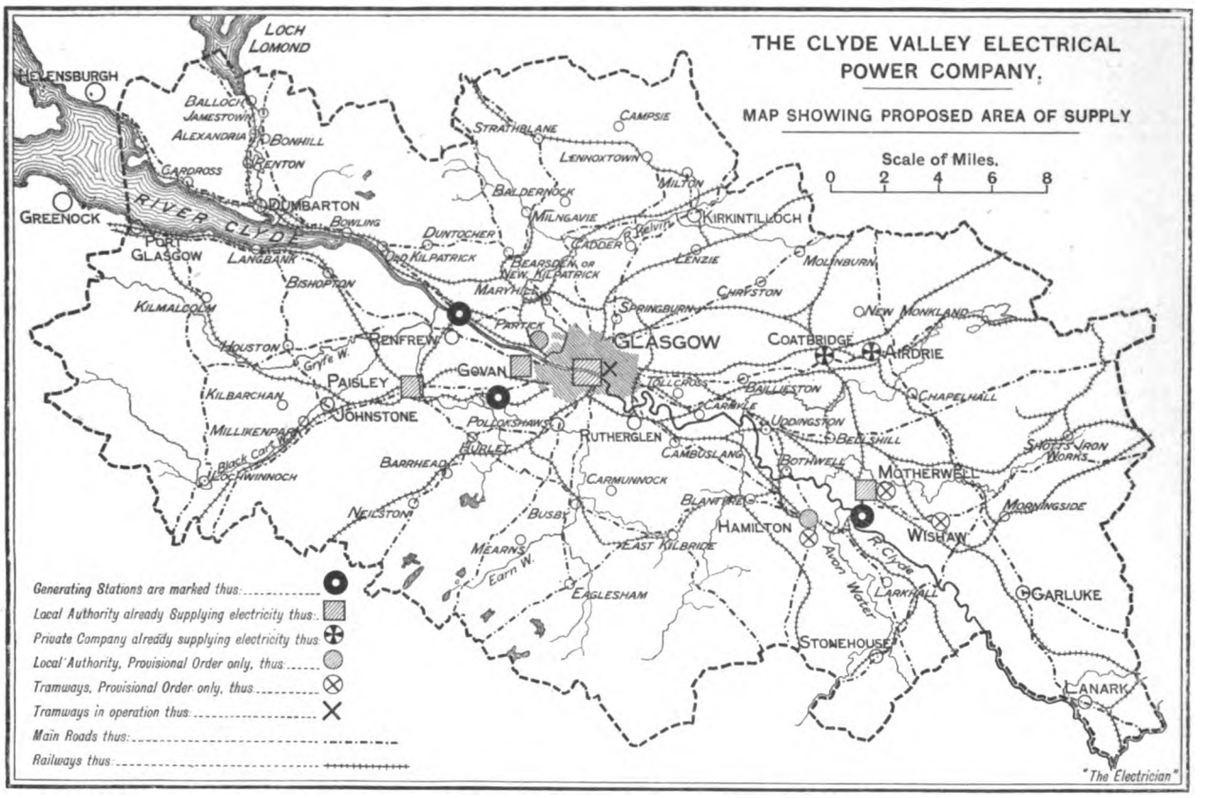
currents at 5,000 volts and 25~. From this station energy will be metered to the several local authorities, and expenses will be divided pro rata. The estimated cost of the scheme is as follows:—Power station, £45,000; mains and sub-station, £58,000; tramway construction, £227,000. The engineers are Messrs. Gibbings and Baker. The bill has been read a second time before the House of Commons and is now before the Committee.




V.—Clyde Valley Electrical Power Co.'s Scheme.

This is one of two schemes competing for the same area, but the second scheme—that of the Caledonian Electric Power Co.—has been rejected by Parliament. The promoters, who are local gentlemen, include Sir David Richmond; and the engineers are Messrs. Preece and Cardew and Messrs. Strain and Robertson. The area covered by this scheme is 732 sq. miles in extent, and includes some 1,200 important works. No less than 800 owners of these works petitioned in favour of the bill, which has been read a third time before the House of Commons. The share capital is fixed at £900,000 in £10 shares, with borrowing powers up to £300,000. A report of the proceedings in the House of Commons Committee appeared in our issues of May 3, p. 64; May 10, p. 111; and May 17, p. 139. At this stage of the proceedings the following places were excluded:—viz., Port Glasgow, Govan, Partick, Paisley and Hamilton.

## THE ELECTRICAL EQUIPMENT OF THE NEW YORK ELEVATED RAILWAY.*

(*Continued from page 254.*)

When supplementary feeder cables are required to keep the terminal voltages within economic limits they are installed in a wooden box and supported on porcelain or vitrified clay insulators, as shown in Fig. 8. The direct-current feeder sections are arranged as indicated in Fig. 9. Each feeder is connected to a single circuit-breaker at the sub-station, the ends of the feeders being also connected normally with a 6,000 ampere circuit-breaker. In order that a short circuit on one feeder section may not affect an adjoining section through the wiring of a motor car a 2,000 ampere circuit-breaker is provided. This circuit-breaker supplies current to an isolated section of the third rail of such length that a motor car cannot span from one section to the next. Feeder sections are designed so as to have approximately the same terminal drop in voltage, so that normally the current from one section to the next section is small. In emergencies, however, one sub-station may be shut down and the train service still maintained, though at a lower speed and with an increased drop in the voltage.

The return circuit is through 90lb. track rails and the elevated structure. The rails are bonded, as shown in Fig. 10, around the splice-bars with flexible bonds made up of No. 4-0 stranded cable welded to copper terminals. Holes in the rail are reamed and the terminals riveted by hydraulic compression. The track rails are bonded to the structure at intervals of 90ft., and the longitudinal girders of the structure are bonded with from two to four No. 4-0 flexible bonds.

The three-conductor cables, illustrated in Fig. 11, are nearly 3in. in diameter, and weigh about 9lb. per lineal foot. They will be installed in underground conduits consisting of 28 vitrified clay ducts laid in cement and surrounded by concrete. A single-conductor cable will be used to transmit the 625 volt direct current from the sub-station to the third rail.

The system of distribution is as follows:—From the generator the current passes to the main switchboard. Thence it proceeds to the feeder switchboard, from which it is conveyed to the sub-station switchboard by the three-conductor cables. After being lowered in potential by transformers and converted into direct current by rotaries, the current is conducted to track feeders and thence to the third rails.

The generators of the power plant—eight in number—were designed and are being constructed by the Westinghouse Electric and Manufacturing Co. Each generator is nominally rated at 5,000kw., but is capable of delivering, during the hours of maximum traffic, 7,500kw. The height of each of these machines is 42ft., the calculated weight 450 tons, the diameter of the revolving part about 32ft., and its weight 185 tons. The amount of power that will be required from the generators is indicated by the curves of Fig. 12, reaching a maximum of 60,000 E.H.P. under the improved schedules by which trains will operate when the electric system is fully installed. One alternator will be sufficient to carry the load from 1 a.m. to 5 a.m.,

* This article has been compiled from the *Street Railway Journal* and the *Electrical World* of New York.

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but between 5 a.m. and 8 a.m. at least five additional generators must be connected to the circuits.

Side and end views of the alternator are shown in Fig. 13 and its construction is illustrated in outline in Fig. 15. The field magnets are built up as an integral part of the flywheel to which they, with their windings, form the rim, as will be seen by reference to Figs. 14 and 15. The construction consists of a steel hub to which

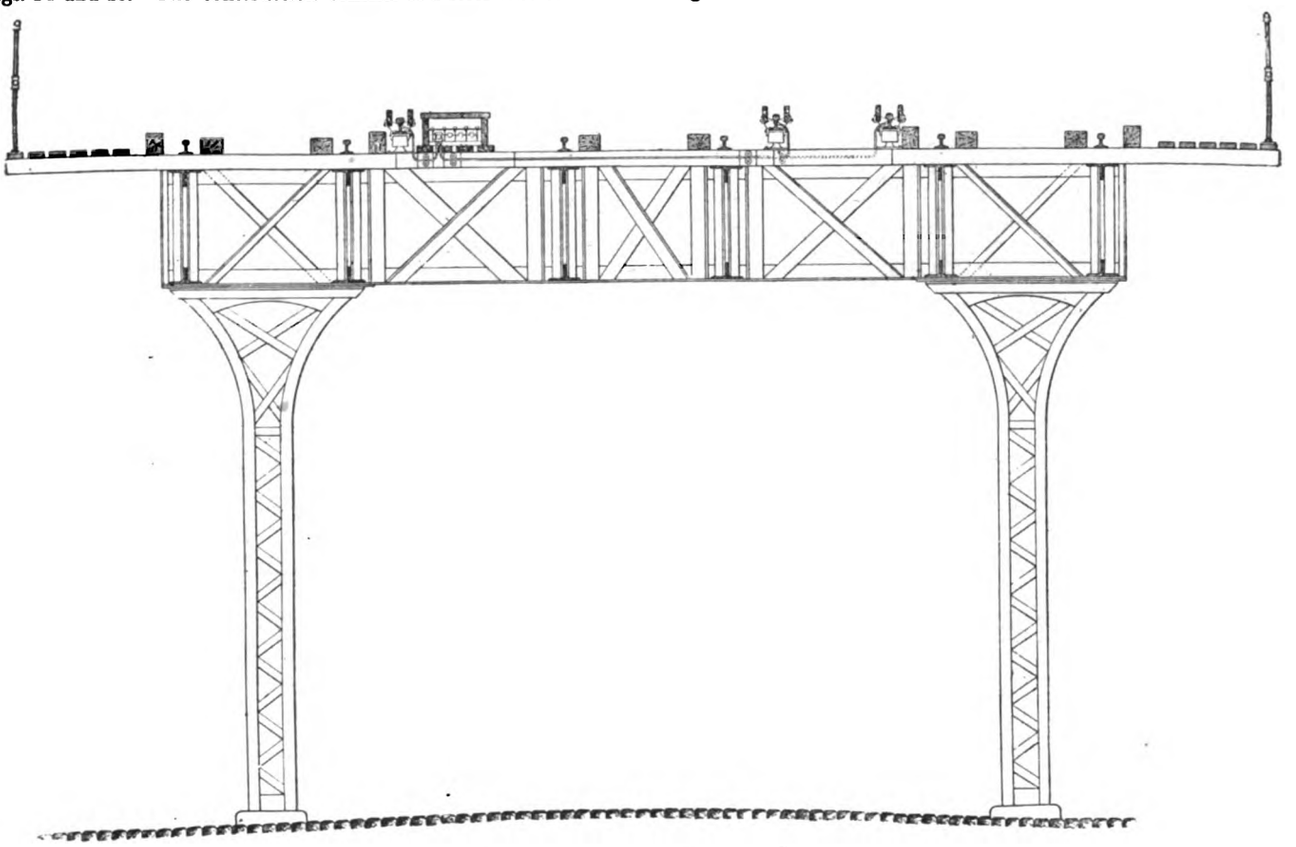

FIG. 8.—CROSS-SECTION OF ELEVATED STRUCTURE.

are bolted and dovetailed annular-rolled steel web plates, which form the driving spider. The field poles and rim are built up of overlapping plates of thin sheet steel, the length of each plate being equal to the width of two poles. These plates are dovetailed into the driving spider, and the rim and poles with their steel end plates are separately bolted together. In the body of the field poles at intervals of about 3in. ventilating spaces or ducts are provided, these spaces extending inward through the laminated steel rim of the flywheel to large openings in the cast-iron driving rim. The ventilating ducts in the revolving field register with corresponding ducts in the external stationary armature.

The field winding consists of copper strap wound on edge, one layer deep, with insulating material cemented in place between the turns,

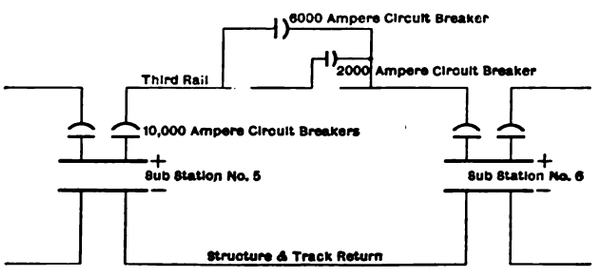


FIG. 9.—DIAGRAM OF DIRECT CURRENT FEEDER CONNECTION.

the edges of the strap being exposed. No supporting shell for the coil is used, and the entire outer insulation, which separates the coil from the pole, can be removed and renewed without injuring the coil. The heat-dissipating surface of the coils is either close to the metal field pole, to which it may readily impart its heat by conduction, or is exposed to free air circulation, thus insuring a low temperature even under abnormal conditions of operation. An important feature of the construction of the field is the use of copper wedges having large external lips which overhang the bevelled edges of the field poles. These wedges assist in keeping the field poles in place, and the overhanging lips, which come directly between the fields, act powerfully to retard any shifting of the field magnetism across the pole faces, thus tending to prevent and correct any variation of the angular velocity. Fig. 14 illustrates the construction of the field poles and shows the field windings in place and also the copper wedges above referred to.

The armature, which is stationary and exterior to the field, consists of a laminated ring with slots on its inner face, the insulated copper bars constituting the armature winding being placed in these slots. The winding is of the built-up or bar type, the bars being separately

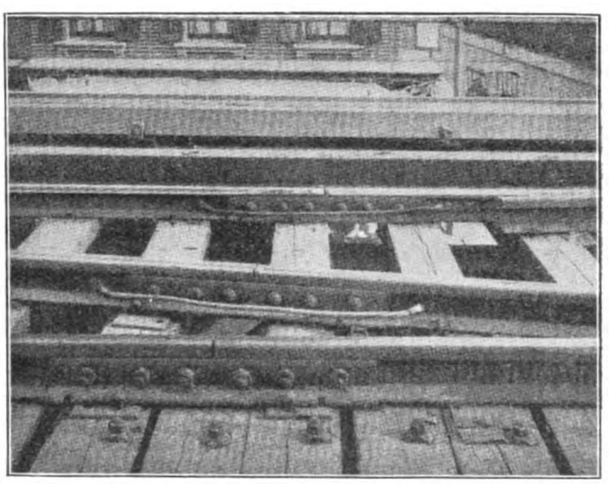

FIG. 10.—VIEW OF TRACK RAILS BONDED.

insulated and placed in partially closed slots in the armature core. There will be three bars per slot, and the winding is grouped in such a manner that end connectors having high differences of potential will not lie close together. In case of an accident causing damage to the insulation, the contents of any slot may be removed without disturbing the other slots and without moving the frame of the machine.

The insulation of the field coils is to stand a pressure test of 2,500 volts alternating potential for a period of 1min., and that of

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the armature conductors a puncture test of 25,000 volts alternating potential for a period of 30min., or 30,000 volts for 1min., or 35,000 volts for 1sec. The field pole tips are bevelled at the edges to produce a magnetic field distribution of such a form that, with a star type of three-phase winding the E.M.F. wave will be practically a sine wave at no load. The field produced by cross-magnetism with load, and magnetic leak along the conductors, will be of such form that the E.M.F. produced thereby in the armature windings will also be practically sine shaped, thus producing a full-load wave necessarily very closely sine shaped. There will be four armature slots per phase per pole, thus securing a distribution of the coil which should produce a wave practically free from irregularities and of the same form within close limits for different loads. By this means harmonics, which are apt to occur with windings in which there are but few slots per phase, are avoided, together with possible evil effects in connection with the capacity and induction of the very extensive system of cables and transmitting apparatus to which the alternators are to be connected. Another advantage obtained by the use of a large number of partially closed slots in the armature core is the possibility of using copper dampers for the pole tips with negligible loss due to eddy currents.

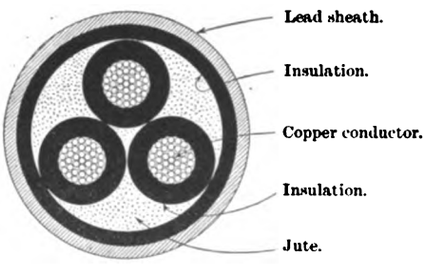


FIG. 11.—SECTION OF THREE-PHASE CABLE.

the manufacturer guarantees that if a load of 263 amperes per terminal at 11,000 volts, and with 100 per cent. power-factor, be thrown off, the potential will rise no more than 6 per cent. with constant speed and constant field excitation. It is calculated that under non-inductive load each alternator will have an efficiency ranging from 90 per cent. at quarter load to 96·5 per cent. at full load and 97 per cent. at 25 per cent. over load, mechanical friction not being included. Under non-inductive load the alternators will operate for 24 hours, delivering their normal rated output with a rise in temperature in no part of the machine exceeding 35°C. above the surrounding air, and not exceeding 45°C. when operating at 25 per cent. greater than the normal full load. With a current for two hours, 50 per cent. greater than normal, the rise in temperature will not exceed 55°C. The above statements are based on non-inductive load.

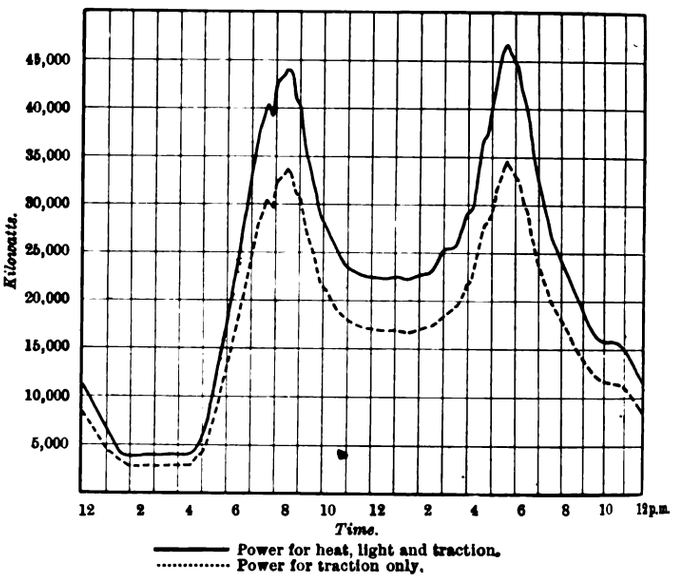


FIG. 12.—POWER CURVES.

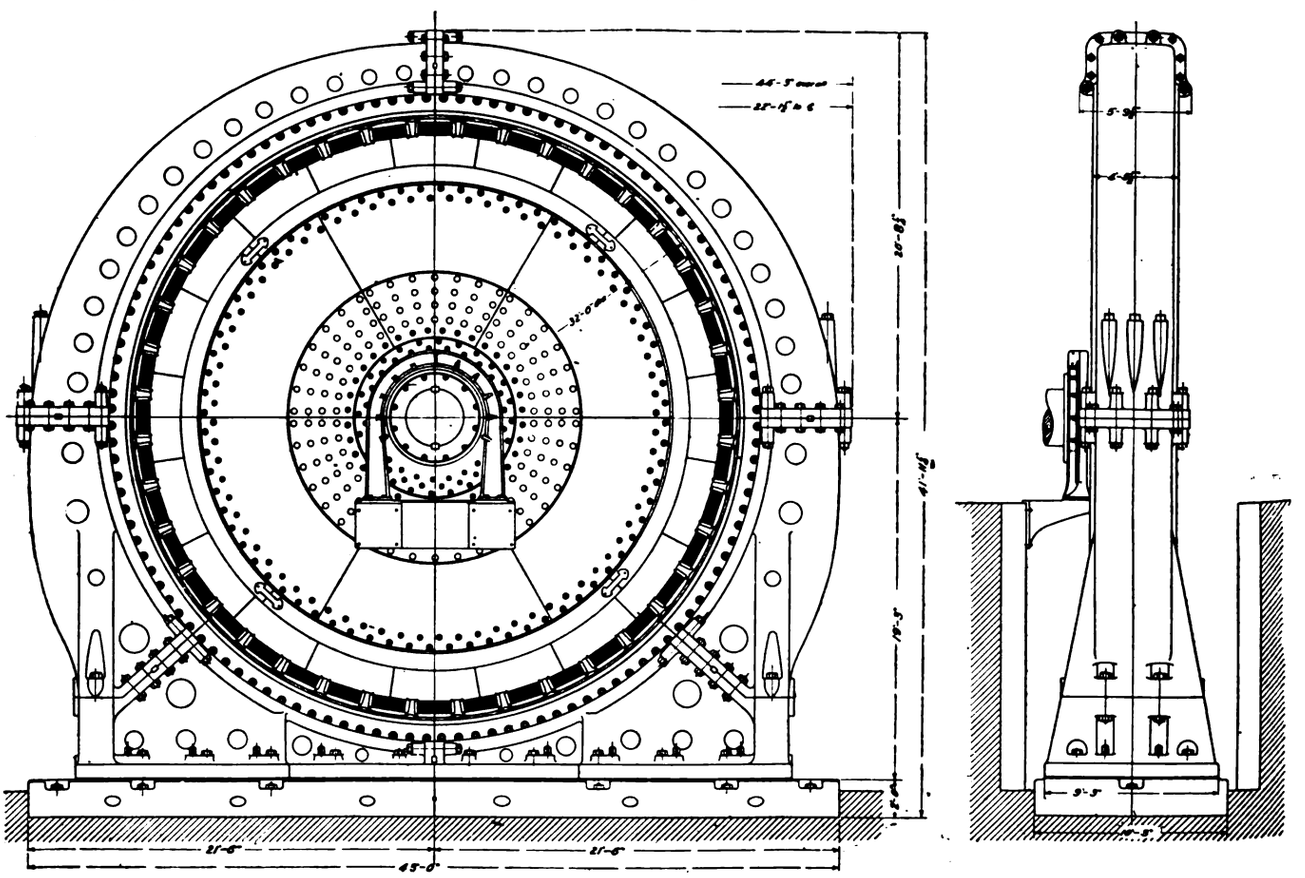

FIG. 13.—SIDE AND END VIEWS OF ONE OF THE ALTERNATORS.

The speed of the alternators is 75 revs. per min., and as there are 40 poles, this corresponds to a frequency of 25. Each alternating field will require approximately 225 amperes at 200 volts when the armature is delivering its full-rated current at 11,000 volts on a non-inductive load. About 15 per cent. more current will be required when the armature delivers its full-rated output at normal voltage to a circuit having a power-factor of 90 per cent. As to regulation,

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Each sub-station has three floors. In five of the stations the two upper floors contain space for storage batteries, in two others corresponding space being provided in the basement. The space

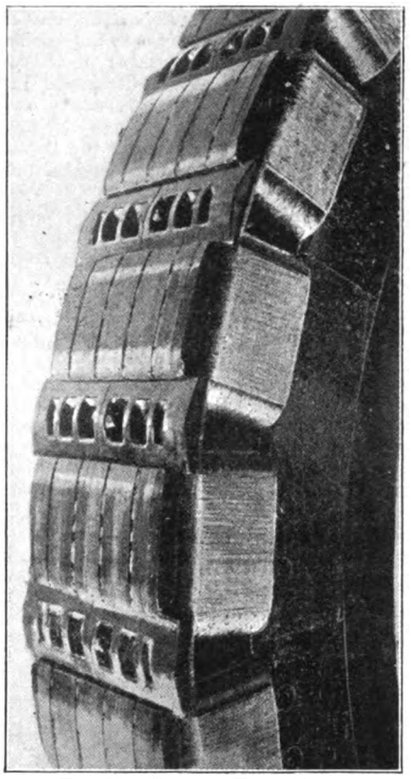

FIG. 14.—VIEW OF FIELD POLES.

thus reserved will in each case accommodate a battery of 3,000 kilowatt-hours, but it is not expected to use storage batteries at the start. The rotary converters are arranged in two parallel row, the tops of their foundations being at the level of the main floor of the sub-station. The transformers are located in groups of three, placed upon galleries which extend along the side of the sub-station at a height of about 15ft. above the main floor, and in close proximity to the converters they serve. Cranes are provided for handling these transformers. The switching apparatus for the sub-station is erected upon galleries at one end of the building.

Each rotary converter receives current from a group of three step-down transformers connected in delta. For each converter six 1,250,000-cir. mil. cables are required. In order that the potential of direct current delivered by all rotary converters shall be equal, provision for adjustment of the ratio of transformation of the step-down transformers is made by means of loops brought out from primary windings.

The transformers are of the air-cooled type, motor-driven blowers being installed in each sub-station for supplying the necessary air. The guaranteed efficiencies range from 95 per cent. at one-quarter load to 97·75 per cent. at full load and 97·7 per cent. at 25 per cent. over load. For the latter load the rise in temperature will not exceed 45deg. in 24 hours.

The rotary converters are of the largest capacity yet constructed. Each has a normal rating of 1,500kw. and is capable of delivering, for a period of several hours, 2,250kw. They have 12 poles, which corresponds to a speed of 250 revs. per. min. and 25 ∿ . The field has shunt and series windings, the former being arranged for self-excitation. The guaranteed efficiencies vary from 89 per cent. at quarter load to 95·75 per cent. at full load and 96 per cent. at 25 per cent. overload.

The armature winding consists of strap and form-wound coils, insulated before being placed in the slots, in which they are held by retaining wedges of hard fibre—no armature bands being used. The insulation is guaranteed to withstand a puncture test of 3,500 volts alternating applied between conductor and core for a period of 1min. The winding is of the parallel type, comprising 12 circuits. There are a large number of cross-acting balancing rings to obtain equalisation of the different armature circuits. The difference of potential between adjacent bars of the commutator will not exceed 12 volts. The pole faces of the field, which are bevelled at the edges, are fitted with copper shields, consisting of heavy copper rings about the pole tips, having lips extending from both edges of the pole toward the centre. The action of these lips is to retard, by means of secondary currents induced in them, any shifting of magnetic field across the pole face, which shifting, if not counteracted, would give rise to "pumping" of the converters. The ring around the pole acts as a secondary and neutralises any pulsation of the entire field magnetism. The rotary converters are designed not only to steady themselves, but at the same time to produce a steadying effect upon the apparatus on the system.

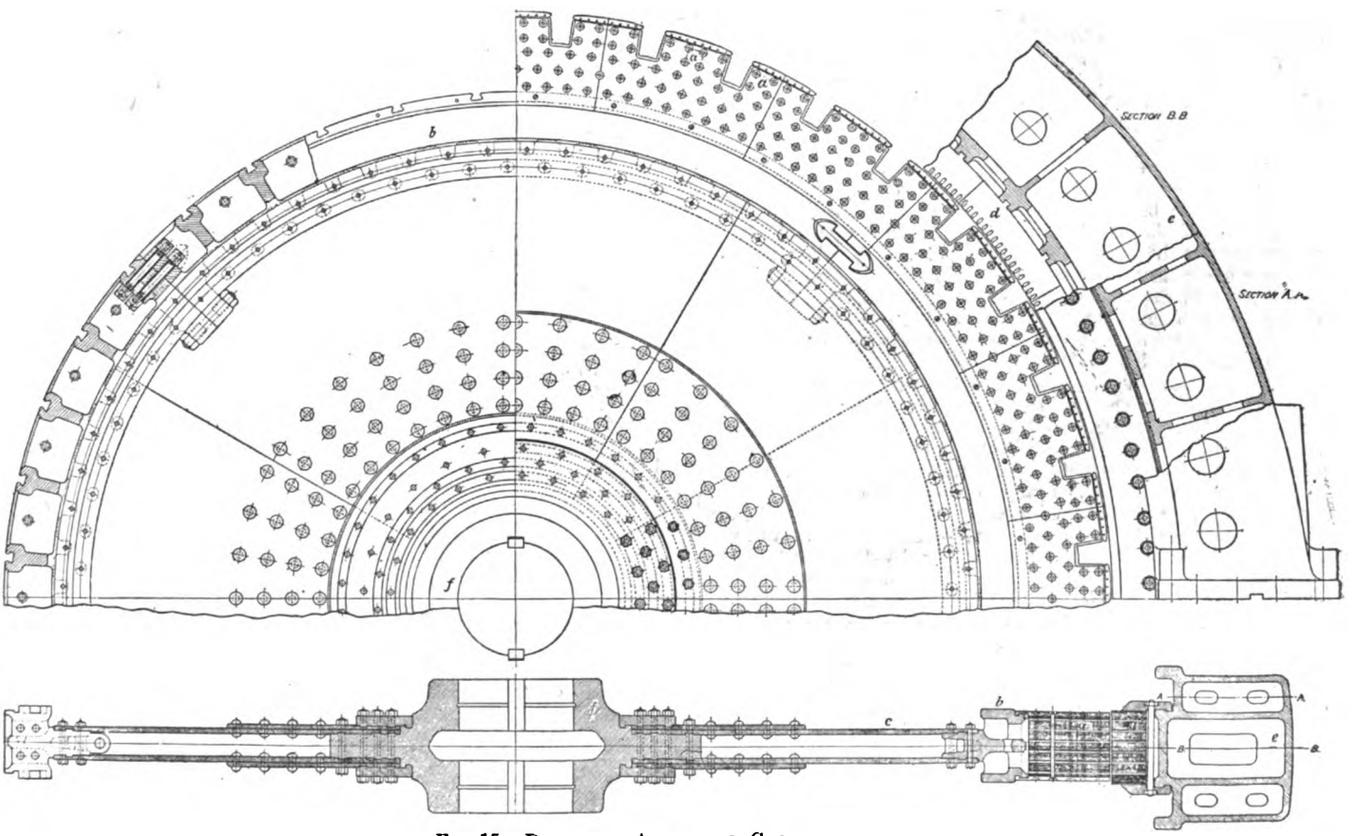


FIG. 15.—DETAILS OF ALTERNATOR CONSTRUCTION.

The shunt field winding will have sufficient capacity for maintaining 625 volts at the direct-current terminals at full load, with a power factor of 100 per cent. at the alternating current end. A

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shunt field rheostat will be provided of sufficient capacity to reduce the potential to 575 volts. In normal operation at full load the shunt field will be adjusted for the lower strength, the armature taking the current from the system. The series field will be designed to add to the shunt as the load goes on the rotary converter, and will be sufficient to compound from 575 volts no load to 625 volts full load with no ohmic drop in the alternating current feeder. Suitable inductances will be placed in each feeder circuit.

The converters are to be started by direct current, a motor generator system being installed in each sub-station for this purpose. This method of starting rather than by the use of direct current from the main 'bus bars of the sub-station was adopted for the purpose of avoiding undue magnetic and electrical strains in the converter, such as might result from the mistake of an operator, for example, in closing the synchronising switches when the machines are not exactly in step. The total weight of each converter is approximately 22·5 tons.

*(To be concluded.)*

## STORAGE BATTERIES IN ELECTRIC POWER STATIONS, CONTROLLED BY REVERSIBLE BOOSTERS.*

BY J. S. HIGHFIELD.

The use of storage batteries in direct-current central stations has now become general, but there seems to be a great divergence of practice among station engineers in the matter of the proportion that the battery bears to the steam plant. A table in the Appendix gives the proportion of battery capacity to the steam plant capacity in many direct-current stations, the figures having been obtained through the courtesy of the engineers of the various towns in supplying the figures. There seems to be no good reason for this great diversity of practice, and this Paper is written with the object of putting before the engineers what seem to be the chief points in considering the designing of batteries for the work they are called on to do in central stations, and to describe subsidiary apparatus which may be found of use and convenience in operating batteries. It is convenient to divide stations into three varieties—namely, (1) lighting and general supply stations, (2) traction stations, and (3) combined stations for supplying to the general town network and to a tramway system.

In laying down a station for a general town supply, where the load factor may not be more than 12 per cent., and where the difference of the magnitude of the load in winter and summer is great, it has been customary to instal a battery having a capacity, reckoned at a three-hour rate of discharge, of but a small proportion of the whole station plant. This battery is usually very useful in the first years of the supply, but as the load increases from year to year, the battery is worked altogether beyond its capacity, and so falls into a bad state of repair and into disuse, and additions to plant do not very often include corresponding additions to the battery. This ill-treatment of the battery is very frequent in stations where the battery works the night shift, as there is a great temptation to delay increasing the capacity of the battery or the hours of working the plant till the last possible moment, and the battery under these circumstances is frequently run down; needless to say, it is very soon irreparably damaged. It seems hardly necessary at this date to insist on the absolute necessity of using storage batteries with the greatest care, of giving them at least as much skilled attention as the rest of the station plant. If an armature becomes grounded or a commutator damaged, the repairs are not a very serious matter; but neglect of a battery, too heavy charging or discharging, insufficient charging and over-discharging damage to some extent every plate in the battery, and consistent treatment of this sort will rapidly reduce the storage capacity and the efficiency of working at the same time.

In an ordinary lighting and general supply station, the battery is nearly always divided into two parts—one, the main battery, consisting of a number of cells arrived at by dividing the pressure in volts maintained at the 'bus bars by 2·5, the usual voltage at which charge is assumed to be complete; the remaining part of the battery consists of such a number of cells as to make the whole number in the battery equal to the figure obtained by dividing the 'bus bar volts by 1·85, the lowest pressure to which it is usual to allow each cell to fall on discharge. This second, or regulating section of the battery, is connected to switches which enable more or less of the regulating cells to be connected to the 'bus bars; the arrangements differ somewhat in different stations, but substantially this is universal practice. For charging, a special dynamo is run at the necessary pressure or boosters are used to raise the 'bus bar pressure to that desired. These devices of heavy regulating switches, boosters, and their connections, are exceedingly costly, and very difficult to operate in practice; moreover, the risk of short circuits between the bars connecting to the regulating switches is somewhat great, and in most stations the battery switch gear is more complicated and more costly than any other part of the switching equipment. The arrangements for charging the battery are two—one is to disconnect the battery entirely from the working 'bus bars and to connect it to bars at a higher pressure, cutting out the regulating cells as they become charged; the other is to connect the cells to the charging bars, and to connect a less number of cells to the supply bars. In this case the charging current is greater in the end cells than in the remainder of the battery; in either case it is quite impossible to properly charge the regulating cells, and it is nearly always found that these, excepting possibly the last two or three, which are rarely used, depreciate at a far greater rate than the other cells in the battery.

After trying the regulating cell system I decided to eliminate entirely this source of trouble and expense, and the arrangement I have used for the past two years is to regulate entirely by means of a variable-pressure booster, so designed that by varying the field strength the pressure can be varied from zero to a maximum in either direction. The booster has a double-wound armature working in one field, each arm of the battery is connected in series with one

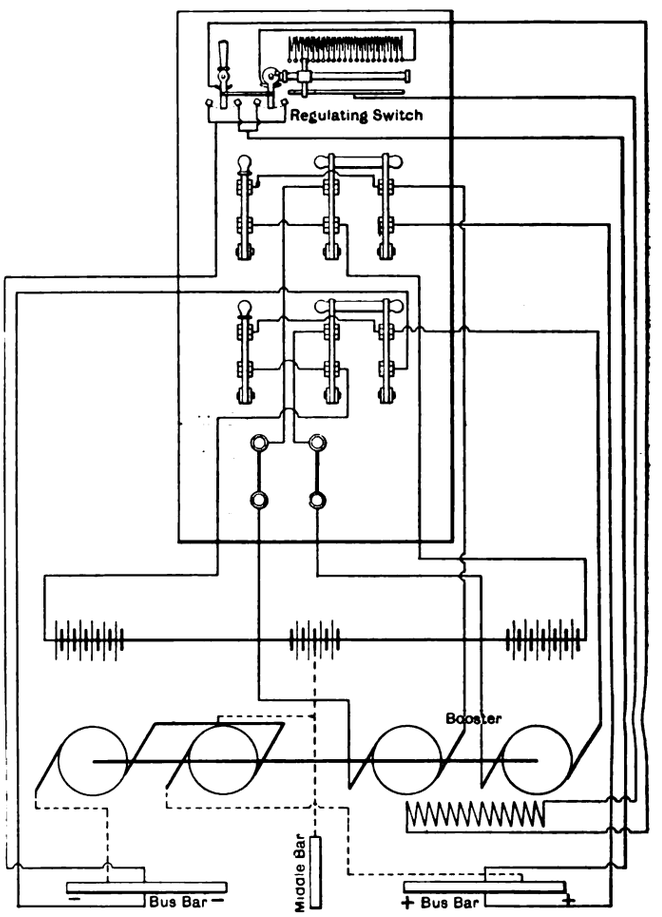


FIG. 1.—ARRANGEMENT OF VARIABLE PRESSURE LIGHTING BOOSTER.

of the armature windings, and the field is varied by a 30-point rheostat and a reversing switch interlocked therewith in such a way as to vary the volts given by each armature from zero to 50, each step of the resistance serving to effect a variation of rather less than 2 volts. The booster is fitted with carbon brushes worked at very low current density, and no trouble is experienced when the current is large and the field strength small. The battery supplies a three-wire system, the middle point of the battery being connected to the neutral 'bus bar; a very good type of balancer is also used, so that the out-of-balance current dealt with by the battery is small. One half of the battery may be charged by disconnecting the other half entirely from the 'bus bars, and charging through the balancer. The arrangement of electrical connections is shown diagrammatically in Fig. 1. The switch gear required to connect or disconnect the booster and the battery is exceedingly simple, and, of course, the whole of the necessary regulating is done by varying the amount and direction of the boost as desired. The battery is always connected to the 'bus bars, and one of the most convenient purposes it serves is to act by means of the booster as the controller of the station pressure, which is regulated solely by the switch handle, which regulates the strength of the booster field and hence varies the amount of boost.

* Paper read before the Institution of Electrical Engineers May 9.

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The arrangement here described was the first one I designed. It has proved an immense improvement on the regulating cell system, but has the objection that a sudden variation in the load causes a variation in the pressure. It is very desirable to make the regulation of the station as automatic as possible, provided that no very delicate gear is used, and the automatic booster to be shortly described, would certainly be an improvement on the one above mentioned. I am at present arranging to use an automatic booster in connection with a three-wire lighting battery. The arrangement of the switch gear shown on Fig. 1 is not the best. I am now arranging to use an interlocked gear designed to prevent all possibility of accident by a careless operator. The method of operation is as follows :—Should the pressure rise by reason of the diminishing load, the boost is varied so as to cause the battery to discharge less or to charge more. Should the pressure fall, the booster is regulated so as to work in the opposite sense. If the speed of the generators is arranged for full load at the correct pressure, by regulating the station pressure, by the booster and battery, the generators will always, in an almost automatic way, be kept at full load, provided always that the battery is of proper capacity. The battery, of course, also serves as a store of energy, which is used to drive the entire load when it is so small as not to be sufficient for a single generator. There are, therefore three purposes which the battery serves to fill : (1) It serves, with suitable means of regulation, as a controller of the station pressure. (2) It serves as a store, so that the running generators may be always fully loaded, and also it may carry the peak of the load, and so serve to improve the load on the steam-raising plant. (3) It serves as a store of energy which may be drawn on at times when the load is within its capacity. In stations of small size up to, say, 1,000kw., the battery is of immense use in steadying the pressure, especially when a few rather large motors are connected to the mains ; in large stations, where units of large size are used, this is not a matter of so much importance. The battery is also a great source of security in the case of partial short circuits on the mains ; it will easily burn out a fault, which might damage the generators, and with very little fall in the pressure. I have had experience of several cases where the battery has burnt a bad main's fault clear, the first news of such an accident coming from the outside gang.

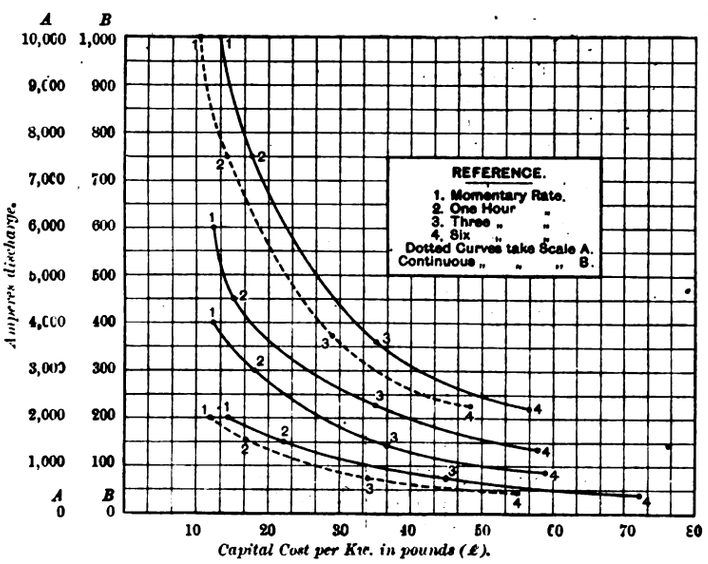


FIG. 2.—COST OF BATTERIES WITH REVERSIBLE BOOSTER AND SWITCHGEAR ERECTED COMPLETE.

The batteries consist of 240 to 250 cells, and the capacity is taken as 30 per cent. less than the full rated capacity when the battery is new, so that at the end of a period, depending on the work and treatment of the battery, the actual capacity will be up to its rated value.

To fully fulfil the above purposes it is necessary to properly proportion the battery to the work which it has to do in relation to the work done directly by the running plant, and it is necessary to take into account the capital cost of batteries in order to decide to what extent it is advisable for financial reasons to instal them in a central station. It is convenient to work out the cost of the battery per kilowatt of discharge at various rates. Fig. 2 gives the cost per kilowatt of storage batteries, including the booster and switch gear complete and ready for work, but excluding the cost of the battery house. The table applies to batteries for 480 to 500 volt circuits, consisting of 240 cells, which is the best number to use for 460 to 480 volt lighting circuits when the booster method of control is adopted. The gear is all designed to work at the one-hour rate—if designed for the three-hour rate a reduction of about 10 per cent. would be made. The cost of steam and electrical plant—excluding buildings—may vary from £25 to £50 per kilowatt capacity. Taking £35 as the usual figure for small stations, it will be seen from the curves (Fig. 2) that at about a three-hour rate of discharge the battery costs per kilowatt of possible output the same amount as the running plant, and as the size of the battery increases the cost per kilowatt somewhat decreases. At a one-hour rate of discharge the cost of the battery is less than the cost of plant of a similar output. The "peak" of a lighting station does not usually last for more than two or three hours in a town where late-closing shops make up a large proportion of the load. The proportion of the maximum load constituting the peak varies from one-fourth to one-sixth, that is to say, if the peak is defined as an amount of load constituting one-fourth to one-sixth of the maximum load, this peak does not remain on for more than three hours, it is usually less. If the battery is to take the whole of the peak it must, therefore, be designed to have a capacity, reckoned at the rate of discharge which will run it down in three hours, of at least one-fourth to one-sixth of the maximum load on the station. In a new station of moderate size the battery might be made to bear a larger proportion to the plant installed than this, as large batteries and their controlling gear are somewhat less costly than small ones, and are also less trouble, owing to the fact that they are usually more solidly constructed. A battery of sufficient size to carry the peak for three hours will be able to serve the three purposes set forth above in a very complete way, and the loss of energy in the battery will generally be amply compensated for by the increased economy due to working the engines at full load and to the improvement of the steam-raising plant load factor. The load factor of the steam-raising plant is usually very poor, the fuel wasted in raising steam and keeping hot long ranges of pipes constitutes a considerable portion of the fuel usefully consumed. It seems impossible to lay down general rules as to the working of boilers in electric works ; the only thing to be said, a fact readily conceded, is that the greater the regularity of working of the steam-raising and distributing plant the greater will be the economy. In works of 1,000kw. capacity or less it will be generally most economical to drive the load from midnight to 6 a.m. from the battery—in summer time the load may be often carried in this way for a longer period—and a battery designed to carry the peak for three hours will generally be sufficient to do this. The boiler fires would be banked during these hours, and one shift of men saved. In larger stations, however, the coal thus used would be nearly as much as if an engine were running all night, and probably in stations above 1,000kw., and certainly in stations above 2,000kw., it would be more economical to drive the load from the running plant, charging the battery to keep the engine at full load. Then on the load rising in the morning the battery would be discharged until the demand inceased sufficiently to load up a second engine, again charging the battery.

Small stations supplying residential towns must be considered on a somewhat different basis from large stations supplying manufacturing towns in respect of the use of batteries as of other matters. In a small station the battery can supply economically a far greater proportion of the yearly output than in a large station. In stations of less capacity than 500kw. the usual practice has been to put down at least two sizes of engines ; it might be better practice to put down two or three engines of equal size and a battery of sufficient capacity to give the output of one engine for three hours. It is not difficult to predict the extent of the load in residential towns of small size, and if it be assumed that in, say, five years' time, 800kw. will be required, a station laid down with two 100kw. generators, and a battery capable of giving about 100kw. for three hours, will make a far more economical station than one in which one or two smaller units are put down to start with. As the load on such a station increased, engines of similar size to those first installed should be put down, the plant being thus maintained of uniform pattern. In stations of larger size a greater number of units would be installed, and in order to load up the running engines to their full capacity it would usually be necessary to instal a battery equal in capacity to the output of one engine for three hours, so that in general the ratio of the battery capacity to the total capacity of the plant will be less in large stations than small ones in inverse proportion to the number of units.

In determining the best size of battery for an existing station, the engineer might consider into what number of units he would divide the plant if he could design and erect an entirely new station. Most engineers in such a case would probably decide to make all the units of similar capacity ; the battery should then be of such size as to take the whole output of 1 unit for a period of three hours, or alternatively 2 units, of, say, one-half of the capacity of the standard unit, might be installed, and a battery equal in capacity to one of these units. The nature of the all-night load must be considered in this connection, however, and the size of the smallest unit and of the battery should largely be determined by the amount of the load from midnight to 6 a.m.

In the case of a station with a large street-lighting load it is not difficult to ensure that the engines are always nearly fully loaded, but even in such a case a large battery will also enable the steam-raising plant to be worked in a more uniform way, a matter as important for economy as the uniform working of the engines.

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To consider a special case, a plant of 1,000kw. will, with a load having a factor of 10 per cent., turn out per annum 870,000 units. If, by the use of a battery giving 250kw. for three hours, which, as before explained, is in most cases capable of dealing with the peak, running plant of 750kw. capacity could do the work, and turn out the same number of units, the plant load-factor would be raised from 10 per cent. to 13·4 per cent., an increase which would certainly result in greater economy in working; but such a battery would be in nearly every case capable of carrying the whole of the load from midnight to 6 a.m. The plant could then be shut down during these hours and one shift of men saved, the running hours being lessened to this extent, the plant load-factor would be raised from 10 per cent., where no battery was used, to 17·8 per cent. In most towns also this battery would, in summer time, serve to carry the load during a part of the day, and the plant load-factor would be thereby still further increased. The above factor applies to the whole plant over the whole year, but since the plant would be divided into, say, four units of 250kw. each (one unit being spare) the plant actually working could be kept always fully loaded if the battery were charged and discharged in a proper manner to attain that end.

The question of the relation between cost of working and load-factor will be further considered in referring to combined stations, but reference may here be made to the fact that a lighting station deals with a load which varies through a wide range during every day, but it varies in an easily predetermined manner. With properly proportioned, sub-divided plant it is easy to ensure that the running engines always work at or near their full load; the average load on the plant considered as a whole, however, simply depends on the outside load, as will, to a great extent, the load on the boilers. In a lighting station, therefore, the battery should be designed to equalise as much as possible the boiler working. A battery sufficiently large to obviate raising steam, even in a single boiler which might not be required for more than an hour, will enable a considerable saving to be made in fuel.

*(To be continued.)*

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"The Influence of Submarine Cables upon Military and Naval Supremacy." By G. O. Squiers. Reprint from Vol. XXVI. of the Proceedings of the United States Naval Institute. (Annapolis, Md.: The Institute.)

"Journal of the Institution of Electrical Engineers." No. 150., Vol. XXX. May, 1901. (London: E. and F. N. Spon.) 4s.

"The Induction Motor." By B. A. Behrend. (New York: *Electrical World and Engineer.*)

"Electrical Designs." Comprising Instructions for Constructing Small Motors, Testing Instruments, and other Apparatus. Reprinted from the *American Electrician.* (New York: "American Electrician" Co.)

"Thèses Présentées à la Faculté des Sciences de Paris pour obtenir le Grade de Docteur ès Sciences Physiques." By M. Victor Crémieu. (Paris: Gauthier-Villlars.)

"Glass Decoration and Design." By the Rev. F. C. Lambert. (London: Dawbarn and Ward). 6d.

"Dynamo-Maschinen." By J. P. Bradwell. 2 vols. (Berlin: A. Steins.) 2m. each.

"Fortschritte der Elektrotechnik." No. 3, 1900. (Berlin: Julius Springer.)

Electricity in Steel Works in Nova Scotia.—From the *Electrical World* of New York we learn that according to the various descriptions given of the great plant of Canada's new iron and steel industries at Sydney, Cape Breton, in the province of Nova Scotia, where the cheapest iron and steel in the world are now being made, electricity plays an important part in the labour-saving operations of this vast industrial undertaking. Electricity as a motive power is used in every conceivable way all over the steel plant. In the winter season, when ore and limestone are used from the stock piles, they are gathered up with scoop buckets worked from a trolley traveller, which delivers its load, two or three tons at a lift, into the bins by the furnaces. All the scooping and carrying is done by electric power. Three of the electrically-worked travellers serve four blast furnaces, up the sides of which the loaded buckets are hauled to a height of 85ft. by electric power also, and dumped automatically into the furnaces. Gravitation and electricity are the motive powers, and no men are seen toiling with shovels and wheelbarrows and labouring amid smoke and fumes.

## ELECTRICITY WORKS ACCOUNTS.

### Walsall Municipal Electric Supply Works.

This undertaking continues to make steady progress, and in the two years covered by our table the operations have resulted in surpluses, which have been applied to the reduction of the deficit handed down from preceding years.

Considering the extent of the business and the moderate total revenue per unit derived the financial results are very commendable.

It will be noticed that the aggregate costs per unit sold were reduced last year from 2·76d. to 2·7d. We think the actual improvement in the working was greater than this change in the total costs appears to indicate. The higher coal prices were bound to influence to a great extent the cost figures of all undertakings last year and the Walsall concern is no exception, but by a splendid reduction in the rather high management costs the increase in the expenditure on coal was far more than neutralised

The most unfortunate item in the costs at this place is that of repairs at the station, which at 0·66d. per unit is at least 0·3d. above what it should stand at even considering this is a battery station. This item is due the fact that the aggregate costs are still somewhat above the normal.

Last year the output was higher by 41·9 per cent. than in 1899, while the load factor was 10 5 per cent., as compared with 9·05 per cent.

### Morley Municipal Electric Supply Works.

The cost figures of this undertaking are discouraging, and the business makes but slow progress.

During the year ended at March 25 last the lamp connections were increased by 19 per cent. The year's output was about 9 per cent. above that of the preceding year. It is a redeeming feature that most of the cost items are being reduced; the fuel charge is one of the exceptions, having risen from 1·47d. to over 2d. per unit.

The working profit still remains a negative quantity, and the ultimate deficit for the two years covered by our table amounts to £2,002.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Ayr (Municipal) | Nov. 2, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bath (Municipal) | April 20, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leith (Municipal) | May 17, 1901 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | May 3, 1901 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 10, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | May 3, 1901 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 28, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | April 19, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 26, 1901 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | South London (Company) | May 31, 1901 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | Southport (Municipal) | July 7, 1899 |
| Folkestone (Company) | April 26, 1901 | Stafford (Municipal) | Aug. 17, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Guildford (Company) | Oct. 19, 1900 | Taunton (Municipal) | June 16, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Hammersmith (Vestry) | June 29, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hanley (Municipal) | July 27, 1900 | Wandsworth (Company) | April 19, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Westminster (Company) | Mar. 23, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Winchester (Company) | May 17, 1901 |
| Hove (Company) | May 10, 1901 | Windsor (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woking (Company) | Dec. 22, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Kens'gton & Knightsbr'(Co.) | Mar. 16, 1900 | Woolwich (Company) | May 31, 1901 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-on-Thames (Mun.) | July 20, 1900 | Great Yarmouth (Mun.) | Dec. 28, 1900 |

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| | WALSALL. | | MORLEY. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Walsall Corporation. | | Morley Corporation. | |
| *Date of Commencement of Supply* | December, 1895. | | February, 1898. | |
| *System of Supply* | High-press. con.-cur. with trans. and storage [batteries | | Alt.-cur. trans. sub-stations supplying 2-wire [network | |
| *Chief Engineer* | Alexr. Wyllie. | | H. Drewett. | |
| **YEAR ENDED** | DEC. 31, **1899.** | DEC. 31, **1900.** | MAR. 25, **1900.** | MAR. 25, **1901.** |
| **QUANTITIES—** | | | | |
| Units generated | 288,115 | 404,682 | 104,883 | 109,861 |
| „ **SOLD (TOTAL)** | **194,251** | **275,643** | **71,497** | **77,776** |
| „ sold to consumers | 167,759 | 246,363 | 45,582 | 47,026 |
| „ sold for public lighting, &c. | 26,492 | 29,280 | 25,915 | 30,750 |
| „ used on works | 12,825 | 17,606 | 9,705 | 8,472 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 14·8 | 14·7 | 8·48 | 9·21 |
| Maximum supply demanded | 245 kilowatts | 301 kilowatts | 80 kilowatts | 80 kilowatts |
| Number of public lamps | 19 arc | 19 arc | 15 arc, 33 (32 c.p.) glow | 15 arc, 33 (32 c.p.) glow |
| Number of consumers | 153 | 169 | 61 | 75 |
| Connections to mains in 8-c.p. lamps | 12,613 | 16,457 | 5,746 | 6,861 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 13,110 | 18,750 | 8,440 | 8,440 |
| **CAPACITY OF PLANT IN KILOWATTS** | 420 | 600 | 270 | 270 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £30,350 / £72·3 | £45,498 / £75·8 | £22,500 / £83·3 | £22,500 / £83·3 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 30,350 / 72·3 | 45,498 / 75·8 | 22,500 / 83·3 | 22,500 / 83·3 |
| **RECEIVED (TOTAL)** | 26,950 / 64·2 | 25,450 / 42·4 | 22,500 / 83·3 | 22,500 / 83·3 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 26,950 / 64·2 | 25,450 / 42·4 | 22,500 / 83·3 | 22,500 / 83·3 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 3,400 / 8·10 | 20,049 / 33·4 | — / — | — / — |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | 3,400 / 8·10 | 20,049 / 33·4 | — / — | — / — |
| **REPAID (TOTAL)** | 902 / 2·15 | 902 / 1·50 | — / — | — / — |
| **RESERVE OR SINKING FUND** | 2,038 / 4·86 | 2,783 / 4·64 | 1,253 / 4·64 | 1,907 / 7·06 |
| **DEPRECIATION FUND** | — / — | — / — | — / — | — / — |
| **EXPENDED (TOTAL)** | 29,385 / 70·0 | 34,310 / 57·2 | 23,607 / 87·4 | 24,181 / 89·6 |
| Lands and buildings | 2,987 / 7·12 | 3,833 / 6·39 | — / — | — / — |
| Plant | 17,263[a] / 41·1 | 20,961 / 34·9 | — / — | — / — |
| Mains | 9,104 / 21·7 | 9,485 / 15·8 | — / — | — / — |
| Miscellaneous | 30 / 0·071 | 30 / 0·05 | — / — | — / — |
| **BALANCE OF CAPITAL ACCOUNT** | −2,435[b] / −5·80 | −8,860[b] / −14·8 | — / — | −1,681[a] / −6·23 |
| **REVENUE—** | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold |
| **TOTAL** | £3,769 / 4·659d. | £4,693 / 4·088d. | £1,318 / 4·425d. | £1,516 / 4·680d. |
| Revenue from supply | 3,254 / 4·020d. | 4,122 / 3·590d. | 889 / 2·985d. | 933 / 2·880d. |
| „ meters, &c. | 73 / 0·090d. | 83 / 0·072d. | 37 / 0·124d. | 40 / 0·124d. |
| „ public lighting | 442 / 0·546d. | 488 / 0·425d. | 284 / 0·954d. | 346 / 1·068d. |
| „ sale of lamps, &c. | — / — | — / — | — / — | 7 / 0·022d. |
| „ miscellaneous sources | — / — | — / — | 108[b] / 0·363d. | 190[b] / 0·587d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £2,233 / 2·760d. | £3,100 / 2·700d. | £1,369 / 4·598d. | £1,663 / 5·133d. |
| **WORKS COSTS** | 1,556 / 1·923d. | 2,520 / 2·195d. | 977 / 3·280d. | 1,257 / 3·880d. |
| *Generation of electricity* | *1,360 / 1·680d.* | *2,346 / 2·044d.* | *903 / 3·031d.* | *1,136 / 3·506d.* |
| Fuel (including cartage, &c.) | 539 / 0·666d. | 1,041 / 0·906d. | 438 / 1·471d. | 678 / 2·093d. |
| Oil, waste, water, stores | 141 / 0·174d. | 159 / 0·139d. | 61 / 0·205d. | 126 / 0·389d. |
| Wages at station | 302 / 0·374d. | 385 / 0·335d. | 336 / 1·129d. | 285 / 0·880d. |
| Repairs and maintenance at station | 378 / 0·467d. | 760 / 0·662d. | 67 / 0·225d. | 47 / 0·145d. |
| *Distribution of electricity* | *107 / 0·132d.* | *87 / 0·076d.* | *8 / 0·027d.* | *38 / 0·117d.* |
| Wages, &c. | 46 / 0·057d. | 78 / 0·068d. | 1 / 0·003d. | 16 / 0·049d. |
| Repairs, renewals of mains, &c. | 61 / 0·075d. | 9 / 0·008d. | 7 / 0·024d. | 23 / 0·071d. |
| *Public lighting* | *89 / 0·110d.* | *89 / 0·078d.* | *66 / 0·222d.* | *83 / 0·256d.* |
| Attendance / Renewals | 89 / 0·110d. | 89 / 0·078d. | 58 / 0·195d. / 8 / 0·027d. | 39 / 0·120d. / 43 / 0·133d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 677 / 0·837d. | 580 / 0·505d. | 392 / 1·316d. | 406 / 1·253d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *211 / 0·261d.* | *246 / 0·214d.* | *67 / 0·225d.* | *63 / 0·194d.* |
| *Management* | *466 / 0·576d.* | *334 / 0·291d.* | *325 / 1·091d.* | *343 / 1·059d.* |
| Salaries | 382 / 0·472d. | 240 / 0·209d. | 269 / 0·904d. | 290 / 0·895d. |
| Stationery, &c. | 22 / 0·027d. | 28 / 0·024d. | 17 / 0·057d. | 11 / 0·034d. |
| Establishment charges | 41 / 0·051d. | 42 / 0·037d. | 31 / 0·104d. | 31 / 0·096d. |
| Law charges, &c. | 21[c] / 0·026d. | 24[c] / 0·021d. | 8 / 0·027d. | 11 / 0·034d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £1,536 / −5·41% | £1,593 / 5·00% | −£51[c] / −0·219% | −£147[c] / 0·615% |
| Sum carried to Depreciation Fund | — / — | — / — | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 734 / 2·58% | 717 / 2·25% | 636 / 2·72% | 617 / 2·58% |
| Net interest on loans (incl. Debenture charges) | 741 / 2·61% | 757 / 2·38% | 718 / 3·08% | 1,238 / 5·18% |
| **BALANCE FROM LAST ACCOUNT** | −456 / 1·61% | −395 / −1·24% | −[a] / — | — / — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — / — | — / — | nil / — | — / — |
| *Deficit* | *395 / 0·139%* | *275 / 0·86%* | *1,404[c] / 6·03%* | *2,002 / 8·37%* |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 59·3% | 66·1% | 104% | 110% |
| Expenditure per kilowatt capacity | £5. 6s. 4d. | £5. 3s. 5d. | £5. 1s. 5d. | £6. 3s. 2d. |
| **REVENUE PER KILOWATT CAPACITY** | £8. 19s. 7d. | £7. 16s. 5d. | £4. 17s. 7d. | £5. 12s. 4d. |
| Expenditure per 8-c.p. lamp capacity | 3s. 4¾d. | 3s. 3¾d. | 3s. 3d. | 3s. 11¼d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 5s. 9d. | 5s. 0d. | 3s. 1½d. | 3s. 7d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 5s. 11⅞d. | 5s. 8½d. | 6s. 7d. | 5s. 3¼d. |
| Price charged for lighting, per unit | 6d. (1½ hrs.) to 2d.[d] | 6d. (1½ hrs.) to 2d.[d] | 5½d. | 5½d. |
| Price charged for power, per unit | 2½d.[d] | 2½d. to 1d.[e] | 3d. | 3d. |
| Price charged for public lighting | £25. 14s. per arc per an. | £488 per ann. for 19 arcs. | £22 per arc lamp. | £22 per arc lamp. |

**WALSALL.**—REMARKS—*a* Includes £422 on lamps and lamp-posts. *b* Over expended. *c* Insurance. *d* Lighting charge on maximum demand system. The lighting and motor charges are subject to a discount of 10 per cent. for 10,000 units per annum, or 12½ per cent. for 15,000 units per annum. *e* On maximum demand system (first 300 hours of maximum demand per quarter at 2½d. per unit.)

**MORLEY.**—REMARKS—*a* Over expended. *b* Cost of steam supplied for heating baths. *c* Working deficit. *d* The deficit of £1,405 for year to March 25, 1899, was met by the rates. *e* Met by the rates.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny

Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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## GOVERNMENT INSPECTION OF GENERATING STATIONS.

In our leading article last week we referred to the patchwork character of the law governing electric supply, based on the Electric Lighting Act of 1888 and the Tramways Act of 1870, with an ill-fitting patch of new material here and there, where the municipal threads in the main fabric had got worn out by misuse. There is danger of yet another patch being applied which will offend alike the eyes of the municipal and company supplier of electrical energy. Just as on previous occasions municipal and company undertakers have combined to resist extortion or to procure the amendment of an objectionable regulation, so now they again join hands to take action with regard to a new piece of legislation which is before Parliament.

The bill to which we refer is "A Bill to Amend the Factory and Workshop Acts," now being discussed in the House of Commons, and the objectionable clause is the apparently innocuous one that there shall be added to the list of non-textile factories in Part I. of the fourth schedule to the Factory and Workshop Act of 1878, "electrical stations—that is to say, any premises in which electrical energy is generated or transformed either for the purpose of supply by the way of trade, or for any purpose incidental to any other business except the transmission of signals or messages." This provision forms the almost imperceptibly thin end of a wedge which, when driven home, would probably not only render electricity generating stations subject to troublesome inspection, possibly by expert inspectors who are not expert electrical engineers, but also make them liable to troublesome regulations of a more or less stringent character. Four years ago a Committee appointed "to inquire into and report upon certain miscellaneous dangerous trades" issued their second interim report to HER MAJESTY'S principal Secretary of State for the Home Department, the subject of which was electrical generating works. Although an admirable survey of the dangers that may arise in high-pressure generating works and transformer stations, this report and the recommendations appended to it were not of a nature to be accepted without protest by the owners and engineers of electricity supply works, who would have to make considerable changes in the arrangements of

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their works and their sub-stations if these recommendations were to become regulations. At the time, however, although the report was commented on and criticised, no representations were made with regard to it, as, without additional legislation, the works in question would not be affected. Some time later, however, a Committee of the Municipal Electrical Association leisurely considered the report, and some suggestions were made by the Association to HER MAJESTY'S Chief Inspector of Factories, suggesting what alterations would be desirable in the technical recommendations contained in it.

The matter rested for some time, but in view of the new Factory and Workshop Acts Amendment Bill it now assumes an aspect of considerable importance. This new bill, as we have already said, places electricity works on the list of non-textile factories within the meaning of the principal Factory and Workshop Act [1878]. But it also provides that the Secretary of State may certify that any "manufacture, machinery, process or description of manual labour" is dangerous, and gives certain rules as to the imposition of regulations for this dangerous trade. The specific designation of an electricity works as a non-textile factory shows that the departmental committee's recommendations above alluded to have not been forgotten, and that after this bill becomes law, the next step affecting the electrical engineering industry would probably be the branding of electrical generation as a dangerous trade, and the imposition of troublesome regulations. A grain of comfort may be derived from the fact that the procedure that must be gone through before these regulations are promulgated affords reasonable facilities for those concerned to raise objections; but do we need such regulations at all, and ought the generation of electrical energy to be considered a dangerous trade or even to be ranked in the same category as an ordinary non-textile factory? These points were not considered by the Municipal Electrical Association when it pondered over the report to the Home Office, and an important matter in this report was also overlooked—viz., the question of the appointment of a "specially qualified person" to advise the Secretary of State or the Chief Inspector of Factories on matters requiring technical knowledge of electricity. Whether the generation of electricity is a "dangerous trade" or not, the question of inspection is an important matter.

As soon as the generating station becomes legally a non-textile factory, the Home Office inspector will pay his periodical visits to it. He will possibly require modifications in the fencing in of the machinery and other alterations which, in his opinion, may tend to the additional safety of the employés, and, so long as he has not to discriminate on matters too technical, his intervention may be tolerated. But if he comes to see the enforcement of highly-technical regulations made by a "specially qualified person," he will become not only a nuisance but a danger, unless he also possesses a fairly intimate technical knowledge of the detail of the machinery and appliances he is to inspect. It would probably be better to appoint two or three "specially qualified persons" to do the inspection themselves, one of whom might act in the advisory capacity mentioned. Or, it might not even be necessary to frame special detailed regulations at all, but to choose persons as inspectors whose special qualifications were considerable, and leave to them a fair amount of discretion as to the safety precautions necessary. The framing of stereotyped sets of rules to apply equally well to all high pressure and all extra high pressure stations might prove a difficult matter; and in the determination of what is safe and what is dangerous in sub-stations a certain amount of latitude ought also to be allowed. These matters all require most careful consideration.

The electrical industry must, therefore, keep an eye on the tendency of the factory legislation now likely to be passed, and it must see that its own interests are safeguarded. To this end, as we have already suggested, a joint conference of municipal and company undertakers of electrical supply would be most desirable; and having made up their minds as to the best policy to pursue, it would be wise for them to appoint a deputation to wait on Mr. RITCHIE (who is responsible for the Factory Workshop Amendment Bill) and express their views to him, before the bill is out of the committee stage.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

**Electric Light Cables, and the Distribution of Electricity.** By STEWART A. RUSSELL. 2nd Edition. (London: Whittaker & Co. 1901.)

In technical literature it frequently happens that the second edition of a good book is disappointing, and this applies to the case of the book on cables and distribution now before us. During the time that has elapsed since the first edition was published, so many changes have taken place in the conditions and practice of electrical supply, and so much experience has been gained, that Mr. Russell's book should have been almost entirely re-written, and considerably extended in the process. In an up-to-date book on electric light cables we might expect to find detailed specifications of the types of cables employed for various purposes, but the only cable to which a complete specification is accorded is the now-obsolete Ferranti tubular main which was laid between Deptford and London. True, an empirical formula is supplied, to determine the thickness of insulation suitable for a given conductor and a given pressure, but no indications are afforded as to the proper thicknesses of lead covering or of the dimensions of the armouring. Cable manufacture is presumably considered outside the scope of the book, as nothing of practical use is given with regard to the methods and machinery employed.

Again, it seems strange to take up a book on distribution and discover in it no map of an actual network, and very little in the way of practical guidance for the disposition of the feeding points, network boxes, &c. Such practical points as the relative merits of two and three-conductor feeders are not discussed, and in comparing the advantages and disadvantages of drawing-in, solid, and directly buried systems, the position and facility of connections to consumers seem to have been overlooked. In view of the large amount of vulcanised rubber cable that was laid in the streets in the earlier days of electric lighting and the small proportion at present employed for street mains, one is surprised to read that—

> So far as the comparatively short time during which insulated cables have been in use for electric lighting mains will allow us to judge, vulcanised rubber cables are also the most durable. . . . India-rubber has, however, one great disadvantage, which is, that it is expensive; and it is on this score that objection is often raised to its use; but, if this is left out of consideration, and the matter looked at entirely from the technical point of view, there is no doubt that rubber cables are the best, so far as our present experience goes.

Then follow two pages damnatory of lead-covered cables insulated with impregnated cotton, jute, paper or other fibrous material, but the author is bound to confess that "notwithstanding these disadvantages" this class of cable has been "extensively" employed, but he unfairly adds that this is "on account of its lesser cost," and "more especially for low pressure distribution." If he had said that vulcanised rubber cable for electric lighting work had been practically superseded except for internal wiring, arc lamp connections and service wires, he would have been more accurate.

Those who are accustomed to laying mains in towns, will be surprised to learn that when the cables are laid directly in the ground, "the cable on its drum is generally mounted on a trolley, which is wheeled along by the side of the trench, and as the cable pays off the drum, it is laid in place in the

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trench." Whether the cable pays off the drum, or the drum pays off the cable, it is certain that the engineer would pay off the foreman who failed to thread his cable beneath the gas and water service pipes in an average city street.

The brief descriptions of the systems of cables employed in connection with various existing electric light works are interesting, but all too short, and a useful collection is made of figures relative to the cost of maintenance of networks culled from the weekly analyses of accounts in *The Electrician*. The source of these is acknowledged, but the same cannot be said for a large portion of the last chapter, devoted to testing, in which the author has derived considerable assistance from contemporary technical literature.

**Moteurs Synchrones à Courants Alternatifs.** By ANDRÉ BLONDEL. (Paris: Gauthier-Villars and Masson & Cie.). In paper 2fr. 50cm., in boards 3fr.

Those engaged in the design of alternating-current machinery will find this volume of the "Encyclopédie Scientifique des Aide-Mémoire" interesting, and should not fail to read it through. Even if it conveys nothing fresh to them it will help to fix their ideas on the somewhat "tricky" subject of the theory and action of synchronous motors. But for the general student, a book dealing with the subject of alternating current motors generally is necessary, or rather a work treating as one subject synchronous and asynchronous motors, motor generators and rotatory converters—and even these can hardly be dealt with quite satisfactorily, apart from the subject of generator and transformer design.

## COPPER SUPPLIES IN 1900.

The annual statistical circular relating to copper, published by Messrs. H. R. Merton & Co., shows that, in spite of high prices, only 14,000 tons more copper was produced in 1900 than in the previous year, the exact figures being 486,084 and 472,244 tons respectively.

Of the more important producing countries, Australasia, Mexico, Peru, Canada, and the States alone show increases of over 1,000 tons in output, while Germany and Japan record actual decreases.

The figures for the German production since 1896 are interesting, the totals for the successive years being as follows:—1896, 20,065 tons; 1897, 20,145 tons; 1898, 20,085 tons; 1899, 23,460 tons; 1900, 20,410 tons. These figures seem to indicate that Germany has reached the limit of her capacity as a copper-producing country. The decrease in the case of Japan is less easily explained, and is possibly due to financial causes.

Of the countries which have increased their output in 1900, the United States have the largest share of the 14,000 tons net increase to their credit, the yield of the American mines for 1900 having been 6,500 tons in excess of the yield of the previous year. When it is remembered that the States produce over one-half of the total world output of copper (in 1900 the exact figures were 268,787 tons out of a total of 486,084 tons) this increase is seen to be insignificant, and is to be explained by the desire of the copper trust financiers to keep supplies back in order to maintain the present high level of prices.

The following figures for the output of the American mines in the period 1895-1900 are instructive:—

| — | 1895 | 1896 | 1897 | 1898 | 1899 | 1900 |
|---|---|---|---|---|---|---|
| Calumet and Hecla | 34,454 | 40,383 | 40,352 | 38,583 | 40,005 | 40,000* |
| Other Lake Mines | 23,582 | 24,286 | 24,301 | 31,879 | 29,358 | 24,396 |
| Montana ..... | 82,559 | 93,276 | 103,528 | 97,400 | 106,650 | 114,144 |
| Arizona ..... | 21,429 | 31,548 | 35,979 | 48,359 | 54,793 | 49,447 |
| Other States ..... | 10,246 | 14,400 | 11,900 | 18,050 | 31,400 | 40,800 |
| Totals ..... | 172,300 | 203,893 | 216,060 | 234,271 | 262,206 | 268,787 |

* Estimated.

The Lake Mines and Arizona show marked decreases in 1900, and it is chiefly owing to the striking increase in the output of the mines in the outside States, that the copper production of the United States has not shown any shrinkage in the past year. In five years these outside mines have quadrupled their output, and if these mines can be kept from passing under the control of the trust financiers they will probably still further augment their production in the present year.

With regard to the other countries showing increased outputs during 1900, the rise of Mexico and Australasia as copper-producing countries is the most noteworthy. In 1895 Mexico was producing only 11,500 tons of copper per annum, of which total 10,450 tons was extracted from the ores of the famous Boleo mine. In 1900 the Mexican production had risen to 22,050 tons, 11,000 tons, or nearly one-half of this amount, being obtained from newly-opened Mexican mines. The figures for the Australasian output since 1895 are as follows:—1895, 10,000 tons; 1896, 11,000 tons; 1897, 17,000 tons; 1898, 18,000 tons; 1899, 20,750 tons; 1900, 23,000 tons. This is a fairly satisfactory record of progress, and as considerable capital has been sunk in the copper mining industry in both countries within the last few years, the increase in production is likely to be maintained.

If the figures of advance are based upon percentages Peru can show more remarkable returns than those of any other country, although the total output of copper in 1900 was only 8,220 tons.

Starting from 1895, when the production of this country was only 450 tons, we have the following totals for the successive years:—1895, 450 tons; 1896, 740 tons; 1897, 1,000 tons; 1898, 3,040 tons; 1899, 5,165 tons; 1900, 8,220 tons. These figures, therefore, show an increase of 1,700 per cent. in five years. This rate of advance of course cannot be maintained.

The production of Canada is slowly but steadily increasing. In 1895 the output of the Canadian mines was estimated to be 4,000 tons. In 1900 the copper produced from Canadian ores amounted to 8,500 tons, an advance of 1,800 tons on the figures of the preceding year. The activity displayed in connection with the nickel industry in the Sudbury district of Canada is likely to augment the copper production of the country, since the Sudbury ores contain both nickel and copper, and to extract the former it is necessary first to remove the copper.

With regard to the remaining copper-producing countries of importance, the figures for Chili, Cape of Good Hope, Italy, Newfoundland, Norway, Russia and Spain and Portugal, show but slight variations when compared with those for 1899. The output of the Spanish and Portuguese mines remains practically stationary at 52,000 tons. It is evident that the mining industry of these two countries has reached the practical limit of its development, for 13 years ago—in 1887—the mines of Spain and Portugal produced 53,706 tons, and in 1888 they attained their maximum output of 56,450 tons.

We may close this article upon the Copper Statistics of 1900 by remarking that England occupies a very humble position in Messrs. H. R. Merton & Co.'s return, the output of 1900 having amounted only to 650 tons. In the early and middle years of the nineteenth century the Cornish mines occupied a leading position in the copper mining industry, and it was only during the second half of the century that the output of other countries exceeded that of the United Kingdom. The famous Anaconda mine in Montana was not discovered until 1883, and it is interesting to speculate whether this mine, which is now producing at the rate of 100,000 tons of copper per annum, will still be worked in the year 2001. The Cornish mines, though now exhausted, have, in their day, played a very important part in the development of the world's copper-mining industry, and as late as 1884 they were producing over 3,000 tons copper per annum.

The present century is likely to witness a repetition of this transfer of the copper-mining industry to other countries, and probably in the year 2001 some mine yet undiscovered, say in South Africa or Australia, will be the chief source of the world's supply of the red metal.

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## PHYSICAL SOCIETY.

At the ordinary meeting of the Physical Society, May 31, Prof. S. P. Thompson, president, in the chair, a Paper

**"On the Resistance of Dielectrics and the Effect of an Alternating Electromotive Force on the Insulating Properties of Indiarubber,"**

by Mr. A. W. ASHTON, was read by Prof. Fleming. The author has obtained from his experiments formulæ for the charging and discharging currents of a condenser with rubber dielectric. The currents are exponential functions of the time. Curves for various potential differences have been plotted and were exhibited. These curves show that the insulating properties of rubber are increased by the application of high alternating electromotive forces.

Prof. Fleming then read a note by Mr. ASHTON

**"On the Electrification of Dielectrics by Mechanical Means."**

A sheet of pure Para rubber was placed in a condenser, the plates of which were connected to a quadrant electrometer. A 2lb. weight was then dropped on to the condenser from a height of 3in. The electrometer received two impulses of opposite sign, one quickly following the other. The rubber was then stretched while in position and a potential difference of 7 volts was shown between the plates, the top plate being negative. The condenser and electrometer were then discharged, the sheet reversed, and the experiment repeated. The same effect was produced, the top plate again being negative. It appears, therefore, that polarisation of a dielectric being thus produced by mechanical energy, some part of the mechanical energy expended on the indiarubber during manufacture would remain in the dielectric as electric energy.

**"A Model which Imitates the Behaviour of Dielectrics,"**

by Prof. FLEMING and Mr. ASHTON, was exhibited by Prof. Fleming. The behaviour of dielectrics with regard to their residual charge is analagous to that of wires subjected to mechanical stress. A simple twisted wire is not, however, able to imitate all dielectric effects, and the present Paper describes a model which represents things more completely. Six pistons, separated by springs, are placed inside a vertical cylinder. The bottom piston fits fairly tightly in the cylinder. The second piston fits slacker than the first. The third piston has a small hole in it, and each succeeding piston has a greater area cut away, the top piston having just sufficient metal left to make the spring come to rest without vibration after being compressed. The cylinder is filled with machine oil and vaseline. To the top piston is attached a rod, by means of which pressures can be exerted on the pistons for any length of time. This represents the charging of the condenser. The motion of the rod after releasing the weights represents the discharge of the condenser. This is registered graphically by a revolving drum, and the curves obtained are very similar to those from condensers with dielectrics.

Prof. AYRTON said he would like to know in what respect the model shown was superior to a strained wire. He had noticed about 10 years ago that alternating electromotive forces appeared to improve condensers. He was then working with comparatively small voltages, and he was interested to know that Mr. Ashton, working with high voltages, had established the improvement. The deflection obtained by stretching the indiarubber sheet might be due to changes in temperature, the dielectric having a high thermo-electric power.

Mr. PRICE was glad that the question as to what actually might be called the resistance of a dielectric had been raised. There are two theories of residual charge, one due to Maxwell and the other to Heaviside. The model exhibited represents Maxwell's theory. He considered that the electromotor experiment with the rubber dielectric favoured Heaviside's theory—that is, that the dielectric is composed of small charged bodies similar to the small magnets conceived to constitute a magnet. He expressed his interest in the fact that the top plate of the condenser was always negative.

Mr. BLAKESBY suggested putting a small hole in the bottom piston of the model, so that it might represent a condenser passing a small steady current. With regard to the stretched rubber experiment he said it would be interesting to make observations with the plates of the condenser vertical.

Mr. CAMPBELL said he had made experiments, and found that the change in capacity of the rubber condenser affects the voltage sufficiently to mask the real effect.

Mr. APPLEYARD said it was important to have perfect contact between the dielectric and the metal plates.

It was pointed out by a visitor engaged in the cable industry that manufacturers are aware that pressure affects the insulating properties of gutta percha. Rubber is a mixture, and different rubbers behave differently under the action of alternating potential differences.

The CHAIRMAN said that if the quantity of electricity taken in on charging was equal to the quantity given out on discharge, then there could be no dielectric hysteresis.

The Society then adjourned until June 14.

## ON TEST-ROOM METHODS OF ALTERNATE CURRENT MEASUREMENT.*

BY ALBERT CAMPBELL, B A.

(*Concluded from page 257.*)

III. *Fictitious Loads.*—Unfortunately it very often happens that sufficient power (at the proper frequency) is not available to allow the meter to be tested with the actual loads at which it is to be used. It thus becomes necessary to arrange fictitious loads whose action on the watt-hour meter shall be practically identical with that of the corresponding real loads.

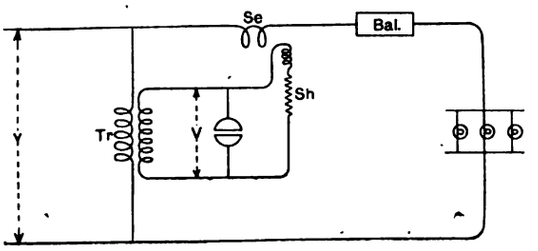


FIG. 8.

*Method* 9.—When the source of supply can furnish the current, but not at a voltage quite high enough for the load required, the well-known arrangement shown in Fig. 8 may be used. The shunt coil *Sh* is disconnected from the series coil *Se*, and is connected with a transformer *Tr* which raises the supply voltage *v* to a suitable value V. The voltage *v* must be high enough to allow the series circuit (series coil, balance, and lamps) to be practically non-inductive.

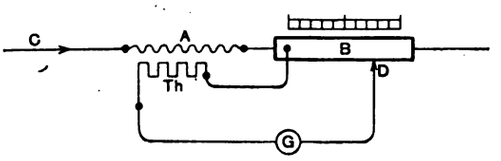


FIG. 9.

*Method* 10.—When a large current is required, a method which I have published recently will be found useful. In it the large current obtained at a low voltage passes through the Kelvin balance, the series coil of the meter, and a low non-inductive resistance; a transformer of high ratio, with its primary across its low resistance, furnishes from its secondary the volts for the shunt circuit.

*Section C. Thermopile Methods.*—A well-known but little used way of measuring a current consists in passing the current through a conductor near which are one set of junctions of a thermopile.

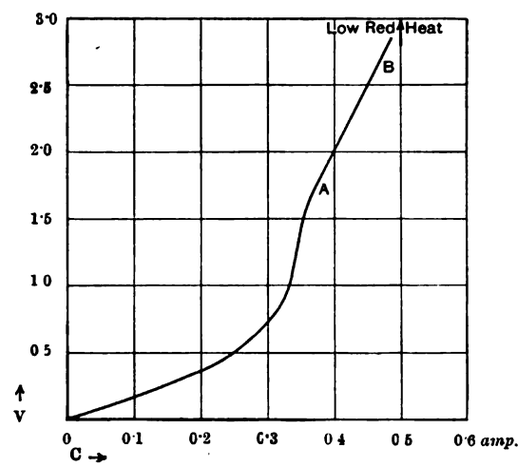


FIG. 10.—Nickel-Wire. Diam. 0·05 mm. (2 mils.).

With rightly chosen conditions, the deflections of the galvanometer connected with the pile are practicaly proportional to the square of the effective value of the current. In common with many other thermal methods, the action is dead-beat, but there is usually the accompanying disadvantage of sluggishness, the zero point not being regained instantly on switching off the current. By making the hot wire and the junctions extremely small, this sluggishness can be

* Abstract of a Paper read before the Institution of Electrical Engineers, April 18.

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much reduced. I have tried a thermopile of iron and nickel wires of 0·15mm. (6 mils) diameter; from a deflection of 100 divisions (400mm.) the light spot, after the switching off of the current, returned to within 1·5 divisions above zero in 30sec., and was still 0·5 division from zero after 75sec. This is prompt enough for many purposes; and it is no difficult matter to braze the junctions of such a thermopile. I have succeeded in brazing junctions of much thinner wire and gained considerably in promptness of working, but this gain scarcely repaid the extreme difficulty of construction.

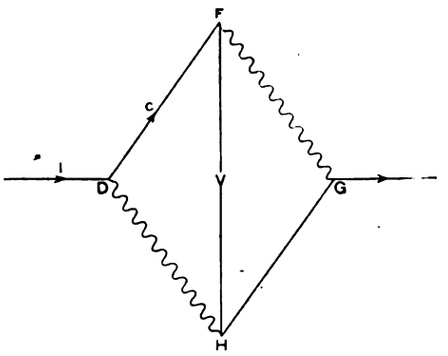


FIG. 11.

*Method* 10.—I may mention here a somewhat interesting null method of measuring continuous current which I have tried; it is shown in Fig. 9. The current passes (wholly or in part) through the thin wire A and also through B, a strip or rod of very low resistance. The heating of A by the current causes the pile Th to give an E.M.F., $e$, which is balanced against a part of the voltage-drop along B by moving the slider D until the deflection of the detector galvanometer G is brought to zero. Here $e=kC^2$ and $v=rC$,

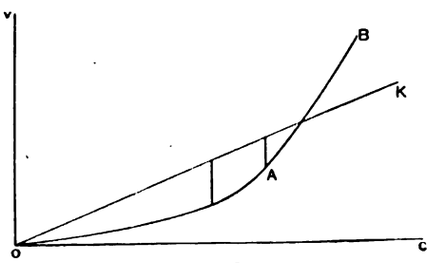


FIG. 12.

$r$ being the resistance of the fraction of B for which $e=v$. Then $r=kC$, and hence the graduations of the scale of the slider are directly proportional to the current measured.

*Section D. On obtaining Steady Currents.*—By the help of an automatic thermal arrangement I have succeeded in obtaining very exact regulation, even when the supply voltage is varied by 10 or 12 per cent. A curve can be drawn for any conductor showing the connection between $c$, the current through the conductor, and $v$, the voltage applied to its ends. It is convenient to call this curve the

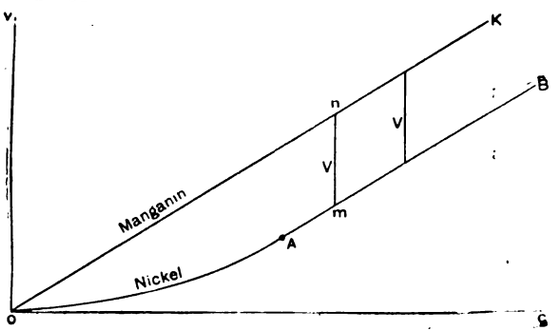


FIG. 13

*characteristic* (*curve*) of the conductor. For manganin, not overheated, the characteristic is practically a straight line whose steepness measures the resistance of the conductor; but for a thin wire of nickel the characteristic curve is of the form shown in Fig. 10, which is drawn from an actual experiment with wire of 0·05mm. (2 mils) diameter. It will be noticed that *the higher part of the curve* (*from A to B*) *is very nearly a straight line.*

*Method* 11.—Now let a Wheatstone bridge be arranged, as in Fig. 11, in which the arms DF and GH are equal resistances of nickel, while DH and FG (also equal to one another) are of manganin. In Fig. 12 let OAB and OK be the characteristic curve of DF and FG. Then it is easy to show that, as long as the branch from F to H is kept on open circuit, the potential difference from F to H, for any particular valve of the current $c$, will be proportional to the vertical distance between the two characteristic curves. It is easy to choose the relative values of the nickel and manganin resistances so that OK shall be parallel to the straight portion AB, as in Fig. 13, and when this is the case $nm$ will be constant from A to B, and thus *$V$ will be practically constant for all values of the current c corresponding to the part AB.*

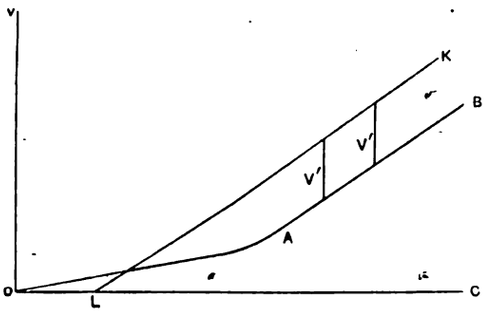


FIG. 14.

This regulation also holds even when current is taken across FH, the constant value of V, however, depending on the current taken. The construction for this case is shown in Fig. 14. OL is taken equal to C, the current through FH and LK is drawn parallel to the characteristic for the manganin wires; $V^1$ will then give the value of the constant voltage from F to H. Thus it is possible to obtain very constant voltage and current, although the main current I (Fig 11) be drawn from a variable source such as

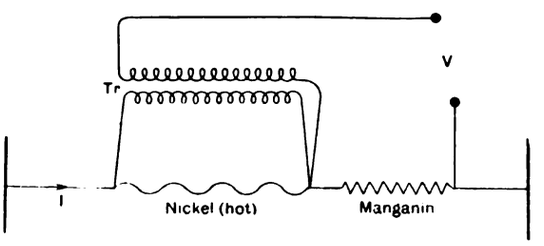


FIG. 15.

the mains of a supply company. With actual apparatus the maximum steady voltage which I have obtained has been about one-third of the supply voltage used; with alternating currents the use of a transformer makes this limitation of small moment.

*Compensation for Variation of Temperature of Enclosure.*—Unless the temperature of the enclosure containing the nickel wires can

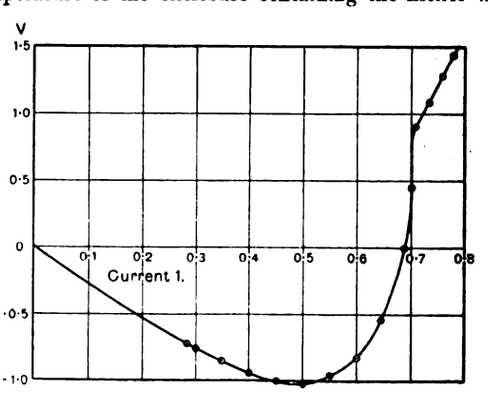


FIG. 16.

be kept constant, it is necessary to introduce compensation for temperature. This can be done by replacing part of each manganin resistance arm by copper (in the same enclosure as the hot arms), sufficient cooling surface being allowed so as to prevent undue heating by the current. It would, I believe, be possible to obtain more extensive and better regulation by using platinum or other material instead of nickel, since the nickel has an abrupt bend in its temperature-resistance curve. Also, by replacing parts of the manganin arms by heated nickel, say, of larger diameter than that

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used in the other arms, it would be possible to make the upper characteristic bend up slightly, and so to attain more exact parallelism of the two curves, and hence better regulation. Again, by applying a once-regulated voltage to a second regulator a much greater steadiness would be obtained.

*Method* 12.—It will be noticed that, in the above regulator, the function of the Wheatstone bridge is merely to obtain the difference between the voltages on the nickel and the manganin resistances. With alternating currents the same may also be done by means of a transformer, as shown in Fig. 15, where the transformer Tr is connected so as to give a regulated voltage at V.

*Section E. Null Methods of Measuring Current.*—If in the Wheatstone bridge arrangement the resistances are so chosen that the characteristics intersect, as in Fig. 12, then we may obtain, for I and V, a curve such as that in Fig. 16, which is drawn from actual experiment (with direct current). With proper temperature compensation V vanishes for a perfectly definite value of the total current I, and if a sensitive detector be added the arrangement becomes *a thermal standard of current.* I have found a telephone with an intermittent contact in its circuit a convenient means of detecting the vanishing of V, the intermittent contact being of advantage even with alternating currents. The accuracy of such a standard is considerable.

*Method* 13.—If such a combination be put in series with a resistance having a part adjustable by a sliding contact, as in Fig. 17, it furnishes a simple null method of measuring a voltage (*e.g.*, of a supply company) which varies between small limits; the slider is adjusted to give silence in the telephone, and the corresponding value of the voltage is show by the position of the slider. With alternating current the transformer method (12) is also applicable here, but a detector other than a telephone is necessary, for since the transformer alters the wave-form slightly it is found impossible to get any position of complete silence with the telephone.

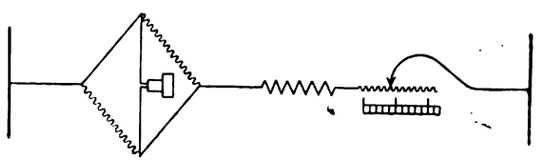

FIG. 17.

*Method* 14.—In conclusion, I may point out that if a voltmeter be put across V (Fig. 11) it will be seen that from the curve in (Fig. 16) that a very open scale can be obtained, corresponding either to the total current I or the outside volts; this furnishes a thermally "set-up" instrument. I have found platinum better than nickel for this. Compensation for temperature can be applied as in the other methods.

## DISCUSSION.

Prof. R. T. GLAZEBROOK was mostly interested in the latter part of the Paper, which dealt with the thermal method of measurement and the thermal regulator. It would be interesting to know how regularly the results were uniformly repeated. Did the form of the curve depend upon the temperature of the nickel? How far had Mr. Campbell evidence of the permanency of the curves so that when once a bridge was set up in the manner described it might be used for a considerable time with the security that its records would be uniform and regular? He also asked if the author would go a little more fully into the method whereby he standardised the instrument when used as a thermal measurer of current.

Mr. G. L. ADDENBROOKE, in a letter which was read, said that he had succeeded in making an electrostatic voltmeter which would measure a drop of 1 volt easily within 1 per cent., and in which he had been able to get rid of the trouble with contact error. He was able to dispense with the transformer altogether. Whether rightly or wrongly he had always been afraid of using them as a basis for accurate work without some means of checking their performances.

Mr. C. V. DRYSDALE said that there seemed to have been a very great prejudice against the use of the alternate-current wattmeter for some time past simply because certain errors were pointed out some years ago, when wattmeters were first used and found defective. As long back as 10 years ago, however, Dr. Fleming had shown by tests that the alternate-current wattmeter appeared to give better results than these more elaborate methods. Further, there was no doubt whatever that all the methods put forward by Mr. Campbell rendered one liable to errors far in excess of what would be the case with the ordinary electrostatic or electromagnetic wattmeter. In order to take a case, he pointed out that in the ordinary three-voltmeter method it was possible for an error of 26 per cent. in the power measurement to occur under certain circumstances, while in Mr. Campbell's modification it was possible for an error of 50 per cent. in the power to occur. As regards the use of transformers, in all these cases the non-inductive resistance was shunted with a transformer. This took an exceedingly small amount of power, but it made a very considerable difference to the effects of the non-inductive resistance, and Mr. Addenbrooke was quite right in saying that people had always been afraid of using such methods. The errors which direct-reading wattmeters were liable to when properly designed were infinitesimal. As instances that such wattmeters as he referred to were obtainable, he mentioned the Siemens instrument, in which the maximum error in the power-factor which could be caused by the self-induction of the coil was 0·0013, which was an amount easily calculated and allowed for. He himself had devised a wattmeter which had an extensive range, in which the error was reduced to even less than this. There were were only 7 millihenries of self-induction in the shunt coil, and the resistance normally used in series with it was 100,000 ohms. With the Siemens instrument these figures were 8·8 and 4,000 respectively, In these circumstances he did not think the methods of Mr. Campbell, though beautiful and ingenious, were really fit for practical use except in cases of emergency when there was not a wattmeter at hand.

Mr. A. CAMPBELL, replying to Prof. Glazebrook's query as to the permanency of the nickel, said the material he used was modern nickel. It gave a very low resistivity indeed, and he had noticed very little change in it. So far as he had observed there was a repetition of results from time to time, but he had not decided the point sufficiently to go deeply into it. Some of the experiments he had carried out were with platinum, and these could be carried to a very high temperature without practically any change at all. Prof. Glazebrook had also asked how the current was standardised in this method. It was not a standard in itself, but once it was standardised it was fairly permanent. It was standardised in the ordinary way either by a Clark cell or silver voltameter. As to Mr. Drysdale's remarks on his alternate current methods, he said he did not put these forward as general methods. Nevertheless, he thought the method of transforming up from a low resistance through an electrostatic voltmeter—provided there was a suitable transformer—was more convenient than a Kelvin balance. His long scale electrostatic instruments came to rest in very much quicker time than one minute. It was possible to take a good many readings in a minute, and with such a scale as he had, and with direct reading, they could read currents of all sizes to an accuracy of perhaps 1 in 1,000. As to the methods of measuring power, he did not agree with Mr. Drysdale that a wattmeter was the best way in all cases. How was he going to calibrate his wattmeter? The method given in Fig. 7 was what he considered the best method of testing a wattmeter on non-inductive loads. With regard to the three-voltmeter method, he did not say that this was desirable in all cases, but they could certainly not always have a wattmeter to do all kinds of loads that might turn up. An extreme range of wattmeters would be necessary, so that it was for extreme cases like those in question that a handy method, although perhaps not quite so accurate, was more suitable and was far more valuable.

## WARD-LEONARD RHEOSTATS.

We have recently inspected a large variety of Ward-Leonard rheostats at the offices of Messrs. Geipel and Lange, in Parliament-mansions, Westminster, and we were much struck by the improvements that have been made in this important branch of electrical apparatus by the specialisation of the works and the standardisation of parts.

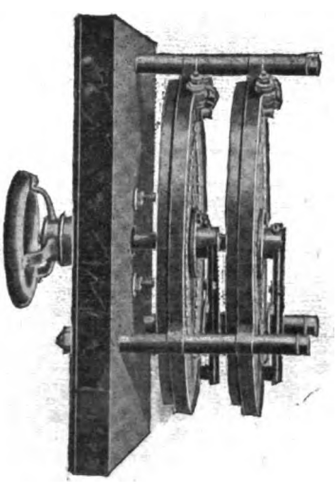

FIG. 1.—Field Rheostat (viewed from back).

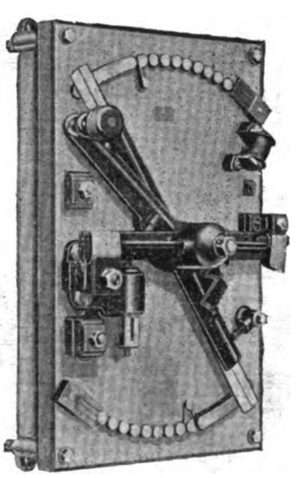

FIG. 2.—Motor Starting Switch.

It has been very common for manufacturers of rheostats to form resistances without paying very much attention to how the resistance is going to be used.

In the Ward-Leonard system three different types are employed, depending on whether the resistance has to carry :—

(1) Steady currents.
(2) Large momentary currents.
(3) Large momentary currents, and then smaller steady currents.

When the resistance is to be used for carrying steady currents, it takes the form of a thin disc of cast-iron, ribbed on the outside to radiate the heat, to which is fixed a sheet of enamel in which the



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resistance wires are buried. These wires radiate in a zigzag formation from the contact studs and as they are immovably bedded they can be placed very close together, so that the whole circuit is fairly non-inductive. The discs can be built up at the back of the switchboard in the manner shown by Fig. 1, so that it is not necessary to run the usual conglomeration of wires from switches to resistances on the wall. They are mostly useful for inserting in the shunt windings of dynamos. Each plate is entirely independent of the switch handle and lever and can be removed and replaced by another in a few minutes. The smallest of the 100-150 volt type has a maximum resistance of 300 ohms and is suitable for placing in series with a field winding of the same resistance. It is made up of one disc, 8in. diameter, and has 35 contacts. The largest has a resistance of 3·75 ohms and is suitable for a field with a maximum current of 40 amperes and a current of 18 amperes with all the resistance in circuit. It is made up of four plates, each 15in. diameter, and it has 120 contacts. For a 200 to 300 volt circuit a similar-sized rheostat has a resistance of 15 ohms, and with 600 volts the resistance would be 60 ohms to carry a maximum of 5 amperes. Rheostats with 11 discs and having a carrying capacity of 150 amperes at 120 volts have been constructed. It will be seen that apparatus built on this principle is absolutely fireproof, and the wires themselves should have a long life, as air cannot reach them.

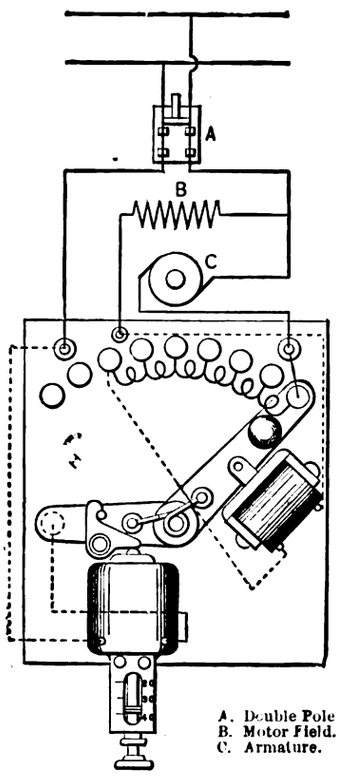


FIG. 3.—Motor Starting Switch. Diagram of connections.

For the second class of rheostats a thin ribbon is used with widths varying from ⅛in. to 2in., and it is bent back on itself to get a large surface in a small space. The ribbon is attached to a frame of slate by means of suitable pins, the slate being protected from overheating by a sheet of asbestos. The resistance is covered in by a cast-iron box insulated with asbestos and micanite, and the whole is filled in with fine white sand, which is found to best combine the properties of good conductance of heat with bad conductance of electricity. These resistances are used for motor starters. The arrangement of overload breaker in the Ward-Leonard motor-starters is especially neat, the circuit being broken by a second switch released by a catch actuated by a coil in series with the motor. It is usual in this class of switch for the overload breaker to act only when the lever reaches the last stop, giving time for the motor armature to be burnt out in the meanwhile, but with the arrangement shown in Figs. 2 and 3 the subsidiary switch is broken immediately the current is too large. In the case of the larger switches, where contact is made on both sides of the lever at the last stop, the no-voltage release is actuated on the hammer principle. The standard sizes are listed suitable for motors from ¼ H.P. to 50 H.P.

The third class of rheostat is used for motor controllers, and for this class of work the resistance wire is wound on porcelain and then coated with a thin layer of enamel. We also inspected a large variety of special rheostats made for cranes, printing presses, hoists charging storage batteries, theatre dimmers, &c.

## MR. MORDEY'S REPORT ON ELECTRICITY SUPPLY IN NEWCASTLE.

At a meeting of the Town Improvement committee of the Newcastle Corporation last Friday, a report by Mr. Mordey on the general question of electricity supply in Newcastle was considered. Before according its authorisation for certain extensions of the Newcastle-on-Tyne Electrical Supply Co., the Board of Trade had given the Corporation the opportunity of expressing its views on the matter. The new proposals, said the report, marked the beginning of a new epoch in the work of the Supply Company, and it was, therefore, very desirable that the Corporation should now carefully consider their bearings on the future interests of the city. The company stood to the Corporation to some extent as a trustee, or in the relation of tenant to landlord, inasmuch as the Corporation had the right to acquire the undertaking about 20 years hence, at its then value, without the goodwill. Whatever the views of the Corporation might be at the present time, it should clearly safeguard its interests, so that when that time came it could, if it then desired, exercise its right of purchase without difficulty.

In order that the new proposals might be clearly realised it was advisable to sketch the position of electrical supply in Newcastle. The Newcastle and District Electric Lighting Co. and the Newcastle-upon-Tyne Electric Supply Co. have been distributing electrical energy under provisional orders, dated 1891 and 1893 respectively. These orders extend for 31 years from July 3, 1891, and have thus 20 more years to run. Both companies adopted the single-phase alternating-current system, but used different pressures and frequencies. By agreement the companies partitioned the area, agreeing not to cross a defined boundary, though each possesses parliamentary powers to serve the whole municipal area of Newcastle. Within the last year the Supply Company had put down in its station in Pandon Dene some direct-current dynamos, and had laid another system of mains, completely independent of the first, to encourage the use of power. The District Company had also recently put down direct-current plant and separate mains, similarly forming two distinct systems. In 1900 the Supply Company obtained an act of Parliament by which it was empowered to construct a new station outside of the Newcastle municipal area, to supply therefrom energy to Newcastle, Gosforth and Longbenton, as well as to supply in bulk to the Walker and Wallsend Union Gas Co. and the Walker Urban District Council, or any other body having powers to distribute electrical energy. Such a station was now in operation in Wallsend, supplying energy outside of the Newcastle municipal area. It was understood that the Supply Company contemplate erecting still another generating station in Wallsend, about half-a-mile beyond the station now at work at Wallsend.

The Corporation was now engaged in the erection of a generating station within the city, with the immediate object of supplying the tramway system, and possibly, hereafter, for other purposes. The District Company was also building a new generating station on the river bank, near its old station. It would thus be seen that there would be in operation five distinct and different services of electrical supply operating from at least three sites within the municipal area of Newcastle, having no connection or intercommunication with one another. The Supply Company now proposed, under the terms of its act of 1900, to supplement its service from one or, possibly, from two stations outside the area of Newcastle. There might thus be ultimately nine distinct sets of cables supplying electrical energy for light and power within Newcastle, as shown by the following table:—

1. Pandon Dene—2,000 volts, alternate current, transforming to 100 volts—100 periods—for lighting.
2. Pandon Dene—480 volts, direct current—for power.
3. Wallsend—10,000 volts, 3-phase 40-period alternate current, transforming to supply the above 480 volts direct-current system for rotating transformers in sub-stations: the middle wire earthed.
4. Wallsend—2,600 volts, 3-phase, 40-period alternate current for special purposes within the city, presumably transformed from the extra high-pressure by static transformers.
5. Wallsend—10,000 volts, 3-phase, 40-period alternate current for transmission through the city to Gosforth. (It is assumed that separate mains will be used for this.)
6. District station—1,050 volts alternate current, transforming to 100 volts, 80-periods—for lighting.
7. District station—480 volts, 3-wire direct current—for power—earthed in middle.
8. Corporation—550 volts for tramways—one pole earthed.
9. ?—— Street—lighting mains (when adopted).

The Supply Company was not yet authorised to supply by the three-phase system, nor to bring "extra high-pressure" mains into the city, nor to employ low-pressure alternate-current distributing mains. It was now asking the Board of Trade to authorise it to do these things.

It is very desirable to keep the number of systems and service cables as simple and few as was compatible with effectively dealing with the needs of the place. Complication of systems was unfavourable to the interests both of the city and consumers, leading directly and indirectly to high charges by large capital outlay, high working cost, and by want of uniformity in consumers' apparatus, In addition, there was the excessive space needed in the streets.

The entire absence of any general scheme for the supply of electric energy for various purposes throughout the city seemed to be very much against the interests of the ratepayers, and if allowed to go on would develop into a complicated tangle, from which there would be no possible extrication except at enormous expense. If the company carried out its proposed changes, it would result in a very undesirable state of affairs.

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The multiplication of mains and system would lead to street difficulties and to heavy and disproportionate capital outlay and working costs.

The report concludes:—

"There is another serious aspect from the municipal point of view. The proposed changes will bring about a condition quite contrary to the spirit and intention of the original provisional order. In effect they will deprive the Corporation of its statutory powers to take the system over. There will be no complete system to take over. The distribution system will consist of a number of parts, of which Newcastle will only be one, the whole being supplied from one or more external stations over which the Corporation will have no powers of purchase. It is conceivable that the Corporation might wish at some future time to take over its own part of this general system inside its own area, but it would be prevented from doing so, as that part could not be suitably served by any new station the Corporation might be prepared to provide.

"After very carefully and anxiously considering the whole subject, we have been driven to the conclusion that the only way out of the very undesirable state of things that will be brought about if the supply company carries out its proposals is by some general scheme under the control of the Corporation. We therefore strongly advise your Council to reconsider the question of purchase by arrangement. We are aware that Prof. Kennedy reported upon this question in 1895, and advised leaving matters as they were. We have seen his report, and in the light of the conditions as they existed at the time, we need hardly say that we agree with the conclusions to which he then came. But the conditions are now entirely different, having been altered in several important respects which Prof. Kennedy could not have foreseen. In 1895 there was no question of an external station, nor of making Newcastle one incomplete unit in a general system, nor of a municipal electric supply for tramway and other purposes.

"The present is the most opportune time for making an arrangement, because the existing Wallsend station is not yet connected with Newcastle, and is, moreover, so well loaded that there can be no fear of it being unremunerative without the load of Newcastle. If this opportunity is not taken advantage of, and especially if the proposed second station is allowed to be built and equipped, the matter will become very much more difficult to arrange on a basis consistent with the public interest.

"We have now explained the views we have formed as to the present, as well as the probable future condition of electric supply in Newcastle. We have thought it necessary to do this, as the Corporation can never again have such an opportunity as the present for a satisfactory re-arrangement. It seems to us that it would not now be difficult to take the matter up, aiming at a general supply by—

1. The development of the existing stations within the municipal area, making full use of the new tramway station.
2. Unification of the system over the whole area.
3. Inter-connecting, so that one station only could supply all needs during periods of light load."

After some discussion it was agreed to appoint a sub-committee to consider the report more fully, and to prepare such form of communication as they might consider desirable, with the consent of the committee, to be sent to the Board of Trade.

# PARLIAMENTARY INTELLIGENCE.

## LONDON UNITED TRAMWAYS BILL.

The Court of Referees of the House of Commons sat on June 7 to consider the objections raised by the promoters of the London United Tramways Bill to the *locus standi* of several of the petitioners. The Court consisted of Mr. Parker Smith (chairman), Sir Chandos Leigh, Mr. Bonham Carter, Mr. H. D. Greene, and Mr. Paulton. The petitioners objected to were the Southwark and Vauxhall, the Chelsea, the Lambeth, the New River, the West Middlesex, and the Grand Junction Waterworks Companies, the ratepayers, owners, &c., of Surbiton, the Richmond Electric Light and Power Co., the National Telephone Co., and the Middlesex County Council.

Mr. BAGGALLAY, K.C., on behalf of the first four water companies, said the grounds for the petitions were common to all. These questions were becoming very serious, especially that which related to electrolytic action affecting the mains of the water companies when the tramways near to them were worked by electricity. Taking the Chelsea Company's petition first, he said that in that company's district there were to be several tramways worked under the bill, and in one case in particular an insufficient amount of soil would be left between the electric wires and the water mains for the protection of the latter. He was entitled to a *locus standi* in order to see before the Select Committee that proper protection was afforded against interference with the water mains. In the notice of objection it was submitted that so far as any of the main pipes of the petitioners were concerned there was ample protection contained in the Tramways Act of 1870 "except as regards the said alteration of levels."

The CHAIRMAN: Do you contend that those words admit your right to a *locus*?

Mr. BAGGALLAY replied in the affirmative. That part of the Act of 1870 to be applied had reference only to surface work, whereas under the bill alterations and street widenings were to be carried out which might involve serious physical interferences with the water mains. From this point of view the Chelsea Company should have a *locus standi* to be heard on the question of the merits of the bill. Dealing next with the case of the Lambeth Company, he pointed out that in connection with several tramway acts last session—certainly, the London County Council and the Croydon Acts—provisions were inserted to the effect that where there was any interference with the mains of the water companies, those companies were entitled to carry out the work themselves. In the case of the County Council bill, that was not obtained without a fight, which showed that the Act of 1870 was not complete in the protection it afforded to water companies. His clients, he submitted, ought to be entitled to go before the Select Committee to show why they should be allowed to do themselves in connection with their mains whatever work was necessary in consequence of alterations to be effected under the bill. As to the New River Co., they were part owners of the Staines reservoirs, and had obtained power to carry an aqueduct from Handsworth to Cricklade, and the tramways proposed would cross that aqueduct; and the New River Co. maintained that they ought to be heard before the Committee to secure their proper protection with regard to the carrying out of the authorised plans and sections and that which was not within the purview of section 30 of the Act of 1870. And this brought him to the question of the apprehension of electrolytic action on the mains of the water companies. This was a question which was of the first importance. Electrolytic action meant the gradual eating away—it might be rapidly or slowly, according to the quantity of electric current which went free—of the coating of the mains, so that they might burst or water might leak out of them. A Select Committee had considered the matter, and recommended that the Board of Trade should make certain regulations. The Board of Trade subsequently made regulations and drew up a clause with the idea of giving effect to the Committee's recommendation. From that time to now those regulations had not been altered, and that clause, though it had been to a certain extent altered, had been regarded as a sort of model clause. In 1898 Lord Cross's Select Committee of the two Houses of Parliament dealt with the question of generating stations, and in consequence of certain evidence given by Sir Wm. Preece, the Committee, calling attention to that evidence, and saying that the clause and regulations had been generally satisfactory, expressed the opinion that the difficulties of working tramways under the overhead trolley system should not be lost sight of. That system was the one to be adopted under this bill. The Committee drew especial attention to the recommendation that there should be a strongly-worded clause adopted for the protection of the water companies, and that being so, his clients, as the owners of waterworks which might be affected by electrolytic action, were entitled to see that the clauses which would be inserted in the bill were sufficient to prevent that action, or, in the alternative, to give them a remedy in the shape of compensation in the event of electrolytic action, which could not be prevented, ensuing.

The CHAIRMAN: Do you say you have outgrown that model clause?

Mr. BAGGALLAY: I say that the fact of its being a model clause should not prevent us having the matter investigated before the Committee. Even if the model clause were sufficient that would not preclude him from his right to be heard before the Committee.

The CHAIRMAN: I do not see what is the use of model clauses unless it is to prevent a great many people coming here.

Mr. BAGGALLAY said it was not so long since the question of the insertion of these clauses first arose. The electric tramway was a new institution. It was hoped that soon after the adoption of electric tramways they would get a knowledge of the effect of the working under different systems. The effect was not yet proved.

The CHAIRMAN: You did not come to Parliament when section 12 was adopted?

Mr. PEMBER, K.C.: Speaking for my clients, the other water companies, we overlooked it.

Mr. BAGGALLAY said the Lambeth Company did come to Parliament in 1899, and they got a clause in the London County Council act providing expressly for compensation in the event of their being able to show that the electrolytic action was due to the electric current escaping from the tramway. This clause was last session put into the South Wales Electric Power Bill.

The CHAIRMAN: That goes beyond clause 12 of the act which has been referred to?

Mr. BAGGALLAY: The House of Lords has followed that precedent, but not this House; but the London County Council, in their Electric Power Bill of this session, have put the clause in voluntarily. The present bill incorporates part of the Tramways Act that is important to the promoters to incorporate, but other parts they do not incorporate. Sec. 55 provided that the promoters should be responsible for all injury done by the act or default, but it only gave rights to damages from the promoters in respect of matters which are within the immediate purview of the Tramways Act of 1870. It was in the nature of a penal section, but would only penalise the promoters in respect of wrongdoing that arose in carrying out the provisions of the Act of 1870. His clients considered that the questions now arising should be thoroughly thrashed out, particularly the question of electrolytic action. That was a matter which was of vital importance to all the companies.

Mr. PEMBER argued in support of the *locus standi* of the West Middlesex and Grand Junction Companies on similar points. He said that on the electrolytic question in the Airdrie and Coatbridge Water Bill last year a similar question was raised. He appeared for the local water company, whose *locus standi* was objected to. The promoters contended that they were protected by the Act of 1870 and the model clauses recommended by Lord Cross's Committee, and the referees disallowed the *locus*. His contention was that no recommendation of a committee and no regulations of the Board of Trade, drawn up in consequence of the recommendations of a committee, ought to oust the right of a petitioner to appeal to Parliament if he thought fit. He insisted on his right to go before Parliament and ask to have protection against the operation of a particular bill. The referees had decided against the position he was taking up, no doubt, but he asked them to reconsider their decision. Electrolysis was a new risk. In 1898 and 1899 the water companies were not so alive to it as they ought to have been, but last year the Lambeth Company did get a clause

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to protect them against electrolysis from the London County Council in the House of Lords, though it was refused in the House of Commons. And this year, in the Sheffield Water Bill, the House of Lords had inserted similar clause, though in the Commons such a clause had been refused in the case of the Kent Water Co., who petitioned against the Bexley Tramways Bill. That was exactly how the matter stood. They had two decisions in the House of Lords in favour of giving the clause and in the Commons they had two decisions against giving it. But as to the refusal of the House of Commons in the first of these two cases, there was this set off, that they subsequently acquiesced in the decision of the House of Lords, passing the bill without amendment. The result was that the London County Council adopted the provision in their perfected act, and, more than that, they had put it into their new bill this year. The London County Council now said in their bill that if it could be proved that any damage or injury should have resulted from fusion or electrolytic action caused by electricity generated by the County Council nothing in the act should relieve them from responsibility for the damage. He did not say that the protecting clause should be put into every bill dealing with electric tramways as he did not know what the merits of the cases might be. He did not know what the merits of the Bexley case were, though he had heard that an extra burden thrown on the promoters would nullify the good of the tramway. Having regard to the growing knowledge in this matter of electricity and the danger arising from it to water mains, he asked the Court to consider the matter *de novo* and say that every case should stand on its own merits.

Mr. GREENE asked whether the contention of the learned counsel as to electrolysis was that it should be determined before the Court or should always be left to the committee as a matter of merits.

Mr. PEMBER said he would rather not embark on a general proposition, but he thought in this class of cases it should be left to a committee.

Mr. BALFOUR BROWNE, K.C., said with regard to the altering of levels, it was always the case that where tramways were constructed the promoters had to alter the levels or widen roads at the instance of local authorities, but that was done, not as substantive work, but only incidentally. In the Airdrie and Coatbridge case the contention, which was upheld, was that by secs. 30 and 32 of the act of 1870 ample protection was afforded, and he contended that there was no reason for altering the decision in the present case. If the Act of 1870 was not sufficient Parliament should alter the general law, and pass another Tramways Act. With reference to electrolytic action his friends seemed to think that a great deal had happened since the Court gave their decision last year, and they argued that every case must stand on its own merits. If that were made the rule they would sweep away joint select committees altogether. Last year everything with regard to electrolysis was known which was known now. His learned friend had not told them the whole story with regard to what happened before the committees last year. The London County Council was not going to operate its tramways by overhead wire, but by the conduit system. The present company would probably use overhead wires, but whatever the system it had to be approved by the Board of Trade. He agreed that the Sheffield case in the House of Lords was against him, but if the Court were to be guided by that why were they not also to be guided by what the House of Commons did in the Croydon and Bexhill cases? Perfect protection was provided in the bill. The promoters were to use insulated returns, and the electrical power was to be used only in accordance with the Board of Trade regulations, and in such regulations there was to be provision for preventing fusion or injurious electrolytic action of or on gas or water pipes, or other metallic pipes, structures, or substances and for minimising, as far as was reasonably practicable, injurious interference with the wires or apparatus of other parties. That was the general clause which was discussed before Lord Cross's Committee, drafted by the parliamentary draughtsman, and inserted in every tramway bill; and the Board of Trade had full power to make further regulations if necessary, and so to prevent the very thing the water companies now feared. If the Court came to the conclusion that there was a clause in the bill which gave the companies full protection (which there was), they would not allow them to go on and ask for anything more.

The CHAIRMAN said: In regard to the interference with mains and widenings, the Court hold that the general law gives sufficient protection, but in the Chelsea case we allow the *locus* against clause 10 that has been conceded by the promoters. In regard to electrolytic action, the Court considers that under the circumstances of this case it should be left to a committee to say whether the petitioners are sufficiently protected, and therefore we allow a *locus* in respect of the necessary clauses.

Mr. C. E. ALLEN next applied on behalf of about 800 ratepayers, owners and other inhabitants of Surbiton, for a *locus* on the ground that the Urban District Council of Surbiton, in consenting to the construction of the proposed tramways, had not considered solely the wishes of the inhabitants of the district, but had been influenced by fear of incurring large cost in offering opposition, and by the Tramway Company having agreed to pay them (the Council) a large sum of money annually. The Council, he contended, did not represent the views of the inhabitants on this subject.

The application was refused.

Mr. FORBES LANKESTER made a similar application in the interests of the National Telephone Co., who have a number of wires which will be crossed by bare trolley wires if the proposed tramway is constructed. The Tramway Company had inserted clauses—those resulting from Lord Cross's Committee—for the protection of the Telephone Company in regard to electrolysis and direct induction, and that of itself, he thought, gave the Telephone Company the right to appear so as to argue as to the sufficiency or insufficiency of the clauses. On former occasions when the Tramway Company were in Parliament the Telephone Company had not sought the protection now asked for because they did not become aware of the circumstances which rendered that protection necessary until the recent accident to overhead wires at Liverpool. The company's wires were always suspended with every possible care, but occasionally they broke and fell. If electric tramway wires were not there the broken wires were practically harmless; but where the overhead trolley system was employed the broken wires might come into contact with another cable charged with electricity of very high tension, and then the harmless wires would become a source of most serious danger. The consequence was that the Telephone Company would become liable to very serious attack from a cause which was not in any way under their control. They therefore asked to be protected from the damages and compensation which they might have to pay in consequence of their wires being enlivened by this dangerous current from the Tramway Company's cables. As to the legal position, he said that a county court judge, in the very circumstances he had indicated, had held that the Telephone Company was liable.

Mr. BALFOUR BROWNE said formerly the Telephone Company used to oppose tramway companies, urging that they should not be allowed to use the road for their return currents because their currents were big currents, which made it impossible for the Telephone Company to use it for the return of their small currents. They succeeded to a large extent, with the result that they began to put an end to electric traction schemes. Hence the inquiry before Lord Cross's Committee, when the whole matter was discussed and the model clauses framed which were now inserted in the bill. Mr. Lankester now said something new had happened since then—viz., that one of his company's wires in Liverpool had fallen and taken from a bare wire there a store of electricity. But exactly the same thing had happened at Zurich long before Lord Cross's inquiry, so that there was nothing new in the circumstance. Really Mr. Lankester wished to say: If my wires break I should not be responsible. Why should he not? He ought to make his wire so strong that it would not break. There might be a case as to whether the tramway company had taken precautions to prevent damage. Where a telephone wire crossed the tram wire there was a protective wire to prevent connection being established; and, in addition, by a new system, as soon as a telephone wire touched the tram wire, by a switch arrangement at the station the wire would be thrown out of operation. He contended that the *locus* should not be granted.

The application was not allowed.

Lord ROBERT CECIL, K.C., on behalf of the Middlesex County Council, applied for a general *locus* under standing order 134c, under which it was provided that if the council of an administrative county alleged that they might be injuriously affected by the provisions of any bill proposing to authorise the construction or reconstruction of any tramway along any main road for the maintenance of which the county council contributed, they should be entitled to be heard. The circumstances here exactly fitted in with the requirement of the order.

Mr. BALFOUR BROWNE contended that the Council were only entitled to a *locus* as regarded the very small portion of the tramway system which would be situated in Middlesex.

The Court granted the general *locus* sought.

## THE LONDON ELECTRIC TRAMWAYS.

The Select Committee of the House of Commons presided over by Sir John Kennaway sat on Wednesday to consider the London United Tramways Bill, which contemplates important extensions of the United Tramway Co.'s system.

Mr. BALFOUR BROWNE, K.C., for the promoters, said the proposed new tramways might be divided into three groups, one carrying the line at Teddington and Hampton Wick to Surbiton, East Molesey, Kingston, the Maldens, and Coombe; the second through Wandsworth, Putney, Barnes, and Richmond, joining the Hammersmith and Kew section; and the extension to Keston and Isleworth, along the Bath-road. Several of the water companies were opposing the bill, but practically only on one point—because, as they said, the clause in the bill which protected their pipes from fusion and electrolytic action was not sufficient. That was an important matter, but he had had an opportunity of talking the matter over with Mr. Pember that morning, and that gentleman agreed with him that the electrolytic question should be taken separately. Describing the company's existing system, he said that only part of this system was complete, but when finished it would be 40 miles in extent. Sixteen miles of the 40 were constructed, and 7 miles 4 furlongs were being worked by electricity at the present moment—from Hammersmith Broadway to Kew Bridge. It was hoped that the Ealing and Hanwell portion would be opened by July 1. But they had been operating the 7 miles 4 furlongs he mentioned by electricity with most marvellous results—results, he believed, the like of which had not been obtained anywhere else in the world. In 10 weeks the number of passengers carried had been as follows:—5,480,208—practically the whole population of London. The average number of passengers per week had been 504,821, and per day 71,260. The average per car per day, taking 70 days at 60 cars, had been 1,200. The highest number carried was, naturally, on Bank Holiday (Whit Monday) when they carried 210,557 people. Dealing first with the Surbiton, Malden and Molesey scheme, he pointed out that seven local authorities interested were supporting the bill as well as the County Council of Surrey. At the Maldens and Coombe the promoters had consented to expend £2,500 on widening and improving roads where they were not considered fit to carry the tramway, at Kingston they proposed to spend £20,815 for the same purpose, at Surbiton £7,104, at Esher and Ditton £10,186, at East and West Molesey £14,437, or a total of £55,043. They also proposed to spend £10,000 on the reconstruction of Kingston bridge and a similar sum on the Hampton Court bridge should it become necessary. They had also agreed to pay £225 to the Kingston Corporation, rising to £450 and £700, in consideration of the purchase of the Corporation's reversion for four years. That was to say, the promoters got four years' extension of time beyond that which the Tramways Act gave them. They had agreed, in like manner, to pay the

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local authority of Surbiton £300 a year, rising in five years to £500, and to the local authorities of Esher and Thames Ditton £150 a year, and of East and West Molesey £100. It had been said, vituperatively, before the referees that the promoters had bribed the local authorities, but he repudiated that allegation. The Middlesex County County opposed the bill on the ground of interference with the Thames bridges, but he submitted that the point was infinitesimal. The County Council also objected to the extensions on general grounds, but it was too late to do that seeing that the promoters had already spent, under the authorisation of Parliament, £1,000,000 in the Council's district. Proof of the soundness of the promoters' finance, which had been assailed, was that when the other day they put £350,000 debentures on the market at 4 per cent. it was subscribed for five or six times over. There was nothing in the allegation of bad finance but the irresponsible frivolity of the County Council. He finally dealt with the opposition of the frontagers, declaring that to object to electric tramways was to show oneself behind the times, and that if individuals suffered slightly it was in order that the public might secure an enormous advantage.

Mr. J. CLIFTON ROBINSON, managing director and engineer to the promoting company, examined by Mr. FITZGERALD, K.C., said that on July 1 there would be 150 cars in operation on the 16 miles of electric tramway which would then be constructed. He denied that there would be any engineering difficulty in carrying the tramway over Hampton Court or Kingston bridges. The generating station of the company at Chiswick was the most complete that had yet been erected. On Bank Holiday they ran a 1½ min. service on the Acton line, and a 9½min. service on the Hammersmith line. This gave a car every ½ min. on the Kew Bridge line, which meant that they ran up a car, unloaded 70 passengers, and started another loaded car with 70 passengers every three-quarters of a minute for 20 hours. Throughout the day he never heard of an accident. Not a single circuit-breaker was fused in the power-house, and they had not worked up to more than 80 per cent. of their maximum load with the existing plant. On Saturday and Sunday last (June 8 and 9) they carried over 200,000 passengers. According to their experience, he anticipated that they would carry 26,000,000 passengers during the year. The only complaints which had been made had come from people who had been unable to travel by the line.

Mr. FITGERALD: When the tramways are opened you expect to carry 52,000,000 passengers in the course of the year?—Yes.

And with the whole of the tramways now asked for you will run up to 120,000,000 a year?—I am afraid to name the figures that I expect. To Hampton Court in the summer I am satisfied that we shall run a car per minute laden with 70 passengers for 20 hours each day. We have all the local authorities through whose districts the tramways run supporting us solid. I look forward to the time when West London will be served, not by a 2d. but by a 1d. tube, and my company's system will carry the people on. During the past 10 weeks we have carried 100,000 people at workmen's fares of ½d. a mile. Small isolated tramways never did and never would pay.

Lord R. CECIL drew witness's attention to a letter signed by Mr. Clifton Robinson which had appeared in *The Times*, in which the connection between tramway companies and the local authorities under the existing Standing Orders of Parliament was referred to as leading to "blackmailing practices," and in which it was said that whilst these practices continued it was well-nigh impossible to carry out tramway enterprises. The learned counsel said the point he was endeavouring to illustrate was that a company hampered with the condition of making terms with the local authority could not be trusted, and were not in a position to carry out a great scheme of tramway development in the best interests of the public, and that such a scheme should, therefore, be left to the public authority—such as the Middlesex County Council.

The CHAIRMAN: The answer to that is that the Middlesex County Council were not in time. The Tramway Company had got there first.

Lord R. CECIL said he would, at any rate, ask the Committee not to allow the matter to go any further. The Middlesex County Council might be able to enter into an agreement—if the bill were dropped or failed—which would arrest the public evil of which he complained, or, at any rate, not allow it to extend any further into the County of Middlesex.

WITNESS, cross-examined by Mr ALLEN, representing frontagers at Surbiton, said he complained of the blackmailing practices of the Surbiton District Council, amongst other councils, against the Tramway Company because he could not find a wider phrase.

You offered them money?—No; it should not be put that way. They exacted it from us.

The Committee then adjourned.

## LONDON UNDERGROUND RAILWAYS.

The inquiry into the various London underground railway schemes before Parliament was resumed on June 11 by the Joint Committee of both Houses, Lord Windsor presiding.

Mr. H. B. PALMER, traffic superintendent of the Metropolitan Railway Company, said he had had 25 years' experience of metropolitan railways. Describing the system of his company, he pointed out that there were 600 trains per day over the widened route, and about 550 on the inner circle. During last year the railway carried over 29 million passengers at 1d., over 13 millions at 1½d., and over 8 millions at 2d. per head, the total carried under 2d. being 51½ millions. The average fare from each passenger was 1·71d. The railway was 64 miles in length. During 1900 the number of workmen carried was 15½ millions. The number of workmen's trains running every day was 100 on the forward journey, giving a mileage of 770. With regard to the proposal of the Central London Railway for a loop at the end of their system, he did not think such a loop was necessary. Its advantages were more imaginary than real, and it would prevent any other railway coming on to the same level. If the loop system became general it would prevent any connection between underground railways on the same level, and would necessitate the multiplication of staircases, lifts and passages for the purpose of interchange. Instead of making a loop, the Central London Railway might deal with a larger number of trains by extending the down line a train's length further ahead and put in a cross-over road from the up to the down line. By that means they could have three trains standing on the down at the Bank station and still have room to admit two more up trains. They could thus deal with five trains at the station at one time and work a service of 30 trains an hour. Before that method was adopted the company might exhaust the capacity of the trains, for he did not see why they should not increase the number of coaches per train to eight. He considered Liverpool-street would make a good centre of exchange, especially with the tubular lines from the north-east of London. At the Bank a very good centre might be made for the regular daily traffic. To centralise the whole systems of London at one point, however, would produce confusion. The extension of the North-East London coincided with his view as to the point of exchange at Liverpool-street, but the proposal to continue the line practically parallel with the Metropolitan line from Liverpool-street to the Monument was unnecessary. By a convenient change at Liverpool-street to the North-East London lines all the necessities of traffic between Liverpool-street and the western portion of London would be met by the Metropolitan Railway. He thought it would be more in the public interest that the tube railways should be self-contained and lead to and from a common centre rather than be carried through that centre as one continuous system.

In reply to a remark by Lord Knutsford that the argument of witness was against tubular railways altogether, Witness said he was against their undue prolongation. Continuing, he said the Islington and Euston Railway would be parallel with the Metropolitan line and would not therefore serve the public advantage. There was also no need for the proposed railway from Paddington to Victoria.

The CHAIRMAN asked whether, if the Metropolitan Railway adopted electric traction, the service could be increased, not only on the inner circle, but also in regard to suburban trains coming into the circle?—Witness said it would spoil the thing to adopt electric traction on a part of the section only.

The CHAIRMAN explained that what he wanted to know was whether there was a possibility of increasing the service of trains on the inner circle by the adoption of electric traction.—Witness thought it would be possible to haul all trains through the tunnels by electric traction if expedients were adopted.

The CHAIRMAN said he understood the Metropolitan District Railway had now so many trains running, that the inner circle service could not be materially increased?—Witness said it had been increased.

Sir CHAS. HOWARD, Assistant Commissioner of Police, was the next witness, and in reply to the Chairman's question as to the effect the establishment of the Central London Railway had had on street traffic, said there was no doubt it had decreased the number of omnibuses on certain routes, but not to any great extent, and it was impossible to say whether it would last with the ever increasing population. He (witness) thought it would be better to have exchange stations below ground. He doubted whether one large exchange station would be advisable. The stations should be so constructed that all the people should not pour into the street at one point. He was afraid the police could give no opinion as to the best routes for railways to take to relieve the traffic. He thought something could be done to relieve the streets if the police had a little more power to control traffic generally.

Ald. DEW, L.C.C, spoke to the point of the housing of the working classes, and said his fear was that a short and incomplete scheme of underground railways, if sanctioned, would stand in the way of a useful public extension that might otherwise be made into the suburbs.

The CHAIRMAN said the Committee would confine themselves at present to the question of route, but the County Council and other witnesses would subsequently be heard on all questions except those touching vibration, subsidence and construction. The Committee wished to leave the question of workmen's trains and housing open until they had heard the County Council.

Mr. J. POWELL, director of the London General Omnibus Co. and chairman of the London Omnibus Association, gave statistics as to 'bus traffic in London. He did not think tube railways would take the people off the streets. The Central London Railway afforded a good instance of that. For a time it took a good deal of traffic away, and his company diverted some of their omnibuses, but now the traffic was all coming back and they were increasing the number of 'buses. They carried just as many short-distance passengers, but the long-distance ones had gone away. If the proposed tube railways were constructed still more 'buses would be taken from the long routes and put on the short ones, so that it would not assist the object the Committee had in view—that of relieving the traffic.

The Committee then adjourned until to-day (Friday).

## YORKSHIRE ELECTRIC POWER BILL.

On Tuesday Sir Wm. Houldsworth's Committee of the House of Commons, which passed the preamble of the bill before Whitsuntide, again had the measure before them for final adjustment of clauses. Leeds, Bradford and Sheffield have withdrawn from the inquiry in order to reserve their opposition until the committee stage in the House of Lords. Mr. FRERE (for promoters) now submitted plans showing that the promoters proposed to draw an absolute circle of a mile radius from the municipal buildings at Leeds and Bradford, such area to constitute the prohibited area for laying the mains of the company, In the case of Sheffield, however, it was shown that the density of the population would make an absolute circle impracticable, and the promoters therefore desired to draw a circle with a radiu

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of a mile and a-half from the Jubilee Obelisk, but to cut off a segment of the circle on the eastern side (adjoining the Midland Railway), and thus leave out of the prohibited area a sparsely populated district which would otherwise be embraced in the mile radius. This arrangement made the superficial area of the prohibited zone a little more than in the case of Leeds and Bradford. The Committee, after examination of the plans, approved of the proposed prohibited areas, and ordered the bill as amended to be reported to the House.

## SUBMARINE TELEGRAPH LINES IN CHINA.

In the House of Commons on June 6,

Mr. AUSTEN CHAMBERLAIN moved that the agreement, dated April 23, 1901, between the British Government and the Eastern Extension, Australasia and China Telegraph Co. and the Great Northern Telegraph Co. for providing, laying, and working a submarine cable between Chefoo and Wei-hai-wei receive the approval of Parliament.

Sir CHARLES DILKE said, in his view, the effect of the agreement would be that the Government were binding themselves to maintain for the two companies concerned—the Eastern Extension and the Great Northern Telegraph Companies—a monopoly in the working of all Chinese submarine lines. It was the declared policy of the United States Government to establish direct communication with China, and the agreement would bind the British Government to resist that. He contended that the more competing telegraph lines there were the greater the advantage to this country, especially in war time.

Mr. A. CHAMBERLAIN said the Government were anxious to have this cable put down as quickly as possible. The Chinese Administration had already pledged itself under a prior agreement to give no landing rights to any companies except the Great Northern (a Danish company) and the Eastern Extension Company. Those two companies were working under a joint-purse agreement. It was only to them, therefore, that the British Government could look for the laying and working of this cable, and he considered the terms they had been able to make were very satisfactory. All that the companies had asked of the British Government, and all that the Government had consented to do, was to use their influence to secure the companies in the possession of those rights to which they were already entitled under their agreements with the Chinese Telegraph Administration.

The resolution, as submited to the House, was agreed to.

## OPENING THE STREETS IN LONDON.

In the House of Commons last night Sir HOWARD VINCENT called attention to the public inconvenience and loss of time and money caused by the manner in which numerous authorities in the same area resorted to the consecutive taking up of the most frequented streets. He desired to know how many London authorities had this privilege for gas and electric lighting, telegraphic and telephonic communication, paving, draining, water supply for domestic use and hydraulic power and other purposes. He desired to know if the Home Secretary would consider the possibility of bringing all these authorities and companies under one licensing head which would have supreme control of the streets in London.

Mr. C. T. RITCHIE said he was unable to give the figures asked for, but the number of bodies, both local authorities and trading companies, who had obtained from Parliament powers to break up streets was large, and it was undoubtedly a great inconvenience to the public. Recently the evil had been aggravated by the operations on behalf of the Post Office telephones, but these, he hoped, were drawing to a conclusion. He was afraid he had no proposal to make that would be practicable.

## TELEPHONIC DELAYS.

In the House of Commons last night Mr. CHANNING asked whether the Secretary to the Treasury was aware that delays were caused to those desirous of using the trunk telephone between Northampton and London, whether these delays were due to there being only one wire, and whether additional wires could be put down to meet the inconvenience.

Mr. A. CHAMBERLAIN said there appeared to be a few cases of delay recently in telephonic communication between London and Northampton, but in several cases the circuit had been temporarily interrupted by unavoidable faults or was occupied by traffic diverted from other interrupted lines. There was at present only one direct circuit, but alternative routes existed for the traffic. A second circuit was about to be completed.

## LONDON-BIRMINGHAM TRUNK TELEGRAPH LINE.

In the House of Commons last night Mr. T. R. DEWAR asked whether the new underground telegraph cable from London to Birmingham had realised official expectations, how it compared for swift and effective working, distance for distance, with overhead lines, both as regarded telegraphs and telephones, and whether the Postmaster-General had any information available showing the results of working the cable as compared with telegraph circuits 300 or 400 miles long, such as those to Dublin and Edinburgh.

Mr. A. CHAMBERLAIN said the Postmaster-General was of opinion that the underground cable between London and Birmingham had realised all expectations. It was not intended to be used as a telephone cable, the idea being that it would benefit the telephone service by setting free overhead telegraph routes which would then be available for telephonic purposes. For long-distance telephonic communication it was important that aerial wires should be available. For ordinary telegraphic communication there is no diminution in the speed of working through the cable as compared with an overhead line, but for high speed news circuits the cable at present involves the use of two wires as compared with one overhead wire. Combined with overhead wires the underground cable was being used for circuits extending to Belfast, Glasgow, and Edinburgh, which are each over 400 miles long. The cable has proved of the greatest utility in giving steadiness to the service, and in enabling the department to maintain that service during interruptions of the overhead lines by storms.

# LEGAL INTELLIGENCE.

## Bicknell v. Kalgoorlie Electric Power and Lighting Corporation (Ltd.).

In the King's Bench, on Wednesday, Mr. Justice Grantham and a special jury heard an action brought for the rectification of the defendant corporation's register of shareholders, plaintiff seeking to have his name removed therefrom as holder of 850 £1 shares on the ground of misrepresentation. Defendants denied misrepresentation and counterclaimed for money alleged to be due for calls.

Plaintiff's case was, that on Sept. 4, 1899, one of the directors of the corporation forwarded him a proof prospectus inviting him to underwrite shares, and he did so. The capital of the company was said to be £225,000 in £1 preferred and deferred shares, and the public were invited to subscribe to 150,000 of the former, the proceeds of which were to be used as working capital. All that was required, according to the prospectus, was for the company to get a site for a generating station and its subsequent equipment to supply the various mining companies near Boulder City and Kalgoorlie, in Western Australia, the prospectus stating that a valuable site had been secured close to the Government railway, where large supplies of water were obtainable. It was further stated that mining rights of considerable value had been secured. It subsequently transpired that certain important passages in the prospectus were untrue, and that the "valuable rights" referred to were not granted till six months after plaintiff received the prospectus and subscribed for his shares. Plaintiff took exceptions to other statements in the prospectus, to the effect that certain companies had promised co-operation in the defendant corporation's undertaking, whereas, as a matter of fact, all these companies had done was to offer to take electric current when it could be supplied by the defendant corporation at least 20 per cent. cheaper than was at that time available to the companies, and that within a period of 18 months.

Mr. ARTHUR C. BICKNELL, the plaintiff, an engineer, admitted he was acquainted with Stock Exchange practice, and, in fact, had a brother who was a member of the "House." He understood that the corporation was going in for electric lighting and power, but did not anticipate that any profits would be made on the gold mining referred to in the prospectus. He now thought the directors wanted a gold mine as well, so as to have two strings to their bow.

Asked if he suggested that there was any difficulty in the corporation obtaining a site for erecting a generating station, witness said there would be great difficulty at Kalgoorlie. He admitted that he had seen a copy of the directors' report issued in December last to the shareholders. He was not present at the meeting of the company, but he was aware that after the shareholders had been addressed by the chairman a unanimous resolution was passed adopting the report, which consisted of a statement that experiments had been made with various methods of evaporating the brackish water found on the company's land. He was further well aware that all these experiments took time, and he did not complain that the directors had decided upon spending time and money in order to come to the best of conclusions in the way of obtaining apparatus and accessories for supplying the various mines with electric power and light. He thought, however, that the company might have commenced operations sooner than they had done. He understood that it was estimated the shareholders might anticipate an 11 per cent. dividend, which would not be a bad return for their money. His recompense for underwriting 850 £1 shares was 25 £10 deferred shares.

Mr. LAWSON WALTON, K.C., for the defence, said that this was an action for rescission, and that was a matter in the discretion of the Court. The plaintiff was disentitled to ask for rescission, because it was a remedy given only in equity where a person claiming it did so at once, and in this case plaintiff waited for twelve months before taking action. It would be both troublesome and unfair to allow such delay, as the longer the delay the greater responsibility would rest on the shareholders of the company on the point of relief being given to anyone connected with the company. Between £40,000 and £50,000 had been subscribed in actual cash, a large amount of which had been expended in machinery erected on the site granted to the company, and it was at this particular stage in the affairs of the company, and certainly against the interests of the whole body of shareholders, that plaintiff now asked for relief. It should further be remembered that this action was not brought by a shareholder, for plaintiff had only entered into an underwriting agreement which did not actually entitle him to take shares. He received a commission on his subscription in the shape of deferred shares, and his remedy, if any remedy was open to him, must be against the underwriters and the stockbrokers with whom plaintiff had transacted his business. With regard to the charge of fraud and misrepresentation against the directors, he (counsel) asserted most emphatically that the defendant corporation was founded and conducted by thoroughly honest and upright men, and it was very wrong for plaintiff to attempt to impeach their character and give effect to some unworthy feeling which he entertained. On these grounds he asked the jury to find for the defendants, for, even if there were some

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vagueness or slight inaccuracies in the language employed in the prospectus, it was, from his knowledge of Stock Exchange transactions and business generally, idle for the plaintiff to say he was misled when entering into this underwriting transaction.

Mr. ROGER WALLACE, K.C., said he had been a director and chairman of the defendant company since its formation. The directors had considered the reports of several experts, including Sir Frederick Bramwell and his partner, and when they prepared the prospectus they believed the statements therein contained accurately represented the substance of these expert reports. As to the site for the generating station close to the railway, at the time the prospectus was issued their agent in Australia was a gentleman who had been made Premier a few days ago. They telegraphed to him. They knew that the vendor syndicate were in possession of the site, and were working on the site, and application had been made for a lease, the actual documents being in Australia. Borings had been made and water found.

Mr. Justice GRANTHAM: You believed on the information of your agent that the syndicate had rights over this site but their exact form you did not know?

WITNESS: Yes. For six months the syndicate remained in possession of the property and went on with the necessary works for raising water. The company had since sent out valuable machinery for the generating station. He had no hesitation in saying that every statement made in the prospectus was true. Before he joined the board he made it a condition that the capital of the company must be guaranteed and although the vendor syndicate had been registered with a capital of only £10,000 he knew that a firm of stockbrokers had undertaken to take 125,000 £1 shares. In the working of their electrical machinery the evaporation of salt water was a great source of expense. It was, he considered, fair to say in the prospectus, without making any reference to this source of expense, that there were no engineering or electrical difficulties. They had a contract in Australia to supply electric power at three times the price they would get in England on account of the greater cost of production.

Mr. Justice GRANTHAM having summed up,

The jury found a verdict for the defendant company on the claim and counterclaim. Judgment was given accordingly with costs, leave to stay execution being refused.

## W. H. Chaplin & Co. (Ltd.) v. Council of the City of Westminster.

An action was brought on Tuesday before Mr. Justice Buckley, in the Chancery Division, in which plaintiffs sought to restrain the defendant Council from erecting an electrical standard in proximity to their business premises on the west side of Villiers-street, Strand, London. The action had previously been brought against the Vestry of St. Martin-in-the-Fields and the Charing Cross and Strand Electricity Supply Corporation, but a day or two after notice of motion had been served the Vestry ceased to exist, and became merged in the Mayor, Aldermen and Council of the City of Westminster. The original action was, therefore, dismissed and the present one raised. Plaintiff said that Villiers-street was a narrow thoroughfare downhill, and on the west side was Craven-passage, made in 1859 by the South-Eastern Railway Co. under their statute. Underneath this passage on both sides were large wine cellars belonging to the plaintiffs. The standard complained of by the plaintiffs was originally erected in another part of the street, but a shopkeeper had complained against the position of the post and it had been re-erected against plaintiffs' premises and would cause them serious inconvenience and prevent their loading and unloading their vans. Plaintiffs claimed to have a right to unload and load their goods as lessees of the soil to the middle of the roadway, and held they had a private right to unload and load vans there for the purposes of their business. They had offered the Council facilities to erect a bracket instead of a standard, but this had been declined.

The defendant Council denied inconvenience to plaintiffs and contended that Craven-passage was a public footpath, and that plaintiffs had no right to pile up cases of wine or other goods in the passage, or to load or unload their vans to the public inconvenience.

Evidence was given on behalf of plaintiffs as to the inconvenience likely to arise from the position of the post.

On the other hand, evidence was adduced by the defendant Council that no inconvenience would arise to the plaintiffs and that the erection of the post at the place selected would be a public advantage.

Mr. Justice BUCKLEY in delivering judgment said he thought it obvious that to place a post where it was proposed to place the one in question would undoubtedly affect the elasticity of plaintiffs' business proceedings, but the only right that plaintiffs could claim was a right as members of the public; and they could not assert their individual convenience against the convenience of the public in general. It had not been proved that the defendants were acting unreasonably in placing a post where they proposed to place it. Both in law and in fact, therefore, the plaintiffs failed, and the action must be dismissed with costs.

## Gwynne and Another v. Medical Electro-Thermic Generator Co. (Ltd.) and Another.

At the adjourned hearing of this case, on Thursday, June 6,

Miss MOXON, a professional nurse, said before Mrs. Gwynne took these baths she had no experience of hot-air baths. On the occasion of the third bath the heat from the top of the bath scorched her (witness's) eyebrows, and she asked Mr. Greville whether the bath was not too hot. Mrs. Gwynne complained of the heat at the top of her body, and that was reduced by means of a switch, the heat at the sides and bottom of the bath being unaffected. She noticed that the asbestos did not come right up the sides, as in the bath in court; there was only a strip 8in. or 9in. wide up the middle. Not knowing that the heat radiated from the bottom of the bath as well as from the top and sides, and having had no instructions as to the packing or any lint sent with the bath, they did not pack the bottom of it. She was told the bath would be sent ready for the patient to be put into it.

EMMA GODBOLT, maid to Mrs. Gwynne, said she was present at Kinton when the bath arrived. She was sure there was no roll of lint inside it. She was present when Mrs. Gwynne had the third bath, and assisted nurse Moxon to put the patient in the bath. She (witness) did not feel the heat herself.

Mr. JELF, K.C., for the defendant company, said the issue was of great importance to his clients. Everybody would regret that the lady had suffered injury at the time she took the third bath, but that was a very different thing from admitting legal liability. He thought that when the jury had heard the evidence they would come to the conclusion that the plaintiffs ought not to succeed. The plaintiffs had to make out an affirmative case of negligence against defendants, and this, he submitted, they had not succeeded in doing. He would prove that a roll of lint was sent in the bath. Mrs. Gwynne had been put in the bath by nurse Moxon, who, as he understood, was an experienced nurse, and who had seen the bath used on two previous occasions.

Mr. ARTHUR E. GREVILLE, the defendant, a solicitor and the inventor and patentee of the bath, said it had been used at Leamington, Harrogate and Bath. In April, 1899, he should think that there were about 100 machines at work. They always, when they sent a machine out, sent a roll of lint with it. No machine had ever been sent out without a complete bottom covering of asbestos.

Mr. HERBERT E. GREVILLE, son of Mr. Greville, the defendant, and secretary of the defendant company, said machines were sent to private houses on an average once a day. It was always their custom to send lint, and it was sent on the present occasion.

Mr. ARTHUR W. GREVILLE, another son of the defendant, said he had been superintending these baths for about a year, and had given close on 1,000 treatments without accident of any kind. He administered the third bath. When he was admitted into the room Mrs. Gwynne was in the machine. She said she was quite comfortable. The highest temperature the bath reached was 280deg., and that was reduced on Mrs. Gwynne's complaint.

This concluded the evidence, and counsel having addressed the jury,

The LORD CHIEF JUSTICE, in summing up, said the jury had to consider whether the injury to Mrs. Gwynne was caused by the negligence of the defendant company's servants, including Mr. Greville, the managing director, and his son, who attended the bath, and whether there had been contributory negligence on the part of Mrs. Gwynne or her attendants. He did not consider the plaintiffs had made out any cause of action against Mr. Greville in his individual capacity, but the company was responsible for the acts of their servants. The jury therefore need not consider any question as to the personal liability of Mr. Greville.

After nearly an hour's deliberation the jury returned a verdict for the plaintiffs, with one farthing damages.

Mr. JELF asked his lordship to deprive the plaintiffs of costs.

The Lord Chief Justice declined to do this, but gave Mr. Greville his costs against plaintiffs.

## Re Cavehill and Whitewell Tramway Co.

An application was made to the Judicial Committee of the Irish Privy Council, on Tuesday, for an Order in Council to amend the existing orders of this company so as to provide for the electrical equipment of their tramways.

Serjeant DODD, for the applicants, explained that steam was used on the existing system and it was intended to convert to electric traction. He thought the Order in Council, granted in 1881, enabled the company to apply any mechanical or animal power, including electricity for locomotion, and what they now sought was an amplification of this provision dealing with the equipment. It was also intended to increase the capital from £27,000 to £64,000, and this increase required sanction by the Council.

At the close of the arguments, the LORD CHANCELLOR said that, having regard to the nature, character and extent of the alterations and changes sought to be made in the existing order, and having regard also to the fact that the local authorities opposed, they thought it right to leave the parties who desired the change to proceed in the regular way.

The application was accordingly refused.

## Kite v. the New Grand (Clapham Junction) (Ltd).

An action was heard this week by Mr. Justice Joyce to restrain a nuisance by vibration alleged to be caused by the electric lighting plant used by defendants for illuminating their palace of varieties. Plaintiff was the owner of a house in Severn's-road, Clapham Junction, and alleged that in November defendants began to run large engines to light their theatre, and since that time he and the inmates of his house had suffered great discomfort and annoyance from constant vibration whenever the engines worked. The vibration, he said, created a constant shaking of the house. Several witnesses gave evidence in support of plaintiff's case, but defendants denied that the vibration complained of was occasioned by the engines, or that if, in fact, any vibration was so occasioned it did not amount to a nuisance. Several experts were called by defendants, and also persons living in the immediate neighbourhood gave evidence that they felt no vibration from the engines and that their lodgers did not complain. During the trial tests were made by experts, who reported that, certain alterations having been made at the engine house, there was now very little vibration felt upon plaintiff's premises. It was, therefore, contended by defendants that no injunction ought to be granted, and that the justice of the case would be met by defendants undertaking to do all in their

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power to abate the nuisance, with liberty to plaintiff to apply in case this undertaking was departed from. Plaintiff insisted upon his right to an injunction, contending that the existence of the nuisance had been clearly proved.

In giving judgment Mr. Justice JOYCE said the question was really one of fact, as to whether there was material interference with the ordinary comfort and enjoyment of plaintiff's premises. His lordship came to the conclusion that at the commencement of the action there was such interference as to constitute a nuisance at law and to entitle plaintiff to relief. The measures which had been taken by defendants to remedy the nuisance were admittedly only temporary. They had not admitted the existence of a nuisance, and it was only during the trial that they had endeavoured to abate it. Therefore, he could find no tangible ground for refusing to grant an injunction, but its operation would be suspended for a month to see the effect of what was being done in the way of abatement. His lordship awarded the plaintiff £5 damages, and costs, with liberty to apply again in the event of the actual damages exceeding this sum.

### Cuba Submarine Telegraph Co. (Ltd.) v. The West India and Panama Telegraph Co. (Ltd.).

In the Court of Appeal on Tuesday before Lords Justices Rigby, Vaughan Williams and Stirling, Mr. Haldane, K.C., made an application on behalf of the defendant company to vary the minutes of the order of the Court made on the appeal in the action. Counsel said that in drawing up the minutes of the order no difficulty had arisen with respect to the definition placed by their lordships upon the words "telegraphic communication," but upon the second point as to the nature of the injunction to which plaintiffs were entitled there was a difference as to the language to be employed. The injunction had reference to telegraphic competing messages, and the order as drawn up was as follows: "And this Court doth declare that a telegraphic competing message means a telegraphic message originating in, or coming from, or going to any place with which the plaintiffs and any other company shall be in telegraphic communication in the ordinary course of business in such manner and at such rates as to make competition between plaintiffs and such other company practicable." He submitted that the words as they stood were too wide, and that the order ought to run: "Telegraphic messages originating in and destined for places with which there was telegraphic communication."

Mr. EADY, K.C., for the plaintiff company, said his learned friend was trying to cut down the form of the injunction, and, in effect, to do away with the judgment.

After discussion, Lord Justice STIRLING suggested words which limited the injunction to competing messages which might be prejudicial to the plaintiff company, and this was agreed to.

### Patent Extension.

An application was made yesterday to the Judicial Committee of the Privy Council by Mr. Bucknill, asking their lordships to fix a day for the hearing of a petition for the extension of the Ferranti patent (No. 12,419, 1887).

Their lordships said they would hear the petition on July 24.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The British Electric Traction Co. require one or two gentlemen possessing the necessary qualifications and experience to carry on negotiations with local authorities. An advertisement contains further particulars. Applications to the Districts Secretary, Donington House, Norfolk-street, London, W.C.

The governing body of the Battersea Polytechnic, London, S.W., require an instructor in electric wiring and a student-demonstrator in mechanical and electrical engineering. Particulars from the secretary. See also advertisement.

A lecturer and demonstrator in electrical engineering will be required at the Hull Municipal Technical School in September. Forms of application, &c., from Dr. J. T. Riley. See advertisement.

A teacher of theoretical and practical electric lighting and power transmission, to conduct classes under the regulations of the City and Guilds of London Institute, is required for the Acton and Chiswick Polytechnic, Bedford-park, W. Applications to Mr. W. H. Barker, B.Sc., by June 24. See advertisement.

The British Electric Plant Co. (Ltd.) require a dynamo designer at their new Alloa works. Applications to managing director. See advertisement.

A car shed superintendent is required for the tramways department of the Sheffield Corporation. Applications to the general manager (Mr. A. L. C. Fell). See advertisement.

Telegraphists are wanted for the Cape Government postal telegraph service. See advertisement.

A mechanical draughtsman is required by Messrs. Johnson and Phillips. See advertisement.

A meter inspector is required at Bradford. Applications to city electrical engineer, Mr. R. A. Chattock. See advertisement.

The Indian Government require the services of an electrical engineer as professor on the staff of the Civil Engineering College, Sibpur. Applications to the Secretary, Public Department, India Office, London, by June 29.

Lecturers in Physics and Electrical Engineering, Mechanical and Civil Engineering and Chemistry are required for the Sunderland Technical College. Applications by June 28.

A lecturer on mechanical engineering and machine design is required at the University of Birmingham. Applications by 29th inst.

Mr. E. E. Hoadley, chief assistant engineer at Worcester, has been appointed resident electrical engineer at Maidstone.

The Bath Electric Light committee recommend the definite appointment of Mr. Francis Teague as borough electrical engineer, at a salary of £350 per annum.

The President of the Local Government Board has appointed Major-Gen. H. Darley Crozier, R.E., to be Chief Engineering Inspector in place of Major-Gen. C. Phipps Carey, R.E., retired. Mr. G. Waller Willcocks, M.I.C.E., has been appointed Deputy Chief Engineering Inspector, vice Major-Gen. Crozier.

Mr. C. A. Burge, assistant superintending engineer of the Midland District of Ireland Postal Telegraphs, has been appointed superintending engineer in the North Wales district, vice Mr. E. Ashton, retired.

Mr. J. F. Coates, of Burnley, has been appointed assistant engineer to the Farnworth District Council.

Out of 26 applicants for the position of tramways manager at Southampton, the Tramways committee have selected the following candidates, from whom a final selection will be made:—Mr. J. H. Cowell, traffic manager and general superintendent, Blackburn Corporation tramways, Mr. Edwin Edwards, deputy-manager Bradford Corporation electric tramways, Mr. Frank Hatch, general manager Wolverhampton and District electric tramways, and Mr. C. G. Simpson, chief inspector Southampton Corporation tramways.

**Accident on the "Twopenny Tube."**—On Monday an accident occurred on the Central London Railway by which a driver met with serious injuries. He was looking from the side of his locomotive to see if the signals were against him when his head struck the signal post.

**Aylesbury.**—The Council have applied for an extension of 12 months for carrying out the terms of their provisional order.

**Bolton.**—The accounts of the Electricity committee for the sixth year's working give a total revenue of £24,103. 15s. 3d., made up of £12,444. 19s. 6d. from the sale of current to private consumers, £421. 13s. 2l. for meter rental, £1,113. 9s. 4d. for profit on the fittings department, £11,107. 1s. 3l. for current supplied to the tramways department, and £16. 12s. for motor rental. The expenses were £13,549. 4s. 5d., leaving a gross profit of £10,554. 10s. 10d. Up to the present no provision has been made for depreciation other than repayment of loans, but the committee have been considering the question and have decided that depreciation should be charged annually as follows:—6 per cent. on machinery, mains and transformers, and 10 per cent. on accumulators, meters and electrical instruments, a total for the present year of £5,881; and, after paying interest (£3,815. 12s. 9l.) there was a net profit of £857. 18s. 1d., which has been voted to relief of rates. During the year the committee have changed over the system of supply in the central portion of the town from alternating to continuous current. The number of consumers has increased from 751 to 888, and the equivalent number of 8 c.p. lamps from 56,705 to 74,395, an increase of 17,690, the highest number connected in any one year. Nearly 44 miles of mains have been laid, 8¾ miles during the past year. The units sold amounted to 2,431,737, or nearly three times that of the previous year. The committee anticipate that the sale of current for power, the receipts from which amounted to £393. 2s. 9d. during the year, will largely increase, thus materially improving the load factor and lowering the cost of production. The total total cost per unit last year was 1·80d., a reduction of 0·464d. The committee place on record their high appreciation of the service rendered to the undertaking by the engineer (Mr. A. A. Day) and his assistants, and also those of Mr. Baker and his assistants in the fittings department.

**Bootle.**—The annual report of the borough electrical engineer (Mr. W. R. Wright) states that when the works were taken over from the contractors in October, 1899, there were 36 public arc lamps, and in March last the number was 107 and the number of 16 c.p. incandescents had increased from 72 to 562. For private lighting there is now an equivalent of 13,710 8 c.p. lamps connected, an increase of 3,750. The tramways in Knowsley, Rimrose, Derby and Stanley-roads have been electrically equipped during the period covered in the report. The number of cars now working

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is 55. The committee and staff had been troubled by the breaking down of the insulation of the mains through the constant breaking up of the footwalks and carriageways, though in many cases the actual expenses had been defrayed by the contractors. As a result of the year's working there was a deficit of about £1,800. During the year 130,913 units were supplied for public lighting, 337,061 for tramways. 159,495 for private lighting, and 21,900 were used on the works. The total units generated was 730,404.

**Bordeaux.**—During 1900 the process of conversion of the horse-driven tramway system to electric traction was taken in hand and this work has now been completed, the whole of the lines being now electrically driven.

An electric tramway has recently been opened from Pierrefitte to Canterets, and from Pierrefitte to Luz in the Pyrenees.

**Bowness.**—It has been decided to instruct an electrical engineer to prepare a report as to establishing electricity works here, and the negotiations with Messrs. Crompton & Co. have in the meantime, we understand, been suspended.

**Bradford.**—On Tuesday the Council were recommended by the Tramways committee to use the Demerbe type of rail in all forthcoming tramway work, excepting for the re-construction of the Manchester-road line, as to which it has been already arranged that girder rails shall be used. In the discussion which followed the chairman of the committee (Mr. Hill) stated that the girder rail for the Manchester-road route had been adopted on the advice of the city surveyor. With regard to the Demerbe rail there was a large amount of tramway work to be done during the next two years, and it was necessary that contracts should be given out. The intention of the committee was that the Demerbe rail should be adopted only for those routes with which it had been decided to proceed at once, and the Corporation were not bound for any indefinite period to the use of this rail. The recommendation of the committee was approved.

**Budapest.**—The Hungarian State Railway authorities have decided to light the railway stations in Budapest electrically.

**Burslem.**—The Council have sanctioned the extension of the Potteries Electric Traction Co.'s tramway system to Sneyd Green.

**Bury (Lancs.).**—It was announced at the Council meeting last week that the loss on the electricity department during the past year was about £600, due to the high price of coal, interest on borrowed capital, and repairs.

**Canadian Electrical Statistics.**—According to the recently-issued report of the statistician of the Dominion of Canada (Mr. G. Johnson) there were in 1900 681 miles of electric railways in operation and 760 miles of new lines, mainly electric, under construction. The number of miles of steam lines was 17,649. The 35 electric railways of Canada carried, in 1900, 118,130,000 passengers, an increase of 14,100,000 over 1899. The steam and electric lines together carried the entire population of Canada 25 times over, the proportion by electric lines being 87 and by steam 13 in every 100 so carried. The percentage increase in the number of passengers carried since 1897 has been 41 by the electric and 25 by the steam lines. The percentage expenses of gross earnings of the electric lines was 60·27 and of the steam lines 67·50. The extension of electric railways to the rural districts of the Dominion Mr. Johnson regards as a great advantage to the farming community.

The telegraph system of Canada in 1900 comprised 3,906 miles of land and subaqueous lines owned by the Government and 30,717 miles owned by companies, making a total of 34,623 miles of lines and 84,510 miles of conductors.

The number of telephone instruments in use in the Dominion in 1900 was 52,417 ; 62 telephone companies are doing business in the Dominion, but many of these are in process of amalgamation, so that only 38 companies may be deemed to be distinct undertakings and to be doing public telephone business. These 38 companies handled, in 1900, 156,217,627 messages, equal to $8\frac{2}{10}$ messages per day per subscriber, comparing with $5\frac{9}{10}$ messages per day in 1895.

**Cardiff.**—Acting on a report of the borough electrical and tramways engineer the Electrical committee recommend that the charge for electric current be made 7d. per unit for the first hour's maximum demand and 2d. after. For power the charge to be 4d. and 1d.

**Carmarthen.**—Electricity supply will not be undertaken by the Council until they obtain a guarantee that current will be taken for 300 houses in the district.

**Chesterfield.**—The Council have applied for sanction to a further loan of £6,000 for electric lighting extensions. An additional 200kw. unit of plant is to be put down.

**City-Piccadilly Underground Electric Railway.**—The *Daily Mail* announces that Mr. J. Pierpont Morgan is interested in the construction of this electric line, parliamentary powers for which are being sought in the present session. The proposed line will start at Piccadilly, pass under Coventry-street, King William-street, Strand, and Fleet-street, and the terminus will be near the existing Cannon-street station. At Piccadilly Circus a connection will be made with the authorised Brompton and Piccadilly Circus and the Baker-street and Waterloo lines.

**Copenhagen.**—The Free Port, which was established in 1894, is one of the largest goods stations in Denmark, and the railway station at the Free Port is provided with electric current for lighting from the electricity supply works erected on the Port, which also provides current for lighting the trains that run on the coast railway from Copenhagen to Elsinore. Current was started in 1897, and there are now 4,000 incandescents and 300 arcs on the Free Port mains. A new 600 H.P. set is to be added. On the west quay large building operations are proceeding, and the structures now being erected are to be furnished with grain-handling machinery of the most modern type. A number of electric winches are being provided for raising goods to the various floors, and a grain elevator with a capacity of 200 tons per hour is being built on the quay, probably the largest elevator on the Continent. A number of special sheds have been erected, all provided with quick working stationary electric cranes, with a maximum lifting power of 2½ tons. The lighting of these sheds is effected by arc lamps, and the busy work proceeds by night and day with great smoothness. On the eastern mole there is to be erected a number of sheds of a similar character, all to be furnished with electric stationary cranes, as well as with rapid-working electric travelling cranes for heavy goods. This installation of electrical machinery and lighting makes the Free Port, Copenhagen, one of the most desirable of continental ports for the rapid loading and discharging of cargo.

**Crewe.**—Application for sanction to a further loan of £5,000 for electric lighting has been made by the Council.

**Dumfries (N.B.).**—The Electric Light committee having found it impracticable to proceed with the scheme for the utilisation of water power, Dr. Mond has been communicated with as to the suitability of Mond gas for electrical power generation. The Board of Trade are being asked to grant an extension of time to carry out the Council's provisional order.

**Edinburgh.**—Brisk demand for electric current continues. During the past three weeks applications for the equivalent of 14,645 8 c.p. lamps were received, including the equivalent of 1,961 lamps for motive power.

**Electric Traction in South Lancashire.**—The South Lancashire Tramways Co. have acquired a site for a generating station at Atherton. It was originally proposed to erect the power station at Leigh, but owing to opposition from the local authority this proposal was abandoned.

**Garw (Glam.).**—Owing to a hitch in the negotiations with the gas company, the Ogmore and Garw Council have decided to ask the South Wales Electrical Power Distribution Co. to quote for supplying electric current for lighting Garw.

**Glasgow.**—At last week's meeting of the Corporation the recommendations of the Electricity committee as to electricity charges, set out in our issue of June 7, were adopted.

On the presentation of the minutes of the Telephone committee, Mr. J. Alexander stated that, as the result of correspondence with the Postmaster-General as to the connection of the Corporation's system with the trunk system of the country, the connection had now been established, and was working satisfactorily.

The electric tramway route to the Botanic Gardens via Byres-road was opened for traffic on Saturday.

**Great Yarmouth.**—The receipts of the electricity department during the past year amounted to £7,225 and the expenses to £5,406, leaving £1,819 to meet interest and sinking fund, which together amounted to £2,570. The nett deficiency is therefore £751, against a profit of £371 last year. The capital expenditure to date is £44,392, but sanction to borrow £67,000 has been obtained. The accounts were presented and passed at Tuesday's meeting of the Council.

**Groningen (Holland).**—The municipal authorities, who are erecting electricity supply works, have let the contract for the electrical generators to the Allgemeine Elektricitäts Gesellschaft. Messrs. Stock Bros. will supply the steam engines.

**Hoylake.**—An inquiry was held last week into the application of the Council to borrow £13,500 for electric lighting extensions. The clerk (Mr. R. Williams) explained that already sanction had been received to borrow £27,000, but owing to the great demand for electric current this amount had been exceeded by £3,000. They had applications amounting to 6,000 8 c.p. lamps, nearly equal to the full capacity of the works. To meet the demand of the coming winter the Council desired to erect plant and lay down mains costing in all £40,500, or £13,500 beyond their present powers. That would give them a capacity of 14,000 8 c.p. lamps, and they had every prospect of at least 10,000 before the end of next winter. The consulting engineer (Mr. T. L. Miller) and the surveyor (Mr. T. Foster) submitted technical particulars. There was no opposition.

**Ilford.**—An inquiry was held last week into the application of the Council to borrow £106,737 for electric tramways. Technical details were supplied by the consulting engineer, Mr. W. C. C.

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Hawtayne, who explained that there would be seven routes. The cars would be double-decked and would accommodate from 40 to 60 passengers each. Evidence was also given by the surveyor (Mr. H. Shaw), by Mr. W. Beer, A.M.I.C.E., the chairman of the Council (Councillor B. Bailey), and the clerk (Mr. J. W. Benton). There was no opposition. The principal items of the capital expenditure were given as follows:—Permanent way £69 400, electrical equipment £9,867. 10s., 12 motor cars complete £7,800, generating plant £7,275, car sheds and workshops £5,000, engineers' fees, &c., £5,000.

**Jarrow.**—The preliminaries for the supply of electric current in this district have been arranged by the County of Durham Electric Power Co., and work will be commenced forthwith. Electric tramways are also to be constructed.

**Kingstown (Ireland).**—The Council was recommended on Tuesday to apply for a loan of £50,000 for electricity works, but the matter has been adjourned for a month. Tenders for plant, &c., have been obtained, and the amount of the lowest complete tender is about £40,000.

**Leyton.**—The situation created by the issue of the writ of sequestration in the action brought by Mr. Hawkes against the Council for vibration and noise caused by the machinery at the electricity works was discussed by the Council last week. It was reported that the General Purposes committee had passed a resolution that Mr. F. Harman Lewis had proved an able and efficient engineer in the past and expressing the committee's continued confidence in him as chief of the electrical department. The chairman of the Electric Lighting committee (Councillor Musgrave) said that it was the gas engines which had caused annoyance to Mr. Hawkes. They had no idea that there had been any breach of the injunction, and were therefore astonished at the writ for sequestration. The operation of the writ had been suspended on the understanding that the gas plant should not be used. The total cost of this gas plant, which would have to be sacrificed, was £9,741. In connection with the much-discussed question of the site of the electricity station, they had acted under the advice of Prof. H. Robinson. After discussion the Council resolved to expend £15,193 on steam plant to supply current to the equivalent of 18,500 8 c.p. lamps.

**Light Railways.**—The Swansea and District Light Railways order has been submitted to the Board of Trade for confirmation. Objections by July 5.

A proposal has been made to construct a light (electric) railway to connect Stroud, Chalford, Painswick, Stonehouse and Nailsworth with a possible extension to Cheltenham. The promoter of the scheme is Mr. T. Nevins, the proprietor of the Cheltenham—Cleeve light (electric) railway.

**Liverpool Motor Trials.**—The judges of the recent heavy motor trials (Mr. E. R. Calthrop, Mr. S. B. Cottrell, Prof. H. S. Hele-Shaw, Dr. Boverton Redwood, and Mr. H. H. West, M.I.C.E., M.I.N.A., M.I.M.E.), have awarded a gold medal to each competitor in classes A, B and C. The awards in Class D will be announced in about three weeks.

**Maidstone.**—Some time ago the Council invited tenders for wiring premises on the "easy" payment system, but no tender was submitted.

**Morecambe.**—An application from a syndicate which proposes to apply for powers to convert the existing horse tramways into an electric system has been referred to the Electric Lighting committee. The estimated deficiency on the working of the electricity department is £2,178.

**Newport (Mon).**—The Council have resolved to proceed with their electric tramway scheme, notwithstanding the protest of a section of the ratepayers, who demanded a poll.

**Personal.**—Mr. Fred Bathurst is about to visit the States, and will take in his journey the Buffalo Exhibition, in order, in particular, to keep abreast of the latest wiring developments in that country. Mr. Bathurst claims that in America concealed wiring and the use of conduit methods is much more favoured and advanced than in England, as American architects, when designing new buildings, provide suitable raceways and outlets, which facilitate the installation of conduit systems, these arrangements comparing favourably with architectural practice at home. One of the objects of Mr. Bathurst's forthcoming trip is to bring home anything that may tend to reduce the cost of installing conduit systems for interior wiring.

**Portsmouth.**—An inquiry was held last week into the Corporation's application to borrow £32,000 for additional generating plant and for mains extensions. There was no opposition. Evidence was given by the chairman of the Electric Light committee (Ald. Ellis) and the superintendent of the electric lighting department (Mr. E. Price).

**Rochdale.**—Extensions of the electricity generating plant and mains are to be carried out at a total cost of £22,736, in addition to a sum for an extension of the tramway switchboard.

**Rosario.**—The British Consul at this South American port states that amongst the openings for capital in this part of the world electric enterprises form a conspicuous feature, especially in connection with lighting and tramways.

**Salford.**—The Corporation have decided, on the recommendation of the Electric Light committee, to abolish the maximum demand system for electric current, which will be replaced by a uniform charge of 2d. per unit for power and 4½d. for lighting. In all cases where consumers have their own plant and only use the Corporation's supply as a stand by, a maximum price of 8d. per unit is to be charged, with a minimum of 13s. 4d. per quarter. It was stated by the chairman of the committee (Ald. Shaw) that the demand system had caused a loss to the Corporation within the last three months of £1,900.

**Sheffield.**—During the year ended March 25 the tramways department carried 34,380,763 passengers, compared with 19,209,714 in the preceding year. The receipts from the electric tramways were £103,300 out of a total of £135,794. The gross profits were £48,657, and after deducting interest and sinking fund there was a net profit of £21,817. The total relief to the rates out of the tramway receipts has been £22,000. The accounts of the electricity supply department for the last 15 months show a total income of £41,939, an increase of £18,597 over the previous year. The expenditure was £15,985, and, after deducting interest and allowing for sinking fund, there was a net profit of £4,018.

At the meeting of the City Council, on Wednesday, Col. Hughes asked Ald. Styring to deal with the question raised by the accountant-auditor that the accounts contained no amount for depreciation of machinery and plant. It was no use stating that they had made a profit of something over £4,000 if they had not allowed anything for depreciation. Ald. Styring said no depreciation was entered under the name of depreciation; but the committee considered that as the machinery was kept in an efficient state of repair out of the revenue, and as they had to pay annually a large sum for the purchase of the freehold of the property belonging to the undertaking, as well as machinery and mains, ample provision was being made. The committee felt they would not be in a position to reduce the price of electric current for some time to come. Col. Hughes considered that it was unbusinesslike not to allow for depreciation, and moved an amendment that the committee be requested to make proper provision for depreciation. After discussion the amendment was lost and the committee's minutes were adopted.

The salary of the chief engineer of the electric light department (Mr. S. E. Fedden) has been increased from £500 to £600 per annum. The Corporation have purchased a site (over 10 acres, at £400 per acre) for a new electric power station.

**Shrewsbury.**—Extensions of the electric lighting mains, estimated to cost £420, were authorised by the Council on Monday.

**Sleaford.**—The Council have taken up a loan of £6,798 from the Prudential Assurance Co., at 3¾ per cent., for electric lighting. Mains are to be laid as promptly as possible to prevent the town being in darkness, as the gas company are said to have cut off the supply of gas to the street lamps.

**South Africa.**—*The British and South African Export Gazette* announces that a concession has been granted to a Maritzburg syndicate for the erection of electricity works at Dundee, Natal. The engineers for the syndicate are Messrs. Swete and Baker, and at the outset the capacity of the plant will be equivalent to about 2,000 8 c.p. lamps. The orders for plant, &c., will be given out shortly.

The Durban Town Council are applying for sanction to borrow £120,000 for the extension of their electric tramways and £75,000 for additional electric lighting plant and extensions of the mains.

The East London Town Council have also under consideration a proposal to extend their electric tramways at an estimated cost of £20,000.

**Southgate.**—Inquiries are being made by the General Purposes committee as to applying for a provisional electric lighting order.

**Swansea.**—At a meeting of the Electric Lighting committee last week 14 tenders were submitted for two-phase motor alternators, and the consulting engineer (Mr. E. Manville) recommended the acceptance of that of the International Electric Co. of Liège at £1,470. In reply to a question, the resident engineer (Mr. Cawthra) said he did not approve of the contract going out of the country, having regard to some German machinery they had in the station. Mr. Manville's report stated that the company was well known and had carried out a good many contracts in this country, including the Dowlais Works. The lowest English tender was £580 higher. Mr. Cawthra said nine-tenths of the foreign machinery had its own standard, and when nuts, bolts, &c., were lost or destroyed three or four weeks might elapse before duplicates could be obtained from the Continent, and in the event of serious breakdown considerable loss might ensue. He hoped his objection would be strong enough to postpone the acceptance of the lowest tender until he was more satisfied with the German plant at the local station. As to the switchboard, the less said about that the better. It was a switchboard, but not what it should be. It was decided that Mr. Cawthra should embody his objection in a report to Mr. Manville, the tender to be in the meantime only conditionally accepted. Regarding the delay in the electric lighting of the streets it was decided to enforce penalties against the contractors, and as to lighting the docks, it was

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decided to submit to an independent expert the question at issue between the Corporation and the Harbour Trust as to what the generation of electric current actually costs the Trust.

**Telephone Charges in France.**—It is announced that the annual telephone subscription in Paris is to be reduced from 400fr. to 300fr., and in Lyons from 300fr. to 250fr. With these reduced rates subscribers will cease to have the right of telephoning from the city call offices free of charge. Subscribers are to have the right to send and receive telegrams over the telephone lines on payment of a special fee of 10c. per message. from Oct. 1 next the fee to be charged for telephonic communication within the area of the city of Paris, which is now fixed at 25c. per five minutes' conversation, is to be reduced to 15c. for a three minutes' conversation, and a charge of 15c. for three minutes' conversation in other telephone centres is to be reduced to 10c.

**Telephone Trunk Line Extension.**—Telephone trunk line communication has been extended to Marlborough, Wilts.

**Wakefield.**—The salary of the electrical engineer (Mr. R. Blackmore) has been advanced to £300 per annum, and, in consideration of supervising the erection of the plant extensions, a bonus of 1 per cent. is to be paid to him on all completed work on capital account.

**Waterford.**—The Council have retained Messrs. Lacey, Clirehugh and Sillar to prepare a report on electric lighting,

**Weston-super-Mare.**—The Weston-super-Mare and District Electric Supply Co. have been asked to state terms for supplying current to the pavilion and new swimming baths.

**Wolverhampton.**—There was a loss of £130 on last year's working of the electricity department, ascribed to expenditure in connection with the alteration of pressure (£545. 18s. 3d.), which was met out of revenue, and to the average price per unit obtained having been only 4·31d., against 4·815d. in the previous year, representing £1,166. The equivalent number of 8 c.p. lamps connected was 33,833, an increase of 34·42 per cent., and the units sold 633,508, an increase of 31 per cent. The total receipts for the year were £9,660. The accounts were discussed and approved at the meeting of the Corporation on Monday.

**Woolwich (London).**—A special meeting of the Borough Council on Thursday last decided to notify the Blackheath and Greenwich District Electric Lighting Co. of the Council's intention to acquire so much of the company's undertaking as is situate within the borough. At the meeting a communication was read from the Woolwich District Electric Light Co. stating that the directors were prepared to recommend the shareholders to accept the Council's offer to purchase their undertaking for £80,000.

**Workhouse Lighting.**—Brighton Guardians have decided to invite tenders for wiring their workhouse buildings.

Greenwich (London) Guardians are to install the electric light in their schools at Sidcup.

Pontypridd workhouse is to be lighted electrically, and tenders are to be invited.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

### TENDERS INVITED.

*Mansfield* Corporation invite tenders for the supply and erection of boiler and engine house plant, Körting condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains and arc lamps, posts and accessories for public lighting, mains and workshop equipment. Further particulars are given in an advertisement. Specifications from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W. Tenders to town clerk (Mr. J. Harrop White), Mansfield, by 4 p.m. July 12.

*Erith* Urban District Council require tenders for generating station plant, mains, conduits, arc lamps and posts, &c., some particulars of which will be found set out in an advertisement. Specifications, &c., can be obtained from Mr. Chas. H. Fry, clerk to the Council, Council Offices, Erith, Kent, and further information from Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C., to whose plans and specifications the works are to be carried out. Tenders have to be sent to Mr. Fry before 12 noon of June 24.

The Electricity committee of the *Poplar* (London) Borough Council require multiple core lead-covered feeder and network cable and accessories for mains extensions. An advertisement contains some particulars. Specifications, &c., from the borough electrical engineer (Mr. A. Blackman), electricity works, Glaucus-street, Bromley-by-Bow, E. Tenders to town clerk (Mr. Leonard Potts), Council offices, High-street, Poplar, by June 26.

*Wallasey* District Council invite tenders for the supply and erection of machinery and tools for their electric tramways department. Specifications from the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead, and tenders to the clerk and solicitor (Mr. H. W. Cook), Public Offices, Egremont, Cheshire, by July 18. An advertisement contains further particulars.

The Electrical committee of the *Stepney* (London) Borough Council require tenders for the supply of Conradty arc lamp carbons for the year ending June 30, 1902. Particulars of the resident electrical engineer (Mr. Wm. C. V. Tapper), 27, Osborn-street, Whitechapel, E., where tenders by noon 26th inst. See advertisement.

*Extension of Time.*—Exeter City Council have extended the time for the delivery of tenders for the equipment of their new electricity generating station from June 14 to the 28th. This contract was advertised in our issue of May 10.

*Nelson* Electricity and Tramways committee require a travelling crane. Tenders by June 25.

*Taunton* Corporation invite offers for wiring premises free of initial cost to consumer. Tenders by noon July 1.

*Leigh* Tramways and Electricity committee require tenders for 12 months' supply of electricity meters. Tenders by noon 22nd inst.

*West Ham* Borough Council invite tenders for three 500kw. continuous-current tramway generators coupled direct to three 850 I.H.P. steam engines, and 11 water-tube boilers. Tenders to town clerk by 4 p.m. 25th inst.

*Wigan* Electric Light and Tramway committee invite tenders for 12 double-deck single truck electric cars. Tenders to borough electrical and tramways engineer (Mr. H. Collings Bishop), by June 18.

*Cleckheaton* District Council invite tenders for the supply and erection of engines and dynamos. Tenders by June 22.

*Bermondsey* (London) Borough Council invite tenders for electricity meters, demand indicators, and main fuses. Tenders to the town clerk (Mr. Frederick Ryall) by noon of July 1.

*Llandudno* District Council invite tenders for 1,673 yards of 0 25 triple concentric feeder cable, paper insulation. Tenders to clerk (Mr. Alfred Conolly) by June 17.

*Dundee* Town Council invite tenders for the construction of new tramways and for the reconstruction of about three-quarters of a mile of existing tramway, &c. Tenders by June 18.

*Manchester* Electricity committee invite tenders for five electrically-driven travelling cranes for Stuart-street station. Tenders by 20th inst.

*Hackney* (London) Electric Lighting committee invite tenders for mechanical coaling apparatus. Tenders by 4 p.m. July 4.

*Epsom* District Council require meters and cut-outs. Tenders by June 22.

*Leith* Corporation invite tenders for a Lancashire boiler and steam piping. Tenders by 19th inst.

*Barking* Council invite tenders for condensing plant. Tenders by 19th inst.

*Bury* (Lancs.) Town Council invite tenders for wiring the new infectious diseases hospital. Tenders by 26th inst.

Tenders are invited until 17th inst. by the General Administration of Turkish Posts and Telegraphs, *Constantinople*, for the supply of wire and insulators required for the new telegraph line to India.

The *Madrid Gazette* of June 3 gives notice that a petition has been deposited for a concession for the construction of an electric tramway from Santiago to Coruña. A month is allowed for the deposit of offers on more advantageous terms to the Government than those of the petitioner.

The same Gazette for June 7 publishes a Royal Order granting authority for two years to carry out studies for establishing an electric railway from Oviedo to Gijon.

### TENDERS RECEIVED AND ACCEPTED.

Hull Corporation have received the following tenders for 12 direct-current street arc lamps :—

| | | | | | |
|---|---|---|---|---|---|
| Oliver & Co. *(accepted)*.. | £368 | 6 | 6 | New Century Arc Light Co. ..... | 354 12 6 |
| General Electric Co..... | 409 | 14 | 6 | Siemens Bros. & Co..... | 352 8 0 |
| Johnson and Phillips ... | 382 | 4 | 6 | Improved Electric Glow Lamp Co. ..... | 351 0 0 |
| Crompton & Co. ..... | 380 | 0 | 0 | Veritys Limited ..... | 348 14 0 |
| Walsall Electrical Co. ... | 361 | 13 | 9 | | |

The Fulham (London) Borough Council have accepted the tender of the General Electric Co. for the supply of Robertson lamps, arc lamps and accessories, fuse wire, tape, &c., required for the electricity department to March 31, 1902.

Kirkcaldy Town Council have accepted the tender of Messrs. Laurence, Scott & Co. for engines and dynamos for their electricity supply scheme at £6,620, that of the Tudor Accumulator Co. for storage battery at £1,364 (with an annual charge of £80 for maintenance), and that of Messrs. Carrick and Ritchie for an overhead traveller at £370.

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Melton Mowbray District Council have accepted the tender of the Melton Mowbray Electric Light Co. for the lighting of the town for three years.

The contract for the supply of a storage battery for the Rhyl electricity works has been given to the Hart Accumulator Co.

The Todmorden District Council have let the contract for putting the Fielden hospital, workhouse, Council offices, &c., in telephonic communication to Mr. R. S. Blackburn.

Hornsey District Council have accepted the tender of Braid, Pater & Co. for the erection of electricity station buildings at £13,777.

## BUSINESS NOTICES.

Mr. J. F. Simpson and Emma Whitten Brown, trading as engineers and machinery importers under the style of Brown & Co., Deansgate, Manchester, have dissolved partnership. Debts by Mr. Simpson, who continues at Hapton, Lancs.

Messrs. F. B. Nicholson and W. H. de Winton, electrical engineers, 53, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. Nicholson, who continues under the style of Nicholson & Co. Mr. de Winton will also carry on business on his own account.

The Electrical and General Contracting Co., of Piccadilly Mansions, Piccadilly Circus, London, W., forward us a statement in reference to the formation of the Hiram Maxim Lamp Co. (Ltd.), with which new concern the business of the Electrical and General Contracting Co. is to be incorporated.

## BANKRUPTCIES, LIQUIDATIONS, &c.

At the London Bankruptcy Court on Friday, the public examination was called of Arthur W. B. Pearson, electrical contractor, lately trading at Palmerston-buildings, London, E.C. The bankrupt was formerly engaged travelling in electrical apparatus, and had a large connection, but in 1898 he started on his own account with a capital of £2,500, and built up a good business. Later on he became interested in various patents, including those for a substitute for vulcanite, a special process for the manufacture of indiarubber, and in a special type of rotary engine and pump. Failure was attributed to liability on discounted bills. Liabilities were estimated at about £17,000, assets about £6,000, in addition to a half-share in a Mexican land concession. It will be remembered that the debtor, since the commencement of the bankruptcy proceedings, committed suicide at the Manchester Hotel, London.

In the bankruptcy of S. F. Walker (trading as Sydney F. Walker & Co.), electrical engineer, Cardiff, the trustee has been released.

Claims against A. W. Hirst (trading as Hirst & Co.), electrical engineer, St. Michael's-road, West Croydon, must be in by 27th inst. to Mr. A. Mackintosh, 24, Railway-approach, London Bridge.

Claims against the Universal Electrical Advertising Syndicate (Ltd.) must be sent to Mr. T. G. Mellors, King John's-chambers, Nottingham, by July 23.

In the Bankruptcy Court yesterday Jacob Guttmann, known as Jacob Goodman, lately trading as J. Goodman & Co., 48, Commercial-street, London, electric fittings dealer, &c., was granted his discharge. There was no opposition by creditors.

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**Plant for Sale.**—Messrs. H. Steele & Son have been instructed by the Phœnix Process Trust, Ltd. (who are removing their experimental works), to sell by auction on the premises at Milton, Stoke-on-Trent, on Tuesday, 18th inst., the recently laid down electrical and chemical plant. Further particulars are given in an advertisement, and catalogues can be obtained from the auctioneers, Queen's Chambers, Burslem, Staffs.

An advertisement contains particulars of an E.C.C. dynamo coupled direct with a 50 H.P. vertical compound engine which are for sale. Applications to Mr. H. A. Couchman, Messrs. Bass & Co., Burton-on-Trent.

**Cable for Sale.**—Whitehaven Water and Lighting committee invite tenders for the purchase of about 20 tons of second-hand rubber-covered cables. Particulars from the borough electrical engineer (Mr. P. J. Watts), to whom tenders by June 24.

**"The Journal."**—Parts No. 149 and No. 150 of the *Journal* of the Institution of Electrical Engineers are now ready. Some particulars are set out in an advertisement.

**Electric Driving Plant.**—In reference to the note in our issue of 31st ult. (p. 235) on the electric driving plant at the works of the Northumberland Shipbuilding Co, we are informed that the electrical apparatus was supplied by the British Thomson-Houston Co.

**B.T.H. Plant.**—Pamphlets 96 and 97, issued by the British Thomson-Houston Co., deal respectively with "Rheostats for generators and motors" and "Electrically-driven ventilating fans and blowers."

**High Voltage Accessories.**—Messrs. Julius Sax & Co. have now ready a new list of high voltage electric lighting accessories for the wholesale trade only. Most of the articles in the list are made from registered designs. Copies can be obtained, post free, on application.

**Electrical Accessories List.**—The International Electric Co. issue a circular giving particulars of a watertight telephone-connecting box for traction work, pocket microtelephones, side-station "Pyramide" telephone switchboards, &c.

**Atkinson New Dead-beat Ammeters and Voltmeters.**—We have just received particulars of the Atkinson patent dead-beat ammeters and voltmeters for continuous current, which have been designed more especially for use in factories for checking the power consumption of individual motors. The moving part of these instruments is shown in Fig. 1, and consists of a sealed glass tube containing a float resembling an hydrometer, carrying a soft iron wire floating in a liquid. This float normally stands with the stem just out of the liquid, and the glass containing-tube is placed in the instrument so that the iron wire just enters a solenoid. The iron is drawn into the coil by an amount which is a measure of the current. The liquid in which the float moves has a constant density at all temperatures, this being achieved by the use of a saturated solution of a special salt, of which a few crystals are left in the bottom of the tube, this salt having the property of dissolving or crystallising out

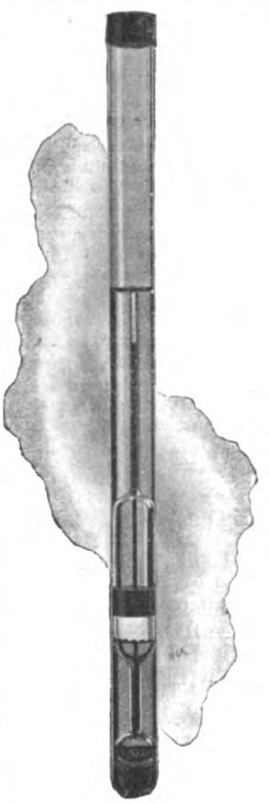

FIG. 1.

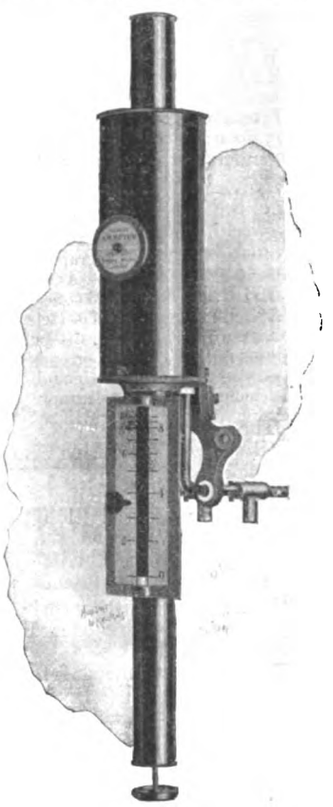

FIG. 2.

in such proportion that by this action the change in density of the liquid by change of temperature is compensated for. The float fits the outer tube quite freely, but is kept from contact or capillary sticking by three glass points on the bulb, so that it floats centrally without touching. The ammeters (see Fig. 2) are made in various sizes for maximum currents of 2 amperes to 140 amperes, and, as well as the voltmeters, are listed at a very low price. The latter are made for 90 volt circuits up to 550 volt circuits.

**Rolling Stock, &c., Catalogue.**—A handsome catalogue of steam locomotives, steam tramway engines, main line passenger carriages, light railway passenger carriages, goods and cattle waggons, bogie cars for steam tramways, double and single-deck horse cars, omnibuses and other vehicles manufactured at the extensive works of the Brush Electrical Engineering Co. at Loughborough has just been issued. Although the list shows nothing electrical it gives an excellent idea of the capabilities of the Brush Company for turning out rolling stock for railways and tramways and passenger vehicles of every description in large quantities at short notice.

**Fan Motors.**—A list of "Eclipse" fan motors, for which Mr. W. H. Merriman, 39, Victoria-street, London, S.W., is agent in this country, has just been issued. Illustrations are given of desk, bracket, ceiling, and other fans.

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during May was £90,281, against £86,629 in the preceding month and £78,350 in May last year. The total for the five months ended May 31 was £498,599, against £334,082 for the corresponding period last year.

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**Foreign Imports and Exports.**—In a review of the German iron trade for 1900, recently received at the Foreign Office from the British commercial attaché at Berlin, a tabular statement shows that electrical machines were imported into Germany from the United Kingdom weighing 239 metric tons, while electrical machines exported from Germany to the United Kingdom weighed 958 metric tons.

Imports into the Argentine Republic, during 1900, of dynamo-electric machinery was valued at £16,000. The United Kingdom supplied less than £950 of this total.

There was imported into Italy, during 1900, electric cables and wires to the value of £184,834, an increase of about £74,000 over 1899. Of electric machines the total value imported was £470,676, an increase of £145,672.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 5 to June 11, with the ports of destination :—

*Africa*—Alexandria, £1,462 ; Cape Town, £2,945 (including £1,307 telegraph material), Durban, £829 (including £515 telegraph material) ; East London, £1,200 (including £1,127 telegraph material) ; Port Elizabeth, £707 (telegraph material). *Argentina*—Buenos Ayres, £740 (telegraph wire) ; Rosario, £380 (telegraph material). *Australasia*—Auckland, £35 ; Fremantle, £132 ; Hobart, £730 ; Launceston, £76 ; Lyttelton, £16 ; Melbourne, £3,109 (including £1,867 telegraph wire) ; Otago, £40 ; Port Chalmers, £55 ; Rockhampton, £300 ; Sydney, £767 ; Wellington, £50. *Belgium*—Ostend, £29. *Canada*—Montreal, £737 (telegraph cable) ; Quebec, £153 (telegraph cable). *Chili*—Boca, £390. *China*—Shanghai, £165 (including £40 telegraph wire). *France*—Calais, £50. *Germany*—Hamburg, £482. *Holland*—Amsterdam, £30 ; Rotterdam, £150 (telegraph material). *Hong Kong*, £23 (telegraph apparatus). *India*—Bombay, £40 ; Calcutta, £784 ; Karachi, £74 (telegraph material) ; Madras, £15. *Japan*—Yokohama, £119. *Portugal*—Lisbon, £75. *Russia*—Archangel, £245 ; St. Petersburg, £45 (telegraph wire). *Siam*—Bangkok, £215. *Straits Settlements*—Penang, £80 (including £40 telegraph material) ; Singapore, £114 (including £41 telegraph material). *Sweden*—Stockholm, £679 (telegraph wire). Total, £18,267, against £9,153 for six days last year (June 7 to 12).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 4, 1901.

4,530. R. Appleyard and J. F. Coote. Kent. Improvements relating to the jointing or terminating of electric cables or combinations of multiple-core cables.

4,532. A. W. Gilbody and D. Robertson. Yorks. Improved safety device for overhead electric wires.

4,533. A. W. Gilbody and D. Robertson. Yorks. Improvements in trolley wires and other overhead electric wires.

4,540. F. L. Broughton. London. Improvements relating to the covering or casing of the electric wires or leads employed in house lighting and for other purposes.

4,549. A. L. Reinmann. Liverpool. An improved incandescent electric lamp.

4,575. H. H. Lake. London. Improvements relating to electric power distribution. (Compagnie de l'Industrie Electrique, Switzerland.)

4,576. R. C. Contardo. London. Improvements in electric furnaces.

4,586. C. N. Gauzentes. London. Improvements in primary batteries.

4,591. H. E. Newton. London. Improvements relating to the preparation and treatment of filaments for incandescent electric lamps. (Charles Garner, United States.)

4,597. A. Wright and The Reason Manufacturing Co. (Ltd.). London. Improvements in electric demand indicators.

March 5, 1901.

4,631. T. Chadwick. Halifax. Improvements in electric stop motions of drawing frames.

4,642. R. R. Harrison. Birmingham. An improved underground or conduit system for the transmission of electromotive force for traction purposes.

4,675. The London Electric Wire Co. (Ltd.) and B. Hawke. London. Improvements in cords for switchboards, telephones, and other electrical instruments.

4,695. F. Strickland. London. Improvements relating to the regulation of dynamos.*

4,700. F. W. Leevers. Liverpool. Improvements in or relating to trolleys and like current collectors for electric railways and tramways.

4,709. H. Schäffer. London. Sound and fireproof walls for use in connection with telephone apparatus.*

4,714. M. Neitzschmann. London. Improvements in electro-magnetic traction.

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

7,372. Tribelhorn. Manufacture of electrodes for secondary batteries.

7,657. Burbey. Cord grips for electric lamp-holders, ceiling roses, and the like.

7,678. Pollák, Virág, Egger and Silberstein. Automatic letter writing telegraph.

7,737. Tribelhorn. Arc lamps.

7,792. Longsdon and Dale. Electrically-operated brakes for centrifugal drying machines or hydro-extractors.

7,861. Brown. Electrical reciprocating apparatus.

7,997. Kammerer. Electric gear for cranes.

8,123. Oppenheimer (Actiengesellschaft Mix and Genest). Electric light wall plugs.

8,234. British Westinghouse Electric and Manufacturing Co. (Ltd.) (Redou). Electric rail bonds.

8,347. Taylor and Hudson. Trolley head employed in connection with electrically-propelled cars or vehicles.

8,427. Kammerer. Electrical presses.

8,610. Cheshire. Chains for electric light fittings.

8,827. Butler. Electrical batteries.

9,469. Peloux. Motor meters for alternating currents.

9,971. Jahr. Method of utilising electrical earth currents.

10,326. Shaw. Electrical stop gear for steam and other engines or machinery.

11,097. Woodward. Electrical accumulators or secondary batteries, and manufacture of same.

# COMPANIES' MEETINGS AND REPORTS.

## Telegraph Manufacturing Co. (Ltd.).

The ordinary general meeting was held on Friday at Liverpool, the chairman of the company (Mr. James Taylor) presiding.

The SECRETARY (Mr. J. Brotherton) having read the notice convening the meeting,

The CHAIRMAN said their profit and loss account did not show the same amount of profit as last year, as they then made a profit of £41,284, whereas this year it was £35,183. There had been one or two causes for the decrease. Last year they had an exceedingly good contract in the form of one of those orders which, if they got once in five years in an industrial business they were very pleased with. It was an order taken by the old company, and the new company certainly got the benefit of it. Last year also was one of great difficulty in making their goods, for during that time they practically reorganised the whole factory. Where they used to drive by steam they now used electric power, and the machinery had had to be altered to have the power applied. To do that and to keep the work going at the same time had not been an easy matter, and it had naturally disorganised them to a large extent. In fact, it meant that they dared not undertake heavy contracts, involving penalties for non-delivery to time, which was work they were now laid out for. They therefore thought it better to put forward their best endeavours to get the works into thorough working order before beginning to tender. He was glad to tell them that they were now in a position to tender, and they had every right to expect a share in some of the large contracts which were being given out. Out of the profits they had paid a preference dividend, also the small expenses of issuing the new shares. They had paid an interim dividend on the ordinary shares at the rate of 8 per cent. per annum, and out of the balance they now transferred £6,500 to reserve, £4,442 to depreciation, and they proposed to pay a further dividend of 6s. per share, with a bonus of 2s., making in all for the year a dividend at the rate of 12 per cent., the same as last year. They would see from the balance-sheet that their property, with machinery and buildings, had been increased by some £16,374, but they hoped the heavy capital expenditure they had had through the last two or three years was now at an end. There were a few little things to do, but not much so far as Helsby works were concerned. Their stock-in-trade was very much larger this year ; but it was all good stock, and a large portion of it was some raw material which they bought for a special order in hand. The book debts owing to them were £48,117—that was after making proper provision for bad and doubtful ones. Last year the reserve stood at £27,500, but they had been able to add £20,000, premiums they got on the issue of shares, which were fully taken up by the existing shareholders. They had added £6,500, and also £1,000 which they had held as a special reserve against claims under the Employers' Liability Act. They did that three years ago, as they could not then make satisfactory arrangements for insuring their workpeople, but they had now done so, and therefore had transferred that account to general reserve. The goodwill paid for the business three years ago was £47,000, and their reserve account now stood at £55,000, which must be satisfactory to everybody. As stated in the report the telephone industry would, they thought, become a most important branch of the business, and in view of that and the fact that their Liverpool factory was being worked to its utmost capacity, they were taking the necessary steps to meet the increased demand. Since last meeting a great many towns had gone into the ques

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tion of providing their own telephone exchanges, and for some years they had made a speciality of equipments for the big central switchboards used by telephone undertakings. He believed they were the only firm in England who had made those to any extent. Previously they all used to come from America. They had fitted up a large number of exchanges for the National Telephone Co., and when Glasgow and Tunbridge Wells gave out their orders for central boards, he was glad to tell them that they secured both orders. In addition he had heard, on the previous evening, that another important town had given a contract to them, so that they were in the unique position of having secured the only orders for those boards which had ever been given out. If other towns proceed with telephone work no doubt an immense business was to be done, but in their present works they certainly could not turn out more than was being done at present. They were fearfully pushed, and had, therefore, in Liverpool, practically negotiated for the necessary land upon which to put a proper factory. Before doing that they took steps to find a suitable building, but they could not find anything suitable. The report and accounts were then adopted and a dividend of 6s. per share, with a bonus of 2s. per share, was declared.

In reply to questions by Mr. Smethurst, the CHAIRMAN said that the reserve fund, as was usual in other industrial concerns, was at present invested in the business. They had a very large sum invested in freehold property and buildings, and also in stock; therefore, although it was earning no interest, it was earning a fairly good dividend, and if they were to invest it in outside securities—which he should certainly like to see—it would mean that they would have to increase the capital correspondingly for carrying on the business.

A vote of thanks to the chairman and directors terminated the proceedings.

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**BARCELONA TRAMWAYS CO. (LTD.)**—At the meeting of this company on Wednesday the chairman (Mr. J. B. Concanon) moved the adoption of the report which appeared in our last issue. He said that the receipts showed an increase of £10,600 over 1899. They had run 3,127,000 miles, against 2,380,000, and the passengers carried were 27,959,000 against 21,735,000, an increase of 6,223,000. The receipts only showed an increase of 12 per cent., due to a great extent to a reduction in fares. The electric section of their tramways, as distinct from the horse section, showed an expenditure of 66 per cent. of the receipts. That was largely increased by the high price of coal, which now showed a decrease of 5s. per ton. The net result was a gross profit of £22,120. Interest on debentures and debenture stock absorbed £10,264, and the preference dividend £5,000. After dealing with the relations existing between the company and its employés and the question of the loss on exchange, the chairman referred to the Ensanche Company, which was in rather a bad way financially. They had, however, come to the conclusion that, with electric traction on the Ensanche line, for which permission had practically been given, they should not only earn the working expenses, but interest on the original debentures and also on the capital necessary to convert that line to electric traction. The actual loss in traffic by the strike of their workmen was £2,280. Owing to the heavy traffic they were compelled to increase the number of cars. Recently the directors determined to order equipments for 40 more cars, 20 of which will be converted out of some of their old mule cars, which could be easily adapted for motor cars. A recently added short electric route would prove an extremely valuable feeder to their line. The report was adopted.

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**MOTOR TRACTION CO. (LTD.)**.—The report of the directors for the half-year ended Dec. 31 states that during the past year the rebuilding of the factory and depôt at Walnut Tree-walk has been proceeding. The two omnibuses which had been running between Kennington and Oxford Circus were withdrawn in December, the directors having come to the conclusion that all the experience that could be got from the working of these vehicles had been gained. The improved omnibuses ordered from the Daimler Company were expected to be delivered in March, but, owing to certain alterations, delay had occurred, and delivery was promised in a few weeks. The company would soon be in a position to undertake the construction of motor vehicles of the most approved type. The company undertakes the repair and maintenance of motor cars, and provides special facilities for charging accumulators.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**AUTO CARRIAGE CO. (LTD.)**—Reg. June 6, capital £20,000 in £1 shares, to carry on the business of manufacturers, hirers, &c., of motors, motor cars, and mechanically-propelled vehicles, manufacturers of and dealers in electric motors and dynamos, engineers, wire drawers, &c. The first directors are F. Lane and G. S. Gulbenkian.

**MAGNUS VOLK (LTD.)**— Reg. June 3, capital £10,000 in £1 shares (5,000 preference), to adopt an agreement with Magnus Volk, to acquire and work the electric tramways on the beach at Brighton, now worked by Magnus Volk, and any additions to and extensions of the said tramway, and to carry on the business of tramway proprietors, electrical and general engineers, &c. The first directors are Magnus Volk, Magnus H. Volk and Walter Crutchfield.

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**BRUSH ELECTRICAL ENGINEERING CO. (LTD.)**—The annual return to April 12 gives the capital as £660,000 in 180,000 ordinary and 150,000 preference shares of £2 each, of which 105,731 ordinary and 113,374 preference have been taken up; £2 per share has been called up on 35,817 ordinary and 41,837 preference shares. £282,902 is considered as paid on 69,914 ordinary and 71,537 preference shares. Mortgages and charges, £250,000.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (June 13, 1901). Price of silver 27 7/8d. per oz. (June 13). Consols (2¾ per cent.) 93⅞—94 for money, 93⅞—94 for account; 2½ per cent. 94¼—94¾ (June 13). Consols Pay Day, July 5; Stocks and Shares Continuation Days, June 26 and July 15; Ticket Day, June 27; Pay Days, June 14 and 28; Mining Share Carry-over Days, June 25 and July 12.

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**BELLISS AND MORCOM (LTD.)**.—In their report for the year ended March 30 the directors propose a further dividend of 7½ per cent., making 10 per cent. for the year, to place £10,000 to reserve and to carry forward the balance.

**BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)**—The transfer books and register of holders of debenture stock will be closed from 17th to 30th inst. inclusive, preparatory to payment of interest due July 1.

**BRISTOL TRAMWAYS AND CARRIAGE CO. (LTD.)**—The directors have decided to issue the further 25,000 4 per cent. cumulative preference shares created at the last general meeting at par to holders of the company's debenture stock, preference and ordinary shares.

**CHELSEA ELECTRICITY SUPPLY CO. (LTD.)**—The transfer books of the preference and ordinary shares and debenture stock will be closed from 18th inst. to July 2 inclusive.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**.—The transfer books and registers of holders of the 5 per cent. first debenture stock and the 4½ per cent. second debenture stock of this company will be closed from 17th to 29th inst. inclusive.

**COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)**—The transfer books and register of holders of debenture stock will be closed from 17th to 30th inst. inclusive, preparatory to payment of interest due July 1.

**DRAKE AND GORHAM (LTD.)**—We are asked to announce that, the capital of this company having been subscribed, letters of allotment have been issued.

**MUNICIPAL ISSUE.**—Plymouth Corporation are making an issue of redeemable stock at 95 to raise £200,000 for the extension and electrical equipment of the tramways, &c.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed the 19th inst. as a special settling day in 9,891 ordinary £1 fully-paid shares (Nos. 7,501 to 11,425, 12,926 to 15,025 and 16,026 to 19,891), and 34,314 6 per cent. cumulative preference £1 fully-paid shares (Nos. 7,501 to 36,045 and 36,146 to 41,914) of the *West London and Provincial Electric Supply Co. (Ltd.)*, and has ordered 6,637 6 per cent. cumulative preference £5 fully-paid shares (Nos. 1 to 6,637) of *Edmundsons' Electricity Corporation (Ltd.)*, to be quoted in the official list.

**WESTERN UNION TELEGRAPH CO.**—The usual quarterly dividend of 1¼ per cent. has been declared. The statement issued for the quarter ending June 30 shows:—Net revenue $1,750,000, increase $149,000; balance for dividends $1,511,000, increase $134,000; surplus after dividend $294,000, increase $134,000; total book surplus $9,307,000, increase $849,000.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | June 8 | 749 | + 25 | 1 | 749 | + 25 |
| *Birmingham Tramways | „ 8 | 4,624 | − 880 | 22 | 95,121 | + 1,992 |
| *Blackburn Corporation.. | „ 7 | 510 | − 242 | 23 | 10,542 | + 951 |
| Blackpool Corporation... | „ 6 | 1 622 | + 305 | †10 | 6,955 | + 2,367 |
| Blackpool and Fleetwood | „ 8 | 878 | − 956 | 23 | 7,871 | + 142 |
| Bolton Corporation ..... | „ 9. | 1,702 | − 46 | 10 | 15,359 | + 2,877 |
| Bradford Corporation... | „ 9 | 1,012 | + 224 | 10 | 10,217 | 5,297 |
| Brisbane Trams ..... | Apl. 24 | 1,824 | + 75 | 16 | 32,473 | + 3,522 |
| *Bristol Trams & Carriage | June 7 | 4,406 | − 302 | 22 | 93,559 | +27,870 |
| *Buenos Ayres & Belgrano | „ 12 | 2,657 | + 509 | 19 | 33,037 | + 9,493 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | „ 8 | 6,063 | ... | 23 | 142,531 | ... |
| City & South London Ry. | „ 9 | 1,922 | + 421 | 23 | 45,208 | +15,953 |
| Cork Elec. Trams ..... | „ 6 | 545 | + 3 | 22 | 9,345 | + 1,210 |
| Dover Corporation ..... | „ 8 | 220 | − 49 | 10 | 2,172 | + 183 |
| Dublin & Lucan Rly. ... | „ 8 | 113 | − 72 | 23 | 2,116 | + 128 |
| Dublin United ..... | „ 7 | 3,820 | − 534 | 23 | 67,115 | − 731 |
| Dublin Southern Dist... | „ 7 | 928 | − 327 | 23 | 18,048 | |
| *Dundee Corporation ... | „ 5 | 696 | + 269 | ... | ... | ... |
| *Glasgow Corporation ... | „ 8 | 11,598 | +1,102 | 1 | 11,598 | + 1,102 |
| Halifax Corporation..... | „ 9 | 1,186 | + 475 | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 8 | 848 | − 106 | 10 | 7,691 | + 1,734 |
| Hull Corporation..... | „ 8 | 1,657 | + 88 | 49 | 73,015 | +35,648 |
| Liverpool Corporation... | „ 1 | 10,159 | +2,209 | 22 | 184,124 | +27,582 |
| *Liverpool Overhead Rly. | „ 9 | 1,651 | − 130 | 23 | 36,106 | + 3,316 |
| Perth (W.A.) Elec. Trams | „ 7 | 900 | + 536 | 49 | 33,179 | ... |
| Portsmouth Corporation | „ 8 | 682 | − 574 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 9 | 3,655 | + 827 | 23 | 72,933 | +26,824 |
| Southampton Corporat'n | „ 6 | 753 | + 56 | ... | ... | ... |

(a) These comparisons are for the corresponding week last year.
* Partly electrical. † Minus 8 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 5. | Price Wednesday, June 12. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending June 12. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ... | ... | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 75 | 70 75 | ... | ... | ... | ... |
| 8,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ 12½ | 11½ 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 104 | 103 106 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ 8¼ | 7⅞ 8¼ | 3 12 9 | ... | 8 | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ 9 | 8¾ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7 7⅛ | 7 7⅛ | 2 6 8 | ... | 7⅛ | 7⅛ |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 10 0 | February and August | 9⅛ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ 5⅝ | 5¼ 5⅝ | 3 18 3 | ,, ,, | 5⅝ | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 6 6½ | 5¼ 6½ | 4 8 0 | March | 6 | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8¾ 9¼ | 8¾ 9¼ | 4 4 3 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 13 | 12¾ 13½ | 4 12 2 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 123 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 103 | 101 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8¼ 9¼ | 8¼ 9¼ | 4 4 3 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11¼ 12¾ | 11¼ 12¾ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 105 108 | 105 108 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5¼ 5¾ | 5¼ 5¾ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/3 | Hove Electric Lighting Ordinary | 7⅛ 8⅛ | 7⅛ 8⅛ | 2 15 5 | ... | 7¾ | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ 12½ | 11½ 12½ | 4 4 0 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ 7 | 6½ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 102 105 | 101 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 104 | 103 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ 1⅝ | 1½ 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 101 | 98 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 14 15 | 13½ 14½ | 4 2 9 | April and October | 14½ | 14 |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 14 15 | 13½ 14½ | ... | ... | 14⅝ | 14 |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 99 | 96 99 | 3 11 5 | ... | ... | ... |
| 8,652 | 10 | 8/0 | Notting Hill Electric Ordinary | 15½ 16½ | 15½ 16½ | 4 13 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6⅝ 6¾ | 6⅝ 6¾ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅝ ¾ | ⅝ ¾ | 10 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 75 | 65 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 104 | 102 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 15 16 | 15 16 | 4 10 8 | February and August | 15⅝ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 101 | 98 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 103,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 13 | 12 13 | 4 0 9 | March and September | 12⅝ | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 4½ | 4 4½ | 4 14 2 | April and October | ... | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 129 | 124 129 | 4 14 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 10 | 8 10 | 2 0 0 | ... | 8½ | 8 |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 99 101 | 96 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4¼ 4¾ | 4¼ 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 101 | 99 101 | ... | ... | 100½ | 99¾ |
| 40,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 22¾ 23½ | 23½ 23¾ | 3 7 6 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10¾ 11 | 10¾ 10¾ | 3 14 5 | ... | ... | ... |
| £130,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 116 | 114 116 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ 7 | 6¾ 7 | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 9⅞ 10 | 9½ 10 | 5 0 0 | May and November | 9⅞ | 9⅞ |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 99⅝ 101⅞ | 99⅞ 101⅞ | 4 9 3 | ... | 101 | 10 ⅛ |
| 62,074 | 10 | 6/0 | British Elec. Trac. Ord. | 14½ 15½ | 14½ 15½ | 5 9 8 | ... | 15½ | 14⅛ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 13 | 12 13 | 4 12 4 | February and August | 12⅝ | 13⅛ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 123 | 120 123 | 4 1 9 | ... | 121½ | 121½ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅞ 1¾ | 1½ 1¾ | ... | ... | 1⅞ | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ 5⅝ | 5¼ 5⅝ | 5 4 4 | ... | 5⅝ | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5 5½ | 5 5½ | ... | ... | 5⅝ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 107 | 104 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 1 8 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) | 10½ 11½ | 10½ 11½ | 2 14 2 | ... | ... | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 103 105 | 103 105 | ... | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | ... | ... |
| 19,980 | 10 | 2/6 | Central London Ordinary | 9¼ 10 | 9¼ 9¼ | 2 16 5 | June and December | 9⅝ | 9½ |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 118 | 113 118 | ... | ... | 11 ⅛ | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ 5⅜ | 5¼ 5⅜ | 4 13 11 | ... | 5⅜ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 103 | 100 103 | 3 17 10 | ... | ... | ... |
| £288,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 51 53 | 51 53 | 2 7 7 | February and August | ... | ... |
| 47,500 | 10 | 2/0 | Do. Ordinary (Nos. 22,501 to 70,000) | 4⅞ 5¼ | 4¼ 5¼ | 2 7 0 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 127 | 122 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 111 116 | 111 116 | 3 9 2 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 14 | 13 14 | 4 5 9 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 4½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5¼ | 5¼ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4¼ 4½ | 4¼ 5¼ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 23½ | 22 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ 15¾ | 14½ 14¾ | 3 18 8 | ... | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 114 | 112 114 | 3 18 11 | ,, ,, | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | ... | ... | January and July | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 8¼ 8½ | 8¼ 8½ | 3 18 9 | May and November | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 13¼ | 13 13½ | 3 15 6 | February and August | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 18 3 | ,, ,, | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts (fllypd) | 104 105 | 104 105 | ... | January and July | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 102 104 | 102 104 | 4 16 2 | ... | 105½ | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 3½ | 3 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 0/0 | Do. 6 per Cent. Cumulative Preference | 4½ 5 | 4½ 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 12 | 11 12 | 1 13 4 | ... | ... | ... |
| 20,000 | 10 | 0/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 107 | 105 107 | 4 4 1 | ... | 105¾ | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 93 96 | 93 96 | 3 2 10 | June and December | ... | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 5. | | Price Wednesday, June 12. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending June 12. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £98,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅛ | 4⅛ | 3⅛ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 54 | 57 | 54 | 57 | 5 10 7 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 | 100 | 97 | 99 | 6 2 0 | ,, ,, | 99 | 97½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10⅛ | 11 | 10 | 10⅛ | 2 7 7 | ,, ,, | ... | ... |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,020 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 | 102 | 101 | 103 | 3 18 3 | ,, ,, | 102½ | 10 ½ |
| 15,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 | 16 | 14½ | 15½ | 6 9 0 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ | 104⅞ | 100⅞ | 104⅞ | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10⅝ | 10⅛ | 10⅜ | 6 10 10 | Jan., Apr., July, Oct. | ... | ... |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | 100 | 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 140 | 145 | 140 | 145 | 4 17 0 | Jan., Apr., July, Oct. | 143 | 14⅛ |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 | 94 | 90 | 93 | 3 15 8 | ,, ,, | 92½ | 91 |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 114 | 110 | 114 | 3 10 2 | May and November | 112 | 110½ |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ | 14½ | 13½ | 14 | 5 0 0 | Jan., Apr., July, Oct. | 14⅛ | 13⅞ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 115 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100⅞ | 104⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust | 9½ | 10½ | 9⅞ | 10⅛ | 5 3 5 | Jan., Apr., July, Oct. | 10 7/16 | 9⅞ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14⅞ | 15⅞ | 3 18 8 | ,, ,, | 14⅞ | ... |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen | 31 | 33 | 31 | 33 | 4 10 11 | January and July | ... | ... |
| £82,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos | 100 | 103 | 100 | 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red.) | 43 | 47 | 43 | 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 18 1 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 10 | ,, ,, | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2 | 3 | 2 | 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 7 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅜ | ½ | ⅜ | ½ | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | 10 0 0 | ,, ,, | 5⅜ | 5 |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | 12 0 0 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zill'n Submarine) | 13¾ | 14½ | 13⅞ | 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14 | 13 13/16 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 102 | 105 | 102 | 105 | 4 15 8 | June and December | ... | ... |
| £348,777 | Stock | 4% | * Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅞ | 4 | 3⅞ | 4 | 5 0 0 | August | ... | ... |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/3 | 2/9 | 2,6 | 3/0 | 10 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ | ¼ | ⅛ | ¼ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2 6 | National | 3⅜ | 5⅛ | 3⅛ | 3⅞ | 7 17 2 | February and August | 3⅜ | 3 3/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 4 16 0 | ,, ,, | 12⅜ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11¼ | 12⅛ | 11⅛ | 12⅛ | 4 16 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ | 4⅜ | 4⅛ | 4⅜ | 5 11 1 | ,, ,, | 4⅛ | ... |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 87 | 90 | 87 | 90 | 3 18 8 | June and December | 89 | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 | 98 | 95 | 98 | 4 2 8 | ... | ... | ... |
| 171,504 | 1 | 0/2½ | Oriental | ⅞ | 1 | ⅞ | 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 5 | 5½ | 4 | 4⅛ | 7 15 7 | July | 6⅛ | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅞ | 5⅛ | 4⅞ | 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 14 9 | June and December | 104 | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ | ½ | ⅜ | ½ | 8 0 0 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 1/32 | 1/16 | 1/32 | 1/16 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | 1/16 | 1/8 | 1/16 | 1/8 | 7 7 8 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 9⅛ | 10⅛ | 9⅛ | 10⅛ | 7 2 10 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5⅞ | 6⅛ | 5⅞ | 6⅛ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅛ | 5⅛ | 4⅜ | 5⅛ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ | 1⅝ | 1⅜ | 1⅝ | 3 8 7 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2⅛ | 2⅜ | 2⅛ | 2⅜ | 5 1 1 | ,, | 2 5/16 | 2¼ |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 104 | 101 | 104 | 4 8 3 | January and July | 103⅛ | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 | 15 | 14 | 15 | 5 0 0 | ,, ,, | 14⅛ | 13⅜ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 9 | ,, ,, | 5 13/16 | 5 11/16 |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | 13/16 | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 | 98 | 94 | 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 15 7 | March | ⅞ | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ⅞ | 1⅛ | ¾ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅞ | 4 | 3⅞ | 4 | 5 12 7 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 1 1 | 104 | 101 | 104 | 4 17 0 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ½ | 1 | ½ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1 | 1⅛ | 1 | 1⅛ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2 | 3 | 2 | 3 | 8 15 6 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 | 89 | 87 | 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 7 7 10 | Half-yearly | ... | ... |
| 50,000 | 5 | 1 6¼ | Do. Cumulative Preference | 5⅜ | 6 | 5⅜ | 5⅝ | ... | ... | 5 3/16 | 5⅜ |
| £110,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 5 | ... | 103 | ... |
| 112,100 | 5 | 1/2½ | Electric Construction Co. (Limited) | 1⅜ | 2⅛ | 1⅜ | 2⅛ | 5 6 8 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July | 3 | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | ... | ... |
| 18,000 | 10 | ... | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅜ | 10⅛ | 9⅛ | 10⅛ | ... | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15⅛ | 16⅛ | 15⅛ | 16⅛ | 6 1 3 | February and August | 16⅛ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | 5 7/16 | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | 21⅛ | 21⅜ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | 102⅜ | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 35 | 39 | 35 | 39 | 5 7 8 | March and July | 38⅛ | 37½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908 | 102 | 105 | 102 | 105 | 3 16 10 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ | 11⅛ | 10½ | 11⅛ | 5 12 6 | ... | 10⅜ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 | 11 | 10⅛ | 11⅛ | 5 4 4 | April and October | 11⅛ | 10⅜ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6⅛ | 6⅞ | 6⅛ | 6⅞ | 4 8 11 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debenture (red) | 104 | 105 | 105 | 107 | 4 0 2 | May and November | 107 | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,205. [Vol. XLVII. No. 9.] FRIDAY, JUNE 21, 1901. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents, or 80c., or 70pf


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## NOTES.

IN our report of the meeting of the Incorporated Municipal Electrical Association on Wednesday, given in another column of this issue (p. 332), it will be seen that Mr. RIDER referred to modifications which had been made in the Board of Trade regulations for electric tramways. These modifications have been included in the regulations issued for the Wigan and Poole tramways, and the arrangements at Wigan were inspected and passed by the Board of Trade as long ago as last March. They consist in the following additions to regulation 5, the original regulation being quoted in Mr. RIDER'S Paper, which we also reprint in this issue:—

When the generator is at a considerable distance from the tramways the uninsulated return shall be connected to the negative terminal of the generator by means of an insulated return conductor, and the generator shall have no other connection with earth; and in such case the end of the insulated return connected with the uninsulated return shall be connected also through a current indicator to two separate earth connections, or with the necessary consents to a main for water supply, or with the like consents to both in the manner prescribed in this regulation.

If the current indicator cannot conveniently be placed at the connection of the uninsulated return with the insulated return, this instrument may consist of an indicator at the generating station, connected by insulated wires to the terminals of a resistance interposed between the return and the earth connection or connections. The said resistance shall be such that the maximum current laid down in regulation 6 (i) shall produce a difference of potential not exceeding 1 volt between the terminals. The indicator shall be so constructed as to indicate correctly the current passing through the resistance when connected to the terminals by the insulated wires before-mentioned.

We may remind our readers that the Board of Trade regulations for tramways are issued for each particular case, and are not a hard-and-fast set of rules, as are the Board of Trade regulations under the electric lighting acts. We learn, however, that in all probability similar regulations to those for Wigan and Poole will shortly be issued for Croydon, Manchester, and West London, and there seems little doubt that, had Mr. RIDER made an application in the right quarter, the regulations issued last month for the London County Council tramways would have contained the amended instead of the original rule 5, as the modification of this rule has been under consideration at the Board of Trade for some time.

THE Factory and Workshop Acts Amendment Bill passed its second reading on Monday last, and was referred to the Standing Committee on Trade, as was also the Factory and Workshop Acts Consolidation Bill, whose object is to consolidate into one act all the legislation on the control of factories and workshops. If representations are to be made with regard to the influence of this threatened legislation on electrical generating stations, therefore, no time should be lost.

MR. ASQUITH, in his speech on the Amendment Bill last Monday, quoted ironically the following extract from the report of a speech by the chairman of Messrs. Kynoch:—

They were inspected to death and they were hampered at every step. . . . What economies could be effected if the manufacturer could carry on his business free from local boards and by-laws, free from sanitary inspectors, free from smoke inspectors, free from chemical inspectors, free from School Board inspectors, free from Home Office inspectors, and factory inspectors—free, in fact, from the whole brood of officials who, not being producers themselves, lived on the produce of manufacturing industry and strangled it.

He then went on to draw a pathetic picture of the state of workers in factories before the beneficial legislation introduced by the efforts of Lord SHAFTESBURY, when "the ordinary sanitary safeguards were uniformly neglected, and it was no exaggeration to say that the whole system was a vast sacrifice of human life." But if we apply this to electricity generating stations we find that no general unsanitary conditions are liable to prevail there, but that, on the contrary, an electric supply station may be ranked as one of the cleanest and healthiest of works. The few cases of accidents that have occurred have more often been due to the carelessness of the victims themselves than to the particular conditions prevailing. We are strongly in favour of the most extreme precautions being taken to prevent accident occurring from high



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pressures, and reasonable inspection to ensure this might possibly be an advantage; but the owners of generating stations and representative members of the electrical industry generally should do all in their power to oppose legislation which would render their business liable to the over-inspection referred to in Mr. ARTHUR CHAMBERLAIN'S speech, quoted above. Electricity generating stations should be put on an entirely different basis to ordinary factories, and it would be a good thing for the electrical industry if Mr. RITCHIE could be persuaded to omit them from his present Act. Instead of imposing fresh legislation in this manner, he would confer a boon on the industry if he were to introduce in the next session of Parliament, as a parallel to the Factory and Workshop Acts Consolidation Bill, a single Bill consolidating, rationalising and modernising the law of electric lighting, power supply and traction.

IT will be remembered that Mr. W. H. MAW, in his recent presidential address before the Institution of Mechanical Engineers, remarked on the debt of gratitude due to electrical engineers from engine builders, as, owing to the accurate tests required, the economy of steam engines had been largely increased. We consider that a number of other manufacturers should be grateful to electrical engineers for similar reasons. To take a specific instance, we would mention the case of boiler feed-pumps, which until lately were veritable *gourmands* for steam. They would appear, however, from tests described in last week's issue of *Engineering*, to be altering their habits and becoming quite temperate machines under the gentle treatment of electrical engineers, though it is possible that some diminution in their consuming power may be due to the competition with electrically-driven pumps. The latter are so frequently installed in electric generating stations, at greatly increased capital cost, that we can only suppose that their efficiency must be very high, though very little, if any, data have been published to show exactly what that efficiency is.

THE tests referred to relate to a triple-compound feed pump supplied by Messrs. G. and J. WEIR to the Croydon Corporation, and consisting of three simple direct-acting pumps connected so that any one of the pumps may be used independently, or the three pumps may be used on the compound principle, the middle pump serving for the high pressure. Each has a capacity of 6,000 gallons per hour. In the test the steam was condensed in a surface condenser at atmospheric pressure, and the drain was led to a tank placed on a weighing machine. The amount of water delivered was measured by means of graduated tanks. The number of strokes was indicated by a counter actuated by a lever from the pump-rod. The pumps were acting against a steam pressure of 170lb. per square inch, the water pressure being about 180lb. per square inch. When working simple at 13½ revs. per min., 74½lb. of water were delivered per pound of steam; at four revolutions 55½lb. of water were delivered; whilst working compound at the normal speed of 12 double strokes per minute 110½lb. of water per lb. of steam were raised. This result is exceedingly good, and we trust it will cause the makers of the electrically-driven pumps to look to their laurels.

A LEAFLET has just been forwarded to us headed "Cause and Prevention of Waste of Electrical Energy, from Direct Observation, Guided by Science and Tested by Experience." It is really difficult to determine, by reading the pamphlet, which is the most inaccurate, the science or the grammar; we should say the former, but we give our readers a couple of gems to enable them to form their own opinion:—

> The estimation of the loss of electric energy cannot be exactly calculated (but is roughly from 5 to 15 per cent. except the loss of copper of conductors) and various installations on the resistance conductor of the earth from one conductor to the other.
>
> It is necessary to carefully observe the resistance of various insulating materials to resist between electric current and atmospheric action; the real nature of electricity which is composed of different chemicals of atmospheric and metallic action which forms an invisible power possessed of magnetism necessary to resist from affecting such as chemicals, earth and general atmospheric action; the insulation must stand a test of about 150°F. and chemical heat action. All these difficulties can be overcome by using ....."s newly-discovered safety and current-saving system of electric installation, full particulars of which may be had at .....

The leaflet is apparently intended for trade purposes to push a particular system of house wiring. To technical men it is merely amusing. Let us hope that the bad grammar will put those without technical knowledge on their guard.

IT may be of interest to our readers to know something of the Verband Deutscher Elektrotechniker, whose meeting the section of the Institution of Electrical Engineers visiting Dresden next week will attend. The Verband or Association of German Electrical Engineers is a body even more representative of the German electrical industry than our own Institution is of British electrical engineering. Every German electrical firm of any importance, and practically every German electrical engineer or electrician of any standing is a member of the Verband, and its meetings, which take place once a year, are more valuable as a means of settling important matters connected with the progress and condition of the industry than for the actual Papers read. Thus, the safety regulations issued by the Verband for electricity supply are officially recognised and enforced by the governments of all the German kingdoms, and several of the other States; standards have been fixed for various electrical apparatus in which interchangeability has been most desired (and these standards are adhered to by members of the Verband); and another instance of the work of this Association is the suggested standard specification for the testing of electrical machinery, which we publish in another column of this issue. Affiliated to the Verband are electrical societies (Electrotechnische Vereine) in all the chief towns in Germany, which hold meetings periodically, when Papers are read and discussed.

Royal Society.—Among the Papers down for reading yesterday was one by Mrs. Ayrton, entitled "The Mechanism of the Electric Arc."

Personal.—It is currently reported that Sir Alexander Binnie, engineer to the London County Council, is about to resign this appointment and to establish himself as a consulting engineer at Westminster.

Wireless Telegraphy in the French Navy.—A *Standard* telegram from Toulon says that the flagships "Bouvet," "Charles Martel," and "Pothuau" have been fitted with special installations of wireless telegraphy for utilisation during the forthcoming manœuvres.

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**Edinburgh University.**—At a meeting of the Curators of Patronage of the University of Edinburgh, held last Wednesday, Prof. J. G. Macgregor, D.Sc., F.R.S., late Monro Professor of Physics, Dalhousie University, Halifax, N.S., was elected Professor of Natural Philosophy, in place of Prof. Tait, resigned.

**Cable Interruptions and Repairs :—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... ..... | Mar. 2, 1900 ... | — |
| Cayenne—Pinheiros .. ..... | April 21, 1901 ... | — |
| Bolama ..... | May 20, 1901 ... | — |
| Gibraltar—Tangier..... | June 11, 1901 ... | June 13, 1901 |

**The Lodge Wireless Telegraph System.**—A syndicate has just been formed to push the system of wireless telegraphy patented by Prof. Lodge and Dr. Muirhead.—We notice in the *Electrical World* of New York for June 1st, that a United States patent was granted to Prof. Lodge on May 21st (application filed on Dec. 20, 1897), whose claims were of a fundamental character.

**Central Technical College.**—The fourth annual dinner of the Association of Old Students of the Central Technical College will be held at the Restaurant Frascati, Oxford-street, on Wednesday, July 3rd, at 7:30 p.m. Prof. O. Henrici, President of the Association, will take the chair. Tickets (price 6s.) can be obtained on application to the hon. secretary, Mr. Maurice Solomon, 12, Edith-road, West Kensington, W.

**FitzGerald Research Scholarship.**—According to *Nature* it is proposed to found a "FitzGerald Research Scholarship," to be awarded annually at Trinity College, Dublin, and a large and influential committee of leaders of science at home and abroad has been formed to obtain funds for this purpose. The scholarships would be attached to the department of experimental physics in the college, and would enable promising students to pursue investigations which, for want of means of immediate support, might otherwise have to be relinquished.

**Foreign Made Machinery.**—With reference to our criticism last week of Mr. Cawthra's remarks in connection with the Swansea tenders for two-phase motor alternators, Mr. E. K. Scott, of the International Electric Co., of Liège, informs us that all his firm's machines are provided with bolts and screws in accordance with Whitworth standard gauge, and that a stock of certain spare parts is kept in London. He also mentions, in view of Mr. Cawthra's disparaging remarks as to foreign-made machinery, that his firm has supplied plant to a number of leading British iron and steel works, shipbuilding yards, &c., during the last 10 years without any question having arisen as to their methods of manufacture or the quality of the machinery.

**New Method of Charging for Electric Light.**—At the convention of the National Electric Light Association in the United States, Mr. L. R. Wallis read a Paper on "A Method of Charging for Electric Energy" which bears a close resemblance to the Wright maximum demand system, the difference in the new system being that the customer selects his own maximum demand and a device is installed which is set for the number of lights fixed by the customer and causes the light to flicker when the number is exceeded. An arrangement is made that for special occasions the device can be changed for a fee of $1. The cost of the automatic device up to 25 lights is $8.00. There are two charges made, one for the plant capacity required for the maximum demand of the consumer, the other for the actual energy consumed.

**Conversazioni.**—A successful and well-attended conversazione was given by Mr. James Mansergh, President of the Institution of Civil Engineers, at Great George-street, on Wednesday. The telegraphone and telautograph were both working before large audiences, and amongst other apparatus on view may be mentioned Mr. F. W. Webb's working model of electric point and signal working, Mr. A. W. Szlumper's models of electro-pneumatic signalling, Mr. P. Bale's exhibit of a Gardner rock drill, and Mr. G. L. Addenbrooke's electrostatic system for the measurement of alternating currents. ——The annual conversazione of the Institution of Electrical Engineers was held last Friday at the Natural History Museum, South Kensington, and was well attended by members of all classes, and an unusually large proportion of ladies.——The Society of Arts conversazione will be held at the Botanical Gardens next Friday at 9 o'clock.

**Shut-down of a Penstock at Niagara Falls.**—We learn from the *Electrical World* of New York that penstock No. 3, of the Niagara Falls Hydraulic and Manufacturing Co., was shut off on May 14th, cutting off six dynamos, the object being to prevent the wearing away of the rocks at the outlet of the tail-race into the river. This wearing away had become a serious matter, occurring very near the power-house, and retaining walls having crumbled away, as has taken place before in other tail-races. The device to overcome future destruction consists of a number of pieces of boiler iron, riveted together to form the bottom of the tail-race. There are upright side extensions, also of iron, to preserve the side walls. At the end toward the river there is a slight upward curve in the iron plate, to throw the water upward and thus prevent further undermining.

**Automobilism in the United States.**—The Automobile Club of America has decided to organise an annual road race, subject to the approval of the local authorities wherever the course is chosen. The stakes will probably amount to $5,000, towards which the club will subscribe $1,000, and further subscriptions are solicited from members. It will be an international race, open to competitors from all over the world, and there will be three prizes. The first race will probably be over the Buffalo-Erie course about the middle of September, and it has been definitely fixed that its length be between 50 and 100 miles. Cars carrying two persons are eligible, and the entry fee will be $100 for each vehicle and $50 additional for starters. The Automobile Club of America will also organise, subject to the consent of the local authorities, an annual race for the mile record. Entries for this are to be made for steam, gasoline and electric carriages in separate classes, and the entrance fee will be $10. The club awards a cup to the winner in each class.

**Standardisation of Iron and Steel Sections.**—A committee has recently been appointed by the Institution of Civil Engineers, with the support of the Institutions of Mechanical Engineers and Naval Architects and of the Iron and Steel Institute, to consider the advisability of standardising the various kinds of iron and steel sections, and, if found advisable, then to consider and report as to the steps which should be taken to carry such standardisation into practice. The committee is composed as follows :—

Mr. James Mansergh (Pres.Inst.C.E.), Sir Benjamin Baker, Sir John Wolfe Barry, Sir Frederick Bramwell, Sir Douglas Fox, Mr. G. Ainsworth, Mr. William Dean, Mr. A. Denny, Mr. J. Allen McDonald, Mr. E. Windsor Richards, Mr. James Riley, Prof. W. C. Unwin, and Dr. J. H. T. Tudsbery (hon. secretary).

Mr. Leslie S. Robertson, of 28, Victoria-street, S.W., has been appointed secretary to this committee, which has already commenced its work by taking evidence tendered by engineers, manufacturers and contractors bearing upon the subject of the inquiry.

**A Movable Electric Coal Conveyor.**—The *Engineering and Mining Journal* of New York, in a recent number, describes a movable coal conveyer which is working at Chicago in a yard which it is necessary to keep clear for the handling of machinery, and where the coal is brought to the consumer in gondola trucks. The conveyor is mounted on a movable framework, which is 90ft. long and about 4ft. high, and supported on three set of wheels which run on a narrow-gauge track. One electric motor serves to drive the conveyor and also to move the entire machine forward and backward, and the coal from six cars can be carried to a common point without its being necessary to shift the cars. To drive the conveyor running empty requires $3\frac{3}{4}$ H.P. To drive it when it is loaded by 14 men scooping from the cars at the rate of $67\frac{1}{2}$ tons per hour, $4\frac{1}{8}$ H.P. is required, and to move the entire apparatus takes $5\frac{1}{8}$ H.P. The conveyor empties three cars from one position then it is moved to a second position, and the direction of the belt's motion is reversed. This is accomplished with a reversing switch at the motor. To move the frame along on its track, power is communicated to the driving wheels through a friction clutch at the end of the conveyor furthest from the motor, the conveying belt being used to transmit the power.

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**Keighley Corporation Electricity Supply Works.**—On Saturday last the Keighley generating station was opened by the Mayoress. The works, including buildings, have been designed and supervised by Mr. J. M. Smyth, the borough electrical engineer, and they have been completed at a cost of £30,400, this being £4,200 less than the original estimates. Two Lancashire boilers have been installed having a total evaporative capacity of 13,500lb. per hour. There are three Allen engines, two directly coupled to 120kw. bipolar Parker dynamos, and one coupled to a 200kw. four-pole Parker dynamo. A battery of 256 Tudor cells has been fixed, having a capacity of 700 ampere-hours and maximum discharge rate of 300 amperes. Three Körting ejector condensers are employed, a 192-tube Green's economiser has been fixed, and the water supply can be taken from the town or river. The current is supplied on the three-wire system, the pressure being 230 volts at the consumers' terminals. The distribution is by means of Callender jute cables, both Doulton ducts and the cast-iron solid system being used. The Wright maximum demand system of charging is employed, prices for lighting being 7d. and 8d., and for power 8d. and 1½d.

**Wireless Telegraphy on Atlantic Liners.**—It will be remembered that some time ago wireless telegraph apparatus was introduced experimentally on the s.s. "St. Paul," when Mr. Marconi was on board. A few weeks ago we recorded that a set of apparatus had been installed in the "Lake Champlain," of the Beaver Line, and now a complete outfit of wireless telegraph instruments has been fixed in the Cunard steamship "Lucania." This vessel started from Liverpool for New York on Saturday, and whilst in the Mersey she was in communication with the training ship "Conway." She next came in range of the station at Holyhead, the next installation was at Rosslare, about 90 miles from Holyhead, and the last station at Crookhaven, near the Fastnet. Unfortunately, it was impossible to keep up communication the whole of the way from Liverpool to Crookhaven, touch being kept with Holyhead for only about 1½ hours, and 2½ hours with Rosslare. We learn that afterwards she interchanged messages with the "Lake Champlain," which reached the Mersey on Monday. The latter ship exchanged messages also with Crookhaven, Rosslare, Holyhead, and Liverpool. Fifty messages were dispatched in the course of rather more than five hours. The greatest distance appears to have been to Rosslare, when 45 miles away. Messrs. Elder, Dempster & Co. have been so pleased with the results that they have cabled a petition to the Canadian authorities begging them to fix installations along the St. Lawrence and Belle Isle.

**Localisation of Earths in Conduit Systems of Traction.**—An ingenious system has been employed by MM. Georges Claude and L. Bombes de Villiers, engineers of the French Thomson-Houston Co., for the localisation of earths on conduit systems of electric traction. An oscillatory current produced by the discharge of condensers is passed through the circuit formed by the car-wheel, rail, fault, and plough working conductor, and passes through a hot-wire ammeter on the car. A condenser is also placed in this circuit to prevent the working current from passing through the ammeter if the test is made when the rails are live. So long as the car is distant from the fault the ammeter will only show a small deflection, as the apparent resistance of the rail and working conductor to high frequency currents is considerable. As the car approaches the fault, the apparent resistance decreases to a minimum and the deflection of the ammeter increases. The high-frequency current is obtained by shunting the discharge knobs of the secondary of an induction coil through two condensers and a solenoid, and tapping off two points of the solenoid. The method may be made more sensitive by regulating the capacity of the condenser in series with the conductor and fault circuit, so that there is resonance between the capacity of this condenser and the self-induction of the connecting wires when the fault is below the car. In this way a greater current can be obtained for a given fault and the localisation is more definite, as the self-induction of the rails added to that of the connecting wires destroys the resonance when the car is not immediately above the fault.

**A New Primary Battery.**—At a meeting of the French Physical Society on May 17th, M. Georges Rosset read a Paper describing a new primary battery. The depolariser of this battery, after being reduced by the hydrogen, is automatically re-oxidised by the air at the surface of the battery during the actual working of the cell, without any manipulation being necessary. It consists of a cuprate of ammonium which, when reduced in the battery, becomes a cuprite. But, exposed to the air, this cuprite is reduced to the state of a cuprate, and the depolariser is thus automatically regenerated. The cuprite itself is an oxidiser and can, if necessary, depolarise by depositing on the positive (carbon) pole of the battery metallic copper. When at rest this copper is re-dissolved and the initial cuprate re-formed. The exciting solution containing chloride of ammonium, supplies ammonia to the positive pole during working, which compensates the inevitable losses of the depolariser in ammonia. The diffusion of the depolariser is prevented by the employment of a semi-porous colloidal membrane of ferro-cyanide of copper, obtained by means of chemical precipitation, in the thickness of the porous partition. By means of the free ammonia of the depolariser, in which the ferro-cyanide of copper is soluble, this membrane, being always recently re-precipitated, is maintained in the colloidal state and thus remains semi-porous. In official tests made at the Central Laboratory of Electricity, on a continuous discharge through 10 ohms resistance, the variation of current was less than 1 milliampere in 24 hours during the month the test lasted. This variation is quite continuous. The consumption of zinc is extremely regular, the zinc pencil becoming thinned down to an actual wire. Renewing the zinc and the exciting solution restores the cell to its original activity, the curve following the same path as before, 1 milliampere below the first one. This shows that the depolariser is not used up, and can be employed over and over again. On stopping up the ventilation hole of the depolariser, the E.M.F. and current dropped more rapidly than before, and they increased again when access was afforded to the air.

**Water Rheostat for a 3,750kw. Circuit.**—The whole of the 200,000 8 c.p. lamps used in the decorative lighting of the Pan-American Exposition are gradually brought up to full power and gradually dimmed by a water rheostat placed where the 11,000 volt line enters the grounds. The rheostat house contains three tanks of water, one for each leg of the circuit. These tanks are 10ft. long, 8ft. wide, and 3ft. deep. They are all mounted on porcelain insulators such as are used on the line. Into this tank three cast-iron plates operate to vary the resistance in circuit. These plates are of cast iron, 8ft. long, ¾in. thick, and are pivoted so that they describe the arc of a circle while being lowered into the water; the width varies from 18in. at the pivot to 8in. at the tip. When fully in the water the tip strikes a submerged clip or switch jaw, which short circuits the rheostat. The increase of candle-power of the lamps from the dullest red to full brilliancy is, according to the *Electrical World*, of New York, very steady, except that there is a sudden rise just before the plate strikes the submerged clip. The plates are lowered simultaneously by an electric motor working on a worm gear. The motor can be controlled from a distance if desired, but is usually started and stopped by a man in the rheostat house. In lighting up, the lamps are brought up to full candle-power in 45 sec. In shutting down, 75 sec. is consumed. Judging from the appearance of the lamps the voltage at the start is not over 20 per cent. of the full voltage. Assuming that the 200,000 25 watt lamps take one-fifth their normal current and voltage at the start the rheostat takes 800kw., and the current makes the water in the tanks boil violently. The lip at the pivot end of the cast-iron rheostat plate is always under water, and the circuit is broken by the main oil switch in the electricity building. It was found entirely impracticable to try to break the arc at the rheostat or even to allow the plate to come the least out of the water, as the resultant arc streamed all over the neighbourhood. The rheostat is used only for turning on the lights at the grand illumination at 8 p.m., and for turning them off for the night several hours later.

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# ELECTRIC POWER SUPPLY AT NEWCASTLE-ON-TYNE.

The honour of being the first statutory undertaking in the United Kingdom to supply electric power "in bulk" for motive power purposes in works, &c., is shared by the Newcastle-on-Tyne Electric Supply Co. in conjunction with the Walker and Wallsend Union Gas Co. On Tuesday last, the 18th inst., "electric power supply on Tyneside" was formally inaugurated by Lord Kelvin, and the large power station at Neptune Bank was declared open. As a matter of fact, however, supply from this station to local works dates from last November. Through the courtesy of the directors of the associated companies we have been permitted to take a preliminary survey of these works, and are therefore enabled to give our readers a detailed account of their present condition. Our thanks are given to Mr. Watson, of the Newcastle Electric Supply Co., and to Mr. McLellan, who is associated with Mr. Charles Merz, the consulting engineer for both the companies concerned, for their kindness in accompanying us over the area of supply and many of the large works where power is supplied. We have also to thank Mr. Merz for the excellent photographic illustrations and the plans which accompany this article. It may not be inappropriate at the outset to congratulate the directors of the two associated companies upon having taken the pioneer place in the actual supply of electric power in bulk to engineering and other works, also to offer congratulations to Mr. Merz and those associated with him in the prompt and highly successful achievement of the engineering solution of this new economic problem. Not merely electric power supply on Tyneside was formally inaugurated last Tuesday, but the era of electric power utilisation all over the kingdom. It is with this great central fact in view that we purpose to devote considerable space to an account of the pioneer undertaking.

The power to operate this complete system has not, as in most of the other power schemes, been obtained at one time by one application to Parliament, but is the outcome of a series of extensions of its area by the Newcastle Electric Supply Co., one of the oldest of provincial supply companies, partly through its co-operation with the Walker and Wallsend Union Gas Co., who obtained their Act of Parliament in 1899. The Newcastle Company, for the last nine years, have been supplying single-phase alternating current from their station near the centre of the town, at Pandon Dene, but in 1898 its directors, in order to meet the growing demand for power, put on order two 500kw. continuous current sets, and proceeded to lay down a continuous-current three-wire network in the centre of the city. They further decided upon substituting continuous current for the whole of their single-phase supply, and on procuring a site away from the town, on which they could construct a station of sufficient capacity to supply the whole of the lighting in their Newcastle area and their extension districts of Gosforth and Longbenton, as well as to supply power to the number of large factories on Tyneside.

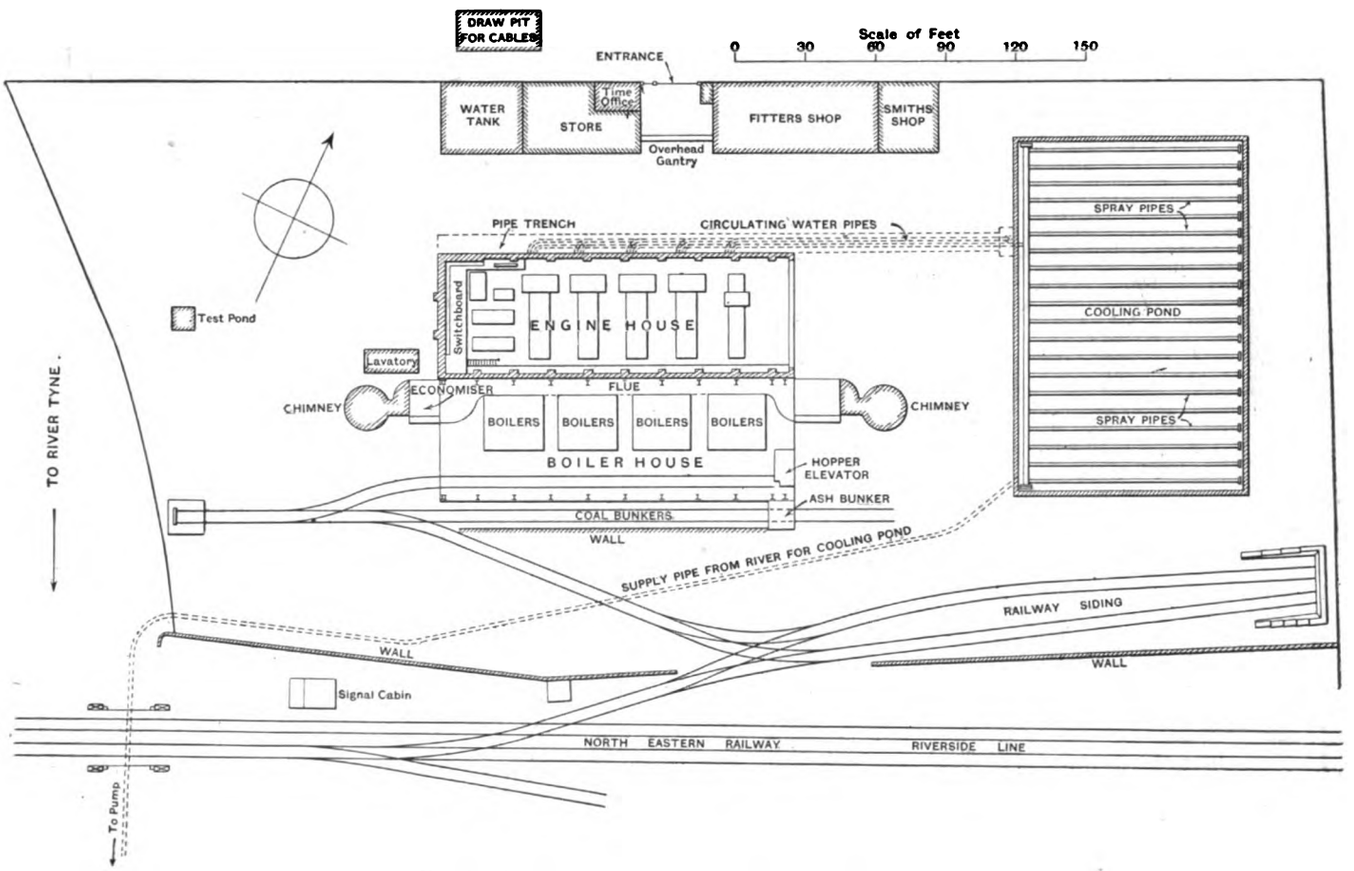


FIG. 1.—GENERAL PLAN OF NEPTUNE BANK POWER STATION.

In the meantime the Walker and Wallsend Union Gas Co. had obtained powers to supply electricity in the manufacturing districts of Wallsend, Willington, and Willington Quay, and were pushing forward arrangements to carry these powers into effect. They had purchased a site (at first with the idea of using it for gas purposes) at Neptune Bank, Wallsend; and, out of the several sites scheduled in their bill, Parliament restricted them to this one for any electrical station which they might erect. This site, therefore, although some little distance from the river, had to be utilised. In November, 1899, or some four months after their bill had received the Royal assent, the gas company placed the first of the plant on order, and shortly after commenced work on the site, which work was, however, greatly delayed during the first few months by bad weather, and after that by the bricklayers' strike, so that the erection of machinery could not be

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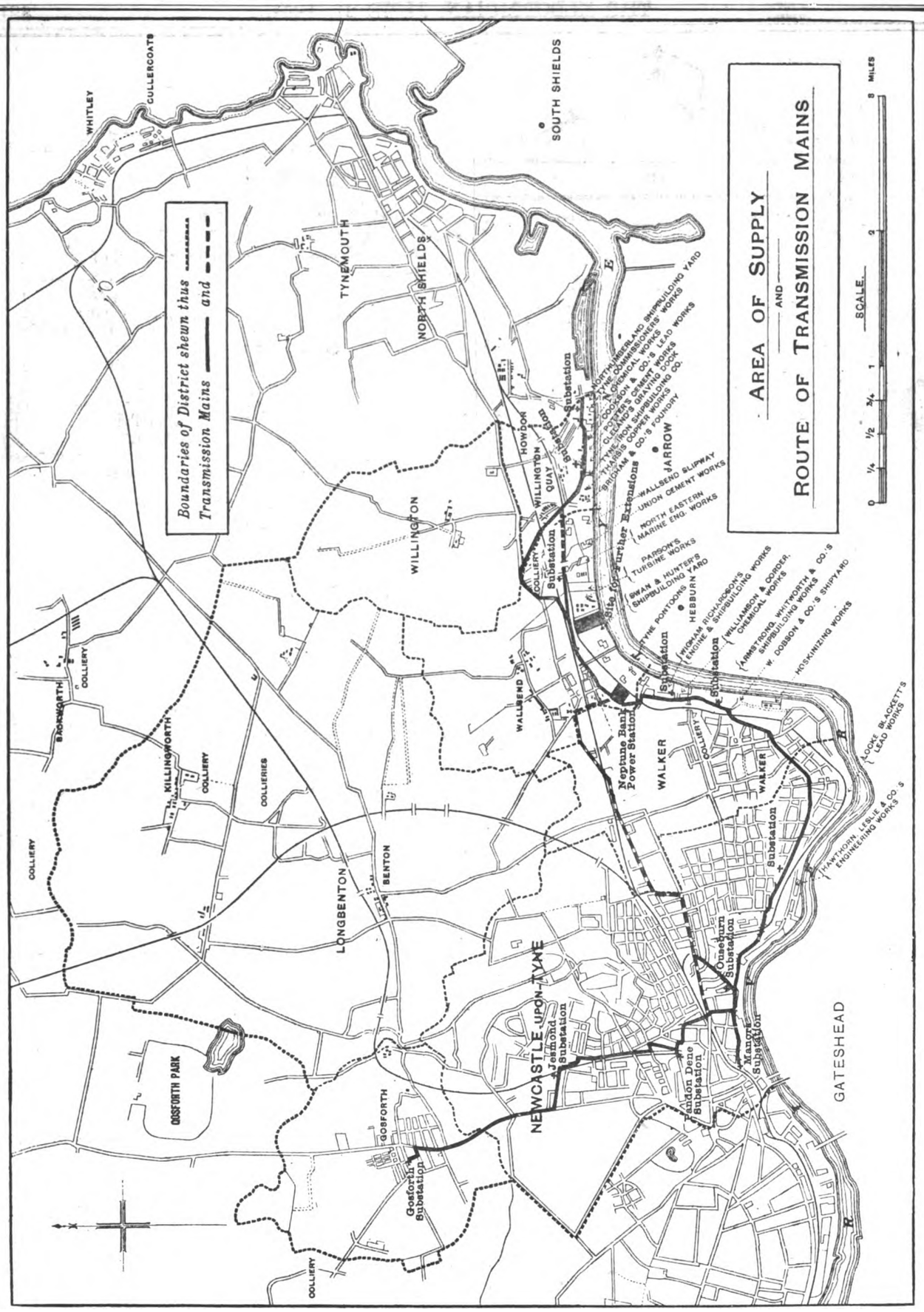


FIG. 2.

commenced until the end of the summer of 1900. Notwithstanding these delays, the station was able to start supplying a small quantity of current for ordinary distribution by December—*i.e.*, practically within 12 months from the ordering of the first lot of machinery. Just before the station was started up the Newcastle-on-Tyne Electric Supply Co. having, as explained, decided to remove their original station from Pandon Dene, entered into an agreement with the Walker and Wallsend Union Gas Co., by which the former took over the Neptune Bank station from the gas company, and agreed to

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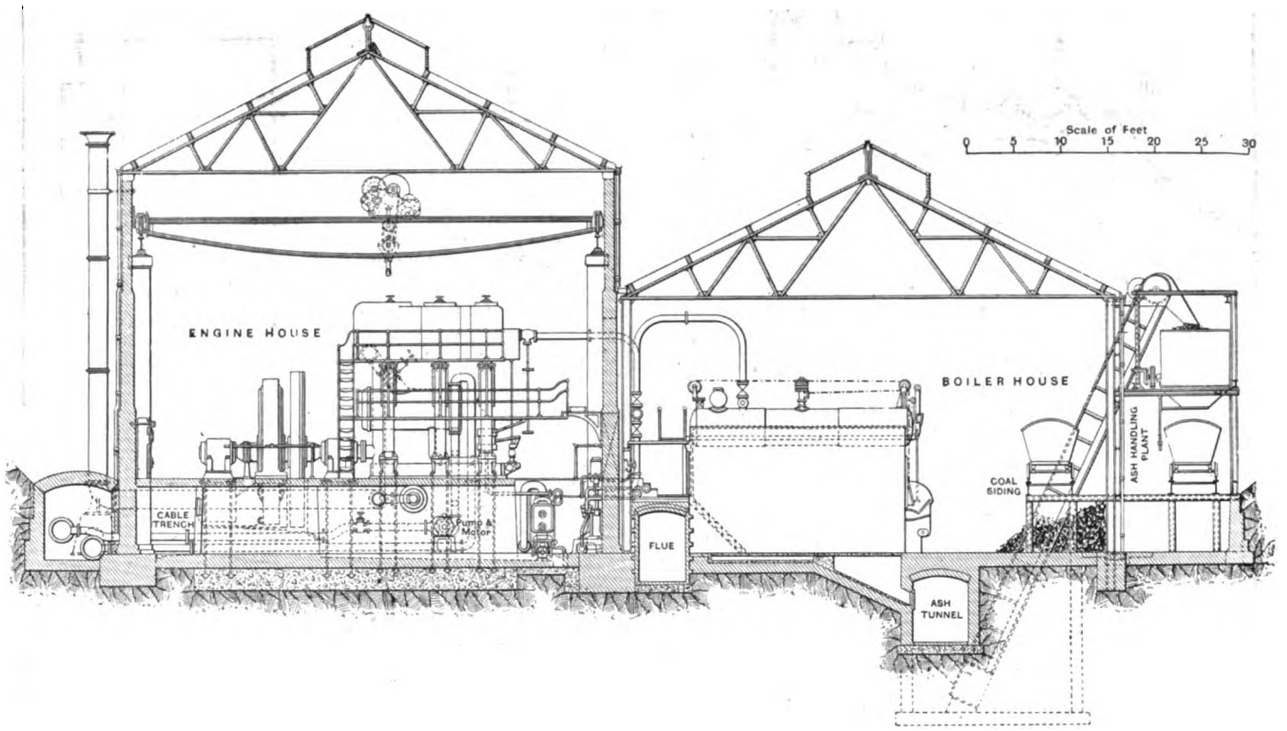


FIG. 3.—CROSS-SECTION OF NEPTUNE BANK POWER STATION.

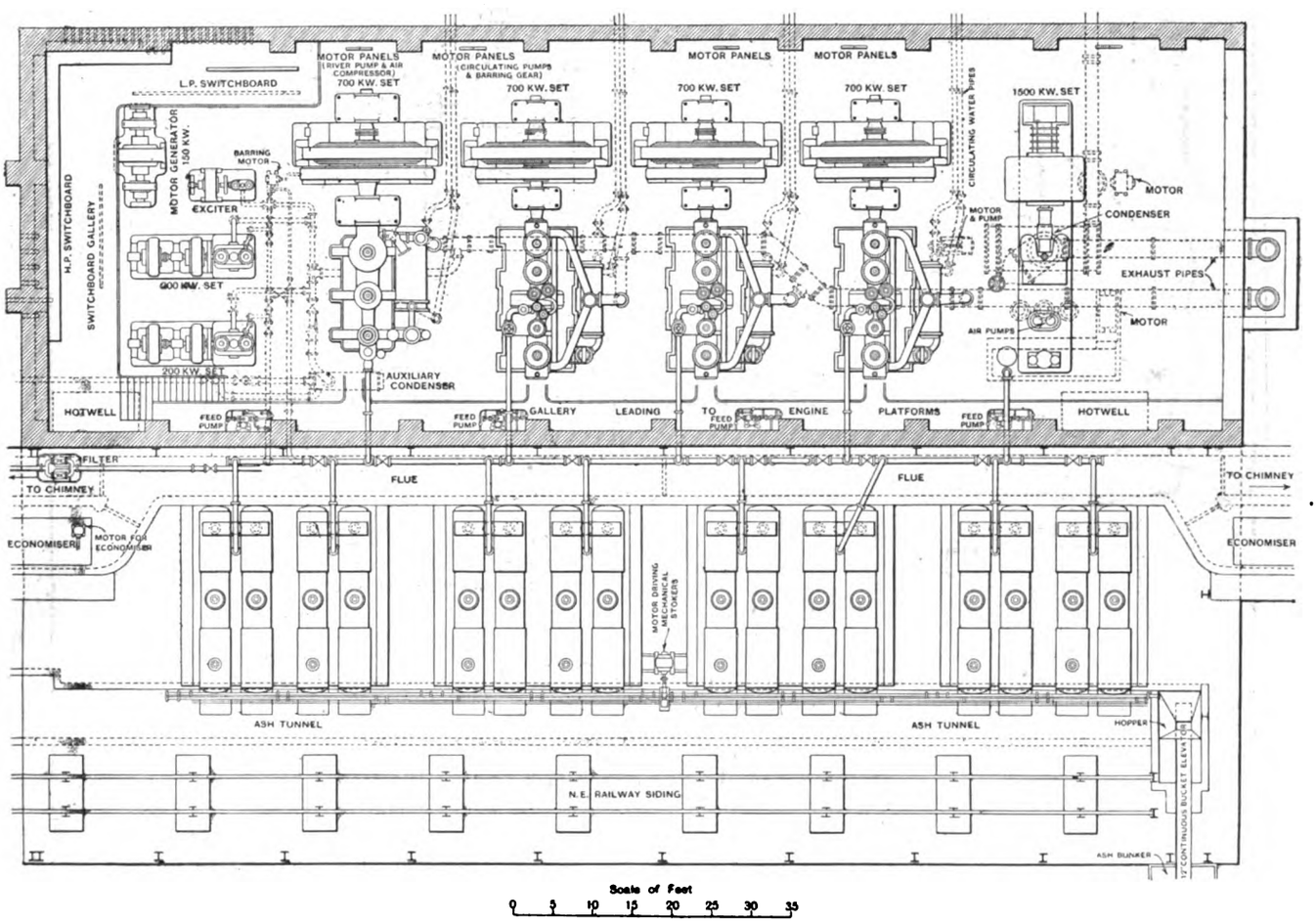


FIG. 4.—DETAIL PLAN OF MACHINERY ROOM, NEPTUNE BANK POWER STATION.

supply the latter with electric power in bulk for the area controlled by the gas company. The reasons which induced the Newcastle Company to enter into this agreement were, in the first place, that they would improve their load factor by adding to their own lighting load the power demand of the gas company; they further obtained thereby a station which was actually under weigh, a matter of considerable importance to them in view of the shortness of plant at Pandon Dene. By this combination the area shown on the accompanying map (Fig. 2) was completely unified.

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These advantages more than counterbalance the fact that Neptune Bank was only capable of moderate extension, and that a further site was required to meet their eventual demand. The Supply Company, after their agreement was completed, at once placed the necessary extensions in hand, and also purchased a riverside site of some 15 acres extent on which to construct their main power station. They further proceeded with the transmission cables along the riverside route from Wallsend to Newcastle, and started the erection of the necessary sub-stations in their old lighting area, so that the high-pressure three-phase current might be converted into continuous current for their three-wire network.

The present description deals with the preliminary power house at Neptune Bank, first started by the Gas Company, and designed to meet the wants of their system. It is intended, when the extension machinery now in hand for Neptune Bank becomes fully loaded, to meet all further requirements by machinery installed at the new riverside site, which is shown in Fig. 2.

## NEPTUNE BANK POWER STATION.

This power station was designed by the Gas Company for supplying three-phase currents at 5,500 volts with a periodicity

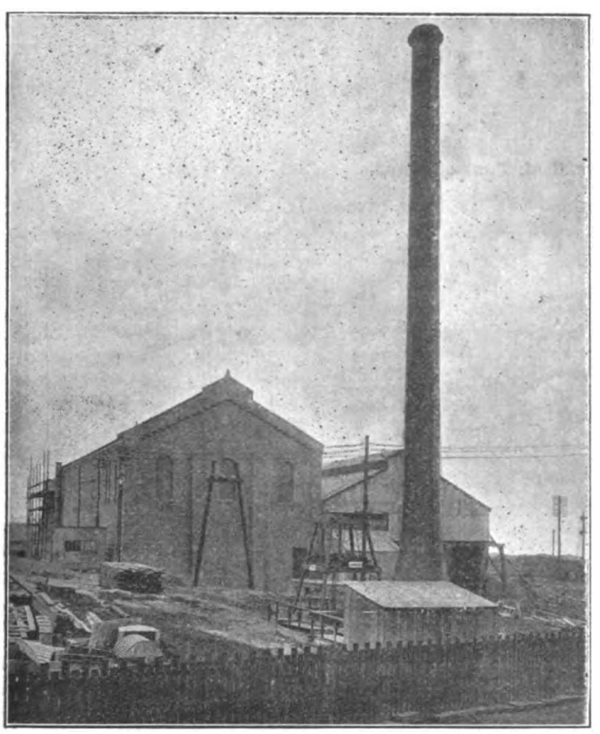

FIG. 5.—EXTERIOR OF NEPTUNE BANK POWER STATION DURING CONSTRUCTION.

of 40 cycles. The sub-stations are supplied at this pressure, and are provided with static transformers and synchronous motor generators, both supplied at the full voltage, whereby current may be obtained either at 440 volts three-phase for motive power, or at 480 volts continuous current on the three-wire system for both lighting and power. The frequency and voltage were chosen so that as far as possible standard machinery might be employed, thereby obtaining better delivery and reasonable cost. When the power station was taken over by the Newcastle Electric Supply Co., the increase in the area of distribution suggested the desirability of increasing the primary voltage; this was, however, abandoned as the saving in copper was almost counterbalanced by the increased cost of insulation required by the Board of Trade. The sub-stations situated in Newcastle will, therefore, work under the same conditions as those in the Gas Company's area, and will be placed in positions affording the greatest economy in low-pressure feeders.

The position of the Neptune Bank station will be found on the accompanying map of the district, and it will be seen that it is some 350yds. from the river and close to the riverside branch of the North Eastern Railway, in connection with which a siding is arranged. A general view of the station is given in plan in Fig. 1. Coal waggons are run on to the siding and are shunted into the coal depôt above the bunkers (Fig. 3) by means of an electric locomotive, supplied with current from an overhead trolley line. The stores and fitting shops can be connected by means of a girder on which a small travelling crane runs. The cooling pond to the north-east is provided with Messrs. Körting Brothers spray nozzles, and is capable of dealing with 325,000lb. of circulating water per hour. This pond had to be installed to meet the difficulty which arose from the fact that the power station is some 60ft. above the river level, for it was found that the cost of pumping the whole of the circulating water would have necessitated long lines of large piping and a pumping station situated on the river bank, which placed this course practically out of the question. The arrangement as it now exists consists of a rotatory pump, electrically driven, placed in a pit at the side of a small stream, which at high tide affords sufficient water to make up for any loss due to evaporation at the cooling pond.

It will be seen from the accompanying plan of the power station (Fig. 1) that both engine and boiler houses are of the same length and width—namely, 160ft. long by 52ft. wide. The chimney is 130ft. high and is of rivetted steel lined with firebrick. The firing level of the boiler house is the same as the basement of the engine room, the floor of this latter being 8ft. above this, which is also the level of the siding, an arrangement which simplifies both flues and pipes. The height of the engine room from basement floor to the crane is 40ft. 6in. and a 25-ton hand traveller runs the full length of the building. The switchboard gallery is 10ft. above the engine room floor level, and from this the middle platforms of all the engines can be reached by a gallery running the full length of the building. A door also opens from the switchboard gallery into the boiler house, and affords a ready means of access to the boiler stop valves, &c. The necessary communication between the switchboard and the engines, for starting up, synchronising, &c., is provided by engine telegraphs of the marine type.

Both the high-pressure and the low-pressure main switchboards are placed on this gallery, auxiliary machine, feeder and station power and lighting panels being arranged underneath these, while other auxiliary panels control the various station motors. The space directly below the switchboard gallery is divided from the remainder of the engine room, so as to avoid danger of interference with the cables, rheostats, &c., below the switchboard. All the connections to the auxiliary machine and feeder panels are made behind this wall. The basement is divided into two portions, one for piping, feed pumps, Wheeler condenser, oil separators and other auxiliary apparatus in connection with the steam plant; the other portion is reserved for cables, rheostats, &c.

Each of the high-pressure cables running between the switchboard and machines is made up of three single insulated cables, braided together and run in iron pipes. No dividing boxes are required at the machines, as the braiding is stripped back and the separate cables connected on to the machine terminals. The three-phase machines have the centres of their star windings connected to earth by means of an insulated cable running to the main earth plates.

The exciting and power cables of the low-pressure machines are single rubber-covered, and are cleated to the walls by means of porcelain insulators carried in iron frames. The main feeder cables are brought into the station through wrought-iron bends, directly below their respective terminal lugs.

Most of the iron work in the engine-room is earthed through a copper strip running the whole length of the building. Woodwork is avoided entirely, thereby minimising fire risk. A motor-driven air compressor is placed in the cable basement, from which compressed air is supplied through pipes for cleaning high-pressure switchgear and armatures.

The ultimate equipment of plant in this power-station is as follows—viz., eight Babcock and Wilcox boilers; two 300 B.H.P. Belliss engines, each driving two 100kw. 240 volts continuous

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current generators; one 75 B.H.P. Belliss engine, driving 50kw. 240 volts continuous current generator; four 1,400 I.H.P. triple expansion engines, each driving a 700kw. 5,500 volts three-phase alternator; one 1,500kw. Parsons turbo-alternator 5,500 volts three-phase; and one 150kw. 5,500 to 240 volts three-phase continuous current synchronous motor-generator. The arrangement of plant, &c., in the machinery room is shown in Fig. 4. An exterior view of the station is seen in Fig. 5.

Boiler Room.—The boiler equipment is divided into four sections (Fig. 6), each section consisting of two Babcock and Wilcox boilers arranged in one battery and working at a pressure of 200lb. above atmosphere. Each boiler has a heating surface of 4,020ft., and will evaporate 14,000lb. of water per hour. Variable feed mechanical stokers are fitted throughout, as also are Babcock and Wilcox superheaters, the latter being designed to impart a superheat of from 100°F. to 120°F. to the steam. With the exception of the dead weight safety valves and the low-water alarm, which are of Turnbull's make, all the mountings were made by Dewrance, while, in addition to the usual fittings, the boilers are provided with double blow-off cocks in series, duplicate feed valves and fixed soot-cleaning gear. At the back of each stoker are fixed automatic dumping bars so arranged that the ashes are discharged down a chute into a truck in the ash tunnel, at the end of which an elevator is provided. The remainder of the boiler-house equipment for the first section of boilers consists of a 280-tube Green economiser and two Rankine feed-water filters. All exposed portions of the boilers are covered to a depth of 2in. with magnesia non-conducting composition bound on with canvas, and a further covering of lead is provided on the top of the steam drums and other portions liable to mechanical injury.

Piping.—The steam piping system (see Fig. 4) has been kept as short and simple as possible, the boilers being arranged symmetrically with regard to the main engines. One boiler is sufficient to drive a 700kw. set at normal load. All steam pipes are of solid drawn steel tube with screwed or rivetted wrought-steel flanges, both T's and valves having cast-steel bodies. All T's of 5in. and over, however, are made up by rivetting a branch pipe directly to the main. Each of the boilers is connected through two valves to the main 7in. header which extends the whole length of the boiler house, the valves in this header being so arranged that the boiler and engine plant can readily be split up into a number of complete units, each engine being fed from the boiler immediately behind it. In addition to this main header there is a smaller pipe running along the whole length of the boiler house about 6ft. above the firing level, from which the feed pumps and Belliss sets are supplied.

The main header is divided into two halves by an inverted U expansion piece, each half being anchored at the middle point of its length, so that from this point it is free to expand in both directions, the weight being taken by long hangers. The steam valves are of Hopkinson's full-way type, all valves above 6in. diameter being provided with by-passes. Drain pockets are provided on both main and branch steam pipes, and these discharge through Geipel traps into the hot-well. The covering is the same as that used on the boilers, and is provided for both steam and hot feed piping.

Engines.—In order to drive the continuous current exciting and local power circuit generators, of which there is about 450kw. installed, three Belliss sets are provided, two each of 300 B.H.P. and one of 75 B.H.P. These are all of the compound two-crank cylinder type, the largest sets running at 380 revs. while the 75 H.P. set runs at 500 revs. They exhaust through two Klein grease separators into a Wheeler surface condenser placed in the engine-room basement, an automatic atmospheric valve allowing them to exhaust into the atmosphere should occasion require.

The engines driving the 700kw. sets are all of Tyneside manufacture—of the triple-expansion vertical inverted type, *i.e.*, practically marine engines fitted with suitable governors and valve gear. The first of these was constructed by the Wallsend Slipway and Engineering Co., and the others by Wigham, Richardson & Co. The three cylinders of the "Slipway" engine have diameters respectively 17½in., 28½in. and 48in., with a stroke of 36in. They are steam jacketted throughout, and fitted with Corliss valves all positively driven except the steam valves on the high-pressure cylinder, which are trip valves closed by dash pots, and controlled by a chain-driven governor of the Proell type. The normal speed of the engine is 100 revolutions, and an Aspinall's governor, mounted in the rocking air-pump lever, shuts off steam when the speed rises above 115 revolutions. The flywheel, generator shaft, and bearings were also supplied by the engine builders. The bearings are self-adjusting to any want of alignment of the shaft. Lubrication is provided by means of an oil-pump worked from the end of the shaft, and delivering oil at a pressure through oil ways of special design. Water service is also provided for use in case of emergency. An expansion governor is provided, which, when running, allows for adjustment by hand of 5 per cent. either way from normal speed. The governor and flywheel specification provides that the engine shall not race or hunt under any conditions of load. The steady speed is not to vary more than 2 per cent. above and below the normal, and the maximum variation of speed when the load is thrown off is not to exceed 5 per cent.

The air pump is driven by a rocking lever off the high-pressure crosshead, while the centrifugal circulating pump is placed in the basement underneath and driven by a continuous-current motor.

The surface condenser is supported on the back framing of the engine columns, an automatic valve being provided so that in the event of the circulating water failing the low-pressure cylinder may exhaust into the atmosphere. When on the atmosphere the engine will drive the generator at full load (700 kw.), and will also in these conditions fill the specification as to governing and angular velocity.

The three Wigham-Richardson's engines are built to a similar specification as the "Slipway" set so far as output speed, atmospheric exhaust, angular velocity, governing, &c., are concerned. Two of these sets are shown in Fig. 7. They are self-contained, with surface condenser, direct-driven Edwards' air pump, Aspinall's emergency governor, and motor-driven centrifugal pumps; but in other respects they present certain novel features. They have four cylinders (two for low pressure) of diameters 19in., 31in., 34in. and 34in., with a 36in. stroke. The four cranks are not set exactly at 90deg., but are balanced on the Yarrow, Schlich and Tweedy system, the object being to do away with all vibration, and to secure even turning moment without the use of a heavy flywheel. The engine is controlled by a governor of the flywheel type (Stumpf's patent) mounted direct on the crank shaft. The governor, flywheel and generator bearings are to the same specification requirements as those of the "Slipway" engine.

Main Three-Phase Alternators.—These are of the type provided with revolving fields and stationary armatures, and were supplied by the British Thomson-Houston Co. Each machine (Fig. 7) is placed tandem to its engine, the field being mounted on an extension of the engine shaft 24in. in diameter. The armatures are arranged to slide parallel to the shaft on base plates secured to the foundations by bolts. The normal output of each generator is 700kw. at 5,500 volts, the speed being 100 revs. per min. The fields have 48 poles, thus giving a frequency of 40 cycles per second. The armature core is built up of punchings of the best soft grade sheet iron specially selected for high permeability and low hysteresis. The punchings are assembled with ventilating spaces at intervals to allow of a free circulation of air in direct contact with the core and winding. The armature winding consists of separately insulated form-wound coils laid in the slots and secured therein by wooden wedges, the coils being completely insulated before being placed in the armature. The winding is so arranged that in case of a burn-out the defective coil can be readily taken out and another put in its place. There is one slot per pole per phase. The field poles are built of punchings bolted together, these punchings being of high permeability, thus reducing the energy required for excitation; also hysteresis and eddy

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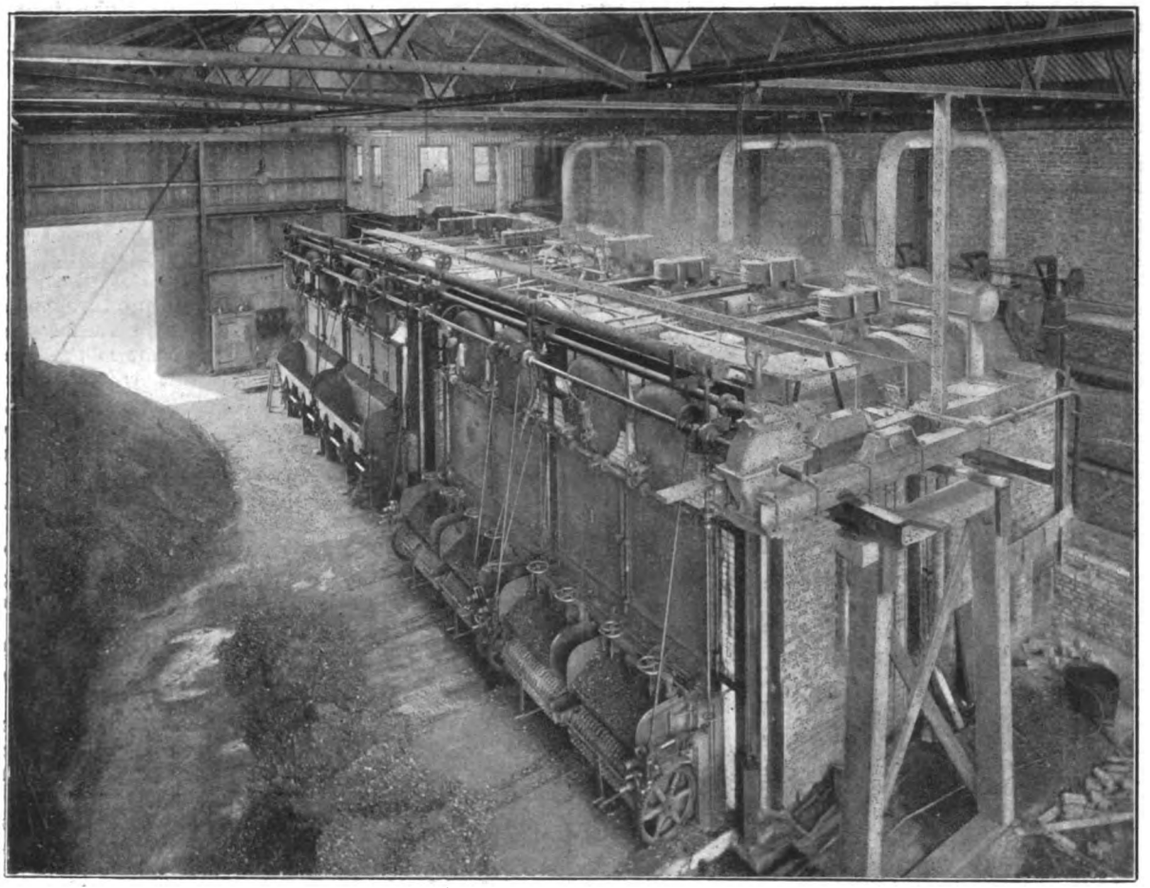

FIG. 6.—VIEW OF BOILER HOUSE.

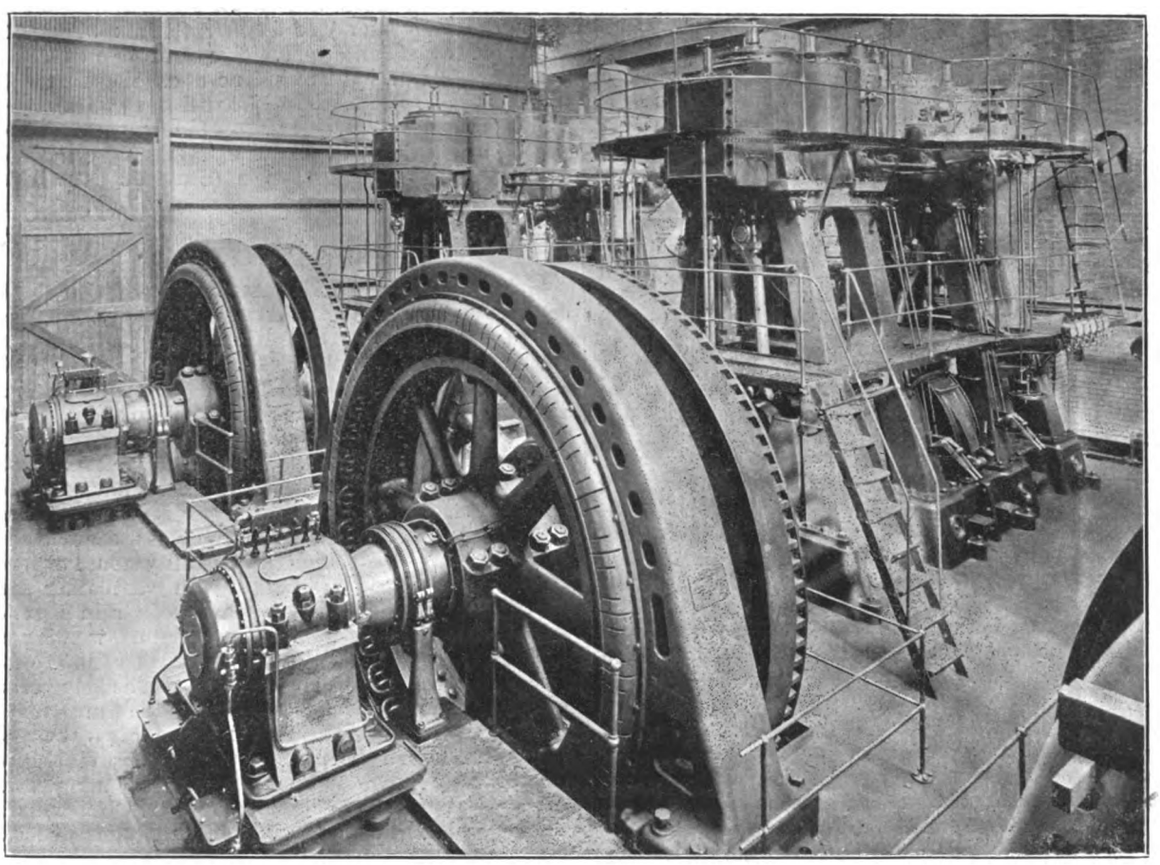

FIG. 7.—PART OF MACHINERY ROOM SHOWING TWO OF THE THREE-PHASE GENERATORS.

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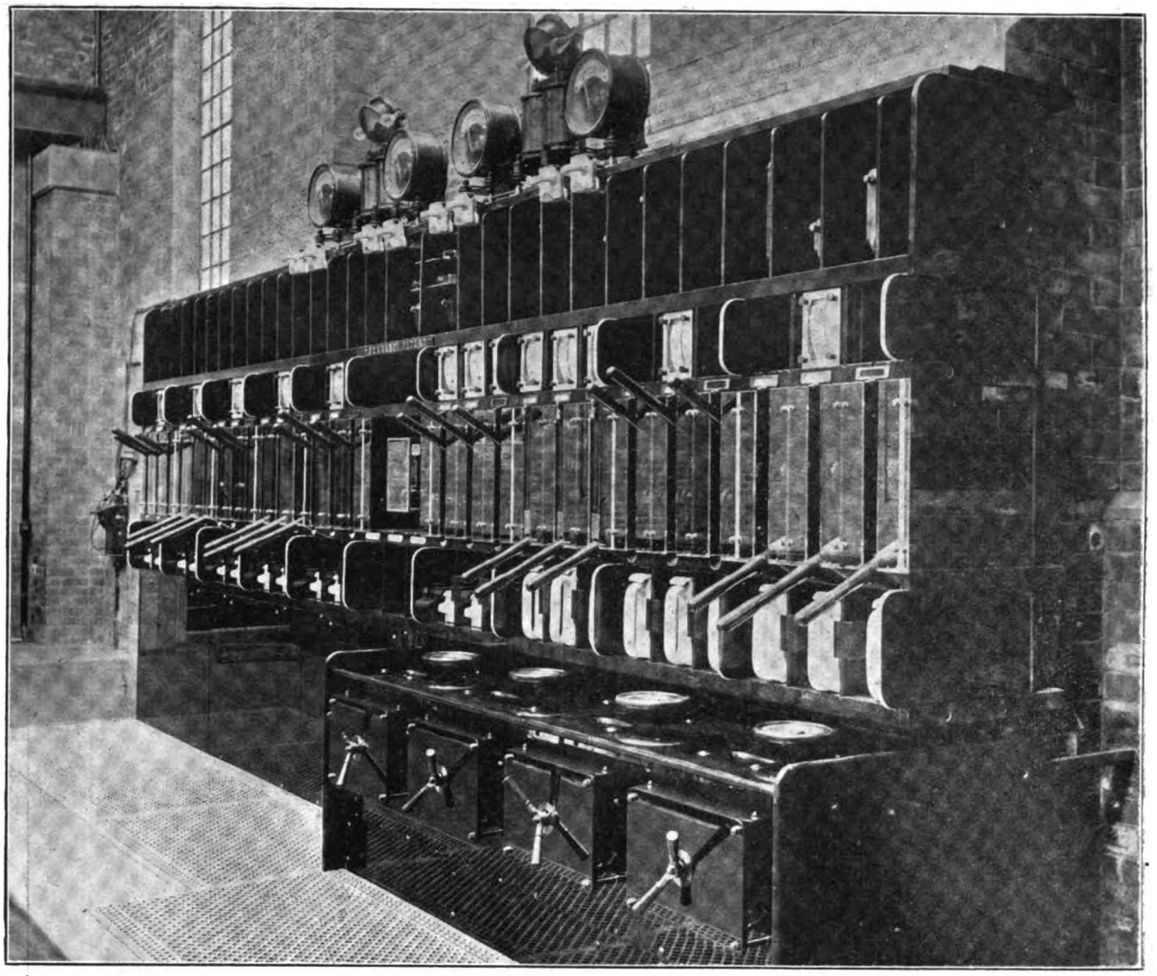

FIG. 8.—FERRANTI HIGH-PRESSURE THREE-PHASE MAIN SWITCHBOARD AT NEPTUNE BANK POWER STATION.

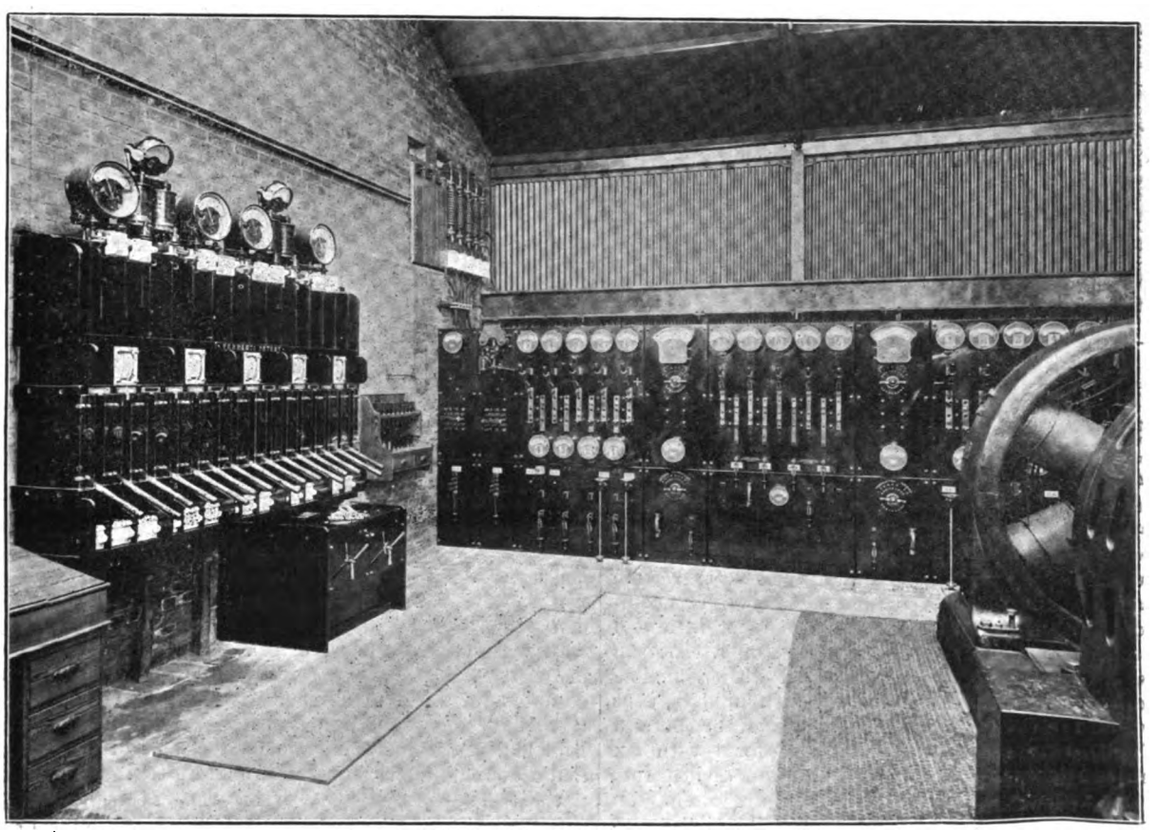

FIG. 9.—HIGH-PRESSURE THREE-PHASE AND LOW-PRESSURE CONTINUOUS-CURRENT SWITCHBOARDS IN THE SUB-STATION FOR THE NORTH-EASTERN MARINE ENGINEERING CO.

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current loss due to fluctuations in the magnetic flux through the poles caused by the reaction of the armature current are almost entirely eliminated. The poles are firmly secured to a cast steel ring supported by a cast steel spider mounted on the shaft. The field winding consists of copper strip wound on edge, the successive turns being carefully insulated from one another and from the core. The normal exciting voltage is 240. Carbon brushes are used for the collector rings. The commercial efficiency of the generators is not less than 95 per cent. at full load and 91½ per cent. at half load, excluding the excitation, and the generators will carry an overload of 25 per cent. for half an hour without injury. The rise in voltage upon throwing off full non-inductive load does not exceed 7½ per cent., and the temperature rise after a 10 hours' run at full load does not exceed 40°C. as measured by the thermometer.

Continuous Current Generators.—Each set consists of two 100kw. generators supplied by the British Thomson-Houston Co. direct connected to a Belliss engine, the armatures being interchangeable. Each engine has an output as a shunt machine of 100kw. at all voltages from 260 to 270 at a speed of 380 revs. per min., and as compound machines they give 250 volts at no load and 262 volts at full load. The armature cores are of the slotted type with special ventilating ducts to ensure low-pressure rise. The armatures are drum wound, the windings consisting of interchangeable copper coils set into slots in the periphery of the core and insulated therefrom with layers of specially prepared paper and linen. The commutators consist of segments of hard drawn copper insulated from each other by mica strips and mounted on a cast-iron shell. The brushes are of carbon provided with a flexible copper conductor connecting them to the brush holders, thus entirely avoiding all sliding contacts between brush and holder. The field magnets are circular in form with six inwardly projecting poles of mild steel, and are divided into two parts horizontally. The magnet coils are wound on separate formers, so that they can be readily slipped on or off.

Motor-Generator.—The motor-generator was supplied by Messrs. Richardsons, Westgarth & Co., and is designed for use in both directions, *i.e.*, either for receiving alternating three-phase currents and delivering continuous current, or vice versâ. The set consists of one three-phase synchronous motor wound for the full pressure of 5,500 volts, direct-coupled to two continuous-current machines, each machine having an output as a shunt machine of 75kw. when running as a generator at 400 revs. per min. Each machine is shunt and compound wound, and gives at full load 240 to 270 volts. The combined commercial efficiency of this set at full load and normal voltage and running either way is 85 per cent. The temperature rise after 10 hours' run at full load does not exceed 72°F. above that of the surrounding air.

Three-Phase High-Pressure Main Switchboard.—This switchboard (Fig. 8) was supplied by Messrs. S. Z. de Ferranti (Ltd.), and consists of 17 panels—viz., 6 generator panels, 1 motor generator panel, 2 wattmeter panels, and 8 feeder panels, and is suitable for working at 6,000 volts three-phase. Each panel contains three fuses, three switches and three ammeters,

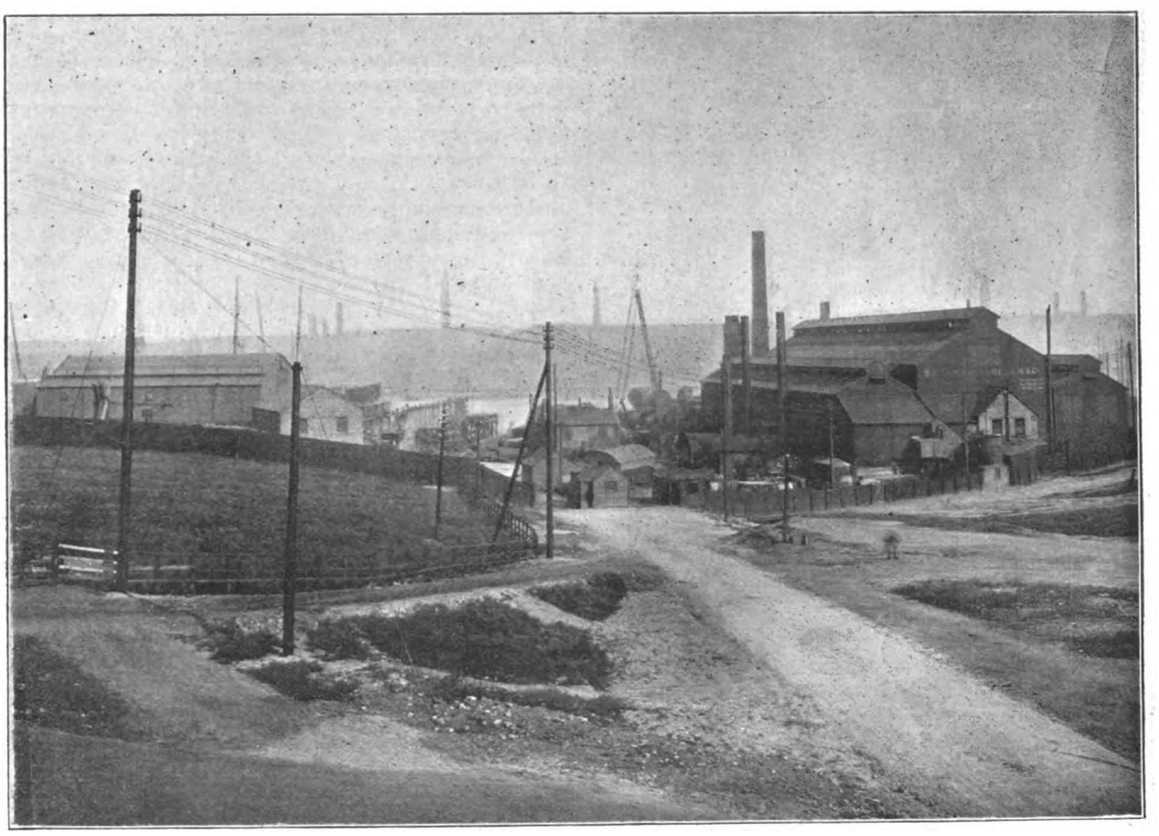

Fig. 10.—View Showing Pole-Line Construction for Distribution to Works.

and provision is made for disconnecting any panel from the 'bus bar when alive by means of insulated tools. 'Bus bar voltmeter and synchronising gear in duplicate are provided at the top of the board. The two wattmeters are required for measuring the respective output of the two companies, the gas company being supplied "in bulk." The switches follow the same lines as the well-known Ferranti type for single-phase work, and the board has no back, the framework consisting of heavy slate panels grouted directly into the wall with vertical slates, dividing the whole into a number of recesses. A regulating table under the generator panels contains for each machine a hand-wheel connected to an "open type" regulating resistance (shown separately in Fig. 11), an ammeter in the field circuit of the alternator, and a double-pole carbon-break field switch.

Low-pressure Switchboards.—The low-pressure switch-gear consists of three boards, two being on the floor level and one being on the switchboard gallery. These panels deal with the

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two Belliss sets, a small exciter set, and the 150kw. motor generator. One of the boards on the floor level holds the main dynamo fuses, the compounding switches and the field switches. The main low-pressure board is on the gallery, and contains three sets of 'bus bars—viz., station, power and lighting 'bus bars, exciting 'bus bars and feeder 'bus bars. The station 'bus bars and exciting 'bus bars are arranged one on each side of the system, so that the station, power and lighting circuits and the alternator exciting circuits are each operated quite independently at 250 volts. In this way the exciting circuits are kept entirely distinct from anything else, thus greatly reducing the liability of any mishap to the excitation. Double-throw switches are provided, by which any generating set can be thrown on to these 'bus bars or on to the feeder 'bus bars. The feeder 'bus bars are connected through a wattmeter panel to the feeder board, which is arranged for four sets of three-wire feeders, and also includes a traction panel for the supply of power to the shunting engine in the yard outside.

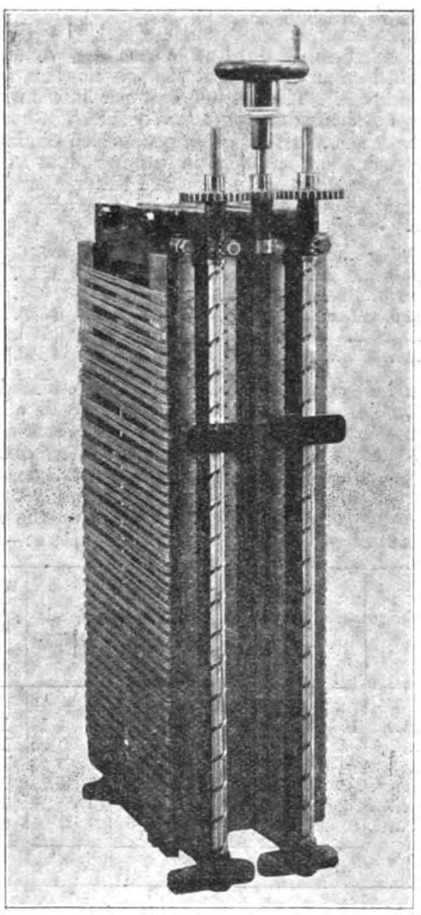

FIG. 11.—FIELD REGULATING RESISTANCE.

Test Pond.—A test pond has been constructed outside the station for the testing of the various generators. The arrangement consists of three plates of lead immersed in a brick pit filled with water. Each plate is separately suspended from a rope passing over a pole carried on a wooden staging above the pit. Three windlasses are provided at a safe distance from the pit by means of which each plate can be raised and lowered independently, and thus the load can be readily balanced and adjusted. Overhead wires connect these plates with terminals fixed on the wall of the switchboard gallery, from which temporary connections are made for testing any of the three-phase or continuous-current generators, the pond being of sufficient capacity to absorb 1,500kw. at 5,500 volts.

Auxiliary Motors.—We have stated that electric motors are used throughout the station for all the auxiliary power. These are of Messrs. D. Bruce Peebles & Co.'s make. The following list may be of interest :—

Five centrifugal pump motors, each 20 H.P. at 800 revs.
Four barring gear motors, each 6 H.P. at 1,000 revs.
One air compressor motor, 2 H.P. at 200 revs.
One vacuum pump motor, ½ H.P.. at 600 revs.
One stoker motor, 15 H.P. at 900 revs.
One economiser motor, 2 H.P. at 700 revs.
One ash hoist motor, 6 H.P. at 600 revs.
One river pump motor, 15 H.P. at 350 to 700 revs.
One air pump motor, 40 H.P. at 100 revs.

## SUMMARY OF OUTSIDE WORK.

In our next article we shall describe in detail and give several illustrations of the outside work done by means of the Neptune Bank power station described above. Before concluding the present article, however, we will briefly summarise this work. Our readers will already have seen that the power is to be used for two main purposes: (1) Supplied in bulk to the Gas Company for sale to shipbuilding yards, works, &c., in Wallsend, Willington, and Willington Quay; (2) supplied over a transmission line (not yet completed) to the sub-stations of the Newcastle-on-Tyne Electric Supply Co. for general purposes. We shall deal with each of these in separate detail in our next article. As regards the supply from the Gas Company to its large consumers, many interesting matters call for notice. In many instances each individual consumer requires so much motive power that a separate sub-station has to be erected for each such consumer. Fig. 9 shows the interior and switchboard arrangements in the sub-station for the large works of the North-Eastern Marine and Engineering Co. Here high-pressure three-phase power is converted to the 240 volt three-wire continuous current system. In other examples we shall describe, the low pressure is on the three-phase system. For some purposes the low-pressure power is conveyed from the sub-station through overhead pole lines. Fig. 10 is a view of a length of pole line in the vicinity of the works of Messrs. Wigham, Richardson & Co., who built three of the main engines.

*(To be continued.)*

## MR. W. A. CHAMEN'S PRESIDENTIAL ADDRESS TO THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.*

I have to congratulate you upon the incorporation of this Association. We are starting into a new century and into a new reign as a newly incorporated body. Drawing up the memorandum and articles of the Association has been a work of great labour, and has extended over some considerable time. Our honorary solicitor, Mr. Alderman Pearson, has carried the whole matter through for us in a most admirable manner, and we owe him for his toil and patience a great debt of gratitude, which we shall find it hard to repay by anything that we are able to do in return.

I have to congratutate you on the further large increase of membership from 77 committee members at last convention to 99, and from 142 engineer members of all classes to 165 at the present time, our present total membership being thus 264, or an addition of 55 since last convention. This increase must be considered most satisfactory, and I think there are indications of a still further considerable increase during the coming year.

I regret that we have to record the loss by death of one member, Mr. A. H. Roe, of Bury St. Edmunds. We have suffered some losses through members resigning their position as corporation engineers to take up posts with companies or to practice as consulting engineers on their own account. More especially have we to lament in this way the loss of Mr. C. H. Wordingham, who was president, I believe, during the second year of our existence, and who was one of the founders of this Association. This is indeed a great loss to us, for the energy and ability which he brought into our meetings was of a kind not easily replaced. Mr. Wordingham was also treasurer of the benevolent fund which owes its existence, I think, almost entirely to his efforts. Though not now one of us I am glad to tell you that he continues to take great interest in our doings, and he has promised that he will, whenever possible, attend our conventions, and join in our discussions. I am sure we all wish him that success in his new departure which he so well deserves.

I have to draw the attention of our Association to the fact that there has not been that enthusiasm displayed by them in sending in

* Delivered at Glasgow, June 19. Slightly abridged.



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Papers, competing for the prize offered by the Association, in consequence of which for the present year the Council have been obliged to suspend the award of the prize.

You will have observed, from the programme, that there are fewer Papers to be read and discussed at this meeting than there were at last year's convention. I believe you will all agree with the council in thinking that it is better to have fewer subjects before us and longer time for discussing them, and, also, that it is more satisfactory for the Papers to be read to the meeting by their respective authors than to be held as read and discussed forthwith. The Council feel that we are likely to get far more useful discussions in this way, as all present will at least understand what it is that is being discussed.

As already indicated, I do not propose, in this short address, to touch upon all the subjects which appear to require, during the present year, the attention of this Association, as they have been already so clearly pointed out by your two past presidents, Mr. Faraday Proctor and Mr. Mountain; but I ought, perhaps, to emphasise one of them—viz., the suspension of payments to sinking fund during course of construction and for two or three years afterwards. Many municipal electrical undertakings are feeling the burden, and I may say the unfairness, of being taxed during the first few years of their existence, while they are in a state either wholly or partially unproductive of revenue, by being compelled to pay from the start their annual contribution to the sinking fund. While it is, of course, necessary that Parliament should take steps to ensure the paying off of the debt in a proper time, it does seem that it is rather unreasonable to enforce this annual payment from the very start of the undertaking, when it must be so obvious that the concern has had no time or opportunity to bring in a revenue at all proportional to the capital which has been expended upon it. This question is now actively engaging the attention of the Council, and I do not know that I need say more about it here, except to point out that it also arises in extensions of existing undertakings into new areas not previously supplied, and which require not only new mains but new generating stations, and, in fact, a new start and new loans for that specific purpose.

There is, however, one point which has not been touched upon by your two past presidents, but which I should like specially to bring before your notice. I refer to the question of system charging for electricity.

The question of price, at first sight, seems a very simple matter. Total up the cost of coal, wages, repairs, and petty store bills for the year, and add all the capital charges (*i.e.*, interest and sinking fund), and the management expenses; divide this sum by the number of units sold, and the result is the cost per unit. Add to this whatever margin is deemed necessary, and the results is the price per unit. Such a method of arriving at the selling price of electricity possesses one advantage—viz., that it is simple. That, however, seems to be all that can be said for it. It is known to everyone that, as a rule, the greater the quantity of any commodity that can be sold the lower will be the cost of producing it, but the real reason why this is so is understood by comparatively few.

We may here note a few facts before proceeding. I quote figures from the Electricity department of Glasgow as being the readiest at hand. The number of units of electricity sold during the year just concluded (May 31) was, roughly, 6½ millions. The maximum load occurred during November, December, and January at 5 o'clock on each night except Saturdays and Sundays. The plant used (allowing ample spares), if continuously in use at full load would have produced some 81 million units in the year, and this extra 74½ million units could have been sold probably at a profit to the existing consumers if they could have taken it for the low price of about ½d. per unit without any additional capital expenditure or increased management expenses of any kind. Of course, I do not suggest that we could ever hope to sell such a quantity as this, but there is a long stretch between 6½ millions and 81 millions, and we might sell more than we do. The cost of buildings, plant and mains runs out at present at about £114 per kilowatt. This figure will go down again when fair proportions become established between the cost of sites, buildings, machinery and mains, perhaps to £80 or less. It is already down to about £104.

The standing charges, being interest, sinking fund, wages, rents, rates and taxes, management expenses and repairs, amount together to, say, £8. 3s. per kilowatt per annum. This figure is arrived at by taking out the individual maximum demands of the consumers and dividing the total standing charges by the sum of them. You will note that the sum of the consumers' maximum demands is greater than the actual maximum demand upon the generating plant by about 25 per cent., which we may take to mean, roughly speaking, that some 25 per cent. of the consumers either do not come on at all, or at least not to their full extent, until after the time of maximum demand upon the generating stations is past. You will note, therefore, that in apportioning the standing charges per kilowatt due allowance is made for this fact, and the standing charges are less than they would be by about 25 per cent. on account of this diversity factor. This shows the advantage which consumers get by taking the supply from a common source. Let us now consider a few different classes of consumers, taking in each case their maximum demand, for the sake of argument, as 1kw., and finding out what number of hours' use per day the quantity of units they each consume is equivalent to, spreading our investigations, of course, over the whole year. We find the following:—

| | | | |
|---|---|---|---|
| Street lighting (all night) | 10½ hours per day | 3,832 | units per ann. |
| Public house | 5 do. | 1,825 | do. |
| Restaurant | 4 do. | 1,460 | do. |
| Domestic consumer | say 3 do. | 1,095 | do. |
| Theatre | 2 do. | 730 | do. |
| Office | 1 do. | 365 | do. |
| Total | | 9,307 | do. |

These figures are simply examples being easy to follow, but they are not quite accurate. For instance, many of the offices average less than half an hour, while domestic consumers average only about 2½ hours. Suppose we had a small concern with these six different consumers as partners; the maximum demand of each is the same—viz., 1kw., and the standing charge of £8. 3s. is incurred by each, quite irrespective of the amount of electricity consumed. It seems to me, therefore, that these partners as ordinary business men would each agree to pay £8. 3s. per annum in a lump sum, plus the working costs, according to the number of units consumed in each case.

Let us look, however, at the question of coal. I am obliged to put before you some figures obtained some time ago, which, while they certainly would be somewhat less at the present time, will serve for our present purpose. The cost of coal per unit for the various different classes of consumers is greater for the short-hour ones than for the long hour ones, owing to the waste which occurs in getting up steam for such short runs and in running plant at light loads. From careful tests which have been made I believe that the following would be about the proportions of the cost of coal for the different consumers:—

| | |
|---|---|
| Street lighting | 0·51d. per unit. |
| Public house | 0·51d. do. |
| Restaurant | 0·62d. do. |
| Domestic consumer | 0·69d. do. |
| Theatre | 0·77d. do. |
| Office | 0·84d. do. |

These costs include carting and handling of the coal and removal of the ashes, &c. The street lighting should really be a lower figure, but no information was at hand at the time the figures were obtained, so that it was put in the same as for a five-hour consumer. (In passing I may say that during the past six months one-third of the coal we have consumed has been wasted practically through intermittent and varying loads.) If we now make up the accounts for these six consumers we find they come out as follows:—

| Class. | Hrs. | No. of units used by each class. | Standing charge | Total coal bills. | Total charge. | Aver. per unit in pence. | Level rate of 1·84d. Total bills. |
|---|---|---|---|---|---|---|---|
| | | | £ s. | £ s. d. | £ s. d. | | £ s. d. |
| Street lighting | 10½ | 3,832 | 8 3 | 8 1 10 | 16 4 10 | 1·02 | 29 6 10 |
| Public house | 5 | 1,825 | 8 3 | 3 17 6 | 12 0 6 | 1·57 | 14 0 0 |
| Restaurant | 4 | 1,460 | 8 3 | 3 12 11 | 11 15 11 | 1·94 | 11 4 0 |
| Domestic consumer | 3 | 1,095 | 8 3 | 3 2 11 | 11 5 11 | 2·45 | 8 8 0 |
| Theatre | 2 | 730 | 8 3 | 2 6 10 | 10 9 10 | 3·42 | 5 12 0 |
| Office | 1 | 365 | 8 3 | 1 5 6 | 9 8 6 | 6·14 | 2 16 0 |
| | ... | 9,307 | 48 18 | 22 7 6 | 71 5 6 | ... | 71 6 10 |

It may be objected that I have not taken into account water, oil, &c., but these are small, and will make no material difference to the result.

You will observe that the street lighting consumer pays an average price of 1·02d. per unit, and the office an average price of 6·14d. per unit, and that the other consumers vary between these two extremes. It seems to me that for lighting purposes this method of looking at the matter is a fair and just one. An electrical engineer of long experience made the following remark in discussing this troublesome question with me some few months ago:—"There are," he said, "two principles upon which consumers can be charged. One is that of dividing the total costs for the year by the number of units sold; that is to say, to charge on average price (which works out at about 4d. per unit). The other is that of approximating the charge to each consumer to the cost of supplying him." I think that expresses our position exactly, but which of these principles are we to work upon? I have shown you in a rough-and-ready manner how the costs per unit must vary between very wide limits, and this mostly on account of the very short use which is made of the plant by many of the consumers. If you take out the average cost per unit from the table I have given you it will come to only 1·84d. per unit. If you charge this uniform price, however, you will be charging the street lighting with over £29 instead of £16, and the office

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will be let off with £6. 14s., instead of paying £9. 8s. 6d., and you must remember that in actual fact the proportions of these different classes of consumers are by no means what are given you in this table. Which of us can show one-sixth of our maximum demand occupied in street lighting and another two-sixths in 5h-our and 4-hour consumers? If you take my table and adapt it to your own circumstances I do not think any of you will be able to work out an average of 1 84d. per unit.

By using a sliding scale of charge in Glasgow the cost of producing our 6½ million units in the year just concluded works out at about 3·18d. per unit, or perhaps less, and we have estimated on selling 9,000,000 units for next year at an average cost of production of 2·61d. per unit. The charges are 6d. for the first 365 hours' use per annum of the maximum demand and 1d. thereafter, with, however, uniform rates of 3½d. for domestic consumers, theatres and halls, 3d. for churches, and 1½d. for power. Many of our consumers, however, will be paying only about 2d. per unit for lighting under the sliding scale. Do you think we should be able to keep them at 3½d. or perhaps 4d., or do you think we should go on increasing our output at the rate of 50 per cent. per annum as we have done for the last two years, if we reverted to a uniform rate? I am afraid we should not.

Power supply seems to me to be a different question, not simply because it is a day load and in use, perhaps, more in summer than in winter, but because there is no natural law which forces it to come on at a maximum far in excess of its normal at any particular time of the day, a feature which is so very strongly marked in the case of lighting. A diagram taken on a day in last December, shows how sharp a peak occurs about 5 o'clock. What is the reason of this? It is probably that the very short office load and the early closing shop load are both just on in addition to everything else. Business men are signing their letters, and clerks are all hard at work finishing off with the greatest possible haste lest they should be guilty of any unpunctuality in getting away at the usual time. At this time probably every light in these offices is in use, though only for a very short time, for shortly after 6 o'clock the load is down again to a much lower point. In the summer, and during the greater part of the year, this does not happen. As soon as daylight draws out to 5 o'clock this nightmare of a load is gone until next winter. In Glasgow we have a load of this kind to the value of about 1,540kw.—*i.e.*, we have consumers of the very short hour class who require this amount of plant to supply them, and whose average use per day is just half an hour. They consume 248,343 units per annum, which brings in at 6d. per unit the sum of £6,208, or about 3·7 per cent. upon the capital expended to supply them. It is certain that if there were no consumers using current for longer hours than these the concern would become bankrupt in a very short time, even with a charge of 8d. per unit. The conditions under which light is required cause this awkward peak and they cannot be altered. The proportions of the peak to the whole diagram can, however, be reduced by getting on a greater number of consumers who use current longer. Power supply is a most excellent way of producing this result if we can get enough of it. In Glasgow up to date we have about 1,894 H.P. connected to our mains. It does not cease at 5 o'clock in the winter, and does not, therefore, simply fill in our load diagram in the shallow places. If it did this it might enable us to charge a uniform rate for everybody. It has no peak of its own, however. It goes on from morning till evening, with some variations of course, due to those motors which are used intermittently, but these variations average out in a reasonable way, as there is no circumstance which compels nearly the whole of the motors, whether in continuous or in intermittent use, to come on together, either at 5 o'clock or at any other time. If we had a power load only to deal with there would not be this peak trouble, and it would seem possible, saving only that a maximum charge of, say, £2 per annum, should be made to cover interest on cost of meter, &c., to do all that can be wanted for all ordinary purposes by means of a scale much more nearly approaching a uniform price than the lighting one. For any purpose requiring a supply for 24 hours per day it would seem to be unfair to make the same charge as for such intermittent use as is experienced in the case of hoists, so that an absolutely uniform rate might not be found satisfactory.

There has been an attempt to arrange a sliding scale of charging by means of meters which work on a different dial at certain hours, so that all units recorded on the second dial can be charged for at a higher price, these being the units consumed on the peak load, but up to the present no one has succeeded in producing a sufficiently cheap and satisfactory two-rate meter, so far as I am aware. Besides, if the system comes to be closely inquired into, I think it will be found that it does not fulfil the necessary requirements, and also that it is very difficult to decide as to how the arrangement should be worked during other months of the year than November, December, and January—that is to say, if the maximum price is to be charged between the hours of 4 and 6 p.m. during those months, during what hours is it to charged in the other months of the year? It does not seem to me to take a grip of the correct principle, for it would result in charging a long-hour consumer the additional price during part of the 24 hours for the simple reason that somebody else wants to make use of the plant which is supplying him, and makes him pay extra for the other consumer's shortcomings.

I must admit that I have not had occasion to think out this system of two-rate meters fully, and I simply mention it as one that should receive consideration in dealing with this subject. It may be that there are ways of getting over these difficulties.

You are aware that the power bills which have been recently passed by Parliament contain a clause to the effect that for the first 400 hours' use per quarter of the maximum demand quantity the price shall not exceed 3d. per unit, and that for all further quantity the price shall not exceed 2d. per unit. This is very taking to the public eye, but where is the magic wand which enables the power companies to produce energy so wonderfully cheap while we are unable to do so? The trick is very simple. There is no deception. The bills contain other clauses which allow the companies to pick and choose their consumers and to make contracts with them in a way we cannot do. Of course, the companies say they do not want to supply light, and would not on any account wish to interfere with the corporations who already do so. They obviously wish to get the supply of power, and would willingly come into any municipality and supply it at low rates leaving the corporations to supply light at much higher prices, which, however, might still not pay. They are willing to supply light, too, under certain conditions if asked, and no doubt the price would be a favourable one, but what would the conditions be? They would be found to work out so that only long-hour demands, such as street lighting or other all-night lighting, could be supplied under them.

Is it not, therefore, a question whether it is right to allow these bills to go through in this way? Surely the fact that they are tied down in price is against the general public interest. It would have been better, it seems to me, to have allowed them a higher maximum price and to have bound them down closer to supply, on a sliding scale, the general wants of the community, no matter whether for lighting or power. I would, in fact, put it to you that, while for power purposes only the 3d. and 2d. tariff may be good enough, there should be in all these bills a special scale for lighting, not, perhaps, with a maximum price per unit at all—for that may work unfairly to the company—but with a fixed charge per kilowatt per annum of, say, £8 or £9, or such other figure as may be found necessary, and 1d. or perhaps 2d. per unit for all current supplied. This is the principle first enunciated, I believe, by the late Dr. John Hopkinson. The principle of fixing a maximum price per unit, at any rate, for lighting purposes, does not seem to me to be a desirable one at all, and it introduces complications in accounts which are entirely avoided by the other method, and at the same time there is a simplicity and justice about the £8 per kilowatt of maximum demand per annum which I have always found consumers of the longer hour class to understand very readily. The fixed charge may be called a "plant rental," being, in fact, nothing but a rent for the plant which they use, and which must be kept for their use whether they want it all the year round or not. If you explain to a house-factor that not paying the "plant rental" when you do not want to use the plant is like declining to pay a proportion of your house rent for such time as you may be absent at the coast or elsewhere in the summer he takes in the situation at once.

The question of storage might under different circumstances affect the matter to some extent, but, so far as I have been able to see, there is not much assistance to be got in that direction at present.

I am indebted to Mr. Wilson for a gas load diagram, taken from the Dawsholm Gasworks, Glasgow, on a December day. A straight line across the sheet shows the "make" of gas. Storage in this case is an immense advantage, but we must not jump to the conclusion that storage would get us out of our difficulty as regards system of charge. The whole diagram is so different from ours, presumably because of the almost universal use of gas, owing to which a much better average load or load factor is obtained. It is probable, too, that our existence is of some assistance to the gas undertaking, as we have relieved it of so many of the short-hour and unprofitable consumers. It is not to be expected that our gas friends will take any great amount of pleasure in perusing our sliding scale arrangements because by means of them we shall probably obtain more long-hour consumers and help to relieve them of some of the profitable as well as the unprofitable ones. I ought, before concluding, to mention the name of Mr. Arthur Wright, our first president, and the inventor of the maximum demand indicator, an instrument which has been of great assistance in the arrangement of sliding scales in the most equitable manner, by enabling us to charge only upon the actual maximum demand the consumer makes, and not upon the size of his installation.

I do not know whether I have succeeded in making the reasons for a sliding scale and against a uniform rate any clearer than they were, but the matter does seem to be of such importance, that I hope some of you will take it up, and perhaps read a Paper at our next convention so that we may get a good discussion upon it.



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Editorial, Publishing and Printing Offices,

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*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

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## JOINT MUNICIPAL ELECTRICITY SUPPLY.

In a leading article last February we referred to the first attempt of a combination of municipal authorities to obtain powers to erect works for a joint supply of electric power over their areas. This attempt was unsuccessful owing to a majority of the ratepayers in some of the districts being opposed to the scheme, or favouring an alternative proposal of a company which had previously applied for somewhat similar powers over a wider area including that of the districts in question. The opposition to this joint municipal scheme of the North Middlesex local authorities in its very earliest stages would have led us to expect that the next proposition for a joint electric supply scheme by local authorities would have had several obstacles to contend with, but instead of this being the case we have to announce that the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board Bill, some particulars of which were given on p. 285 of our last issue, is passing through Parliament as an unopposed measure.

As this will be the first example of a joint municipal electric power supply, it is of interest to examine the provisions of the Bill in question. The route of the proposed tramways was shown in the map published in our last issue, and the Board also acquires powers to supply electricity for lighting, power, and all other purposes within the four boroughs mentioned in the title of the Bill. Part of the tramways have been worked hitherto by the Manchester Carriage and Tramways Co., and are now passing into the hands of the Stalybridge Corporation under the 21 years' purchase clause, and the Hyde and Dukinfield Corporation's provisional electric lighting orders (of 1900 and 1899 respectively) are also to be transferred to the Board. The Board is to be constituted of 24 members, six from each of the four borough councils interested, and these representatives are to be appointed annually by the Councils in question. In view of the recent incident at Manchester, it is interesting to note a clause specifying that no member of the Board is to have an interest (either in his own name or in the name of any other person) in any work done for the Board, except as the shareholder of a company, and in the latter case he may not vote with regard to the award of any contract for which his company is tendering. Clear rules are set forth in the Bill as to the calling and holding of meetings, and as to the appointment of a chairman and a deputy-chairman, and the low number of three members is to constitute a quorum. The powers given to this Board are in the main those of an ordinary provisional order and tramways act, Parts II. and III. of the Tramways Act of 1870, the

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Electric Lighting Acts of 1882, 1888, and the Electric Lighting (Clauses) Act of 1899 being incorporated with the present Bill. Certain additions to the provisions of these Acts are, however, necessary to meet the special case. Thus the accounts are to be made up annually to December 31st, and are to be submitted to each of the constituent local authorities, as well as to the Board of Trade as specified in an ordinary provisional order, and in the event of a dispute between the constituent authorities the matter is to be settled by the Local Government Board or an arbitrator appointed by this body. This latter provision is important, for, in spite of the precise regulations set down, acute differences of opinion are still possible, and if such do occur their obstructive effect on business are likely to be four times as great as in the council chamber of a single local authority.

Coming now to more technical matters. The gauge for the tramways is to be standard, but no railway trucks are to be run on them, and the rails are to meet with the approval of the Board of Trade, whose authority with regard to inspection and regulations, it may be added, is the same as in the Electric Lighting and Tramways Acts. In addition to the notice to the road authority required under section 26 of the Tramways Act when a road is to be broken open, particulars of the work and of the materials to be employed have to be submitted to and approved by the Board of Trade. Conditions as to the maintenance of the rails and road are laid down, and on the complaint of 20 ratepayers the Board of Trade may at any time re-inspect the tramway. The objectionable Sheffield electrolysis clause is considerably modified in this Bill:—

> The [Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity] Board shall take all *reasonable* precautions . . . . . so as not injuriously to affect by fusion or electrolytic action any gas or water pipes or other metallic pipes, structures, or substances. . . . .

The italics are ours. For the purposes of comparison we give the Sheffield clause:—

> Provided that, notwithstanding anything contained in the said Acts or this Act, if it be proved that any injury or damage to any mains, pipes or apparatus of the Sheffield United Gas Light Co. shall have resulted from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any of the tramways for the time being belonging to the Corporation, nothing in the said Acts or this Act shall relieve the Corporation from any liability to make compensation for such injury or damage which would have existed but for the passing of the said Acts and this Act.

In the case of differences arising under this and other protective clauses, the Board of Trade or its nominee is again constituted arbitrator, as also in the case of the following clause, which we give in full:—

> When any department of His Majesty's Government represents to the Board of Trade that the use of electrical power under this Act injuriously affects or is likely to injuriously affect any instruments or apparatus, whether electrical or not, used in any observatory or laboratory belonging to or under the control of that department, the Board of Trade, after such inspection or inquiry as they may think proper, may, by their regulations, require the Board to use such reasonable and proper precautions, including insulated returns, as the Board of Trade may deem necessary for the prevention of such injurious affection. For the purposes of this sub-section, any inspector of the Board of Trade may, during his inspection of the Board's works and apparatus, be accompanied by any person or persons appointed in that behalf by the Government department concerned, and the Board shall give all due facilities for the inspection. Provided always that in the case of any observatory or laboratory established after the passing of this Act, or of any instruments or apparatus hereafter used in any existing observatory or laboratory which may be of greater delicacy than those used therein at the passing of this Act, the Board of Trade shall consider to what extent, if any, it is expedient in the interests of the public that the powers of this sub-section should be exercised, regard being had to the site of the observatory or laboratory, or the purposes of the instruments or apparatus as the case may be.

Clauses for the protection of the Postmaster-General follow. He is, as usual, very well protected, for due regard is to be had for the telegraph lines from time to time used, or intended to be used, by him, but once again arbitration is be resorted to in the case of any differences arising. In regard to the attachment of wires to house fronts, the undertakers are placed in a very favourable position, as if a householder unreasonably refuses his consent they may appeal to a petty sessional court, which will have power to allow the attachment and fix the compensation or rent to be paid. The fares are not to exceed 1d. per mile, fares on Sunday to be the same as on week-days, and the fares on workmen's trains are not to exceed ½d. per mile. An important provision affecting the question of inter-urban tramways is a clause permitting certain working agreements with the Corporations of Manchester and Ashton-under-Lyne.

As regards lighting and electricity supply for other purposes, it is apparently not intended to meter electricity to each of the four local authorities wholesale for them to distribute to consumers, but rather to carry on ordinary retail electricity supply business as under a provisional order. The maximum price is fixed at 8d. per unit, with a minimum of 13s. 4d. per quarter, and a "compulsory area" is defined just as in the case of a provisional order, being in this instance the two boroughs of Stalybridge and Mossley.

It remains to refer briefly to the financial provisions. The Board may borrow money for tramway and electricity supply purposes, the period for repayment being in practically all cases 30 years. A curious provision in the original Bill allows money to be borrowed on a 10 years' repayment for paying the cost of the opposition to the Oldham, Ashton-under-Lyne and Hyde Light Railway Order. Mortgages are also permitted under clauses 236 to 238 of the Public Health Act, 1875. If the year's trading results in a surplus, a reserve or renewal fund may be formed up to a certain amount after the usual capital and sinking fund charges have been made, and if there is still a surplus it is to be divided in equal shares and carried to the credit of the borough funds of the four local authorities interested. A deficiency is to be met by the four partners in equal shares out of their district or borough funds and rates.

These are the outlines of the first joint municipal electric supply and tramway bill. It clearly carries out the spirit of the Electric Lighting and Tramway Acts, and gives this new departure in municipal trading every chance of success. Going through the House of Commons as an unopposed measure, it does not constitute so serious a precedent as if it had successfully defeated the opposition of a company desiring to work in the same area. We cannot but hope, however, that the ambition of local authorities to possess joint supply schemes will be confined to a few instances of similar character, and that it will not rise to the height of attempting to imitate the companies in the large wholesale supply of electric power.

## THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION AT GLASGOW.

The sixth annual convention of the Municipal Electrical Association was inaugurated on Wednesday morning last at the buildings of the Institution of Engineers and Shipbuilders in Scotland, Bath-street, Glasgow. The proceedings commenced with a hearty welcome to the Association from the Lord Provost of Glasgow, after which the President, Mr. W. A. Chamen, read his inaugural address. A reprint of this able speech will be found in another part of our issue this week. Abandoning the customary platitudes of such occasions, and

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wasting no time upon historical reviews or self-congratulatory remarks, Mr. Chamen elected to take for the subject of his address a topic of ever-present and vital importance to the electric supply industry—viz., the costs and charges for supply. Going down to fundamental principles, the president sketched the rival claims of the various systems of charging, and showed on business and equitable grounds the justness and superiority of the system which proportions the rate of charge to the actual demand made by the consumer on the capital and current expenses of the undertaking. In other words, he showed that the sliding scale of charges is the one system which reconciles the relative rights of consumers of all classes with the business principles upon which all electric supply undertakings, whether municipal or company-owned, must be worked.

The first Paper to be read and discussed was on the subject of "Street Electric Lighting," by Bailie W. Maclay, convener of the Glasgow Corporation Electricity committee. This Paper led to a very lengthy and heated debate on the rival claims of gas and electricity for street lighting, though the discussion was necessarily somewhat of a partisan character. Much was said on the merits of incandescent gas mantles, especially for the lighting of side streets. Bailie Maclay objects to them on the score that they do not stand the wind and vibration attendant on their use in streets. He also finds that for really effective lighting they are more costly than electric lighting. The speakers in the discussion were largely chairmen or other members of lighting committees. Among these were Bailie Mackenzie (Edinburgh), Ald. Pearson (Bristol), Dr. Allfrey (Hastings), Councillor Radford (Plymouth), Ald. Bruce (Sunderland), Ald. Potter (Taunton), Bailie Finlay (Glasgow), and Councillor Deakin (Shrewsbury). Other speakers included Mr. C. H. Wordingham, Mr. Harrison, and Mr. Newington, of Edinburgh. We shall give a report of this discussion in a later issue.

The second Paper read and discussed on Wednesday was entitled "Uninsulated Returns in a Tramway System," and was contributed by Mr. J. H. Rider, chief electrical engineer to the London County Council. A mysterious announcement had been made early in the morning that the discussion on this Paper would be quite short, and after reading the Paper Mr. Rider explained the mystery. It appears that the modification in the Board of Trade tramway regulations, which the Paper was written for the purpose of advocating, had already been made by Mr. Trotter's recommendation, between the times when the Paper was written and the time when it was read. Accordingly, as every speaker in the discussion took care to remark, the ground of their debate was cut away from under their feet, or, as one speaker put it, the sting was taken out of his speech. There certainly was no sting in the discussion, which, however, proved interesting enough. Naturally, electrolysis came in for a share of attention. Mr. W. B. Sayers criticised M. Claude's experiments, which we discussed in our leading article of May 31st. Mr. Sayers thinks that these experiments assume too confidently that the tramway earth is a homogeneous body. He is inclined to the view that it acts very differently in different localities. With regard to the tramway practice to which the Paper referred—viz., the earthing of the system at the rail end of the return feeder instead of at the station—it was confessed by more than one tramway engineer that the now permissible practice of earthing the rail end of the feeder had long been in operation on their lines.

Mr. Wilmshurst, for instance, spoke of having adopted it at Halifax, and Mr. Snell and Mr. Minshall testified to its use at Sunderland and Croydon respectively. Some amusement was created by the remark made in a communication from Mr. A. Bromley Holmes, of Liverpool. Mr. Holmes' casuistry is sufficient to allow him to regard the insulated return feeder as being practically a long extension of the negative terminal of the dynamo; so to earth the far end of the feeder is, on this showing, no whit different from earthing at the actual negative terminal—a very ingenious way of getting over the difficulty.

(*To be concluded.*)

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Atmospheric Electricity.*—F. Exner concludes his summary of recent investigations in atmospheric electricity with a discussion of the variation with altitude of the fall of potential. All the more recent balloon observations to higher altitudes have shown a decrease in the fall of potential. It appears that the supposed self-charge of a balloon by the friction of its netting is not appreciable. The air is, speaking in general, negatively charged in the lower regions, and positively in the upper regions, but in such a manner that up to altitudes of 4,000 metres the sum of the earth's charge and that of the air remains negative. In clear weather the air exhibits almost always irregular local electrification. Whether the air itself is electric or any ingredient of it, such as water or dust, remains as yet undecided. The author further criticises the theories of atmospheric electricity put forward by Elster and Geitel, Brillouin and Le Cadet, and agrees that neither these nor his own are entirely satisfactory. He recommends the use of recording balloons fitted with polonium collectors for investigations in the higher regions of the atmosphere. These investigations are of special importance for solving the problem as to whether the total charge of the earth and its atmosphere is zero or not.

[F. Exner, *Terr. Magn.*, May, 1901.]

*New Effects of the Continuous-Current Arc.*—W. Peukert describes some interesting discoveries made in connection with the speaking arc. He found that acoustic effects could be produced by means of the arc itself without the use of a telephone or a microphone. A condenser of 7·7 microfarads was mounted in parallel with the arc, and contained a key in its circuit. On depressing the key a loud whistling noise proceeded from the arc when it had a certain definite length, say $\frac{3}{4}$mm. The length could be varied within narrow limits, and the pitch of the high note emitted then varied accordingly. But as soon as the arc exceeded a certain length the whistling ceased abruptly, setting in again on reducing the arc to its proper length. It appears that the alternate charges and discharges of the condenser produce alternating currents which coalesce with the continuous current of the arc to form a periodic current of 10 to 20 amperes from a continuous current of 6 amperes. The E.M.F. is not sensibly augmented, the value found being about 68 volts. The frequency would be about 10,000 ~ per second. The experiments are important as placing within our reach the production of charge currents of an intensity never yet attained with condensers, and also the production of strong alternating currents of high frequency and low voltage.

[W. Peukert, *Elektrotechn. Zeitschr.*, June 6, 1901.]

*Magnetic Work of Nansen's Expedition.*—Part VII. of the "Scientific Results of the Norwegian North Polar Expedition, 1893-96" is devoted to the discussion of the magnetic observations made by Lieut. Scott-Hansen during the voyage of the "Fram." It has been prepared by Prof. Aksel S. Steen, of Christiania. The regular magnetic observations, made while the ship was fast in the ice, were begun on October 7, 1893, and ended July 8, 1896. Observations were made on 194 days at 223 different places, yielding 70 declination, 80 dip, and 99 horizontal intensity results. In addition, there were 60 sets of declination observations, for which no azimuth observations could be obtained, and 48 sets of deflections with the dip circle for determination of relative total intensity. For the first few days a tent was set up on the ice to protect the instruments, but from October 16, 1893, to February 10, 1894, the screwing of the ice prevented its use, and observations were made in the open air, about 80 metres from the ship. After that the tent was again brought into requisition, and was used until November 9, 1894, at which time the instrument was transferred to a snow hut, about 100 paces from the ship. From June to September the tent was again used, being then superseded by an observatory built of blocks of ice, in which observations were made until its downfall in June, 1896. The observations of July 7 and 8, 1896, were

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made in the open air. Lieut. Scott-Hansen found it necessary to have a revolver or other weapon always at hand as a protection against bears, but he was careful to place it so that the magnets would not be affected. The declination observations are affected by diurnal variations, which was not determined on the spot. To judge from the analogy of the Grinnell land observations of 1883, the correction should be between 80min. and 40min., as the observations were mostly taken in the afternoon. Compared with Schmidt's theoretical values the magnetic elements show large discrepancies, amounting to −5deg. to +10deg. in declination. But the discrepancies are tolerably systematic, and indicate the absence of strong local disturbing causes. The observations were continued by Nansen and Johansen even on the sledge journey, whenever exigencies of the struggle for existence permitted.

[D. L. HAZARD, *Terr. Magn.*, May, 1901.]

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*Magnetic Analysis of Radium Rays.*—H. Becquerel has improved his method of analysing radium rays into their constituent forms of radiation. The active substance is placed in a uniform magnetic field. A thin flat sheaf of rays parallel to the field is picked out, and the photographic impression of the rays, some of which are deflected by the field, is received on a sensitive plate normal to the field at nearly grazing incidence. The tracks left upon the plate are arcs of circles, which fuse together to form patches with circular outlines. A suitable disposition of successive screens with slits enables the observer to pick out any circular arc at pleasure. Two screens are necessary, since an infinite number of cylinders could be drawn through the linear source and a slit parallel to it. The undeflected rays are marked by straight tracks. They have the greatest penetrative power, and after traversing glass they traverse aluminium 0·1mm. thick without suffering any change, and evidently retaining their characteristic value of $mv/e$. They produce no secondary radium rays, such as are produced whenever the rays are absorbed. The secondary rays produce tertiary rays, and rays of higher orders. They proceed from both surfaces of the material they impinge upon.

[H. BECQUEREL, *Comptes Rendus*, June 3, 1901.]

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*Physiological Effects of Radium Rays.*—All the leading workers on the subject of radium rays have in turn subjected their own persons to some painful experiments for the advancement of their fascinating branch of science. Giesel placed a radium preparation in celluloid case on his arm for two hours. The skin only showed a slight reddening at first, but two or three weeks afterwards inflammation set in and the skin came off. P. Curie was the next voluntary victim. He exposed his arm for 10 hours to the deadly rays. On the 20th day a crust formed, and then a sore, which had to be bandaged. On the 42nd day the skin began to reform, but even on the 52nd day after the exposure a greyish tract of skin remains to indicate the mortification. H. Becquerel placed a very active radium preparation in his waistcoat pocket for six hours. The resulting sore, which took 10 days to develop, required 39 days to heal. Another sore took 84 days to develop. No action was produced when the tube was encased in lead. Madame Curie underwent experiments of a similar nature. The preparation was in her case enclosed in a thin metallic box, and only applied for half-an-hour; but the resulting burn took a fortnight to heal. All those who worked with the very active preparations experienced pains and sores in their fingers, which took two months to recover.

[BECQUEREL and CURIE, *Comptes Rendus*, June 3, 1901.]

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Physical Society.—The next meeting will be held on Friday next, June 28th, at the Wheatstone Laboratory, King's College, Strand. The following Papers are down for reading:—(1) "The Effect of a High-Frequency Oscillatory Field on Electrical Resistance," by S. A. F. White; (2) "The Spectrum of Cyanogen," by E. C. C. Balz and Dr. H. W. Syers.

## A GRAPHIC METHOD FOR CALCULATING THE DISTANCE OF A BREAK IN A SUBMARINE CABLE.

BY E. JONA.

Kennelly's methods (and those derived from it, like Schaefer's, &c.), involve rather tiresome calculations. In the two-current Kennelly test, taking any two currents, the calculation of the results is long; if one graduates the current with a resistance box, in order to have such currents which will simplify the calculation (*e.g.*, in the proportion 1 : 4) the calculation of the resistance to be added every time is also troublesome. With the three-current method these calculations become even longer. I have tried therefore, together with Mr. Pirelli (my fellow electrician in the firm of Messrs. Pirelli & Co.) to simplify the aforesaid calculations in order to get at the result more rapidly.

One of the first simplifications we adopted, was to measure the strength of the currents instead of calculating them, which system we have followed these many years. To do this I use a Weston galvanometer of 150 ohms resistance, made on

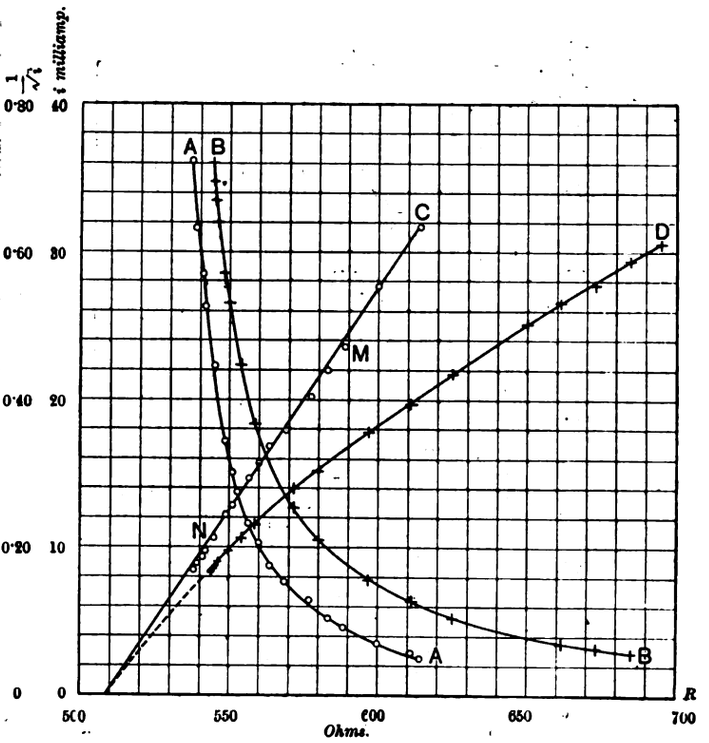


FIG. 1.

purpose, with which, by means of proper shunts, we can get a deflection of one division for 0·05, − 0·1, − 0·2, − 0·5, − 1 milliampere, so that we are able to obtain very accurate measurements. By altering the resistances inserted in the battery circuit, one gets at the currents which are the most adapted for these calculations; but these alterations take up valuable time, and I have therefore found it better to test with a series of different currents, plotting the results in a curve in which the abscissæ represent the resistances R of the cable and the ordinates the various values $i$ of the current through the break.

After drawing the curve, let those values of $i$ be taken which suit the calculations best, and the corresponding values of R. Thereby great rapidity in taking measurements is obtained—a thing which is extremely important in testing; besides, the curve itself corrects the small errors and shows at once whether the general course of the tests is right.

Kennelly's method with false zero is based on the following fact, which he found out experimentally—viz., the resistance of a break varies inversely as the square root of the current, provided this current be not higher than 25 milliamperes. Let $x$ be the distance in ohms from the break, R the total resistance of line ($x$) plus break ($z$), $i$ the current through the

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break, and $z$ the resistance of the break, with a current of 1 milliampere. Then

$$R = x + \frac{z}{\sqrt{i}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

With the three-current method the formulæ would be much more complex.

All these methods admit that the resistance peculiar to the break is an inverse function of the current. Physically, there is a limit to this intensity, beyond which the formulæ do not correspond any longer; but, mathematically speaking, there is no inconvenience in supposing the test continued outside these limits and in prolonging the corresponding curve.

The equation (1) represents, then, a curve of the third order in R and $i$; this curve has an asymptote parallel to the axis of the $i$, the equation of which is $R = x$. This asymptote then cuts the R axis at a distance corresponding to the distance from the break in the cable. But the curve cannot always be prolonged enough to enable us to draw the asymptote by means of experimental data only. It is, therefore, most useful to transform such a curve, bringing the values $1/i = I$ or, better still, $1/\sqrt{i} = J$ as ordinates, instead of the values of $i$.

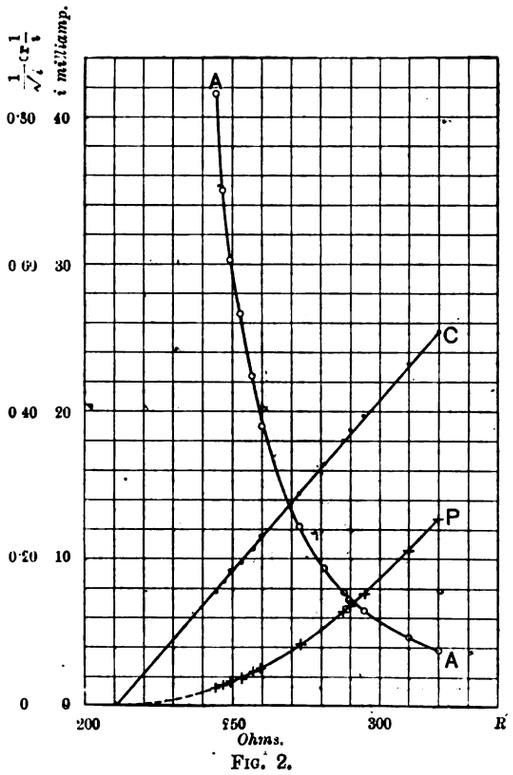


FIG. 2.

By the first transformation the equation (1) would become

$$R = x + z\sqrt{I},$$

which represents a parabola tangential to the R axis in the point corresponding to the break.

By the second transformation the equation (1) becomes

$$R = x + zJ, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

which represents a straight line, cutting the R axis at the point corresponding to the break; and as there is no uncertainty in prolonging a straight line, it will always be better to avail oneself of this last transformation.

By the three-current method with the true zero one can do likewise. But here the line obtained by bringing the R as abscissæ and the $1/\sqrt{i}$ as ordinates is no longer a straight line but a curve, which also will, if prolonged, cut the R axis at the break.

In Fig. 1 there is an instance of this method. With the false zero the results we got were as follows:—

| $i$ | R | $i$ | R | $i$ | R | $i$ | R |
|---|---|---|---|---|---|---|---|
| 2·5 | 614 | 7·8 | 569 | 13·8 | 553 | 26·3 | 542 |
| 3·43 | 600 | 8·9 | 564 | 15·3 | 551 | 28·5 | 540·7 |
| 4·52 | 589 | 10·3 | 560 | 17·1 | 549 | 31·8 | 539·2 |
| 5·2 | 583 | 11·7 | 557 | 22·3 | 545 | 36 | 538·5 |
| 6·28 | 577 | | | | | | |

With the true zero we obtain the following ones:—

| $i$ | R | $i$ | R | $i$ | R | $i$ | R |
|---|---|---|---|---|---|---|---|
| 2·65 | 695 | 5·30 | 625 | 18·2 | 559 | 32 | 546 |
| 2·90 | 685 | 6·45 | 611 | 22·2 | 554·2 | 33·5 | 545·4 |
| 3·23 | 673 | 7·88 | 597 | 26·5 | 550 | 34·8 | 544·9 |
| 3·56 | 661 | 10·6 | 580 | 28·6 | 548·3 | 36 | 544·2 |
| 3·97 | 650 | 12·8 | 571·5 | | | | |

The results with the false zero are plotted in curve A, and those with the true zero in curve B; line C is curve A transformed by taking the values $1/\sqrt{i}$ as ordinates, and line D is curve B likewise transformed by taking the values $1/\sqrt{i}$ as ordinates. Line C is a straight line, cutting the R axis at a distance between 509 and 510 ohms; taking only the points between M and N (viz., leaving aside, as Kennelly does, the highest currents—31·8 to 36 milliamperes—and also the too low currents), the R axis would be cut between 507 and 508 ohms. The break was afterwards found at 506 ohms. But this is not what matters here; the straight line leads to the same results as the calculating of the tests.

Also line D, when prolonged, will cut the R axis at a distance corresponding to the break.

In Fig. 2 there is another instance of the method with false zero. The experimental results were as follows:—

| $i$ | R | $i$ | R | $i$ | R | $i$ | R |
|---|---|---|---|---|---|---|---|
| 3·92 | 320 | 7·7 | 288 | 19·0 | 260 | 30·2 | 249·5 |
| 4·7 | 310 | 9·4 | 281 | 22·6 | 257 | 35 | 247 |
| 6·52 | 295 | 12·1 | 273 | 26·6 | 253 | 41·5 | 244·5 |
| 7·2 | 290 | | | | | | |

and these are plotted in curve A. P is the parabola derived from A by taking $1/i = I$ as ordinates; it would be easy to establish geometrically the vertex of the parabola, knowing that the R axis is tangential to the curve at the vertex. C is the straight line derived from A by taking $1/\sqrt{i} = J$ as ordinates; it cuts the R axis at 211·5 ohms.

Of course, in practice it would be useless to draw all the curves A, P, &c.; the straight line C is sufficient, and this straight line gives us immediately an average of the various tests. The points are not always absolutely in a straight line, on account of errors in testing and because the inverse square root law is not absolutely correct; but the straight line C gives us immediately an average and leads to the same results as the calculations of the tests.

In order to save calculations, I give here a table of the values of $1/\sqrt{i}$ from 1 to 30 milliamperes.

*Values of* $\frac{1}{\sqrt{i}}$.

| | 0 | 0·1 | 0·2 | 0·3 | 0·4 | 0·5 | 0·6 | 0·7 | 0·8 | 0·9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1·000 | 0·954 | 0·913 | 0·877 | 0·845 | 0·816 | 0·790 | 0·761 | 0·745 | 0·726 |
| 2 | 0·707 | 0·690 | 0·674 | 0·660 | 0·646 | 0·633 | 0·620 | 0·609 | 0·598 | 0·587 |
| 3 | 0·577 | 0·568 | 0·559 | 0·551 | 0·542 | 0·534 | 0·527 | 0·520 | 0·513 | 0·506 |
| 4 | 0·500 | 0·494 | 0·488 | 0·482 | 0·477 | 0·471 | 0·466 | 0·461 | 0·456 | 0·452 |
| 5 | 0·447 | 0·443 | 0·439 | 0·434 | 0·430 | 0·426 | 0·423 | 0·419 | 0·415 | 0·412 |
| 6 | 0·408 | 0·405 | 0·402 | 0·398 | 0·395 | 0·392 | 0·389 | 0·386 | 0·384 | 0·381 |
| 7 | 0·378 | 0·375 | 0·373 | 0·370 | 0·368 | 0·365 | 0·363 | 0·360 | 0·358 | 0·356 |
| 8 | 0·354 | 0·351 | 0·349 | 0·347 | 0·345 | 0·343 | 0·341 | 0·339 | 0·337 | 0·335 |
| 9 | 0·333 | 0·332 | 0·330 | 0·328 | 0·326 | 0·324 | 0·323 | 0·321 | 0·319 | 0·318 |
| 10 | 0·316 | 0·315 | 0·313 | 0·312 | 0·310 | 0·309 | 0·307 | 0·306 | 0·304 | 0·303 |
| 11 | 0·301 | 0·300 | 0·299 | 0·297 | 0·296 | 0·295 | 0·294 | 0·292 | 0·291 | 0·290 |
| 12 | 0·289 | 0·287 | 0·286 | 0·285 | 0·284 | 0·283 | 0·282 | 0·281 | 0·279 | 0·278 |
| 13 | 0·277 | 0·276 | 0·275 | 0·274 | 0·273 | 0·272 | 0·271 | 0·270 | 0·269 | 0·268 |
| 14 | 0·267 | 0·266 | 0·265 | 0·2644 | 0·2635 | 0·2626 | 0·2617 | 0·2608 | 0·2599 | 0·2591 |
| 15 | 0·258 | 0·2573 | 0·2565 | 0·2556 | 0·2548 | 0·2540 | 0·2532 | 0·2524 | 0·2516 | 0·2508 |
| 16 | 0·250 | 0·2493 | 0·2484 | 0·2477 | 0·2469 | 0·2462 | 0·2455 | 0·2447 | 0·2440 | 0·2432 |
| 17 | 0·2425 | 0·2418 | 0·2411 | 0·2404 | 0·2398 | 0·2391 | 0·2384 | 0·2377 | 0·2370 | 0·2364 |
| 18 | 0·2357 | 0·2351 | 0·2344 | 0·2338 | 0·2332 | 0·2325 | 0·2319 | 0·2313 | 0·2306 | 0·2300 |
| 19 | 0·2294 | 0·2288 | 0·2282 | 0·2276 | 0·2271 | 0·2264 | 0·2259 | 0·2253 | 0·2247 | 0·2242 |
| 20 | 0·2236 | 0·2231 | 0·2225 | 0·2219 | 0·2214 | 0·2208 | 0·2203 | 0·2198 | 0·2193 | 0·2187 |
| 21 | 0·2182 | 0·2177 | 0·2172 | 0·2167 | 0·2162 | 0·2157 | 0·2151 | 0·2147 | 0·2142 | 0·2137 |
| 22 | 0·2132 | 0·2127 | 0·2122 | 0·2118 | 0·2113 | 0·2108 | 0·2103 | 0·2099 | 0·2094 | 0·2090 |
| 23 | 0·2085 | 0·2081 | 0·2076 | 0·2072 | 0·2067 | 0·2063 | 0·2058 | 0·2054 | 0·2050 | 0·2045 |
| 24 | 0·2041 | 0·2037 | 0·2033 | 0·2029 | 0·2024 | 0·2020 | 0·2016 | 0·2012 | 0·2008 | 0·2004 |
| 25 | 0·2000 | 0·1996 | 0·1992 | 0·1988 | 0·1984 | 0·1980 | 0·1976 | 0·1972 | 0·1969 | 0·1965 |
| 26 | 0·1961 | 0·1957 | 0·1954 | 0·1950 | 0·1946 | 0·1943 | 0·1939 | 0·1935 | 0·1932 | 0·1928 |
| 27 | 0·1925 | 0·1921 | 0·1918 | 0·1914 | 0·1910 | 0·1907 | 0·1903 | 0·1900 | 0·1896 | 0·1893 |
| 28 | 0·1890 | 0·1886 | 0·1883 | 0·1879 | 0·1876 | 0·1873 | 0·1870 | 0·1867 | 0·1863 | 0·1860 |
| 29 | 0·1857 | 0·1854 | 0·1850 | 0·1847 | 0·1844 | 0·1841 | 0·1838 | 0·1835 | 0·1832 | 0·1829 |
| 30 | 0·1826 | 0·1823 | 0·1820 | 0·1817 | 0·1814 | 0·1811 | 0·1808 | 0·1805 | 0·1802 | 0·1799 |

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## THE ELECTRICAL EQUIPMENT OF THE NEW YORK ELEVATED RAILWAY.*

(*Concluded from page 290.*)

The switching apparatus is largely automatic, and interlocking or equivalent means are adopted where sequence in throwing switches is essential. In every way the designers have kept in view the necessity of manipulating the switchboard devices with the utmost possible degree of promptness and accuracy. As in the case of the new plant at Niagara Falls, the switching apparatus will be operated by means of a controlling board so arranged as to present to the eye of the operator at all times an accurate diagram of the more important connections of the alternators, 'bus bars and feeder circuits.

In the organisation of the switching apparatus great care is taken in order that any failure of a cable, a switch or other device shall not result in a general interruption of service. Among the special provisions to procure this result are the following :—

Each of the high-tension cables is equipped at the power-house end with an oil circuit-breaking switch, with a time-limit relay device which may be so adjusted that in case of a short circuit in the cable the supply of current shall be interrupted at the end of a fixed interval, say 3 sec. At the sub-station end the cable is connected to the 'bus bars through a similar oil circuit-breaking switch, but in this case the automatic device is arranged to open the switch in the case of a reversal of the current such as would be caused by a short circuit in the cable. This reversed current relay will be adjusted to act instantly, and thus any cable which may become short circuited will be instantly cut off automatically from the sub-station apparatus, and at the end of 3 secs. will also be automatically disconnected from the power-house.

In case the feeder switch fails to open the circuit, which operated automatically or by an attendant, the group switch in series with it may be opened. While this will result in temporary cessation of supply to one of the sub-stations, trains will still be able to operate at somewhat reduced speed until the supply of power to the sub-station affected is restored similarly. If one of the two switches, which in service are connected in series between each alternator and the 'bus bars, should fail to open, the other may be used.

In each high potential alternating-current circuit which connects the 'bus bars at the sub-stations with a group of step-down transformers, and through them with a rotary converter, an automatic circuit-breaking oil switch with time-limit relay will be placed ; and in the direct-current circuit between the converter and direct-current 'bus bars, the circuit-breaker will be arranged to open the circuit when power exceeding a certain predetermined small amount does not flow back through the direct-current 'bus bars into the converter. In case of a short circuit in the group of transformers, or in the converter, or in the connecting circuits between the alternating-current circuit-breaker and the direct-current circuit-breaker, these breakers are intended to act automatically and disconnect from the alternating-current 'bus bars and from the direct-current 'bus bar the converter unit affected.

The Manhattan switching apparatus will be controlled electrically and without the intervention of compressed air, the large switches being operated by means of electric motors working in conjunction with powerful springs. The motors, and consequently the switches, are in turn controlled by electric circuits which pass through small switches immediately under the hand of the operator, these switches being assembled upon a bench-board, where they are arranged in conjunction with dummy 'bus bars and connections so as to place at all times before the eye of the operator an accurate diagrammatic representation of the existing connection of the alternators for the switches, 'bus bars and converters.

Two complete sets of 'bus bars are used, to which any alternator or any feeder may be connected. The eight alternators to be installed immediately will be divided into two batteries of four each ; thus there will be two sections of 'bus bars, and two duplicate sets of 'bus bars in each section.

The main 'bus bars are not divided into generator and feeder sections, but feeders will be tapped off at the same point where generators are tapped in. As a result of this, the 'bus bars will be traversed normally by only a small portion of the total current delivered from the plant, the larger part of this current flowing directly from alternator switches to group switches, the 'bus bars thus to some extent serving as equalisers.

The high-potential oil-break switches, which, together with the entire switching apparatus, will be supplied by the General Electric Co., are of such a form that each phase of the circuit is isolated from the other phases in a special enclosed brick compartment, each compartment containing two enclosed brass vessels partially filled with oil, below the surface of which the circuit is broken. As stated before, the quick opening and closing of the switch is obtained by means of powerful springs, the mechanism being such that a motor not only serves to close up the springs ready for the next operation, but also serves as a tripping device, allowing the springs to operate as soon as the motor is started. All of the motors operating the oil switches will be supplied with power from the 110 volt storage battery mentioned in the description of the power-house.

The alternating-current switching devices in each of the sub-stations will resemble in general those in the power-house, but there will be no duplicate 'bus bars. Each station will have a single set of 'bus bars placed in isolated brick compartments with incoming feeder switches to one side of the 'bus bars and out-going rotory converter switches to the other side. The 'bus bars will be divided by knife switches into sections, one for each rotary converter, in order to make it possible to shut down any section of the 'bus bars for repairs. The sub-station switchboard will be supplemented by a controlling bench board.

In the arrangement adopted for switch control, the advantages of the "closed circuit principle" are retained without its disadvantages. The term "closed circuit principle" signifies connections such that when the supply of direct current used for operating the switches fails, all switches open, the controlling current being used to close the switches, and some opposing force, for example, gravity, to open

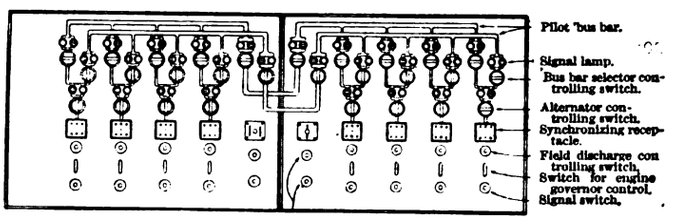


FIG. 16.—ALTERNATOR CONTROLLING BENCH BOARD.

them. The advantage of this principle, which is much used in railway work, lies in the fact that any failure of the controlling circuits is at once manifested and may be corrected, and there is, therefore, no danger that the system of control will fail to operate at the time when the operator attempts to use it.

Obviously, the disadvantage of the closed circuit principle is that any momentary failure of the supply to direct current used for the controlling circuits results in opening all of the alternating current switches in the power-house, and so interrupting the entire service. In the Manhattan arrangement, indicating devices of the visual signal type, resembling those in use on the modern common battery telephone switchboard, are introduced, which obviate the disadvantage referred to. These indicating devices will be bulls' eyes, illuminated by small incandescent lamps, which will be supplied with current over the operating wires from the oil switches and by a circuit completed through the motor of the oil switch, so that the lamps are at all times a guarantee of the integrity of the circuit. Two of these lamps will be used for each oil switch—one to indicate

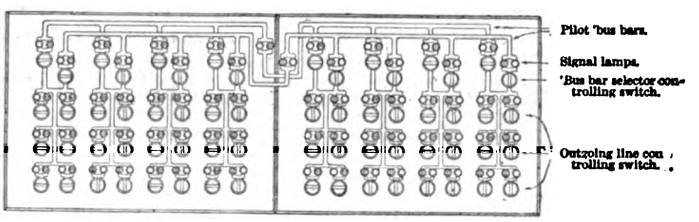


FIG. 17.—ALTERNATING CURRENT FEEDER BENCH BOARD.

that it is closed and the other to indicate that it is open. The lamps thus serve as a check on each other in case of the failure of the filament or any broken connection in the lamp circuit.

The alternator controlling bench-board is illustrated diagrammatically in Fig. 16. On the upper or rear part of the board the duplicate 'bus bars are represented by two strips of oxidised copper. They are divided by 'bus junction switches into two sections, to each of which four alternators are connected. In the diagram the row of "rectangular synchronising receptacles" serves also to represent the alternators. The connections of alternators, switches, 'bus bars and 'bus junction switches are diagrammatically represented on the alternator controlling bench board, while the group switches and the feeder switches are similarly represented on the alternating-current feeder controlling bench-board in Fig. 17. Referring to the former, it will be noted that for each alternator there are three oil switches, one at all times in series with the alternator, the other two connecting the alternator respectively to the two sets of duplicate 'bus bars ; thus there are always two switches in series with each other between each alternator and either set of 'bus bars, affording opportunity to test the operation of any oil switch at any time when the corresponding alternator is not in service.

* This article has been compiled from the *Street Railway Journal* and the *Electrical World* of New York.



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The controlling switches on the bench board will have horizontal swing handles, which in their up and down position on the board open the main oil switches, while in a cross position on the board they open the main switches. For simplicity, the diagram represents only one conductor of each circuit—the diagrammatic conductor, consisting of strips of oxidised copper—the handles of the controlling switches and opaque strips in the little round glass windows immediately over the signal lamps. The pilot diagram of circuits on the bench board is so run that the switch handles apparently open and close the diagrammatic circuit. The opening and closing of these small controlling switches, of course, does actually open and close the oil switches, and, therefore, the actual position of the oil switches is at all times indicated by the position of the controlling switches in the diagram.

The lamps will be similarly arranged. The two bulls'-eyes for each switch will be of different colours, red to indicate that the switch is closed, and green to indicate that it is open. Opaque strips closing the pilot diagram of circuits under the red bulls'-eyes and opening the pilot diagram of circuits under the green bulls'-eyes will also be used to apparently complete the diagrammatic circuit connection, the operator having immediately before him at all times an exact representation of the actual connections of the alternating-current circuits, and not having to trust to memory to determine what alternators are connected to one or the other set of 'bus bars, nor what 'bus bars are connected to each other. A glance at the controlling board for the feeder circuits similarly will show him how the several groups of feeders are connected to the 'bus bars.

Referring again to the view of the alternator-controlling bench board, there will be seen below each main alternator switch a six-point synchronising receptacle, which serves also the purpose of representing the alternators in the diagram. Two synchronising voltmeters will be used, one at the rear of each panel of the alternator-controlling board. These will be connected on a new principle, synchronising neither bright nor dark, but at the middle of the voltmeter scale. This plan has several advantages—showing the slip or angular displacement more accurately, indicating the instant of proper synchronism with greater accuracy, and also indicating whether the alternator to be synchronised is running too rapidly or too slowly.

Immediately below the synchronising receptacle is the field discharge controlling switch, used for tripping an electrically operated field discharge switch on the exciter board. As the tripping of this switch unintentionally while the alternator is in operation might interrupt the service, the controlling switch will be what might be termed a "pull button," which must be pulled up from the face of the board in order to operate the trip. This form is used to avoid danger that the switch might be accidentally manipulated.

Below the field discharge pull button on the alternator-controlling bench board will be located a motor governor controller for adjusting the governors of the main engines and equalising the division of the load between alternators. Below the motor governor controller will be a signal switch, connecting to signal lamps, or gongs, on the starting platform of the corresponding engine. The alternator controlling bench board will also carry a system of emergency field discharge 'bus bars, four in number, corresponding to the four duplicate sections of main alternating-current 'bus bars. The alternating selector controlling switches will make contact between the field discharge circuits and the emergency discharge 'bus bars, thus completing controlling circuits by means of which the fields of all main alternators operated in multiple may be simultaneously discharged by pulling the emergency pull button. The 'bus-junction controlling switches will be provided with contacts for uniting the emergency field discharge 'busses, so that under any circumstances all alternators operating in parallel will have their fields simultaneously discharged by the pulling of a single pull-button switch.

Referring to the alternating-current feeder controlling bench board (Fig. 17), it will be noted that each group of six feeder switches may receive current from either set of 'bus bars through a group switch. In the bench board, as on the switchboard galleries, provision is made for six alternating-current feeders in each group. Not all of these feeders will be required at present, but in a plant of this character it is very important to provide for possible additions and extensions. Two bench boards will be located side by side, the alternator bench board being placed directly in front of that part of the instrument board which carries the instruments belonging to the alternator panels, while the feeder controlling bench board occupies a corresponding position in front of the instrument board which carries the alternating-current feeder instruments.

Immediately behind the controlling bench boards will be the instrument board, 28ft. in length, containing all indicating instruments for alternators and feeders. The instruments for two alternators are combined upon one panel, the instruments for each alternator being mounted in a vertical row. At the top are three ammeters, combined in one case. Below these are placed a voltmeter, an indicating wattmeter, with a scale reading up to 10,000kw., and a power-factor indicator. By means of the relative readings of the last-named instrument, the operator will be enabled to accurately adjust the relative field excitation of the various alternators, thus minimising the magnetising cross-currents between the alternators.

The power factor indicators will also serve as an automatic signalling device between sub-stations and the power-house. The voltage of the whole system will, of course, be determined by the sub-station requirements. If the voltage delivered by alternators at the power-house is too low, sub-station attendants will attempt to raise it by cutting out the field resistance of the rotary converters, and thereby drawing leading currents from the power-house. This will be shown upon the power-factor indicators of the alternators, whereupon the operator at the power-house will raise his voltage to meet the sub-station's requirements, restoring the power factor to unity. The reverse sequence of operation will occur when the direct-current voltage is too high.

## STORAGE BATTERIES IN ELECTRIC POWER STATIONS, CONTROLLED BY REVERSIBLE BOOSTERS.*

BY J. S. HIGHFIELD.

(*Continued from page 292.*)

The efficiency of battery working is a most important factor, since every unit supplied from the battery costs more than the units supplied direct by an amount depending on the efficiency. I have results obtained from a battery of 240 cells capable of giving 100kw. for three hours. The units were metered through a watt-hour meter, which recorded charge and discharge separately, and which was checked by the switchboard ammeters and voltmeters from time to time, and was found to be sensibly correct. The units of charge from July 1 to Dec. 31 were 62,560, and of discharge, 46,390 for the same period, corresponding to an energy efficiency of 74 per cent. The battery is charged at varying rates to suit the load on the engines. The charging current starts at 170 to 200 amperes, and varies from time to time as the outside load varies, but it never exceeds 70 amperes when the cells are full. The maximum charging pressure per cell is 2·41 volts, the minimum discharging pressure 1·9 volts; the average charge per 24 hours is 341 units, the average discharge 253 units; the maximum discharging current is 200 amperes. Additional figures are given in the Appendix. The battery has cost for repairs a small amount, consisting of labour in filling up the cells with water and in cleaning. Two faulty positive sections were replaced by the makers, otherwise no work has been done in keeping the battery in order.

The usual directions of the makers are impossible to carry out in practice, and I find the most convenient method of keeping note of the condition of the cells is to make a weekly test all round of the specific gravity of the electrolyte, being careful to take the readings only when the cells are fully charged by the switchboard voltmeter. By comparing the results with those last taken, it is easy to see if the proper amount of charge has been given during the week; if the specific gravity has fallen, rather more charge is given to bring it right up again. From the results obtained of battery working at various times, I am of opinion that charging with a constant current at the battery maker's usual figure is not so conducive to efficient working and to the long life of the cells as finishing up the charge at quite a small current. On the other hand, the charging current at the commencement, when the cells are empty, may safely be much greater than the maker's figure. It would be most interesting to have accurate figures over a great number of charges and discharges giving the efficiencies of various methods of working and at various rates of charge and discharge. The curves in Figs. 3 and 4 show the ordinary work done by the battery on the lighting load in the station of which I have charge.

There is one point to which I have not alluded, and that is the immense convenience that a battery is when repairs have to be done to steam pipes or valves. The advantage of being able to shut down entirely and still keep the mains alive is so great that for this reason alone a battery in a central station is almost a necessity, at any rate where a motor load exists. In such a case a shut down, even for a few hours on Sunday, is almost impossible, and on a week-day cannot be tolerated.

Apart from this use of batteries in the power station, there may arise occasions when the battery may be used in a sub-station at one or more important feeding-points. About 15 per cent. of the copper put down in feeders is only required for a few hours each day for, perhaps, one month in the year, from the middle of December to the middle of January. This copper can be saved by using a battery in a sub-station, provided, of course, that a site can be found at not too great a cost. In addition to the saving in feeders, the economical area of distribution can be extended, and the pressure can be maintained more nearly constant. It is not possible to lay down general rules for the use of batteries in this way, but I now have a case

* Paper read before the Institution of Electrical Engineers May 9.

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where it is necessary to give supply at a point about 3 miles from the station. The extent of the supply will be about 100kw. There is an excellent site for a sub-station aboat 2½ miles from the station, and a battery at this point works out at a less first cost than a boosted direct-feeder or a high-tension transmission scheme.

### Batteries in Traction Stations.

In power stations supplying energy to work tramways and railways the character of the load is entirely different from that of a lighting load. The output varies but little according to the time of the year or from day to day. There are peaks during which the output and the maximum load are greater than at other working out the load. In each figure the horizontal line shows the average load, during the hours of running the plant, necessary to turn out the metered units. It is evident from the curves that a generator of 200kw. can easily give the output if a battery be used to discharge on the peaks. For such a load the battery may be used at the one-hour rate of discharge normally, and on occasions at even a greater rate. Such occasions might be when the road is very heavy through a snowfall or like reason, or when cars get bunched during holiday traffic. In the case of a traction load, therefore, the capital cost of the battery may be taken at the one-hour rate, that is, about £15 to £18 per kilowatt. This is considerably less than the cost of the running plant. For the load shown in Fig. 5 over 24 hours, the

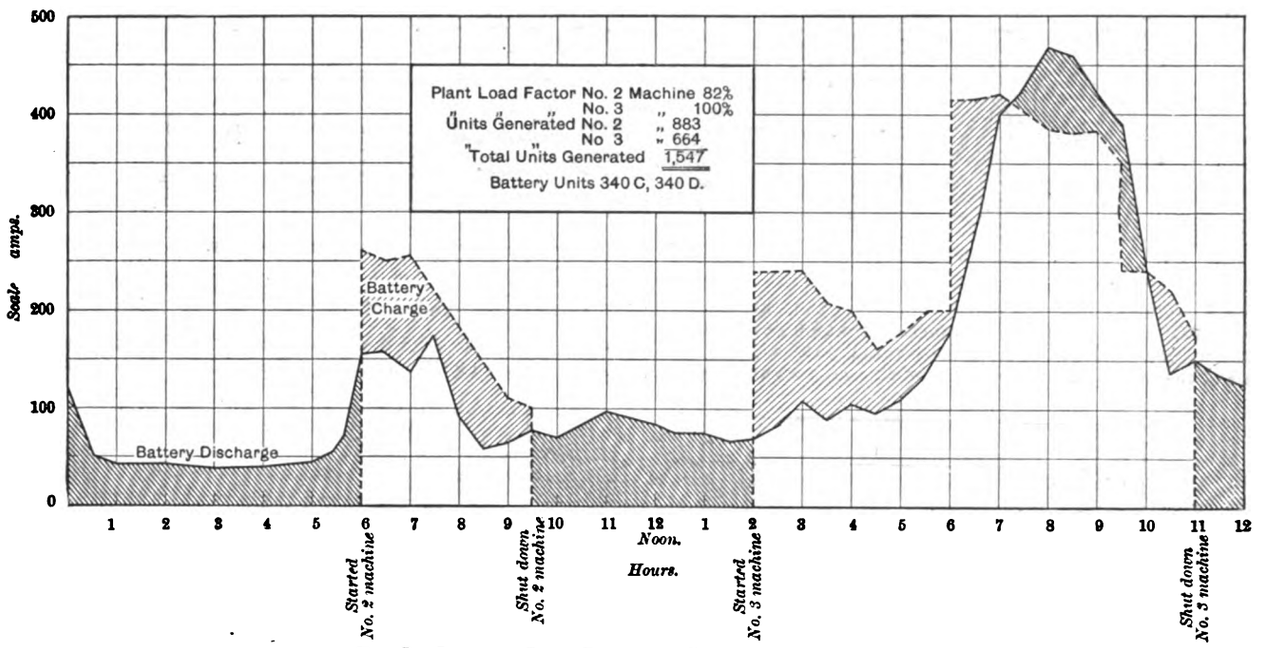
Plant Load Factor No. 2 Machine 82%
" " No. 3 " 100%
Units Generated No. 2 " 883
" " No 3 " 664
Total Units Generated 1,547
Battery Units 340 C, 340 D.
Battery Charge
Battery Discharge
Scale amps.
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
Noon.
Hours.
Started No. 2 machine
Shut down No. 2 machine
Started No. 3 machine
Shut down No. 3 machine

Fig. 3.—Lighting Load Diagram. Generator and Battery.

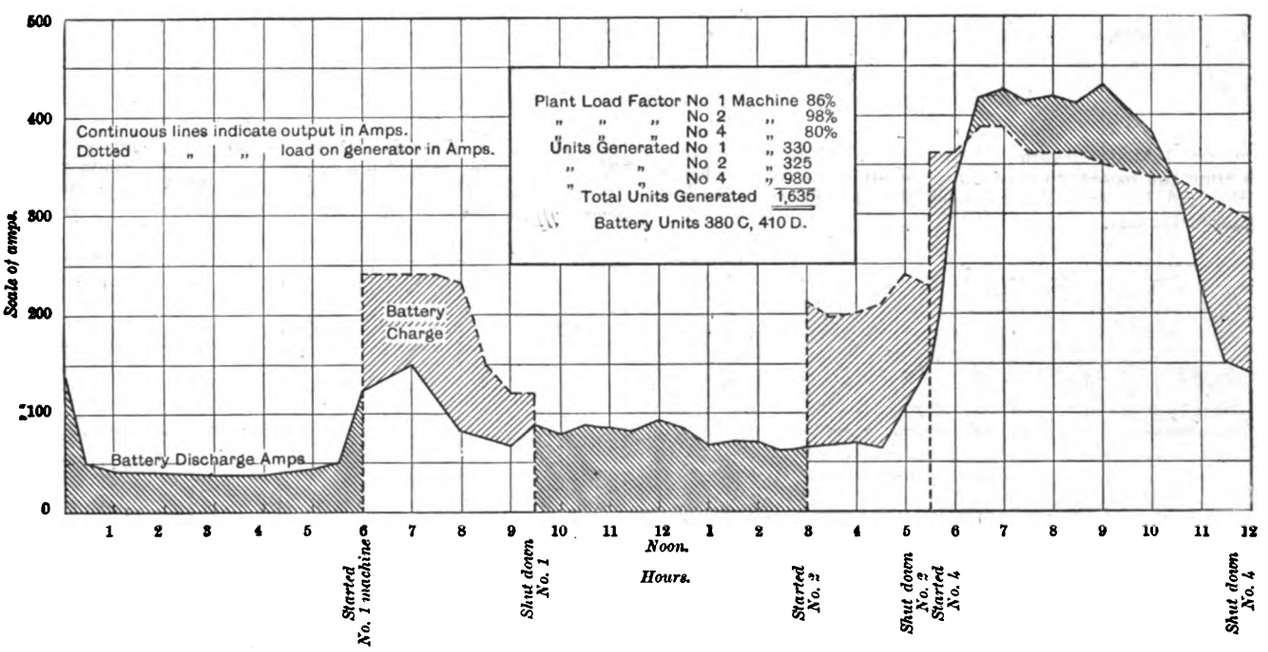
Continuous lines indicate output in Amps.
Dotted " " load on generator in Amps.
Plant Load Factor No 1 Machine 86%
" " " No 2 " 98%
" " " No 4 " 80%
Units Generated No 1 " 330
" " No 2 " 325
" " No 4 " 980
Total Units Generated 1,635
Battery Units 380 C, 410 D.
Battery Charge
Battery Discharge Amps
Scale of amps.
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
Noon.
Hours.
Started No. 1 machine
Shut down No. 1
Started No. 2
Shut down No. 2
Started No. 4
Shut down No. 4

Fig. 4.—Lighting Load Diagram. Generator and Battery.

times, but not nearly to so great an extent as in lighting work. The load, however, varies very rapidly and through very wide limits, the variations becoming less as the number of cars or trains increases. In the case of a road operating 50 to 100 cars the maximum loads are usually about three times the mean load. With 100 to 200 cars the maximum loads are usually less than twice the mean load. Fig. 5 shows the load variations for a road operating 25 to 30 cars; Fig. 6 shows the variations of the mean load at any time during the day, this curve being plotted by taking the output in units every half-hour, and from the readings load-factor is 23 per cent. Such a load cannot be very economical, since the steam plant would be, on the average, very lightly loaded.

The plant load-factors for a lighting station and a traction station differ in one respect—in a lighting station, by using units of several sizes, the engines may be run nearly at their full load always, but the load on the boiler plant will vary considerably; in a traction station, on the other hand, the boilers will supply, during about 16 hours, about the same amount of steam per hour. The engines must, however, be large enough to take the maximum load, and therefore work at only a small part of their full capacity.

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If a battery be used in parallel with the steam plant on the load shown in Fig. 5, it will take up some portion of the peaks; but the conditions of battery discharge and charge must be such that the variations in the battery pressure must be small, which would necessitate working the battery at a much slower rate than the one-hour rate allowed for above. The ideal arrangement would be to run the generator at constant load—making the constant load as nearly the full load of the generator as possible, to work the necessary number of hours, say, 16 daily, to turn out the required number of units—and to allow the battery to take charge of all peaks, and to charge when the load is small, and to work the entire service for the remainder of the day.

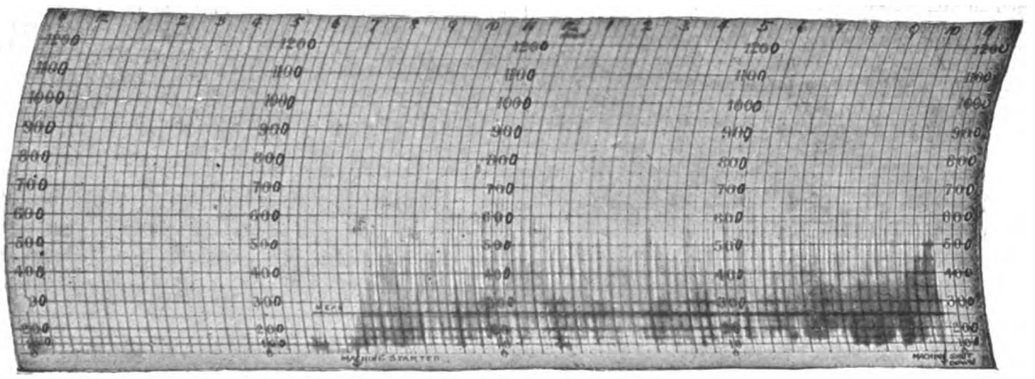

FIG. 5.—RECORDER CURVES FOR TRACTION LOAD WORKED WITH BATTERY AND REVERSIBLE BOOSTER.

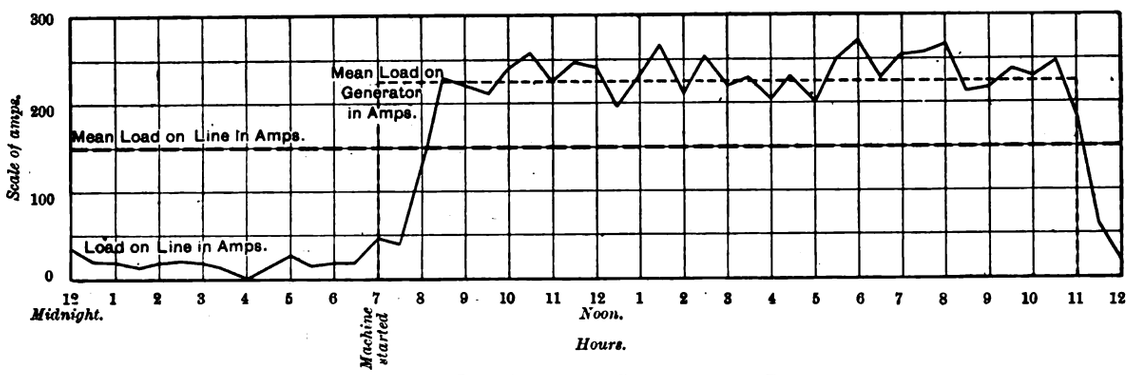
300
200
100
0
Scale of amps.
Mean Load on Generator in Amps.
Mean Load on Line in Amps.
Load on Line in Amps.
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
Midnight.
Machine started
Noon.
Hours.

FIG. 6.—TRACTION LOAD DIAGRAM. GENERATOR AND BATTERY.

It is here necessary to consider the nature of the battery as a reservoir of energy. Fig. 7 shows the well-known rise of voltage on charge and fall of voltage on discharge at various rates. Fig. 8 shows the fall in voltage due to throwing on the load in sudden steps, the fall in the latter case being due to the ohmic resistance of the cell, and possibly, to a less extent, to polarisation. In a battery working in parallel with a shunt-wound generator at such a speed as to give about the mean output, so that the battery neither gained nor lost very much, the number of cells should be determined by the formula, number of cells $= \frac{\text{line volts}}{2{\cdot}08}$. I have found that when in the best condition for working in this way, a battery capable of giving 450 amperes for one hour will discharge 200 amperes with a fall of pressure of 25 volts, and will charge 200 amperes with a rise of pressure of 25 volts, these limits being the greatest permissible on a 500 volt circuit. With compound-wound generators the pressure rises with the load, so that the battery working in parallel with the generator will do very little work. In working a battery in simple parallel with shunt-wound generators, it is impossible to charge the battery during working hours and at the same time have it available to discharge on any peaks; this is a great drawback, and necessitates running longer hours to complete

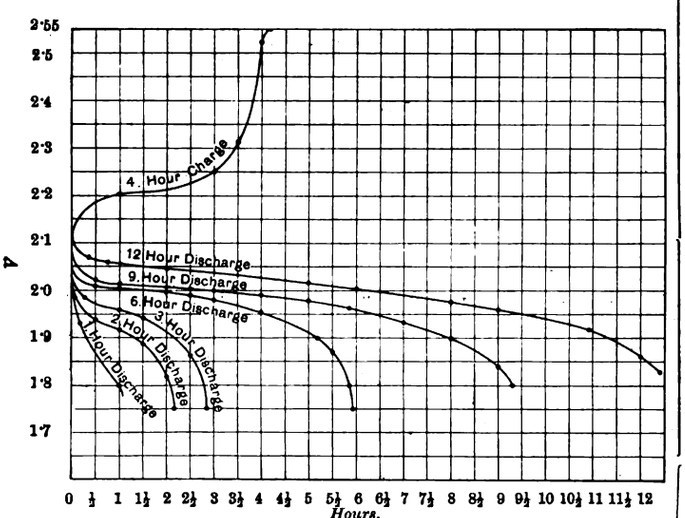


FIG. 7.—CURVES SHOWING RISE OF VOLTAGE ON CHARGE, AND FALL OF VOLTAGE ON DISCHARGE AT DIFFERENT RATES.

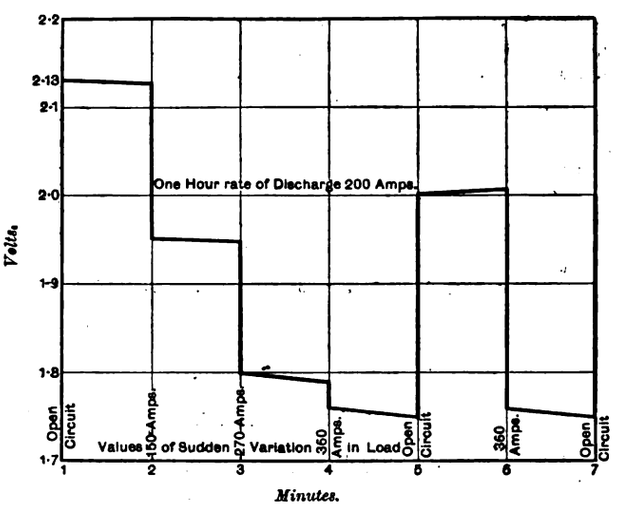


FIG. 8.—VARIATION IN VOLTS OF ONE CELL WITH SUDDEN VARIATION IN THE LOAD.

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the charge. The only way to work a battery on a tramway or other variable load to keep the generator output constant, to fully charge during working hours, and to discharge up to its momentary rate, is to use some device to compensate for the variation of the battery pressure. For this purpose I have used a booster of somewhat special design, the booster armature being always in series with the battery. This machine is run throughout the time the generators are working, and sometimes when the battery alone is working the line.

*(To be continued.)*

## STANDARD SPECIFICATION FOR THE TESTING OF ELECTRICAL MACHINERY.

The following are, in a slightly abbreviated form, the standard conditions for the testing of electrical machinery proposed by a committee of the Verband Deutscher Elektrotechniker. They will be considered at the meeting of the Verband in Dresden on Friday, June 28.

*Definitions.*

A dynamo is defined as any rotatory machine for the conversion of electrical into electrical, electrical into mechanical, or mechanical into electrical energy, and this includes generators, motors, motor generators and rotatory converters.

*General.*

1. Unless other conditions of delivery are agreed upon, the following specifications as to tests are to be considered as implied. Regulations 4, 5 and 6 must, however, be followed in any case, and machines or transformers not bearing a plate with the output marked on it as prescribed below will not be considered to comply with these regulations.

*Output.*

2. The outputs of all dynamos and transformers are to be given as follows:—Continuous current in kilowatts, alternating currents in kilowatts with the addition of the power factor, motors in horse power. In addition to this, on the same plate or a separate plate, are to be given the standard values of the speed or frequency, pressure and current as in regulations 4, 5 and 6.

3. With regard to the output, the following different conditions of working are to be considered:—

(*a*) Intermittent working, as in the case of motors for cranes, lifts, tramways, &c., in which the period of work and rest alternate, each lasting a few minutes.

(*b*) Working for periods shorter than is necessary for the final temperature to be reached, and with periods of rest long enough for the temperature of the machine to drop approximately to that of air.

(*c*) Continuous working long enough for the final temperature to be attained.

4. The output of machines and transformers for "intermittent" working is to be rated as that which the machine can give for one hour without the temperature rising above the value specified hereafter.

5. The plates on machines coming under the category (*b*) must bear, after the statement of the output, the words "for.....hours" and the stated output of the machines must have been rated on the assumption that the machine can work at that output for the given number of hours without the temperature rising above the value specified hereafter.

6. The plates on machines coming under (*c*) must bear the words "continuously working" after the output, and the stated output must be based on the assumption that the machine can work any desired time without the temperature rising above the below-specified value.

7. Different outputs for different conditions of working may be given.

8. Generators or rotatory converters for variable pressure need only have marked on them the normal values of the pressure, current, and speed, but the limiting values must be given in the conditions of delivery.

9. Machines with commutators must run at any load within the permissible limits so sparklessly that no treatment of the commutator with glass paper, &c., is necessary until after at least 24 hours' working.

*Temperature Rise.*

10. The periods after which this is to be measured are, in the case of (*a*) and (*b*), as above; in the case of (*c*), for dynamos, motors, &c., after the machine has run for 10 hours; and for transformers, after sufficient time has elapsed for the temperature to become stationary.

11. The temperature may be measured earlier in the case of small machines, which reach their final temperature after a shorter time than 10 hours.

12. In measuring the temperature, the various casings, &c., of the machine must not be removed or opened. Any artificial cooling which is allowed for in the construction of the machine may be followed during the test, but it is not permissible in the case of tramway motors to reproduce by artificial means the draught produced by the motion of the car.

13. The temperature of the air is to be taken as that of the air flowing towards the machine, or, if there be no perceptible draught, the room temperature near the machine—both measured at about 1 metre from the machine. During the last quarter of the time test the temperature is to be measured at regular intervals and a mean to be taken.

14. If a thermometer is employed to measure the temperature, as good a conductor of heat as possible (for instance, tinfoil) must be inserted between this instrument and the part of the machine to be measured. To prevent loss of heat the bulb of the thermometer and the place at which the measurement is made must be surrounded with a bad conductor of heat, such as cotton-waste, &c.

15. Except in the case of field coils excited with continuous current, the temperature rise of all parts of generators and motors must be measured by thermometers. As far as possible the points having the highest temperature are to be chosen in the temperature measurements.

16. The increase in pressure in field coils excited with continuous current is to be tested by the increase of resistance, for which purpose the temperature co-efficient of copper may be taken as 0·004.

17. In transformers the highest temperature at a point in the winding is to be measured by a thermometer. In oil-insulated transformers the temperature of the upper layers of the oil is to be taken.

18. In ordinary cases when the temperature of the air is not greater than 35deg. the increase of temperature in insulated windings, commutators and slip rings must not be greater than—

| | |
|---|---|
| With cotton insulation | 50°C. |
| Do. paper insulation | 60°C. |
| Do. insulation by mica, asbestos or preparations of these materials | 80°C. |

In stationary windings these values may be increased by 10°C.

19. The rise in temperature of the corresponding parts of tramway motors after one hour's working at normal load in the testing room is not to be above:—

| | |
|---|---|
| With cotton insulation | 70°C. |
| Do. paper insulation | 80°C. |
| Do. insulation of mica, asbestos or preparations of these materials | 100°C. |

20. If more than one sort of insulation is employed, the lower figure above is to be taken.

21. In the case of continuously short-circuited windings the above limits may be exceeded.

*Overload.*

22. In practical working overload should only take place for such a short time, or when the machine or transformer has such a temperature, that the permissible rise in temperature is not exceeded thereby. With this limitation machines and transformers must be capable of overload within the following limits:—

| | |
|---|---|
| Generators, motors, and rotatory converters | 25 per cent. for half an hour, assuming in the case of alternating current generators that the power factor is not below that marked on the plate. |
| Motors, rotatory converters, and transformers | 40 per cent. for 3 min., during which the normal pressure is to be kept up at the terminals of the motors. |

23. At constant speed the pressure of generators must be kept constant up to 15 per cent. overload, assuming that the power-factor for alternate current machines is not below that marked on the plate.

24. The test shall determine the mechanical and electrical overload capability without regard to heating, and should, therefore, be begun at such a temperature that the permissible rise in temperature is not exceeded.

25. These rules apply to generators with variable pressure, in which the variation in pressure is attained by approximately proportional changes in the speed. In generators with approximately constant speed (so that they work with a weakened field at normal pressure) an overload test is not necessary. The same applies to motors if they work with a weakened field.

*Insulation.*

26. The measurement of insulation is not prescribed, but a test of dielectric strength. An excess pressure, as given below, is to be applied for half an hour while the machine is hot. Apparatus up to 5,000 volts to be tested to double the working pressure, but not less than 100 volts. Apparatus of 5,000 to 10,000 volts to be tested with 5,000 volts excess pressure, and above 10,000 volts 50 per cent. excess pressure.

27. These testing pressures refer to the insulation between the windings and the frame, as well as between the electrically separated windings. In the latter case, if the windings are of different pressure, the higher one is to be taken in fixing the test pressure.

28. If two windings are connected together electrically, the pressure at which the test is to made, under No. 26, is to be determined with relation to the one with the higher pressure.

29. If machines or transformers are connected in series, in addition to the above tests, the connected windings are to be tested with a pressure calculated, under No. 26, from the pressure of the whole system and applied between the windings and earth.

30. If continuous current machinery is tested with alternating currents 0·7 of the prescribed test pressure will suffice. If the converse—viz., alternating current machinery tested with continuous currents, 1·4 times the prescribed pressure must be taken.

31. If a winding is connected electrically to the frame during working, this connection is to be interrupted for the test of dielectric strength. The pressure with which this winding is then to be tested is to be determined from the maximum pressure which will occur between any point of that winding and the frame.

32. Separately excited magnet coils must be tested with three times the pressure at which they will be used, but at least 100 volts.

33. The winding of the secondary armature of asynchronous motors is to be tested with twice the starting pressure, but at least 100 volts. Short-circuited armatures need not be tested.

*Efficiency.*

34. In determining the efficiency, the indirect method—viz., measuring the losses, is preferable. In stating the efficiency, the method employed is to be mentioned by a reference to a corresponding paragraph of these rules. The power wasted in field excitation and in the field rheostat has to be taken account of in calculating the efficiency.

35. In generators, synchronous motors and transformers the given efficiency assumes no difference in phase between the current and pressure.

36. When machines have separate exciters, the efficiency of the two machines is to be given separately.



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*Method of Determining the Efficiency.*

37. *Direct Electrical Method.*—This method can be employed with motor generators, rotatory converters and transformers by measuring electrically the power put in and given out. In order to employ similar measuring instruments, it is desirable in this method to test similar machines or transformers in pairs.

38. *Indirect Electrical Method.*—If two similar machines are obtainable they are mechanically and electrically coupled so that one runs as generator and the other as motor. This system is driven by means of current from an external source in such a way that only the power required to cover the necessary losses is led to it and measured. The arrangement is to be regulated so that the mean between the power given to the motor and given out by the generator is as nearly as possible the normal output of the single machine, this average value being determined by measurement. The power supplied to cover the losses can also be applied mechanically and measured electrically.

If belt gearing cannot be avoided in this measurement the losses occasioned by it are to be taken account of.

The method above described can also be employed with transformers if the latter are identical so far as output, pressure, and frequency are concerned. The loss occurring in any auxiliary apparatus is to be taken account of.

39. *The Direct Brake Method.*—This method is generally employed for small motors, but can also be employed for a small generator which is being driven as a motor, in which case the conditions must be so chosen that the magnetic and mechanical stresses, speed and output differ as little as possible from what they would be if the machine were used as a generator.

40. *Indirect Brake Method.*—If a generator or motor of corresponding output is obtainable whose efficiency at various loads is exactly known, this can be employed as a brake or as a driving motor. If a belt drive is employed the loss in it must be taken account of.

41. *No Load Method.*—The machine is run light as a motor, and the loss at normal speed at field strength is determined. This represents the losses due to air, bearing and brush friction, hysteresis and eddy currents whose variation with the load is not taken account of. By electrical measurements and calculations the $C^2R$ loss in the field, armature, brushes and contact resistances at the corresponding load is determined when the machine is warm. In the case of asynchronous motors the losses in the secondary armature may be made by measurements of slip instead of by measurements of resistance. The losses in different resistances in series with the field windings are to be taken account of. In calculating the efficiency from these figures the ratio of the output to the same output and of the above losses is taken.

42. *Auxiliary Motor Method.*—If there are difficulties in the way of direct determination of the friction losses as well as of the hysteresis and eddy currents, or if a suitable source of current cannot be obtained for driving the machine, the frictional, hysteresis and eddy current losses may be determined by means of an auxiliary motor. The machine to be tested is given its normal excitation, and the power required to drive the auxiliary motor to which it is coupled at the normal speed of the machine is determined. The losses in the auxiliary motor are then deducted, having been obtained by measurements and calculations as in No. 41. A steam engine can be employed in place of the auxiliary motor if it can be disconnected from the dynamo. In this case the steam engine first drives the generator at light load at normal speed and excitation, and then the steam engine is indicated again after the dynamo has been uncoupled. The difference between the two indicated horse-powers may be taken as the light-load losses of the generator. This method must be used with great care on account of the inaccuracy of light-load diagrams.

43. *Indicator Method.*—If the generator is driven directly by a steam engine and cannot be uncoupled, the efficiency may be determined without regard to friction. The hysteresis and eddy current losses occurring at no load are determined at the normal speed and pressure by taking indicator diagrams with the machine excited and not excited. If the excitation is provided from the same steam engine, the power required for it is to be subtracted. By electrical measurements the calculations of the various $C^2R$ losses are determined as before, and attention is again called to the danger of inaccuracy due to the light load indicator diagrams.

44. *Separation Method.*—In machines which are not to have bearings of their own, the efficiency is to be determined in the following manner, without taking account of friction. The hysteresis and eddy current losses are determined electrically by running the machine as a motor as in the no load method (No. 41). To separate the various friction losses from the hysteresis and eddy current losses, the machine must be tested at several different pressures at a normal speed, going down to as low pressures as possible, and also making observations at normal pressure, and, if possible, at 25 per cent. excess pressure. These observations are to be drawn out graphically, and the curve extended so that the losses at zero pressure can be estimated. This gives the friction losses at normal pressure, and is to be substracted from the no load losses at normal pressure. The remainder is to be taken as hysteresis and eddy current losses whose variation with load is not considered. The remainder of the losses are determined electrically as in No. 41. The determination of the hysteresis and eddy current losses may also be made by means of an auxiliary motor.

45. The pressure variation in alternating current generators is to be given for the normal armature current with an inductionless load, and for a third of the normal armature current with an inductive load whose power factor is not greater than 0·3.

46. The pressure variations at an inductionless load is the difference of pressure which is attained when the fully-loaded machine (whose power-factor = 1) has its load completely taken off, the normal speed of the fully-loaded excitation being maintained.

47. The pressure variation on an inductive load is defined as the difference in pressure obtained if the armature current is switched off without varying the speed or excitation. Before switching off, the machine must be run at full load with a power-factor of 0·3, and so excited that it has its normal terminal pressure.

48. Machines for inductionless load need not be tested as described in No. 47, and machines for inductive load need not be tested as described in No. 46.

49. If continuous-current machines are to be tested for variations in pressure, the following is to be observed :—Continuous-current machines with shunt, compound or separate excitation, are tested at four different approximately equi-distant loads from full load at normal pressure to no load, without the excitation being adjusted. The difference between the greatest and least observation of pressure is to be taken as the pressure variation.

50. For transformers the ohmic loss of pressure and the short-circuit pressure with the normal secondary current has to be given, both for the secondary circuit. The ohmic loss is taken to be the pressure variation for inductionless load ; the short-circuit pressure as the pressure variation for inductive load. It is permissible to make the test with a current differing slightly from the normal, in which case the variations in pressure for normal currents must be calculated.

## UNINSULATED RETURNS IN A TRAMWAY SYSTEM.*

BY JOHN H. RIDER.
(Chief Electrical Engineer, London County Council Tramways.)

The general regulations prescribed by the Board of Trade, under the provisions of the Tramway Acts, include, amongst others, clauses which relate to the employment of uninsulated metallic return circuits of low resistance. Such returns, in the shape of the tramway rails, are up to the present in universal use in this country, and consequently the clauses mentioned are of universal application. It is provided that the uninsulated return shall be connected with the negative terminal of the generator, and that all parts of the return circuit which do not consist of the rails shall be insulated, unless of such cross-sectional area as will reduce the difference of potential between the ends of the uninsulated return below 7 volts. This is also the maximum pressure allowed between the ends of the uninsulated return farthest from and nearest to the generating station.

Excepting, perhaps, that the maximum allowed is too high, no fault can be found with these requirements, as unless the differences of potential be kept low, excessive earth currents will flow, causing considerable damage to any metal pipes in the vicinity. The earth, being more or less a conductor, practically connects all buried metal near the track to the rails. Unless great care be taken, therefore, the return current leaks out from the rails and flows through any other metal which may be lying in the neighbourhood of the track. Being no respector of paths, it has been even known to make use of the lead sheathing of the tramway feeders. The mere passage of the current through these irregular paths does no harm, but at all points where the current *leaves* the rails or the pipes or the sheathing, corrosion takes place by reason of electrolytic action. The number of places at which the current flows into or out of the rails or pipes, is entirely a question of relative resistance (or of conductivities) between the various paths open to the current, and at each place of leaving corrosion goes on. The only way to prevent leakage currents is to make the proper path of so low a resistance that the difference of potential between any two points is at all times exceedingly small. The requirements of the Board of Trade in this particular are most reasonable, and the engineer who thoroughly appreciates the position will endeavour to bring the maximum below this amount for other reasons than to comply with the regulations.

In the opinion of the writer, however, some of the other regulations are not only unnecessary, but even undesirable, as, for instance, those relating to the earthing of the negative 'bus bar. Regulation No. 5 says :—

When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections which shall be placed not less than 20 yds. apart. Provided that in place of two such earth connections the corporation (or company) may make one connection to a main for water supply of not less than 3in. internal diameter, &c.

Regulation No. 6 says :—

When the return is partly or entirely uninsulated, the corporation (or company) shall in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity ; (*b*) so connect together the several lengths of the rails ; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point, and the potential of the uninsulated return at any other point ; and

* Paper read on Wednesday before the Incorporated Municipal Electrical Association.

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(*d*) so maintain the efficiency of the earth connections specified in the preceding regulation (No. 5) as to fulfil the following conditions—viz.: (1) That the current passing from the earth connections through the indicator to the generator shall not at any time exceed either 2 amperes per mile of single tramway line, or 5 per cent. of the total current output of the station. (2) That if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return.

In order to provide a continuous indication that the condition (1) is complied with, the corporation (or company) shall place in a conspicuous position a suitable, properly-connected and correctly-marked current indicator, and shall keep it connected during the whole time the line is charged.

Condition (2) is, of course, merely intended to show that the earth connection is maintained in good order. It will be observed that the current coming back from the rails, via the earth, to the negative 'bus bar must not exceed a certain value. The strength of this earth current will depend entirely upon two things—(1) the difference of potential between the rails and the negative 'bus bar, and (2) the resistance of the earth path. The former is the fall of pressure on the return feeder, which, although it may be only a small amount, from the point of view of economy in transmission, may be enough to send a large current back through the earth, particularly if the resistance of the earth path be low. This may readily happen on account of the existence of water or gas pipes near the return feeder, and particularly when a water pipe is used as the earth plate at the generating station.

In the case of the Plymouth electric tramways, where the shortest return feeder is 760 yds. long, being connected to the rails at their nearest point to the generating station, the resistance between the rails and the earth plate (water pipe) is only about 0·5 ohm. It was found that 25 per cent. of the return current came back through the earth. Now the resistance of the earth path can be made practically infinite, by the simple expedient of removing the earth connection from the negative 'bus bar. Regulation No. 6 (1) is apparently intended to protect gas and water pipes, by ensuring that no current (or only a very small amount) shall come back through the earth to the generators. Regulation No. 5 practically invites such current, and provides means for its measurement. If the earth connection be removed from the negative 'bus bar no current can come back through the earth. Why, then, should the connection be made?

The Board of Trade regulations appear to provide for an earth connection at the wrong place. When the return circuit of a tramway system consists partly of uninsulated rails and partly of insulated cables, the insulated part should be kept insulated, except at a point where it joins the uninsulated part, and there the earth connection should be made rather than at the other end, where it is joined to the negative 'bus bar. With more than one return feeder negative boosters may be necessary to keep the points of earth connection at the rails at about the same potential. Earth currents would then be practically non-existent. With only one return feeder no negative booster would be needed, unless it were desired to reduce the fall of pressure for economical reasons. In this case it would depend entirely upon the length of the return feeder as to whether it would be better to add to its cross-section, or to use a negative booster. In the majority of cases the latter would probably prove the better way.

If the ventilation of this subject by the Incorporated Municipal Electrical Association should result in a modification of the Board of Trade regulations, then this short Paper will not have been written in vain.

# PARLIAMENTARY INTELLIGENCE.

## LONDON UNDERGROUND RAILWAYS.

The Joint Parliamentary Committee on the London underground railway schemes resumed the consideration of this bill on Friday last.

Sir H. OAKLEY gave evidence in support of loop curves as against junctions at termini.

Representatives of the omnibus companies said that tube railways would not interfere with their short services, and counsel, on behalf of the omnibus interest, contended there would not be one 'bus less running through the busy streets as a result of the railways. There would be less weight carried, that was all. It was only on the long distances that the tube railways would take the traffic away. He submitted that there should be in the centre of London a zone not passed by any tube line.

Sir ALEXANDER BINNIE, chief engineer to the London County Council, said he had given much attention to the question of metropolitan railways. There were 24 proposed and authorised line. The rolling stock of the underground tube railways could pass outwards on to the general railway system provided the platforms conformed to the peculiar type of rolling stock. But the ordinary rolling stock of the railway companies of the country could not pass into the tubes because the diameter of the tubes was only 10ft. 6in. or 12ft. 6in., the only exception being the Great Northern and City line, which was 16ft. in diameter to allow the rolling stock of the Great Northern Railway to pass down from Finsbury Park into the City near Finsbury-square. One of the reasons for constructing tube railways was the enormous cost which similar lines to the Metropolitan Railway would entail. Another advantage possessed by the tube railways was that they could be so constructed as not to interfere with sewers and gas pipes.

Asked if he advocated the lines being worked on the shuttle system, Witness said he did, or in the form of a close circuit. Trains on a circuit would run without interference from trains coming in from other lines. Lines with confluent junctions were almost unworkable, except in extreme suburbs. End-on junctions might possibly be made to facilitate the rapid transit of traffic. Interchange stations would have to be worked for the purpose of getting from one line to the other. Such stations should be constructed underground with subways, which should be very largely under the control of the local authorities because of their great public convenience. Tube railways had to be placed in a different category to the other railways of the country. As to the best routes for railways in London to take, witness said that the general principle he advocated was either to radiate from the dense populations of the suburbs or to pass from one suburb at one end of London to the suburb at the other. A central station was not desirable or necessary. It might be desirable to follow along the old-established routes, as that was the general direction in which the traffic flowed. In the case of tube railways, it was possible to go under private property at great depth without damaging the houses above. Another possible line of route was underneath the existing railway lines, where they lay in the right direction. In making suggestions for the best routes, he was hampered by the railways already authorised, some of them being in course of construction. Among the lines witness suggested was one from Hammersmith to Tottenham, the line going right through the City. If worked on the shuttle system, it would be desirable to have a branch at Stoke Newington, and it might be advantageous to have exchange stations at various points along the route. If the close-circuit system were adopted the Charing Cross and District Railway might be constructed from Hammersmith Broadway to Hyde Park Corner, and from there the authorised Brompton and Piccadilly line could be adopted. The line connecting Paddington to Victoria might be extended into the Western area. The Brompton and Piccadilly line as at present proposed would form a block in the railway system of London. The Great Eastern Railway proposed underground lines would be of great benefit to the public.

Dealing with the cost of tube railways, Witness said the three existing underground tube railways had money powers to the extent of £6,718,000, the authorised and partially constructed tube railways £5,259,000, the authorised but yet unconstructed lines £11,710,000, the railways requiring additional powers £5,728,000, and the entirely new railways £19,226,000. The total money powers of the existing and proposed underground tube railways was £48,632,000. In his opinion, some of the lines before the Committee were not compatible with a good scheme of general communication in London. The authorised line of the District Company from Earl's Court to the Mansion House in the present financial position of the company, and in view of their proposal to use electric traction on the inner circle, must remain for some years in abeyance, and yet the obtaining of Parliamentary powers for the authorised line prejudiced the position. He contended that the Metropolitan and Metropolitan District Railway Companies had been trying to do exactly what the Committee of 1863 and 1864 said they should not do—trying to convert each system into a terminus of the suburban line instead of assisting internal communication. If the whole of the inner circle were under one management, and worked by electricity, there would be interchange stations where there were now confluent junctions. Even now the position could be retrieved if the circle were worked by electricity with a two minutes' service. A great deal could then be done to facilitate traffic in London. He thought the loops at the termini of the Central London Railway could be made without interfering with traffic.

Mr. H. L. CRIPPS, Parliamentary agent to the London County Council, said the District Railway had now power to make a deep level under their existing line, and it would be a good thing if the Metropolitan Company could do the same, so that the suburban traffic of each could be separated from the inner circle traffic pure and simple. This would avoid the quadrupling of the District Railway under the electrification scheme.

On Tuesday, Mr. LITTLER, K.C., mentioned the Charing Cross, Euston and Hampstead Railway, and, in reply to a question by Lord Knutsford, said that whatever terms the Vibration Committee imposed the promoters were prepared to adopt. He could call evidence to prove, if necessary, that the capital would be subscribed and the line constructed.

Mr. BALFOUR BROWNE, K.C., representing the North-East London Railway and the Piccadilly and City Railway, remarked that he was not prepared to go to the length of acquiescing in "whatever" terms the Committee imposed.

Mr. CRIPPS (continuing his evidence) said the London County Council had powers in various ways to assist the construction of light railways. Of course it was doubtful whether there were routes through which such light railways could be made. Underground railways could not be considered as light railways in the sense understood in the act, but following upon the principle of that act there was no reason why municipal or local credit should not assist the construction. Under the Light Railways Act of 1896 Parliament had authorised contributions for the purpose, and the London County Council and the Middlesex County Council had under their consideration plans with a view of extending tramways and underground railways.

A MEMBER of the COMMITTEE: You do not propose grants from the London County Council to these railways?

WITNESS said these questions were not definite enough at present to be discussed by the Council, who, however, thought that the financial question was of great importance. The suggestion was that in the com-

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pletion of these lines the ultimate public convenience of London was to be carefully considered. Where a line would be of great public convenience, but would not return sufficient interest to induce capital being subscribed, some form of guarantee might be given or some such arrangement as was contemplated by the Light Railways Act might be come to. He was not putting forward any scheme of giving financial assistance to underground railway companies. The matter had never been considered by the Council, but many members had considered the matter individually.

The CHAIRMAN: I gather from your evidence that the London County Council prefer that the Inner Circle should be complete, with exchange stations rather than with junctions for the various suburban lines.

WITNESS thought that was the view of the Council. It was possible that when the junctions were made there appeared to be room for the Inner Circle to work all the services together. But the traffic had outgrown the possibility of being adequately treated in that way. The proposed railways might also find room at first to work confluent junctions, but no doubt as the traffic grew it would be found best for the line to be worked either on the shuttle system or as a close circuit, which would involve exchange stations at the termini and at any points where east and west lines were crossed by north and south lines. As regarded fares, the London County Council had come to a rough general conclusion that working men could be fairly asked and could afford to pay 1s. a week to travel between their places of residence and occupation. That sum would also give a fairly moderate return to the railway company. If the County Council asked the railway company to take a passenger the whole way for 2d. the Council ought to assist the passenger on the tramways by making an inclusive fare. A clearing-house system however, would involve a great deal of difficulty and cost. What they should aim at was to place the ownership as far as possible in one hand. In his own opinion a system should be completed by means of money raised on the most economical terms, which terms would be best effected by a guarantee which might be given for a certain limited dividend, and the difference might be shared between the promoters of the railway and the ratepayers, by whose credit and assistance the money would be provided, and who should take a share in the profits. He thought it would be better if a general scheme were promoted by one set of promoters instead of having a number of smaller sets. He doubted whether a purchase clause in the bills would meet the case. It would make the raising of capital more difficult. Under the Electric Lighting Acts of 1882 such an arrangement made it impossible to raise capital, with the result that we were behind the rest of the world in electric lighting.

Mr. F. G. PAINTER, a member of the City Corporation, said the views of the London County Council and the Corporation were almost identical. He generally expressed agreement with the evidence given by Sir A. Binnie, but the Corporation wished to reserve to themselves the power of expressing an opinion upon the individual lines as they came before their respective committees, because of the all-important question of the sites for stations in the City and the route of the railways as they affected important and heavy buildings such as St. Paul's Cathedral.

Sir H. OAKLEY, re-called, declared that the contemplated loop at the end of the Central London Railway would put no impediment in the way of further extension of the line, nor would it impose any great engineering difficulties in the way of other lines in the neighbourhood requiring a loop also. The contemplated loop measured 15 chains, and the shortest possible curve that engineering would permit was 5 chains.

The CHAIRMAN, before adjourning, announced that the Committee hoped, on Tuesday next, to be able to state what course they proposed to pursue.

## LONDON UNITED TRAMWAYS BILL.

The Committee of the House of Commons presided over by Sir John Kennaway resumed its consideration of this bill on Friday last.

Mr. GEORGE M. WALKER, chairman of the Surbiton District Council, and a member of the Surrey County Council, said he was not an advocate for tramways, but there was an evident desire for the tramways in the district. With regard to the charge of bribery which had been levelled against the District Council, the Council had not been wrongly influenced, as suggested, by the payment of a large sum. He thought the tramways would not injure, but improve property in Surbiton. When omnibuses were first brought into the district the inhabitants said they would leave, but they did not do so, and were now using the conveyances. He did not consider the present facilities of communication in Surbiton sufficient. The District Council's tramway scheme of 1899 was rejected by the Board of Trade because the majority in its favour on the Council was not sufficient.

Mr. HENRY H. JUDD, a member of the Surbiton District Council, and for 35 years a resident, said the feeling of the inhabitants generally was very much in favour of the proposed tramway. Some property might be depreciated, but property generally would largely benefit.

Mr. F. J. BELL, deputy clerk to the District Council, said the promoters had agreed to pay the Council £1,000 in respect of costs. The costs hitherto incurred by the local Council in connection with tramway undertakings amounted to £895, the bulk of which had already been paid by the ratepayers.

Mr. J. NIXON HORSEFIELD, F.S.I., a member of the Kingston Town Council and surveyor to the Hampton Wick Urban District Council, said he considered that the £10,000 which the Tramway Company had undertaken to pay towards the cost of rebuilding Kingston Bridge a handsome contribution.

Mr. W. G. HOWELL, surveyor to the Surrey County Council, said tramways in this district were inevitable, and if there were to be tramways they must be connected with the trains on the north of the Thames, and the system would not be complete without the connection over Kingston Bridge.

This closed the case for the promoters so far as the Kingston, Coombe, Surbiton, Ditton, and Molesey tramways were concerned. For the Middlesex County Council,

Mr. J. E. WALLER, M.Inst.C.E., said Hampton Court Bridge should be strengthened and widened so as to accommodate four lines of rails.

Mr. F. T. WAKELAM, engineer and surveyor to the Middlesex County Council, said the £10,000 which the company proposed to contribute towards the expenses of Kingston Bridge was not liberal or fair. The Surrey and Middlesex County Councils would have to pay each more than £30,000. The Tramway Company would pay £10,000 and monopolise the bridge.

The CHAIRMAN said the Committee would reserve their decision on this part of the case.

Mr. ALLEN having addressed the Committee on behalf of the frontagers in Surbiton and district, and evidence having been given on their behalf by several witnesses,

On Monday Mr. FITZGERALD, K.C. (representing the Tramways Company), announced that a clause had been agreed to with the Chelsea Water Co., which would relieve the Committee from hearing the case in regard to the alteration of levels so far as the Water Company was concerned. The clause would give the Water Company the right to do the work of altering pipes and mains, &c., rendered necessary by the proposed tramways. The question of electrolytic action, in which all the water companies were concerned, would have to be dealt with hereafter.

Mr. BALFOUR BROWNE, K.C., then explained the proposals with regard to the Bath-road tramway at Hounslow. The line would be about 2 miles in length, and would commence at a tramway at Hounslow, which had been constructed at the instance of the local authority, and which would be opened on July 1. The only opponent to this line was the Middlesex County Council, who, now that it was too late, the Tramway Company having become established in the district, wished to become the tramway authority. The Council had deposited with the Light Railway Commissioners an application to make a tramway along the Bath road, and they said they had made themselves the light railway authority by passing a resolution. That, however, of course, they could not do.

Mr. HENRY PERKS, a former chairman of the Hounslow District Council, said the majority of the inhabitants were in favour of the company's scheme, and would prefer that the tramways should be in the hands of the company to insure connection with the other parts of the promoting company's system.

Mr. KINCAID, C.E., for the Middlesex County Council, produced maps showing the network of light railways promoted by the Council and sanctioned by the Light Railway Commissioners, and those they had authority to purchase, and also the light railways or tramways proposed by the London County Council. He held that if the Committee sanctioned the present Bath road proposal they would practically leave the key of the position in the hands of the London United Tramway Co. so far as the schemes before the Light Railway Commissioners were concerned.

Mr. MORETON SMITH, on behalf of the Heston and Isleworth District Council, said his Council, and not the Middlesex County Council, had the reversionary interest in the Bath-road tramway. The District Council objected to the County Council coming into their district at all.

Mr. V. B. D. COOPER said he laid out the light railway scheme of the Middlesex County Council, and he regarded the section along the Bath-road as essential to it. It would be practically impossible to carry out the scheme if this section belonged to the company. He read a letter from the District Railway Co., in which it was stated that if the Middlesex County Council constructed a light railway along the Bath-road to the company's Hounslow terminus the company would allow a rebate on traffic brought to them over the light railway, or they would enter into a working arrangement with the County Council to work the lines and run through cars from the light railway on to the District Railway.

The CHAIRMAN: How could that be done?

The WITNESS: By widening the line in Bath-road and running the cars by electricity up to Hounslow. The Middlesex County Council had agreed with the Metropolitan Tramway and Omnibus Co. to work their lines when sanctioned. That company had reserved the right of declining to work any line of which they disapproved.

Mr. BIGWOOD, M.P. for the Brentford Division, and chairman of the Parliamentary committee of the Middlesex County Council, said that committee on Feb. 3, 1899, decided to construct a number of lines of light railway. He regarded it as of the greatest public importance that there should only be one light railway authority, which authority should undertake to produce a scheme on a comprehensive basis, so that there might be no variation in the lines in a district, and to secure that certain districts which could not afford to promote a line should not be ignored. In order to produce rapid and cheap locomotion, the whole county should be covered by a network of lines. The County Council worked with the local authorities where they could, but in some cases the local authorities had revolted. Those who had revolted, however, were now showing signs of a desire to agree with the County Council. The local authorities apparently thought the county should own the light railways, and the County Council were prepared to consider the views of the local authorities. The County Council did not object to the local authorities constructing railways if they did it in accordance with the plans of the County Council. His committee put aside altogether the question of profit, though profit was bound to come. The object at first was to give the population of London means of distributing themselves in the neighbouring areas. The Middlesex County Council had opposed the London United Tramway Company in regard to their lines in Middlesex, but had been defeated. The company had obtained profitable lines, and he prophesied that the more profitable they were the more money the County Council would have to pay when they took them over. The Middlesex County Council had not agreed to the proposal of the London County Council to work with them in London, or to allow them to work with the Middlesex County Council in Middlesex. They would, however, work amicably with the London County Council for interchange of traffic.

Lord ROBERT CECIL, for Middlesex County Council, said most of the

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roads over which the tramways would require to pass were owned by the County Council, who contributed to the cost of Bath-road. Clearly, therefore, anyone who was going to occupy the surface of that road should be under the control of the Middlesex County Council. The Bath-road section was absolutely vital to the development of the County Council scheme in West Middlesex, and if the Council did not get authority with regard to the section they would be very seriously injured.

Mr. E. J. HALSEY, chairman of the Surrey County Council, said the question of widening Kingston Bridge under any circumstances has been before the Council on several occasions, and he thought the question was one of the somewhat near future, whether the tramway came there or not. They had come to the conclusion that in the interests of the public generally the £10,000 offered by the United Tramways Company was a fair consideration to carry out—for the present, at any rate—certain widenings which the Council were advised could be done. Some two or three years ago there were indications that the London County Council intended to apply for powers to come to Surrey with tramways or light railways of their own. At that time they came to the conclusion that the Surrey County Council was the proper authority for combining all interests connected with tramways, and they accordingly propounded certain schemes; but although on one occasion a majority of the County Council approved of the County Council being the tramway authority, they had not secured the two-thirds majority required under the Light Railways Act. Eventually they came to the conclusion that if they were not to be the light railway authority for the county the best thing they could do would be to take care that a responsible body, who would be prepared to carry out a scheme which could ultimately be made a complete and comprehensive one, should receive their support. The scheme now before the Committee contained, to a very large extent, the scheme the Council originally propounded, and it was capable of extensions, which the authorities applying for powers now are, in their opinion, capable of carrying out when the time came. Provisions had been arranged with the Tramway Company which were satisfactory to the Council by which, after a cetain period, if each or any local authority does not exercise their option to purchase, the Council would be allowed to step in so that the reversion to the whole of the road occupied by this company will practically come under the control of the local authorities for the benefit of the inhabitants at the end of 25 years, the usual period of 21 years having been extended with the Council's consent. The Surrey County Council considered that these tramways would be an enormous convenience to everyone in Surrey.

Mr. BALFOUR BROWNE, K.C., then explained the promoters' proposals in regard to the Barnes lines. The new tramway would commence at the Broadway, Hammersmith, and for a short distance run through the administrative county of London, entering Surrey by passing over Hammersmith Bridge, thence to Upper Richmond-road, and, by a junction, to near Putney station one way, and through Barnes and Richmond through Kew-road to Kew Bridge by the other way. The total length of lines would be 8 miles. The existing horse tramway running from Kew Bridge to Richmond would be replaced by electric tramways. The local authorities concerned were Richmond, Barnes, Hammersmith and Wandsworth, and also the Surrey and London County Councils. With all these authorities agreement had been arrived at except the London County Council and Wandsworth, the latter body insisting that widenings beyond those proposed in the bill should be executed.

Mr. VESEY KNOX (representing Wandsworth) said Wandsworth objected altogether to the tramways.

Mr. BALFOUR BROWNE said the widenings asked for were absolutely unnecessary. The promotors had agreed to spend on widenings in Richmond £28,797, Barnes £15,143, Wandsworth (if they carried out their proposals) £34,618, and Hammersmith £900—£79,458. Further, to induce the authorities to extend the period of purchase for 21 to 25 years, the promoters agreed to make annual payments of £500 to Richmond, £350 to Barnes, and £100 per mile of main road to Surrey County Council, a total annual expenditure of £950. The London County Council's opposition was that the tramways were inexpedient and not for the benefit of the county. He (counsel) agreed that it would not be right to allow in London a large system of tramways in the hands of a company, but all the company were seeking was to construct connecting links, one with their system on the north, and another at Putney, with the Metropolitan District Railway.

Mr. CLIFTON ROBINSON said, with regard to the opposition of Wandsworth, if the company agreed to widen the 1½ miles of road along which the line would pass to 54ft. throughout this opposition would be withdrawn. It was already proposed to expend £35,000 on widenings in Wandsworth, but the additional widening demanded would cost £20,000, which would be prohibitive. Such a widening was unnecessary. The London County Council had control of Hammersmith Bridge, which it was proposed to use for two lines of rails. His company already had 4 miles of tramway within the district of the London County Council.

Mr. W. J. BULL, M.P. for Hammersmith and representative of Hammersmith on the London County Council, said communication between Hammersmith and Putney and Barnes was very imperfect. The benefit derived by the tramway now in existence to Kew and Acton was so great that further benefit would be conferred by its extension to Putney, Richmond and Barnes.

Mr. CLIFTON ROBINSON (further examined by Mr. Vesey Knox, for Wandsworth) said there was a distinct understanding up to the past fortnight that if the company carried out the widenings as desired by the Council they might pass through Wandsworth. The system of electric traction to be adopted in Wandsworth had been agreed. Wandsworth had, therefore, not consistently objected to the tramway.

Mr. VESEY KNOX: I am instructed that that is incorrect. We think if any tramway is made here it should be as part of the London County Council tramways, so as to give us a through service into London.

The CHAIRMAN: How do you propose to get the London County Council there?

Mr. VESEY KNOX: A mile and a-quarter from the proposed terminus of these tramways there is a tramway which the London County Council are now in process of acquiring and turning it into an electric tramway. They can extend that line.

The CHAIRMAN: Supposing they did extend their tramways, they would come to a dead end. If you came to the boundary of the county you would have to change from underground to overhead wires.

Continuing, Witness said Richmond and Barnes would determine for themselves whether the mode of traction should be by overhead or underground lines, and thus there might be different systems at different portions of the lines.

Mr. T. SKEWES-COX, M.P. for Kingston and a member of Richmond Town Council and of the Surrey County County, said these bodies were strongly favourable to the proposed tramways. The local authorities, in the agreements with the promoters, had made very good bargains. It would be absurd to stop, as suggested, at the county boundaries.

Sir JAMES SZLUMPER, Mayor of Richmond, said the proposals of the Tramway company had been well discussed by the Richmond Council, who fully approved the scheme.

Mr. BARTON (chairman of the Highway Committee of the Barnes District Council) and Mr. DAVENPORT (a member of the Barnes Council) gave evidence strongly supporting the bill.

On Wednesday Mr. FITZGERALD, for the Tramways Company, said the case for the promoters was now closed.

Lord ROBERT CECIL, for residential frontagers, urged that the tramways in Bridge-road, Hammersmith, would interfere greatly with his clients' convenience and enjoyment. No public necessity for the lines had been shown.

Evidence was then given in support of the opposition by frontagers, after which

Mr. MOON, for the London County Council, said that the Council had the strongest objection to the construction of those parts of the tramways within the County of London, not because they were tramways, but because they were to be constructed by a private company within the area of London of which the Council were the tramway authority. The London County Council were the owners of 74 miles of tramway out of 115 authorised in the County of London, and in 1903 the whole of the tramways of London, practically, would be in the control of the Council, who would in the near future also acquire the pieces of tramway belonging to the present promoters at Hammersmith. As far as he was aware there was no instance in which Parliament had permitted an independent company to make a tramway in the area of a tramway authority without the consent of that authority. The London County Council did not wish to block the tramways in question, but would come forward and make the lines if the local authority called on them to do so.

Mr. J. W. BENN, L.C.C., said, with reference to the proposed line at Hammersmith, both the London United Tramways Co. and the London County Council proposed identical schemes. The London County Council vetoed the company and the Hammersmith authority vetoed the County Council. The reason the Hammersmith authority preferred the company to the London County Council was that a sort of Dutch auction was held at which the company offered most. If tramway extensions in Hammersmith or Wandsworth were necessary in the opinion of the local authority the London County Council were quite prepared to make them. The London County Council desired to extend tramways in and around London. It was not correct to say that the London County Council ever objected to the introduction of electric traction for tramways, but as the central authority they held that they should have a voice as to the method to be employed. He had never described the demands of Wandsworth as blackmail.

Are you prepared to spend on a mile and a-half of tramways in Wandsworth, without any contribution from them, £55,000 for street widenings?—That will have to be settled by the County Council. To show our disposition to agree with Wandsworth, we have just carried through Parliament a scheme in regard to some miles of tramways under which the County Council bears two-thirds of the cost and Wandsworth one-third—about £100,000. That is the tramway along Garrett-lane.

By the CHAIRMAN: If the company were prepared to allow the piece of line over Hammersmith Bridge to fall in with other pieces in 1909 he thought the Council would withdraw their opposition.

Mr. BALFOUR BROWNE thought the suggestion was in the direction of fairness, but he would like to ask how Mr. Benn thought the company could lay their line and recoup themselves in eight years. At the end of the eight years the line would have to be sold to the Council as old iron.

The Committee adjourned at this point to enable the promoters and the Council to come to some arrangement if possible.

On resuming yesterday (Thursday), however, Mr. MOON said that no arrangement had been come to.

Mr. BENN (resuming) said the Council would have to bring in a fresh bill to make the lines in the scheme which were in the County Council area. The Council could make the extension over Hammersmith Bridge and lease it to the company until 1909, but not after; and they would charge the company for the expenditure similar terms to those which obtained with the North Metropolitan Company.

Mr. J. D. FITZGERALD: That means you will charge them a good deal more than your expenditure.

WITNESS: It would represent our share of the profits on that section, because we contend that if the line is constructed we are entitled to the whole of the profits for the ratepayers of London.

Mr. LIDDIARD, Mayor of Wandsworth, said the Borough Council had never objected to tramways as such. There were four lines of tramways in the borough, all of which, in a year or two, would be the property of the London County Council, who, on acquiring them, would convert them into electric tramways. The Borough Council wanted a through service of

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trams, under one management. Now that the London County Council had become the chief tramway owner in the Wandsworth district, the Borough Council thought it important that all the tramways in the district should be laid by them. The Borough Council was dealing with a certain company now, but if the bill passed they did not know with whom they might have to deal, because clause 30 would enable the company to reconstitute itself with any capital they might think fit to put upon the undertaking, and no one would have any power to control them. Clause 30 stated specifically that it should not be necessary to obtain the consent of the Board of Trade to such an arrangement. He admitted that upon certain terms Wandsworth had been willing to allow the London United Tramways Co. to come into the borough.

Mr. VESEY KNOX, on behalf of Wandsworth, said it would be establishing an entirely new precedent in party legislation if the wish of a great representative authority such as the Wandsworth Borough Council were to be overruled. The only possible reply of the promoters was that the line could not be made by the London County Council under any bill now before Parliament, and that they would have to come to Parliament again next year. But that was also the position of the Tramway Company, because the company were in the dilemma that they must either make the tramway without widening the thoroughfares or else wait for another bill next year.

At this point Mr. PEMBER objected on behalf of the water companies, whose mains might be affected by electrolysis if the tramways were constructed.

A discussion followed as to the regularity of this point being raised on the preamble, and the Committee decided to hear Mr. Balfour Browne for the promoters before taking this part of the case.

Mr. BALFOUR BROWNE, for the promoters, ridiculed the idea that the Middlesex County Council would make a light railway along the Bath-road to join the underground railway at Hammersmith. With regard to the London County Council's contention that this portion of the promoters' scheme should be left in their hands, counsel said this piece of line was simply a link between the company's existing or authorised system and Surrey, and was no part of the great London system of tramways. If allowed to carry their traffic into Hammersmith, the promoters would agree to the London County Council making that portion, but on condition that the company were granted a lease of it for 25 years, the period for which the company would hold the piece of line adjoining to the south of the bridge, and the company would pay 4 per cent. on the cost; or he would agree that the company should make it themselves on the ordinary terms.

A MEMBER of the COMMITTEE: There is another suggestion—that the promoters should make the tramway into Hammersmith, and that at the end of nine years it should be taken over at some value other than its material value.

Mr. BALFOUR BROWNE: As a going concern I would not mind, except that after that I must have some means of getting my traffic over it into Hammersmith. With regard to Wandsworth, the only reason they opposed was because the company would not give them £20,000 more for street widenings. With regard to the opposition of the London County Council, rather than that the bill should not proceed at once, he was prepared to construct the line over Hammersmith Bridge and work it, on condition that he should give it up to the London Council at the end of nine years, when the other tramways in London would be acquired by the Council.

The CHAIRMAN said: The Committee are prepared at this stage to declare that the preamble of the Surbiton group, crossing Kingston and Hampton Court bridges, is proved, with slight modifications. The Committee are of opinion that the widening of Kingston Bridge should be coincident with the laying down of the tramways. In view of the fact that both the promoters and the Middlesex County Council have declared their intention to bring a scheme before the Light Railway Commissioners for a through route, including the part of Bath-road, the Committee will leave this matter to the decision of the Light Railway Commissioners, and not give the powers now sought under this bill, it being clearly understood that it is the wish of the Committee that the promoters shall not be prejudiced before the said Commissioners by this decision. The preamble of the bill in regard to the tramways from Kew Bridge to Richmond will be declared proved, and in regard to the tramway from Richmond to Putney, and the line along Bridge-road and Ranelagh-gardens up to Hammersmith Bridge not proved. The Committee are prepared to give powers to the promoters to construct their tramways from Kensington-road over Hammersmith Bridge, subject to conditions of reverter to the London County Council in 1909 on reasonable terms, and the Committee ask that an arrangement clause should be brought up to that effect.

Mr. BALFOUR BROWNE then referred to the opposition of several of the metropolitan water companies, who sought the introduction of clauses affording them special protection in respect of their pipes against electrolysis. He urged that ample protection was afforded by the model clause incorporated in the bill.

The Committee at this stage adjourned till to-day (Friday).

## FINCHLEY AND HENDON TRAMWAYS BILL.

On Monday the Select Committee of the House of Lords presided over by Lord Pirbright commenced the consideration of this bill. The petitioners against the bill were the West Middlesex Waterworks Co., the Middlesex County Council, and Madame Ella Russell de Righini, landowner.

Mr. FREEMAN, K.C., for the bill, said it was sought to confer powers on a company to construct two tramways, one to run to Hendon, and the other towards Finchley. The consent of the Hendon authority had been obtained, but owing chiefly to pressure of time, an agreement had not been arrived at with the Finchley authority, and, therefore the tramway would stop at the boundary of Finchley, instead of, as was originally proposed, passing through Finchley to Tally Ho corner. These tramways would be run in connection with the proposed extension of the Charing Cross, Euston, and Hampstead Tube Railway to Golder's Green farm, Hampstead, and would thus form a through communication with the heart of London. A bill for that extension was now before Parliamet, and being practically unopposed and very generally approved, there was little doubt as to its passing. The tramways proposed by the present bill would be operated by electricity on the overhead trolley system. The petition of the Middlesex County Council objected that it was the intention of the promoters to run railway engines and carriages on the tramways, but although it was true to say that these lines would be worked in connection with the railway, it was an entire mistake to suppose that trains would be run up from the tube railway on to these tramways. Up to the present the Middlesex Council had done nothing whatever in regard to the provision of tramways, and yet they now complained that they ought to be allowed to make these tramways themselves. The Council had handed over its powers to an omnibus company who had simply sought to place shares on the London market. The West Middlesex Water Co., in their petition, complained that the tramways would hamper the repair and laying of their pipes and mains, but the real point of this opposition lay in the question of electrolytic action, but the clause specially framed to meet this question was in the present bill, and had satisfied the Gas, Light and Coke Co., the New River Company, and everybody except the West Middlesex Company.

Evidence having been given in support of the bill,

Mr. PEMBER, K.C., for the West Middlesex Waterworks Co., said there had been conflict in the discussions of the two Houses of Parliament on the matter of electrolysis, and no special clause had been given in the House of Commons for the protection of the water companies, although a clause had been conceded in the House of Lords. Careful consideration of the subject, however, had induced the water companies to think that that clause was not sufficient for their protection. But, as it so happened, the whole question of forcing tramway companies to use insulated returns would be fought out before a Committee of the House of Commons, where all the water companies would be represented, because all their pipes were affected. The West Middlesex Company, therefore, thought it best to fight the matter in the Commons on the London United Tramways Bill, and would, therefore, not continue their opposition to this bill, reserving their right to take what steps they thought fit when the bill reached the Lower House.

The opposition of the Middlesex County Council having also been withdrawn on the understanding that an attempt would be made to meet them, the preamble of the bill was declared proved.

## ELECTRICITY ON THE UNDERGROUND RAILWAYS.

The Court of Referees of the House of Commons, on Wednesday, heard an application by Mr. Balfour Browne, K.C., on behalf of the Middlesex County Council, for leave to appear against the Metropolitan District Railway bill. Counsel said he was asking for a *locus* to some extent against past legislation, but when the bill referred to was before the Committee the County Council did not know that they would be affected by the conversion of the District Railway Co.'s line to electric traction. Since the opening of the Central London line it was found that serious damage had been done by vibration, and the object of his application was to protect the Council's County Hall at Westminster from damage from this cause. He asked that the County Council might be allowed to appear against the application of the Railway Company for powers to raise money for the electrification of their line with a view to the insertion in the bill of a clause to protect the County Council building. He believed it was possible to work an electric train without appreciable vibration by the distribution of the motors over the whole of the train instead of using a locomotive.

A similar application was made on behalf of the City of London Corporation, who urged that their experience of the working of the City and South London Railway showed that electric railways could be worked without vibration, and this had led them to allow the District Railway Co.'s bill to pass without opposition, but the introduction of electric traction on the underground railways might have a serious effect upon the Corporation buildings in the City.

The Court disallowed the application in both cases.

Applications to be heard against the bill were also made on behalf of the East London, the South-Eastern and Chatham and Dover, the Whitechapel and Bow, the London, Tilbury and Southend, and the London, Brighton and South Coast railways, who, conjointly with the Metropolitan District, have running powers over the East London line. They claimed that it would be necessary, in order that the Metropolitan District should continue running over that line, to change their electric locomotive for a steam one, and for that change there was no provision in this bill.

All these applications were refused.

## LOWESTOFT CORPORATION BILL.

Yesterday the Select Committee of the House of Lords presided over by Lord Pirbright considered the omnibus bill of the Lowestoft Corporation for powers, among other things, to construct and work tramways, and to make further provision in respect to the electric lighting undertaking.

Mr. FREEMAN, K.C., for the promoters, said Lowestoft Corporation had taken over the electric lighting of the town. When it came to deal with the lighting it was thought desirable that electric tramways should also be set up. Up to the present the town had been served by horse-chain brakes, which were insufficient in the summer and very bad in the winter, and the Corporation had been asked to provide a service of electric tramways. The Drake and Gorham Electric Power and Traction Co. (Ltd.) had, with the approval of the Corporation, applied to the Light Railway Commissioners for a provisional order empowering them to construct a light railway from Gorleston, near Yarmouth, a

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distance of about 8 miles, to Lowestoft, passing through the town to Kessingland, 5 miles to the south. A public inquiry was held by the Light Railway Commissioners in 1899, at which the tramways were opposed by the Great Eastern Railway Co. on the grounds of competition, and the Light Railway Commissioners allowed the construction of the tramways to the south of the town, but refused to allow the northern portion. The effect ofthis would have been to provide an incomplete scheme. The Corporation of Lowestoft opposed the confirmation of the order, and the present scheme was the result of negotiations which had gone on between the Corporation and the company. The effect of that agreement was that the company should withdraw their application for a confirmation of their light railway order as far as the lines within the town were concerned, and the Corporation should apply to Parliament for powers to construct a tramway from the borough boundary on the north to the borough boundary on the south, together with branch lines, to be leased to the company at an annual rental, terminable at the end of 7, 14, or 21 years, at the option of the Corporation.

Threatened opposition having been withdrawn, the bill passed to the Unopposed Bills Committee.

## ROUNDHAY ELECTRIC LIGHTING PROVISIONAL ORDER CONFIRMATION BILL.

The Select Committee of the House of Lords presided over by Lord Pirbright on Wednesday considered this bill.

Mr. WEDDERBURN, K.C., said the provisional order was promoted by the Roundhay and District Electric Lighting Co., incorporated in June last year, with a capital of £20,000. The object of the order was to enable the company to supply the district with electric light. The matter came before the Committee, as it came before the Board of Trade, with the full consent and approval of the Roundhay Rural District Council, and there was no doubt that the provision of the electric light would be of great advantage to the district. The cost of the works was estimated at £19,000. The only opposition came from the Leeds Corporation, but all that Leeds had now to say against the proposal had been placed before the Board of Trade, and the Board had decided against them. It was true Leeds supplied Roundhay with gas, but that was because it had acquired the undertaking of the company which formerly supplied both Leeds and Roundhay, and they were, therefore, in the position of the old company. The Corporation now asked for the insertion of clauses empowering them, if any extension of their city should include Roundhay, to purchase so much of the undertaking of the electric lighting company as they might desire to purchase. He asked that the *locus* of the Corporation be disallowed.

Mr. PEMBER, K.C., for Leeds Corporation, said Roundhay was practically a suburb of Leeds. Of the 1,482 acres of Roundhay, 675 were were absolutely owned by the Corporation of Leeds, who objected to the company supplying electricity within their estate. It was impossible for the company to supply electric current without competing with the Leeds Corporation gas supply.

The Committee restricted the *locus* of the Corporation to that of a private owner and to the question of special damage beyond that covered by the general law.

Mr. VESEY KNOX said that, as the Corporation could not make any case in respect of money damage, which would bring out the points they desired, they would not proceed further.

The measure was, therefore, reported to the House as unopposed. An application by the promoters for costs was refused, on the ground that the opposition was not really vexatious.

## STALYBRIDGE, HYDE, MOSSLEY AND DUKINFIELD TRAMWAYS AND ELECTRICITY BOARD BILL.

Among the bills which passed the Committee stage in the House of Commons on Thursday last, as an unopposed measure, was the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board Bill, which seeks to constitute a joint board with authority to construct new tramways in the districts of the authorities mentioned, and to supply electricity for all purposes in the same area.

The bill forms the subject of our leading article this week.

## THE POSTAL TELEGRAPH SERVICE.

In the House of Commons on Thursday last week, Mr. LONSDALE asked, having regard to the estimated value of work done by the Postal Telegraph Department for the public services in the year to March 31, 1900 (£70,746. 11s. 6d.), what was the corresponding value of the services rendered for the same period, and for the year ended March 31, 1901, in respect to work done without charge for the railway companies in the kingdom by the department; and whether, as there was a loss of revenue on the working of the department, steps can be taken to have the relations of the department towards the railway companies brought before the House with a view to their revision.

Mr. A. CHAMBERLAIN said the value of the services rendered by the Post Office to railway companies during the years ended March 31, 1900 and 1901, in respect of the transmission of telegrams on the business of the companies, either free or at reduced rates, was estimated at £59,676 and £52,063 respectively. These services were not, however, on the same footing as the work done by the Post Office for public departments, seeing that the full message privilege was given to the railway companies as part of the consideration paid for the acquisition of their telegraph rights. Some time ago the matter was brought under very careful review, and the Postmaster-General did not at present see any sufficient reason for altering existing arrangements.

## POST OFFICE TELEPHONE SYSTEM.

In reply to a question in the House of Commons on Tuesday, Mr. A. CHAMBERLAIN said that the expenditure already authorised under the Telegraph Act, 1899, for works in progress, or about to be undertaken, amounted to £813,040. Of that amount £677,945 was for the London telephone system and £135,095 for the development of other parts of the Post Office system in various places, but particularly in the north-east of England and in South Wales. The actual payments for new works up to March 31 amounted to £269,941. It was not possible to state definitely what the final cost of the London system would be, but the £2,000,000 authorised by Parliament would be expended in such extensions of the Post Office telephone system as seemed most necessary, either in London or elsewhere. Delay in opening the London system had been caused by scarcity of skilled labour, difficulty of getting materials from contractors, restrictions on opening streets to avoid excessive interference with traffic, and difficulty of constructing exchanges in buildings in use for other Post Office work. Particulars of the rates and conditions of the new service would be published shortly, and it was hoped that the Post Office exchange system would be available in some parts of London in the coming autumn

## ADVANCES UNDER THE LIGHT RAILWAYS ACT.

In reply to a question in the House of Commons last week Mr. GERALD BALFOUR said the Treasury had conditionally agreed to special advances under sec. 5 of the Light Railways Act amounting to £197,250, of which £181,750 was by way of free grant and £15,500 was loaned. There remain £52,750 available for special advances. No loans had been granted under sec. 4, and therefore the whole of the £750,000 remained unappropriated.

# LEGAL INTELLIGENCE.

### In re the St. James' and Pall Mall Electric Lighting Co.

An application was made in the Chancery Division, before Mr. Justice Cozens-Hardy, under the Memorandum of Association Act, 1890, to enable the St. James' and Pall Mall Electric Lighting Co. to acquire power to guarantee the repayment of moneys and interest to secure the debentures of a company to be formed for objects similar to those of the St. James' Co.

Mr. THOMPSON, in support of the application, said the St. James' Co. was formed to supply electric energy within the district covered by its provisional order, but the business of the company had increased so that it required to erect further generating stations. Its own district was unsuited to the erection of such stations, and, accordingly, a site had been selected outside the supply area on the Regent's Canal. Another electricity supply company similarly situated to the St. James' was the Westminster Electric Supply Corporation. These two companies, therefore, had formed a subsidiary company, called the Central Electric Supply Co., to which the two companies contributed equal shares of capital. This company was formed to erect the stations required by the companies for the generation of electric current for distribution within their areas of supply. To enable the Central Company to borrow moneys for the erection and equipment of the generating station on reasonable terms it was desired that the St. James' and Westminster Companies should enter into a guarantee. The capital of the Central Company was £100,000. The power now sought was to enable the St. James' and Westminster Companies not only to guarantee the payment of interest but the payment of the principal.

Mr. Justice COZENS-HARDY said he failed to see the difference between the two.

Mr. THOMPSON said that for some purposes it was no doubt the same thing, but he submitted that a guarantee for interest alone was not the same as a guarantee for principal, and the bank had refused to advance moneys on the former guarantee alone. The cost of the erection and equipment of the generating station was estimated at £350,000.

The order was granted.

### Glasier v. Berrenberg Electric Lamp Syndicate.

This matter came before Mr. Justice Cozens-Hardy, in the Chancery Division, on Friday. Plaintiff is holder of 12 debentures of £100, issued by defendant company in July last, in which it was provided that the interest should become due on Dec. 31 last. No interest was paid, and, therefore, the principal moneys became payable. Plaintiff asked for the appointment of a receiver and manager, and defendant company not opposing the application was granted.

### Berrenberg v. Berrenberg Electric Lamp Syndicate (Ltd.).

Mr. Justice Darling, in the High Court yesterday, heard an action brought by Mr. Adolf Berrenberg, patentee and inventor of the Berrenberg electric incandescent lamp, who claimed two months' salary, amounting to £82. 16s., and damages for wrongful dismissal to the extent of £167. 4s., representing four months' salary. The defendants admitted their liability to pay £74 salary, but justified their dismissal of the plaintiff, who, they alleged, absented himself from their place of business on a holiday without permission, and that he refused to adjust an electric pump which he alone was competent to keep in order. The defendants counterclaimed for £112 on a promissory note, and this the plaintiff admitted.

In the result his lordship found for the defendants for £37 and costs.

### Guildford Electricity Supply Co. v. Guildford Corporation.

In the Chancery Division on Friday before Mr. Justice Byrne, Mr. A. W. Greig moved on behalf of the Guildford Electricity Supply Co., for an

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injunction to restrain the Guildford Corporation from removing, taking up, or otherwise interfering with plaintiffs' electric cables in or upon the town bridge. It was agreed that the application should stand over for a week, counsel for the Corporation undertaking that they would not in the meantime interfere with more than another 6ft. of cable, this arrangement being without prejudice to any rights of the company.

### Hawkes v. the Leyton Urban District Council.

This case was before Mr. Justice Buckley in the Chancery Division on Monday.

Mr. H. TERRELL, K.C., for defendants, said the matter was before his lordship on May 14 on an application by defendants to suspend the operation of the writ of sequestration granted by his lordship and confirmed by the Court of Appeal for breach of an injunction to restrain a nuisance. Counsel then read affidavits to the Court showing what defendants were doing to substitute steam for gas plant, and by the consent of the other side his lordship further stayed the operation of the sequestration for 18 months, with liberty to either party to apply in the meantime. Defendants were ordered to pay the costs of the present and last applications.

### Brush Electrical Engineering Co. v. Governor of Malta.

Judgment was given in the King's Bench Division on Wednesday in this matter. The previous proceedings were reported in *The Electrician* for May 10. When the case was last before the Court Justices Kennedy and Phillimore differed, and an additional judge (Mr. Justice Bruce) was called in and the matter re-argued. The case now came before the Court as a special one. The action showed that differences arose between the plaintiff company and the Governor of Malta in respect of certain claims made for payment for work done under contract and as to certain deductions on the ground of delay, and the dispute was referred to the arbitration of Mr. E. Manville. Questions then arose as to the evidence to be tendered before the arbitrator, and on this point further differences occurred. The points now left for the decision of the High Court were:—(1) Whether the engineer's certificate was a condition precedent to the claimants' right to recover under the contract; (2) whether the engineer's certificate was binding and conclusive between the parties with regard to the points raised in the statement; (3) whether the engineer's certificate was binding and conclusive between the parties with regard to the amount due to the claimants apart from questions of damages for delay; (4) whether the engineer's certificate was binding and conclusive between the parties with regard to the amount due to the respondent in respect of damages for delay.

Mr. Justice BRUCE and Mr. Justice KENNEDY, in giving judgment, having reviewed the facts, said it was unnecessary to answer the first question, as the subsequent answers showed their opinion. Their answer to the second question was "No," to the third "Yes," and to the fourth "No."

Mr. Justice PHILLIMORE dissented as to the third question.

No order was made as to costs.

### Fitzgerald v. Dublin United Tramways Co.

At Dublin last week a Divisional Court, consisting of the Lord Chief Baron, Mr. Justice Johnson and Mr. Justice Kenny, unanimously refused an application to vary the verdict of a special jury, which awarded the plaintiff £1,000 damages for personal injuries owing to the slippery condition of the tramway pavements. This case was reported in our issue of Feb. 8 (p. 594).

### J. and W. Stewart v. Irish Independent Newspaper Co.

In the King's Bench Division, Dublin, on Wednesday, Mr. Justice Boyd heard a motion made on behalf of Messrs. J. and W. Stewart, builders and contractors, Belfast, for discovery of documents. The main action is being brought to recover £5,000 damages for alleged libel published in the *Irish Daily Independent and Nation* and in the *Evening Herald*. The plaintiffs obtained the contract for the erection of an electricity generating station for the Corporation of Dublin and the articles complained of (counsel for the plaintiffs urged) gravely reflected upon the firm's method of doing business, and was likely to be injurious to the standing and reputation of the plaintiffs. The defence is that the articles contained only fair comment.

The Court made the order sought.

### Telephone Way-leave Dispute.

At the West London Police Court yesterday, Mr. Lane had before him an application under the Telegraph Acts to arbitrate upon a dispute which had arisen between the Postmaster-General and a shopkeeper, named Barrett, of High-street, Kensington, with reference to the laying of telephone wires under the pavement. Sir Robert Hunter, solicitor to the Post Office, appeared on behalf of the Postmaster-General; and Mr. Eustace Hills, who represented Mr. Barrett, made a preliminary objection, on the ground that it was not a road or street, but private property, where it was proposed to lay the wires.

Sir ROBERT HUNTER explained the position in front of Mr Barrett's shop, showing two kerbs, but it was all pavement on the same level. It was proposed to lay the wires under the pavement, inside the inner kerb, as the other part was fully occupied with pipes. He contended that the inner space had been dedicated to the public and used by foot passengers, subject to Mr. Barrett placing goods outside his shop. It was important, he said, that the authorities should be able to use the path for laying telephone conduits, and that the Postmaster-General should have every facility to carry the pipes and wires along the streets of London. All the work of repair would be executed at the junction boxes, so that any disturbance of the pavement after the wires had been laid would be extremely remote.

Mr. HILLS complained that his client had been treated in an arbitrary manner, the pavement having been disturbed without his consent.

Sir ROBERT HUNTER said he was willing to accept a consent to safeguard Mr. Barrett.

Mr. W. CHAMBERS LEETE, town clerk of Kensington, stated that consent had been given to the Postmaster-General to lay pipes and wires under the streets. The portion of the inner kerb, in front of Mr. Barrett's shop, was not under the jurisdiction of the Council. Mr. Barrett had a limited user for his goods, but the public had access over it. Any enclosure of the land would be resisted by the Council. Negotiations had been opened to pay a small compensation to Mr. Barrett to surrender his rights, but it was not accepted.

Mr. HILLS submitted that the evidence was not sufficient to show a dedication.

The Magistrate adjourned the case for Mr. Hills to call witnesses.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The Committee of the Manchester municipal school of technology (to be opened in September) invite applications for the position of head of the physics and electrical engineering department. An advertisement contains further particulars, and applications should be sent to the principal (Mr. J. H. Reynolds), Princess-street, Manchester, by June 29.

A teacher of theoretical and practical electric lighting and power transmission, to conduct classes under the regulations of the City and Guilds of London Institute, is required for the Acton and Chiswick Polytechnic, Bedford-park, W. Applications to Mr. W. H. Barker, B.Sc., by June 24. See advertisement.

A lecturer and demonstrator in electrical engineering will be required at the Hull Municipal Technical School in September. Forms of application, &c., from Dr. J. T. Riley. See advertisement.

The Portsmouth Technical Instruction committee invite applications for the positions of assistant lecturer in mathematics and physics and workshop instructor and assistant in engineering for their municipal technical institute. Applications by July 4. See advertisement.

Wellington (N.Z.) Municipal Council require an electric tramway engineer. Particulars may be obtained from Messrs. John Duthie & Co., 23, Lime-street, London, E.C., to whom applications must be delivered before noon of July 20. An advertisement contains further particulars.

Edinburgh Corporation require a second assistant to the superintendent of mains. Applications to the resident electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh, by July 1. See advertisement.

Dewsbury Corporation require an engineer to take charge of their electricity works. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. G. Trevelyan Lee) by July 4.

The directors of the English Electro-Metallurgical Co, Leeds, invite applications for the post of commercial manager of their copper tube works. Applications to the chairman, 39, Coleman-street, London, E.C. See advertisement.

A chief clerk is required in the consumers' department of a London electricity supply company. See advertisement.

An assistant teacher of electrical engineering is required for the Bolton Borough Technical School. Applications to director (Mr. F. Wilkinson) by June 30. See advertisement.

Switchboard attendants are reguired for extra high tension substation operating electric tramways. Applications by July 4. See advertisement.

Telegraphists are wanted for the Cape Government postal telegraph service. See advertisement.

Kingstown (Dublin) Council require a principal for their technical schools. Applications by 24th inst.

A teacher of theoretical and practical electric lighting and power transmission is required for the Acton and Chiswick Polytechnic, Bedford-park, W. Applications by June 24.

The Stepney (London) Borough Council has appointed Mr. Arthur Wright consulting electrical engineer to the borough at a retaining fee of £800 per annum. Mr. Wright's agreement with the late Whitechapel Board of Works is cancelled, and he enters into a fresh agreement with the Stepney Council whereby his services will be secured for five years from Feb. 14, 1901. Mr. W. C. P. Tapper has been re-appointed borough electrical engineer and manager of the electricity department at a commencing salary of £350 per annum, rising annually by £25 to £400.

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Mr. J. H. Cawthra, borough electrical engineer at Swansea, has been appointed to a similar position at South Shields, in succession to Mr. J. A. Jeckell, recently appointed to Coventry.

Grays District Council have appointed Mr. E. D. Long, of Grays, resident electrical engineer at their electricity works.

Mr. Frank H. Newman, M.A., Ph.D., B.Sc., has been appointed director of technical education for Carlisle.

Mr. A. J. Ostler, of West Ham, has been appointed charge engineer at the Bristol electricity works.

Mr. L. Paton Greig has been appointed borough electrical engineer at Bury St. Edmunds in succession to the late Mr. A. H. Roe.

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**Argentina.**—South of the city of Cordoba, distant about 2 miles, and on the line of the Malagueño railway, there has just been established a new English factory for the manufacture of carbide of calcium. £30,000 is invested in this undertaking. Electric motive power is supplied by the Cordoba Electric Light and Power Co., and at present about 1,000 H P. is provided. This amount is to be increased to 4,000 H.P., when the works will turn out about 100 tons of carbide per month, the present output being 25 tons. The electrodes are made from carbon obtained from Germany, and the quality of the carbide is said to be superior to the imported article.

Another factory of a similar character is being constructed in the Cordoba mountains alongside the track of the Cordoba and North-Western Railway, near Casa Bamba station. The capital in this case will be subscribed locally. Electric motive power for the new factory is to be obtained from the river Primero, near at hand.

**Baku (Russia).**—It is stated that in this district electricity generating stations are being constructed with an aggregate capacity of more than 10,000 H P. The main object of these stations is to supply current as motive power on the extensive oil field as a substitute for the steam power now used. The experiment, for so it may be called, is being watched with much interest, as there are said to be numerous serious difficulties to the success of the undertaking. The whole of the plant and apparatus for these stations has been supplied by German makers. The steam plants, which it is intended to supersede by electric driving, are almost exclusively of British manufacture.

**Blackburn.**—Owing to a deficit on the working of the electric tramways, the Tramways committee recommend the Council to increase the fares on the lines as suggested by the borough electrical and tramways engineer (Mr. A. S. Giles).

**Burton-on-Trent.**—It appeared from the accounts of the electricity department, presented at the meeting of the Council last week, that the receipts were £4,038. 8s. 6d. from the sale of current, £147. 2s. from meter rents, and £90. 3s. 5d. from fittings, the total expenditure being £4,160. 13s. 6d., leaving a profit of £115. 0s. 5d., against £5. 9s. 6d. in the previous year. In moving the adoption of the accounts Councillor Lowe said that the working of the department had been disappointing. The receipts had increased over £500, but this had been almost entirely swallowed up by increased expenditure. Although the accounts showed a profit of £115, that would not have been the case had they taken up the loans, as the interest and sinking fund instalment would have been nearly double. The motion was adopted.

**Canal Lighting.**—The waterways of Canada form one of the most important means of commercial intercourse between certain parts of the Dominion, and the number of these canals is very considerable. In 1900 the Soulanges canal was opened, forming one of the most important links in the interior waterways of the country. The canal is lighted throughout its course by electricity, and this feature has proved so great a success that electric lighting is to be extended to a large number of the chief canals in the Dominion as promptly as the work can be carried out.

**Cardiff.**—The permanent way of the Cathedral-road electric tramway route was officially inspected on Tuesday.

**Cheltenham.**—An inquiry will be held here on Tuesday into the application of the Council to borrow £25,000 for electric lighting extensions.

**Chester.**—The accounts of the electricity department for the year ended March give the receipts from the sale of current for lighting as £11,110. 1s. 6d.; meter rentals and miscellaneous receipts, £309. 17s. 10d.; and £85. 15s. 7d. from previous year, making £11,587. 7s. 7d. to meet an expenditure of £6,058. 18s. 2d., or a gross profit of £5,405. 11s. 3d. after putting aside £122. 18s. 2d. for bad debts. Interest amounted to £2,102. 5s. 8d.; sinking fund instalment, £1,903. 5s. 7d.; and £1,400 was transferred to reserve. 513,854 units were supplied to private consumers, 266,713 for public lighting, and 100,933 were used on the works, making 944,857. There are 165 public arc and 313 incandescent lamps, and the total maximum supply demanded was 527kw.

**Condition of the Electrical Industry in Germany.**—The *Financial News* of the 18th announced the failure of the Aktien-Gesellschaft Elektricitäts Werke vormals O. L. Kummer & Co. The failure is attributed to the company having accepted large orders from Japan on unprofitable terms.

**Coventry.**—The annual report of the Electric Light committee states that the number of customers has increased from 226 to 331 during the year, and the equivalent number of 8 c.p. lamps connected from 17,806 to 23,637. The number of units sold has increased from 229,607 to 341,810, and the revenue from £4,188. 16s. 7½d. to £6,053. 17s. 3½d. The increase in units sold to private consumers has been from 169,056 to 268,982, the revenue from that source being £5,120. 18s. 6d., against £3,500. 8s. 4d. The profit is £1,538. 18s. 2½d., against £786. 19s. 8½d. The capital charges amount to £3,789. 14s. 2d. The net charge on the rates is £2,250. 15s. 11¾d., against £1,745. 3s. 5½d. last year. The capital expenditure to date is £75,813. 9s. 9d.

**Dewsbury.**—The borough electrical engineer (Mr. O. M. Jonas) has resigned, and the Council are advertising for a successor.

**Dublin.**—At a meeting of the Electric Lighting Committee on Friday, it was decided to report to the Council that they should accept tenders for the various sections of their electric lighting scheme as follows:—No. 4, £16,727; No. 5, £28,255; No. 6, £10,358: and No. 7, £5,225; total, £60,566. The Corporation have sanctioned £265,661 for the entire scheme, and the present tenders conclude the placing of contracts for the complete undertaking at £246,189, which, with £13,000 for engineer's fees, &c., makes £259,000. There is thus a sum of £6,000 remaining for contingencies, &c.

The Hill of Howth-Sutton electric tramway was opened on Monday.

**Dutch East Indies.**—Concessions have been granted to Messrs. H. R. der Mosch and H. Jul Joostenz for the construction and working of electric light and power plants in the cities of Padang and Djokjakarta. The latter city has a population of 85,000, and Pedang, which is the largest city on the west coast of Sumatra, has a population of about 35,000.

**Electric Traction.**—Mr. Philip Dawson read a Paper on "Electric Traction" before the Exeter Chamber of Commerce on Wednesday. He said that there was no question in which the public at large took so great an interest at the present time as that of electric traction. With the increase of population in our cities, the question of the proper housing of the working classes had become difficult, and the only satisfactory solution was by providing cheap and convenient means of rapid transit between dense centres of population and the outlying suburbs. He quoted figures to show the great and rapid development of electric traction, especially in the United States. He reviewed the various systems of electric traction. The best constructed overhead systems, including truck and overhead work, cost from £7,000 to £8,000 per mile of single track, while under similar circumstances the conduit system would cost from £15,000 to £30,000 and in special cases as much as £50,000. All surface-contact systems possessed grave defects, which rendered their application inadvisable. In practice, it was difficult to be certain of the devices adopted for connecting and disconnecting the contacts and the feeders. The accumulator system had been tried repeatedly and failed owing to the great cost of the batteries and their maintenance. In regard to running gear experience had demonstrated that the only effective method was to attach the motors to an independent truck frame, and to have all the mechanism of the car entirely independent of the car body. The success or failure of electric tramways depended to no small extent upon the location and extent of the power station. The load was a constantly varying factor, and the variations very large and unexpected. Breakdowns were more serious than in electric lighting plants, and such precautions must be taken as would render a suspension of service practically impossible under any circumstances. One of the greatest obstacles to the progress of electric traction had been the fear of electrolysis, and there was also a large amount of needless fear with regard to the danger of electric shocks.

**Electric Traction in Switzerland.**—The Limmat Valley electric railway, 8 miles long, connecting a number of large villages with Zurich, was opened for traffic in April. The line has been constructed under the direction of Dr. Du Riche Preller, M.I.E E., as managing director and chief engineer, the general contractors being Messrs. Brown, Boveri & Co.

**False Pretences.**—At the Westminster Police Court on Monday Hans St. Lausnitz, described as a German engineer, late of Victoria-street, London, was charged with obtaining goods by false pretences from various firms, including the Electrical Co. and the Edison and Swan Co. Prisoner pleaded guilty, and he was sentenced by Mr. Horace Smith to nine months' imprisonment in the second division.

**French Indo China.**—Much industrial activity is shown in Cochin China, and amongst the undertakings approaching completion is the establishment of electricity works at Cholon, near Saigon, where a joint-stock company has obtained a concession from the Government.

The town of Saigon is partly lighted electrically, between 600 and 700 16 c.p. lamps being already in use. Considerable extensions are in progress.

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**Glasgow.**—The Corporation have decided to apply for a provisional electric lighting order for the Kinning Park district.

**Hamburg.**—In a recently issued report on the trade of Hamburg and district for 1900 it is stated that a Marconi wireless telegraph station has been established on the island of Borkum, communicating with the Borkum Riff lightship; that a station on the Schaefer system was established at Bremerhaven, communicating with the Rothersand lighthouse at the mouth of the Weser; and that there is shortly to be opened at Cuxhaven another wireless telegraph station on the Braun system, communicating with the light vessels at the mouth of the Elbe as well as with Neuwerk lighthouse.

Rapid extensions of the application of electricity for lighting and locomotion have been a feature of the past year's work at Hamburg. A third large generating station has now been established which will supply current for lighting the remainder of the main thoroughfares of the city, and a part of this work has been already carried out. The number of consumers connected up to the Hamburg stations at June 30, 1899, was 3,099, and at the same date in 1900, 3,770. The progress to June 30, 1901, is expected to show still greater increase.

There are 540 cranes of various kinds in use in connection with the port of Hamburg, and of these 150 are hand, 276 are steam and 22 hydraulic. The balance of 92 are electric, and of this number 84 are electric travelling cranes, lifting from 47 to 56 cwt.

**Harrogate.**—The total receipts of the electricity department during the past year were £9,269 and the expenditure £6,007. After paying interest and sinking fund there was a net profit of £698.

**Hove.**—Messrs. Handcock and Dykes have been appointed consulting engineers to the Council in connection with the Aldrington electric lighting scheme.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Isle of Thanet Light Railway (Amendment) and the East and West Yorkshire Union Light Railways Orders.

The Board of Trade have, after modification, confirmed the Blackpool and Garstang Light Railway Order, 1901.

**London County Council.**—At Tuesday's meeting it was stated that loans on electricity account of £10,600 had been advanced to Battersea, Hampstead £17,225, and Stepney £10,000. It was agreed to loan for electric lighting: Hackney £50,000, St. Pancras £50,000, Southwark £13,980 (the application in this case was for £15,300—there was an item for meters on which the committee were not yet prepared to report), Hampstead £9,525 (in this case an item of £2,810 for meters was left in abeyance), and Stepney £380.

The Parliamentary committee presented a report dealing with the question of loans to enable local authorities to wire and fit consumers' premises for electric lighting. Several applications had been made requesting the Council to seek legislation to enable this work to be done, the desire being to provide fittings on a system of hire or other easy terms of payment. The Finance committee thought some such arrangemement was necessary to the success of the electric lighting undertakings of local authorities, and considered that loans might be granted by the Council for a period not exceeding 10 years. The solicitor considered that while it was not within the Council's spending power to promote legislation generally on behalf of local authorities, yet this matter might, without practical risk, be included in the Council's General Powers Bill, and the Parliamentary committee recommended that this should be done.—This was agreed to.

The Highways committee reported on the private conference held on May 16 between the Council and the metropolitan local authorities on questions arising consequent upon the establishment of generating stations for the supply within the County of London of electrical energy in bulk. The conference passed resolutions to the effect that it was essential to the interests of London as a whole that a purchase clause similar to that in the Electric Lighting Acts which applies to defined areas, should also be made to apply to such companies as supplied or proposed to supply electrical energy in bulk to the whole or any part of London without regard to area; that the Council should be in the position to undertake the supply of electric energy in bulk to any local authority provided it did not become competitive with the local authority, and that the County Council should draft a bill to this effect and submit it for the consideration of the local authorities. The suggested clause is as follows:—

Where a company or person is authorised by special act or any order under the Electric Lighting Acts confirmed by Parliament to supply electricity within any area extending into the district of more local authorities than one, such authorities may combine for the purpose of purchasing the undertaking of such company or person whether by agreement in anticipation of the date at which powers of compulsory purchase may be exercised under the Electric Lighting Acts or compulsorily at such last mentioned date, and in any such case the London County Council, with the consent of the local authorities of the districts concerned, may either by agreement in anticipation of the date of compulsory purchase, or compulsorily at the date of compulsory purchase, purchase the undertaking of such company or person.

Where, either by agreement or compulsorily, the London County Council shall have purchased the undertakings of any such company or person, the Council may, by agreement with the local authorities concerned, either manage and carry on the undertakings or any part thereof, or transfer the same wholly or in part to any such local authority or authorities.

Where a company is constituted for the purpose of holding lands or providing a station for generating electrical energy and for supplying electrical energy to any other company, body, or person, and such first-mentioned company is not a company supplying energy directly to persons consuming the same, the undertaking of such first-mentioned company shall become subject to purchase at the times and upon the terms prescribed by sec. 2 of the Electric Lighting Acts, 1882 and 1888. Provided that, in lieu of the period of 42 years from the date mentioned in sec. 2 of the Electric Lighting Act, 1888, there shall be substituted a period of 42 years from August 25, 1889. Where the London County Council shall have purchased the undertakings of any such first-mentioned company, the Council may either manage and carry on the undertakings or any part thereof or transfer the same wholly or in part to any local authority or authorities.

The report was adopted.

It was decided to oppose the application of the Middlesex County Council to the Light Railway Commissioners for powers to construct light railways, certain portions of which were within the County of London.

The Highways committee presented a report dealing with proposed extensions of the tramway system of London, to come before Parliament next session. The total length of new tramways proposed north of the Thames is 12 miles, and estimated cost about £620,600. On the south side of the Thames the total length of proposed lines is about 16½ miles, and estimated cost £1,311,700. It is proposed that the new tramways to be connected with the northern system, now leased to the North Metropolitan Company, be constructed for horse traction, unless the company are willing to convert their system to electricity, but that the rails be of sufficient weight for the use of electric traction. The other lines are to be constructed for electric working. The committee propose to construct 3 miles 6 furlongs of tramway from the Marble Arch, along Edgware-road, to the county boundary at Cricklewood. The borough of Marylebone will oppose. Another line is from Harlesden to Putney Bridge (5 miles 2 chains), with a junction with the London United Tramway Co.'s line a Hammersmith. The line from the south side of Clapham Common to the county boundary will be 5 miles 3 furlongs, and that from Deptford to Woolwich 5½ miles. Consideration of this report was adjourned for a week.

**Oldham.**—The Park-road, Glodwick-road, and Lees-road sections of the Corporation electric tramways were opened on Saturday.

**Perth.**—A proposal to establish municipal electricity works has been rejected by 880 to 421 votes.

**Poti (Russia).**—An electricity generating station has been established here, and, in addition to supplying current for public and private lighting, the owning company has entered into a contract to instal the electric light in the harbour, and this work is to be completed in a few months. The loading and unloading of vessels will then proceed by night as well as day.

**Prestwich.**—The Board of Trade have approved the draft transfer of the Council's provisional order to the Manchester Corporation.

**Protection in Norway.**—The Storthing on May 28 unanimously passed a resolution that it was desirable to give preference to tenders from Norwegian firms for works and materials required by the Norwegian public works department, army and navy, &c., and amongst the industries to which reference was made in the debate as requiring special protection was the manufacture and sale of telephones.

**Saddleworth.**—A preliminary report on electric lighting and tramways has been prepared for the Council by Messrs. Gibbings and Baker. The lighting scheme is estimated to cost £26,100, and the tramways £45,700 -a total of £71,800. The Council have received an offer from a Manchester firm as to the construction of the tramways, and it has been decided to invite other firms to submit terms.

**Scarborough.**—In view of the Council's intention to apply for a provisional tramway order next session, it has been decided to appoint a consulting engineer to prepare a scheme.

**Stafford.**—The total receipts of the electricity department for the year to March 31 were £2,506. 11s. 1d.; expenditure, £1,888. 15s. 6d.; gross profit, £617. 15s. 7d. Interest takes £531. 17s. 2d., and sinking fund £622. 8s. 10d, showing a deficit of £503. 4s. 1d. The equivalent number of 8 c.p. lamps connected is 10,813. 200,271 units of current were sold, and 11,692 used on the works.

**Sunderland.**—The report of the borough electrical engineer (Mr. John F. C. Snell) on the sixth year's working of the electricity undertaking states that the equivalent number of lamps connected on March 31 was 50,092, compared with 35,024 in 1900, an increase of 43 per cent., against 36 per cent. in the previous year. The units sold were 1,218,768, against 640,079 in 1900, increases of 90 per cent. and 35 per cent. on 1900 and 1899 respectively; 256,240 units were supplied to the Tramways committee. During the year four new steam dynamos (of 450 I.H P. each) were added for the tramways, together with surface-condensing plant and a re-cooling tower, four Galloway boilers with fuel economiser and induced draught fans. Coal-handling apparatus is also being fixed. The gross profit for the year amounts to £7,253. 14s. 9d., and after paying interest and sinking fund (together £5,996. 14s. 7d.) there was a net profit of

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£1,257. The price of coal represents, it is stated, an increased cost of £2,315. The capital outlay to March 31 was £121,914, equal to £52 per kilowatt installed. During the year negotiations were completed for the purchase of a site for a new generating station at Hylton-road. Contracts for plant have been let, the buildings are making rapid progress, and there is every prospect of the new station being able to supply current during the coming winter.

**Telephone Competition.**—To meet the competition of the municipal telephone system the National Telephone Co. announce a reduction in their tariff at Tunbridge Wells from £8. 10s. to £4.

**Telephone Trunk Line Extensions.**—Alnwick has been connected to the telephone trunk line system of the country.

The Tunbridge Wells Corporation telephone exchange is now connected with the Post Office trunk line system.

**Theft.**—At Leeds on Tuesday three labourers, named Wright, Demaine and Ainley, were charged with stealing 108lb. of bronze and copper, the property of the English Electro-Metallurgical Co., on June 12. Prisoners were caught taking the metal away, and when arrested Wright admitted the theft. Committed for trial.

**Ventnor.**—The question of acquiring the undertaking of the local electric lighting company has been abandoned for the present.

**Village Lighting.**—The village of Esh Winning (Darlington) is to be lighted electrically. The contract for plant has been let to Messrs. F. Reid, Ferens & Co. at £256. 6s. 8d. The village of Quebec (co. Durham) is to be similarly lighted.

**Warrington.**—An inquiry was held here last week into the application of the Council to borrow £66,000 for tramways. The town clerk (Mr. J. Lyon Whittle) supported the application, which concerned the construction of tramways from Sankey Bridges to Knutsford-road swing bridge, Latchford, on to Stockton Heath swing bridge across the Ship Canal. The Corporation had, he said, entered into an agreement with the promoters of the Warrington and Northwich light railway to purchase a portion of their line in order to take a circular route outside the borough from the tramway terminus at Stockton Heath swing bridge to Knutsford-road swing bridge, where it would connect with the Latchford tramways. An agreement had also been made with the South Lancashire Tramway Co. to connect their proposed line from Earlestown with the Warrington tramways on the north side of the borough. Mr. A. H. Preece (Messrs. Preece and Cardew, consulting engineers to the Corporation), said that tenders had been provisionally accepted for the construction of the line from Sankey Bridges to Latchford. The tender for the permanent way was £28,789, for overhead equipment £4,833. 19s., and for cars £4,833. A car shed and shop would cost, in addition, £6,000, feeders £350, contingencies and engineering £3,368. 6s., making £48,000 for this line. The Wilderspool Causeway tramway was estimated to cost £17,650, making the total £66,050. Opposition was offered by the ratepayers' association.

**Willesden.**—The Board of Trade have intimated to the Council that they will defer considering the question of revoking the Council's provisional electric lighting order for 12 months. The Electricity committee has been in correspondence with the Metropolitan Electric Supply Co. on the question of the supply of electricity in bulk, but the company are not prepared to submit further proposals. The committee therefore recommend that the company's terms be not accepted. This has been agreed to. The British Insulated Wire Co. are to be invited to submit an offer for carrying out the electric lighting scheme prepared by the electrical engineer (Mr. E. T. Ruthven Murray) and for maintaining and working the same for five years.

**Withington.**—Appeal has been made to the Board of Trade for extension of time to construct the tramways authorised by the Withington Tramways Order, 1897.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

The Electricity committee of the *Poplar* (London) Borough Council require multiple core lead-covered feeder and network cable and accessories for mains extensions. An advertisement contains some particulars. Specifications, &c., from the borough electrical engineer (Mr. A. Blackman), electricity works, Glaucus-street, Bromley-by-Bow, E. Tenders to town clerk (Mr. Leonard Potts), Council offices, High-street, Poplar, by June 26.

The Electricity committee of the *Poplar* Borough Council also invite tenders for the supply of condensing plant, boiler feed pump, and steam and water piping, &c. Specifications, &c., from the borough electrical engineer (Mr. A. Blackman), and tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, E., by July 1. Further particulars appear in an advertisement.

*Nelson* Corporation invite tenders for a steam engine and dynamo, balancer, two Lancashire boilers, feed pumps, economisers, &c., condenser and steam pipes, cables and switchboards. Specifications from the borough electrical engineer (Mr. W. Alan Fraser) and tenders to the town clerk (Mr. J. H. Baldwick), Town Hall, Nelson, by noon July 1. An advertisement contains further particulars.

*Bradford* Corporation require electric motors (enclosed type) of 4½ H.P., 7 H.P., and 10 H.P. for the 12 months commencing Nov. 1. Specification, &c., from the city electrical engineer (Mr. R. A. Chattock), and tenders to the town clerk (Mr. F. Stevens) by July 4. See advertisement.

*Pontypridd* Guardians invite tenders for the electric lighting of the union workhouse, infirmary and other buildings. Tenders to the clerk (Mr. W. Spickett) by July 23. See advertisement.

*Darlington* Gas and Electric Lighting committee invite proposals for "free" or "assisted" wiring. An advertisement contains further particulars. Applications to the town clerk (Mr. H. G. Steavenson) by July 16.

*Dudley* Electric Light and Tramway committee require tenders for the supply and erection of steam engine and dynamo. Further particulars are given in an advertisement. Specification, &c., from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, London, S.W. Tenders to the Town Hall by noon July 6.

*Mansfield* Corporation require boiler and engine house plant, condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains and arc lamps, posts and accessories for public lighting, mains and workshop equipment. Tenders to town clerk by 4 p.m. July 12.

*Manchester* Tramways committee require tenders for rail bonds. Specifications from the general manager, Mr. J. McElroy, 55, Piccadilly, Manchester, and tenders (addressed chairman) must be in by 5 p.m. July 1. An advertisement gives further particulars.

*Stepney* (London) Electrical committee require tenders for Conradty arc lamp carbons for year ending June 30, 1902. Tenders to Mr. Wm. C. V. Tapper, 27, Osborn-street, Whitechapel, E, by noon 26th inst.

*Erith* Urban District Council require tenders for generating station plant, mains, conduits, arc lamps and posts, &c. Tenders to clerk before noon June 24.

*Wallasey* District Council require machinery and tools for their electric tramways department. Tenders to Mr. H. W. Cook, Public Offices, Egremont, Cheshire, by July 18.

*Wallasey* Council also invite tenders, until 24th inst, for the maintenance of the electric installation on their steamers for 12 months from July 1.

*Bermondsey* (London) Borough Council invite tenders for electricity meters, demand indicators, and main fuses. Tenders to the town clerk (Mr. Frederick Ryall) by noon of July 1.

*Hurst* District Council require tenders for constructing permanent way of tramways. Tenders to clerk, Booth-street Chambers, Ashton-under-Lyne, by noon June 28.

*Hackney* (London) Electric Lighting committee invite tenders for mechanical coaling apparatus. Tenders by 4 p.m. July 4.

*Taunton* Corporation invite offers for wiring premises free of initial cost to consumer. Tenders by noon July 1.

*Bury* (Lanca.) Town Council invite tenders for wiring the new infectious diseases hospital. Tenders by 26th inst.

*Barnes* District Council invite tenders for a refuse destructor. Tenders by July 9.

Tenders are invited for wiring the new floral hall of the *Brighton* market. Tenders by 26th inst.

Tenders are invited for the erection of municipal electricity work at *Cadiz*. Tenders by Aug. 15.

### TENDERS RECEIVED AND ACCEPTED.

The Electrical Co. (Ltd.) have received an order from Messrs. Asa Lees & Co., Oldham, for a 350kw. three-phase generator and the necessary motors for driving their shops electrically.

The Allgemeine Elektricitäts Gesellschaft, of Berlin, have received an order from the Cape Government for the Table Bay Harbour plant for three 250kw. direct-current dynamos, coupled direct to Belliss engines (the boilers being by Davey, Paxman & Co.), and cranes from 3 to 8 tons carrying capacity, and 11 capstans. The mechanical portion of the cranes is supplied by Messrs. Stothert and Pitt, of Bath.

Walsall Town Council have accepted the tender of Thomas Parker (Ltd.) for a transformer at £780, and a spare armature for the transformer at £266.

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As announced in our last issue the Kirkcaldy Town Council have accepted tenders for plant in connection with their electric lighting and tramways scheme, and below we give a list of the tenders received :—

*Engines and Dynamos.*

| | |
|---|---|
| *Laurence, Scott & Co. (Browett compound engine) *(accepted)* | £6,620 0 0 |
| Anchor Electric Co. | 9,388 4 0 |
| Easton & Co. | 9,310 0 0 |
| McClure and Whitfield, 4 tenders, from £7,478 0 0 to | 9,076 19 6 |
| Mather and Platt, 5 tenders, from £7,435 5 0 to | 8,980 5 0 |
| Bergtheil and Young, 8 tenders, from £7,126 0 0 to | 8,927 0 0 |
| Electric Construction Co., 3 tenders, from £7,574 9 10 to | 8,744 17 6 |
| D. Bruce Peebles & Co., 4 tenders, from £7,377 2 6 to | 8,567 2 6 |
| Ernest Scott and Mountain | 8,282 0 0 |
| Mavor and Coulson, 6 tenders, from £6,636 0 0 to | 8,274 0 0 |
| Lancashire Dynamo and Motor Co., 7 tenders, from £6,134 10 0 to | 8,231 19 0 |
| Thomas Parker (Ltd.), 7 tenders, from £6,600 0 0 to | 8,214 0 0 |
| Newton Electrical Works | 7,867 0 0 |
| Bow, McLachlan & Co. | 7,820 0 0 |
| Johnson and Phillips | 7,668 0 0 |
| Sunderland Forge and Engineering Co. £7,329 0 0 and | 7,473 0 0 |
| Vauxhall Ironworks Co., 4 tenders, from £6,652 0 0 to | 7,356 0 0 |
| British Schuckert Electric Co. | 7,283 8 0 |
| Compagnie Internationale d'Electricité, Liège | 7,280 0 0 |
| Greenwood and Batley | 7,265 10 0 |
| W. H. Allen, Son & Co., 4 tenders, from £6,442 10 0 to | 7,187 10 0 |
| Crompton & Co. | 7,144 0 0 |
| Clayton Engineering and Electrical Construction Co. | 7,122 15 0 |
| Siemens Bros. & Co. | 7,046 0 0 |
| Thames Ironworks Co. £6,071 10 0 and | 6,898 12 0 |
| General Electric Co. | 6,619 0 0 |
| Matthew Paul & Co. £6,239 0 0 and | 6,557 0 0 |
| Johnson-Lundell Electric Traction Co. | 6,286 10 0 |
| Electrical Co. | 5,960 0 0 |
| Brush Co. | Figures not given. |

NOTE.—The extra for spares with the various tenders ranges from £70 to £150.

* Messrs. Laurence, Scott & Co. sent in 13 tenders, from £5,895 (Browett compound engine) to £7,898 (Belliss triple engine).

*Storage Battery.*

| | | | |
|---|---|---|---|
| Tudor Accumulator Co. *(accepted)* | £1,364 0 | Hart Accumulator Co. | £1,375 14 |
| Chloride Elec. Stor. Synd. | 2,005 0 | Pritchetts and Gold | 1,345 0 |
| Rooper and Robins | 1,855 0 | British Power, Traction, &c., Co. | 1,333 10 |
| Marquand Accum. Co. | 1,522 0 | Ashmore, Benson, Pease & Co. | 1,290 0 |
| D.P. Battery Co | 1,467 5 | Elec. Power Storage Co. | 1,075 4 |
| De Grelle, Houdret & Co. | 1,425 0 | | |

*Overhead Travelling Crane.*

| | | | |
|---|---|---|---|
| Carrick & Ritchie *(accepted)* | £370 0 | J. M. Henderson & Co. | £434 0 |
| Compagnie Internationale d'Electricité, Liège | 567 0 | T. Broadbent & Sons | 420 0 |
| J. Booth & Bros. | 485 0 | Southgate Engineering Co. | 347 10 |
| Marshal, Fleming and Jack | 440 0 | J. Carrick & Sons | 342 0 |
| J. Spencer & Co. | 440 0 | J. Hitchin & Son | 220 10 |

Dublin Electric Lighting committee having considered the tenders sent in (100 in number) for sections 4, 5 and 6 of their electric lighting scheme, recommend the following for acceptance :—

| | |
|---|---|
| British Westinghouse Co. (transformers) | £6,320 |
| Ditto (meters) | 4,670 |
| Veritys Limited (arc lamps) | 6,198 |
| Ditto (arc lamp pillars) | 6,042 |
| Brush Co. (sub-station switch-gear) | 5,880 |
| Graham, Morton & Co. (coal-handling plant) | 5,475 |
| J. and W. Stewart (building 19 sub-stations) | 5,225 |
| Babcock and Wilcox (pipework) | 4,805 |
| Ditto (superheaters, Part 2) | 705 |
| Witting Bros. (motors and motor generators) | 3,970 |
| General Electric Co. (main switchboards) | 3,814 |
| Alley and Maclellan (condensers) | 3,030 |
| Wm. Coates & Sons (works wiring) | 967 |
| Easterbrook, Allcard & Co. (workshop plant and tools) | 795 |
| Electrical Power Storage Co. (accumulators) | 751 |
| Carrick and Ritchie (overhead crane) | 670 |
| D. Stewart & Co. (feed pumps) | 395 |
| John Musgrave & Sons (superheaters, Part 1) | 332 |

## BUSINESS NOTICES.

Messrs. C. C. Wardrop and C. C. F. Monckton (carrying on business as Wardrop and Monckton), civil and electrical engineers, 1, Army and Navy-mansions, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. Wardrop.

On and after June 24 the registered offices of the D. P. Battery Co. (Ltd.) will be at 11, Victoria-street, Westminster, London, S.W., the company being about to remove from No. 66. It is further notified that the extensions made at the works, Lumford Mills, Bakewell, Derbyshire, will enable the company to concentrate the whole of their manufacturing at these works.

Messrs. W. Mackie & Co. have removed to 122 and 124, Goldenlane, London, E.C. Telephone 1930 London Wall.

The British Columbia Electric Railway Co. (Ltd.) have removed to Threadneedle House, 28-31, Bishopsgate-street Within, London, E.C.

Messrs. Ernest Scott and Mountain (Ltd.) have purchased land just outside Darlington, and will shortly remove their works from Newcastle-on-Tyne.

## BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankrupcy of A. G. Inrig (trading as the Globe Electrical Co.), 46, Whitepost-lane, Victoria Park, London, E., the trustee has been released.

In the bankruptcy of J. E. Bunce, electrical fittings manager, 16, Elmfield-terrace, Halifax, a first and final dividend of 1s. 7d. will be payable on 25th inst. at the O.R.'s, Town Hall Chambers, Halifax.

A receiving order has been made against C. A. Church (trading as Hy. Conolly & Co.), manufacturing electrical engineer, Aldborough Hatch, Ilford, and 42, Hampstead-road, and 120, Kentish Town-road, London, N.W. The first meeting of creditors will take place on 27th inst., and the public examination on July 24, at Bankruptcy-buildings, London, W.C.

Alfred Ebenezer Mavor, described in receiving order as Alfred Mavor, and whose present address is unknown, has been adjudicated bankrupt.

Alfred Sharp, electrical and mechanical engineer, late of Barnsley, now of Lane Head, Rastrick, Yorks., has been adjudicated bankrupt. Liabilities about £160, assets nil.

Claims against the Electrical Inventions and Manufacturing Co., Ltd. (in liquidation), must be in by July 15 to Mr. C. W. Provis, jun., 3, Mount-street, Manchester.

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**Plant for Sale.**—An advertisement contains particulars of an E C.C. dynamo coupled direct with a 50 H.P. vertical compound engine which are for sale. Applications to Mr. H. A. Couchman, Messrs. Bass & Co., Burton-on-Trent.

**Insulating Tape.**—The St. Helens Cable Co. has sent us a sample of a new insulating tape which they are putting on the market, and which is called "Dia's" adhesive N tape. It is manufactured by a patent process, a thin facing of Para rubber being applied to a prepared sheet of previously vulcanised rubber. The pure rubber assists the adhesion of the turns of tape as they are laid on, and the vulcanised rubber is claimed to be far less perishable than pure rubber would be. The makers inform us that they have tested the material after a three days' immersion in water and found that its insulation resistance was unimpaired.

**Tramway Trolley Accessories.**—Messrs. R. W. Blackwell & Co. have issued a new list of flexible suspensions, guard wire supports and clips, earthing devices for telephone wires, &c.

**Accessories List.**—Messrs. J. C. Lyell & Co. have issued an illustrated pocket price list of electrical accessories, including "Firefly" glow lamps, which have just been placed on the market.

**Turning and Boring Machinery.**—Messrs. John Hetherington & Sons, Ancoats Works, Manchester, have just completed a large horizontal turning and boring mill to take articles up to 32ft. diameter, and admitting 6ft. under the tool holders. This new mill is claimed to embrace all the latest improvements for this type of machinery, and to be specially adapted for turning and boring parts for electric generators and general heavy engineering work, the feed motions being horizontal, angular, and vertical, and instantaneously changeable whilst in motion by means of an indexed hand-wheel giving a variation of eight feeds to each of the machine's 36 different speeds.

**Parsons' Turbo-Alternators.**—Messrs. C. A. Parsons & Co. forward particulars of the first turbo-alternator constructed by Messrs. Brown, Boveri & Co., of Baden, under the Parsons patents. The machine is three-phase, of 250kw. capacity. We learn that amongst the turbine plants now constructing are two of 2,600kw. single-phase and 3,200kw. three-phase respectively for Frankfort, and two of 3,000kw. and 2,000kw. (both three-phase) respectively for Milan. The turbine for the latter set will be manufactured at Newcastle.

**The "Osmium" Electric Lamp.**—The *Financial Times* of June 18 and 19 contains an interesting review of the present position of the Welsbach Incandescent Gas Light Co., and especially refers to the delay in placing upon the market the "Osmium" electric lamp, which was shown at the Paris Exhibition last year, and which was to have been procurable by the public last autumn. It will be remembered that Sir Henry Burdett, chairman of the Welsbach Co., referred to the new electric lamp as "an invention for electric lighting just as important as was the Welsbach lamp for gas lighting."

**Turbines, Dynamos, Motors, &c.**—Mr. S. Howes, of 64, Mark-lane, London, E.C., has an exhibit of improved dynamos, turbines, motors, &c., on view, which those interested are invited to call and inspect.

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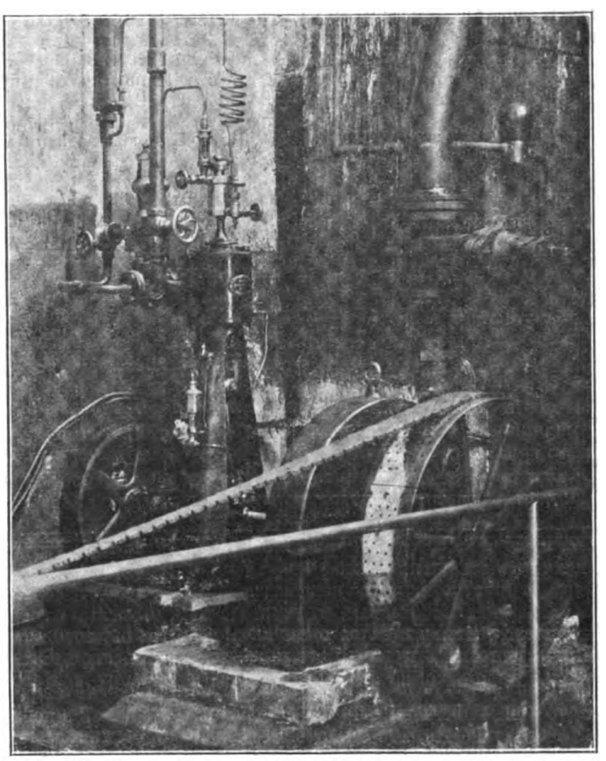
**Combined Pelton Wheel and Steam Engine Installation.**—At the Tower Works of the Chester Water Works Co. there has been installed a combination of high-speed steam engine and Pelton water wheel, which has proved very successful in operation. The accompanying illustration shows the arrangement of this set, which is used to drive dynamos for lighting the pumping station and filter beds, the arrangement being that either the Pelton wheel or steam engine can be run separately or combined, as required. The wheel is 3ft. in diameter, fitted with phosphor-bronze buckets, the sides of the buckets being widened out to allow the spreading of the water as its velocity diminishes. The main shaft is fitted with stuffing-boxes, which prevent the lubricating oil from mixing with the water, special attention being given to this important point, as the water is subsequently filtered and passes into the town mains. Two ¼in nozzles are fitted to the wheel, but only one of these is generally required. The installation is somewhat similar to that put in at the Lynton and Lynmouth Company's electricity works, where Pelton wheels and turbines are used alternately, the steam engine in this latter case



Combined Pelton Water Wheel and High-speed Engine Installation at Chester.

being used only in cases of emergency. The Pelton wheel at the Chester Company's works was supplied by Mr. P. Pitman, of Stanley-road, Halifax, who is a specialist in this class of machinery.

**Customs Tariffs.**—In a Customs circular issued by the Government of India "Sirocco" and "Blackman" fans are now classed as machinery and passed free of duty, providing they are not specially adapted for use by animal or hand power.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 12 to June 18, with the ports of destination :—

*Africa*—Alexandria, £202; Cape Town, £2,148 (including £339 telegraph material), Durban, £2,661; Port Said, £42; Port Elizabeth, £18. *Australia*—Adelaide, £55; Christchurch, £67; Fremantle, £112; Melbourne, £1,351 (including £1,023 telegraph cable); Perth, £105; Sydney, £191; Wellington, £170. *Brazil*—Rio Janeiro £89. *British Guiana*—Berbice, £30. *Canada*—Halifax, £71. *Ceylon*—Colombo, £331. *Denmark*—Copenhagen, £374. *Germany*—Hamburg, £300 (telegraph material). *Holland*—Amsterdam, £75. *India*—Bombay, £491; Calcutta, £338. *Japan*—Yokohama, £6,534. *Mauritius*, £41 (telegraph material) *Norway*—Christiania, £20. *Spain*—Bilbao, £100. *United States*—New York, £1,360. Total, £17,276 against £12,993 in the corresponding week last year (June 13 to 19).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 6, 1901.

4,736. E. M. Munro, H. Brecknell and H. I. Rogers. Bristol. Improvements in swivelling trolley heads employed in overhead wire electric traction.
4,751. R. Detert. Berlin. Process for insulating hollow conductors.
4,760. A. Campbell. London. Improvements in electric measuring instruments.
4,763. H. Edmunds. London. Improvements in insulated electric conductors.
4,765. E. W. Whiteman. London. Improvements in and relating to the transmission of power in the electrical propulsion of railway, tramway and other vehicles.
4,767. C. Meissner. London. An improved cable for supplying the electric current to electrically-driven ploughs and for like purposes.*
4,768. C. Meissner. London. An improved electric bell circuit for mechanically-driven ploughs.*
4,776. R. W. Barker. London. Combined engine and air-compressing means for electric railway systems. (The Murphy Safety Third Rail Electric Co., United States.)*
4,777. R. W. Barker. London. Improvements in switch mechanism for surface contact railways. (The Murphy Safety Third Rail Electric Co., United States.)*
4,791. F. M. Lewis. London. Improvements in induction motors.
4,810. F. De Mare. London. Improvements in electrolytic interrupters.*
4,812. J. R. Milne. London. Improvements in coherers for wireless telegraphy.
4,813. J. R. Milne. London. Improvements in wireless telegraphy.
4,814. J. G. Childs. London. An improved method of operating an electric chopper switch.
4,815. J. G. Childs. London. An improved method of making fuse contacts and holders for my detachable fuse plug, patent No. 18,051, 1898.

March 7, 1901.

4,819. H. J. Weintz. Huddersfield. A new or improved device for connecting the trolley with the trolley wire in electrically-driven vehicles.
4,820. W. Du Bois Duddell and Thomas Mather. London. Improvements in switching apparatus for electric circuits.
4,822. J. S. Scott. Belfast. Improvements in arc lamps.
4,841. H. E. F. Brecknell. Bristol. Improvements in and relating to swivelling trolley heads employed in the overhead wire system of electric traction.
4,863. W. E. Rossetter. London. Improvements in combined electro magnetic and carbon microphone.
4,868. C. W. Scott. London. Improvements in electric switches. (Date applied for under Patents, &c., Act, 1883, Sec. 103, August 16, 1900, being date of application in United States.)
4,870. E. D. Abel. London. Electric coupling for railway cars. (Siemens and Halske Aktien Gesellschaft, Germany.)
4,892. J. M. Davidson. London. Improvements relating to electrical interrupters.
4,899. H. R. Burnett. London. Improvements in and relating to overhead wires and guard wires for electric traction and other purposes.
4,902. M. J. P. O'Gorman. London. Improvements in electrical cables.

March 8, 1901.

4,928. P. Mushet and D. Buchanan. Selkirk, Glasgow. Improvements in fuses for distribution boxes, the same being applicable for single fuses of electric light installation.
4,940. M. Bailing and G. H. Ide. London. Improved coupling joint or connection for electric wires and fittings.
4,967. K. Edgcumbe and E. I. Everett. London. Improvements in electrical measuring instruments for use as power indicators and the like.
4,981. G. Bowron. London. Improvements in or relating to Röntgen-ray apparatus.
4,936. F. H. Headley. London. Improvements in or relating to electric switches and cutouts.

March 9, 1901.

5,007. A. Watson. Birmingham. Improvements in the manufacture of electrical switches.
5,033. H. C. Mance and Nernst Electric Light (Ltd.). London. Improvements in incandescent electric lamps.
5,039. C. C. Garrard and Nernst Electric Light (Ltd.). London. Improvements in preparation of Nernst conductors for electric lamps.
5,040. C. C. Garrard and Nernst Electric Light (Ltd.). London. Improvements in Nernst incandescent electric lamps.

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5,041. J. SWINBURNE and NERNST ELECTRIC LIGHT (LTD.). London. Improvements in incandescent electric lamps.
5,042. B. M. DRAKE, M. SOLOMON and NERNST ELECTRIC LIGHT (LTD.). London. Improvements in glow-bodies for Nernst incandescent electric lamps.
5,043. L. S. POWELL and NERNST ELECTRIC LIGHT (LTD.). London. Improvements in rods for Nernst incandescent electric lamps.
5,055. D. L. LINDQVIST. London. Improvements in alternating electric current induction motors.
5,062. A. T. M. THOMSON and THE THOMSON-DAVIS TELEPHONE SYSTEM (LTD.). London. Improvements in cord-controlled switches for electrical purposes.
5,063. T. T. A. HANSEN and C. C. F. F. PETERSEN. London. Improvements in accumulators for secondary batteries.
5,077. F. DE MARE. London. Improvements in devices for X-rays.*

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

11,469. PETIT. Phonograph record cylinders.
11,560. WURTS and HANKS. Electric incandescent lamps.
13,751. SINTAS Y ORFILO and SCHULTZ. Automatic device for the safe operation of electric conductors, with or without guard wires.
14,139. PURVIS. Electric railways on the closed conduit system.
14,568. HADDAN (American Toll Telephone Co.). Toll collecting machines for telephones.
14,893. ATKINSON. Electrical measuring instruments.
14,924. ROSE, HALIFAX and ANTROBUS. Electric accumulators.
15,225. BREMER. Electric arc lamps.
15,951. SCHLATTER. Automatic switch for groups of transformers with members of various capacity.
17,437. PARAMORE. Telegraphones.
17,453. DAVIS. Electric perforating and recording machines, more particularly applicable for use with musical instruments.
17,757. THOMPSON (Akkumulatoren und Electricitäts-Werke Aktiengesellschaft vorm. W. A. Boese & Co.). Electrode plates.
19,394. CHARD. Lampholder switches for electric lighting.
19,416. STROUD. Telephone call recorders.
19,674. LAKE (Brown). Electric railways working on the surface-contact system.
20,707. RYAN. Electric exercising machine.
20,778. HEANY. Electric arc lamps.
20,779. HEANY. Electric arc lamps.
20,929. F. W. PEISKER, F. SCHLOMKA, and H. KAUTZ. Phonographs and like instruments.
20,938. F. W. PEISKER, F. SCHLOMKA, and H. KAUTZ. Diaphragms or membranes of phonographs and like instruments.
22,026. BOULT (American Wireless Telegraph Co.). Electric wave telegraphs.
22,685. BREWSTER. Flexible supporting structures for electric lamps.
22,698. FRASCH. Process of extracting and reducing metals by electrolysis.
22,779. BYNG and BELL. Mounting telephonic instruments and accessories so as to admit of interchanging or renewal of the various parts.
23,087. REYNOLDS. Apparatus for electrically operating keyed musical instruments.
23,106. ALLISON (Waterbury Battery Co.). Galvanic batteries.
23,107. ALLISON (Waterbury Battery Co.). Galvanic batteries.
23,322. WETTER (Elektrizitäts Aktiengesellschaft vorm. Schuckert & Co.) Speed regulators for electric lifts.
23,387. SCHURMANN. Manufacture of braided cords or cables for electric lighting and like purposes.
23,390. BRITISH THOMSON-HOUSTON CO. (LTD.) (Perry). Electric controller casings.
23,391. BRITISH THOMSON-HOUSTON CO. (LTD.) (Sargent). Electrically-operated switches for controlling circuits at remote points from central stations.
23,394. BRITISH THOMSON-HOUSTON CO. (LTD). (Case). Electric brake systems.
23,490. HEADLEY. Electric switches.
23,514. BURBEY and WATERLAND. Electric house service or fuse-boxes.
23,523. CRUVELLIER. Electric block signalling and supplying electric current to trains in connection therewith.
23,583. LAKE. (Renault). Supporting devices for electrically insulating telegraph and similar wires.
23,586. PEARSON. Fusible electric circuit-breaker for fire alarm purposes.
23,743. TIQUET. Electric battery cells.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27 7/16d. per oz. (June 20). Consols (2¾ per cent.) 93⅝—93⅞ for money, 93⅝—93⅞ for account; 2½ per cent. 94¼—94¾ (June 20). Consols Pay Day, July 3; Stocks and Shares Continuation Days, June 26 and July 15; Ticket Days, June 27 and July 16; Pay Days, June 28 and July 17; Mining Share Carry-over Days, June 25 and July 12.

**AFRICAN DIRECT TELEGRAPH CO. (LTD.)**—The coupons of this company's 4 per cent. mortgage debentures due July 1 will be paid at Parr's Bank, Bartholomew-lane, London, E.C. Interest warrants on the registered debentures will be sent out on 29th inst., and the debenture register will be closed from 24th to 29th inst. inclusive.

**BRITISH ELECTRIC TRACTION CO. (LTD.)**—The directors recommend a dividend at the rate of 12 per cent. per annum for the half-year ended March 31, making a total distribution of 9 per cent. for the year.

**CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)**—At the annual meeting on Friday the chairman (Mr. Wm. Chadburn) said the past year had been a satisfactory one, the net profit available for dividend being £11,793 4s. 6d., against £7,904. 4s. 3d. for the previous year. It was proposed to pay a dividend of 10 per cent. per annum for the half-year ended March 31, making, with the interim, 8 per cent. for the year, against 7 per cent. for 1899. The directors did not think it wise to divide all the profits without making provision for the future, and for that reason had decided to carry forward a somewhat large sum to provide for contingencies. The directors would consider the question of establishing a permanent reserve fund. The report was adopted.

**EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)**—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share, tax free, payable 15th prox. The share register will be closed from 6th to 13th prox. inclusive.

**W. T. GLOVER & CO. (LTD.)**—The debenture stock transfer books of this company are closed from 18th to 30th inst. inclusive.

**GREENWOOD AND BATLEY (LTD.)**—The directors' report for the year ended March 31 states that, after providing for debenture interest and management expenses, writing off £7,500 for depreciation on buildings and plant, &c., the accounts show a profit of £35,626. 11s. 8d., making, with £463. 5s. 6d. from the previous year, £36,089. 17s. 2d. The directors have allotted £5,000 towards cost of completing the electrical installation throughout Albion Works, £1,000 as provision against contingencies and £10,000 to reserve (now £20,000), and recommend that dividends be declared at the rate of 7 per cent. per annum on the paid-up cumulative preference and 5 per cent. per annum on the paid-up ordinary share capital, absorbing £15,615. 13s. 3d., and leaving £4,474. 3s. 11d. to be carried forward.

**ISLE OF MAN TRAMWAYS AND ELECTRIC POWER CO.**—A committee of the large shareholders has been formed for formulating a scheme and forming a new company to take over the undertaking from the liquidator.

**PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.)**—The coupons on this company's 4 per cent. guaranteed debentures due 30th inst. will be paid on and after July 1 at Parr's Bank, Bartholomew-lane, London, E.C.

**SOCIEDAD GENERAL GALLEGO DE ELECTRICIDAD.**—This is the title of a new company formed in Madrid with a capital of 2,000,000 pesetas.

**STOCK EXCHANGE NOTICE.**—The Stock Exchange committee has ordered the further issue of £100,000 4½ per cent. first mortgage debenture stock of the *Castner-Kellner Alkali Co. (Ltd.)* to be quoted in the official list.

**WESTERN TELEGRAPH CO. (LTD.)**—Notice is given that the coupons of this company's second issue of 5 per cent. debentures, due 30th inst., will be paid on and after July 1 at Parr's Bank, Bartholomew-lane, London, E.C.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | June 15 | 705 | − 25 | 2 | 454 | ... |
| *Birmingham Tramways. | ,, 15 | 4,640 | + 190 | 23 | 99,761 | + 2,182 |
| *Blackburn Corporation.. | ,, 14 | 553 | + 92 | 24 | 11,096 | + 1,053 |
| Blackpool Corporation... | ,, 13 | 747 | − 491 | †11 | 7,702 | + 1,876 |
| Blackpool and Fleetwood | ,, 15 | 553 | − 437 | 24 | 8,425 | − 293 |
| Bolton Corporation ..... | ,, 16 | 1,337 | − 227 | 11 | 16,696 | + 2,663 |
| Bradford Corporation... | ,, 16 | 1,144 | + 567 | 11 | 11,362 | + 5,865 |
| Brisbane Trams ..... | May 1 | 1,945 | + 30 | 17 | 34,418 | + 3,552 |
| *Bristol Trams & Carriage | June 14 | 4,504 | + 1,324 | 23 | 98,063 | + 29,194 |
| *Buenos Ayres & Belgrano | May 19 | 2,847 | + 673 | 20 | 35,884 | + 10,166 |
| Calcutta Trams. Co. ... | June 15 | R21,725 | + R4,757 | ... | ... | ... |
| Carlisle Trams. Co. ..... | ,, 8 | 185 | ... | 23 | 3,272 | ... |
| Central London Railway | ,, 15 | 6,239 | ... | 24 | 148,770 | ... |
| City & South London Ry. | ,, 16 | 1,862 | + 382 | 24 | 47,071 | + 16,336 |
| Cork Elec. Trams ..... | ,, 13 | 536 | + 97 | 23 | 9,881 | + 1,307 |
| Dover Corporation ..... | ,, 15 | 217 | + 3 | 11 | 2,389 | + 186 |
| Dublin & Lucan Rly. ... | ,, 15 | 114 | + 3 | 24 | 2,231 | + 131 |
| Dublin United ..... | ,, 14 | 3,779 | + 52 | 24 | 70,894 | − 780 |
| Dublin Southern Dist.... | ,, 14 | 914 | − 92 | 24 | 18,962 | |
| *Dundee Corporation ... | ,, 12 | 712 | + 301 | ... | ... | ... |
| *Glasgow Corporation ... | ,, 15 | 11,420 | + 1,433 | 2 | 23,018 | + 2,535 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 15 | 932 | + 209 | 11 | 9,623 | + 1,943 |
| Hull Corporation ..... | ,, 15 | 1,651 | + 357 | 50 | 74,677 | + 26,005 |
| Liverpool Corporation... | ,, 8 | 9,590 | + 199 | 23 | 193,714 | + 27,781 |
| *Liverpool Overhead Rly. | ,, 16 | 1,607 | + 183 | 24 | 37,713 | + 3,499 |
| Manchester Corporation | ,, 15 | 965 | ... | ‡1 | 1,359 | ... |
| Perth (W.A.) Elec. Trams | ,, 14 | 855 | + 507 | 50 | 34,034 | ... |
| Portsmouth Corporation | ,, 15 | 636 | − 254 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 16 | 3,583 | + 1,302 | 24 | 76,516 | + 28,126 |
| Southampton Corporat'n | ,, 13 | 782 | + 258 | ... | ... | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding week last year.
* Partly electrical. † Minus 3 days. ‡ Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 12. | | Price Wednesday, June 19. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending June 19. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | | | | | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ | 8⅛ | 7⅞ | 8⅛ | 3 12 9 | ... | 8 | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅛ | 9 | 8⅛ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7 | 7½ | 7 | 7½ | 2 6 8 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | 9⅝ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5½ | 5¾ | 3 18 3 | ,, ,, | 5¼ | 5⅛ |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5½ | 6¼ | 5¾ | 6¼ | 4 8 0 | March | 6⅛ | 5¼ |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | 110½ | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9⅛ | 8¼ | 9⅛ | 4 4 3 | February and August | 8⅝ | 8⅜ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 12⅝ | 13½ | 4 12 2 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 102 | 104 | ... | ... | 104 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 8¾ | 8½ | 8¾ | 4 4 3 | ... | 9 1/16 | 9 |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | 12⅜ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 105 | 108 | 105 | 108 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5½ | 5¾ | 5⅝ | 5¾ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/3 | Hove Electric Lighting Ordinary | 7½ | 8⅛ | 7½ | 8⅛ | 2 15 5 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ | 12½ | 11½ | 12⅝ | 4 4 0 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6⅝ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 | 104 | 102 | 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ...xd | 98 | 101 | 98 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13½ | 14½ | 13⅝ | 14⅝ | 4 2 9 | April and October | 14 3/16 | 13¾ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13½ | 14½ | 13⅝ | 14⅝ | ... | ... | 13¾ | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 11 5 | ... | ... | ... |
| 8,652 | 10 | 8/0 | Notting Hill Electric Ordinary | 15½ | 16½ | 15⅝ | 16⅝ | 4 13 4 | March | 15⅞ | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6⅛ | 5⅝ | 6⅛ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/8 | Rand Electric | ⅞ | 1 | 15/16 | 1 1/16 | 10 18 2 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15⅜ | 15½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅞ | 9⅜ | 9 | 10 | 3 10 0 | ,, ,, | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | 99½ | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | | ... | ... | 2 | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2⅞ | 3⅛ | 2⅞ | 3⅛ | ... | ... | 3 | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 17⅛ | 17⅛ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4¼ | 4⅛ | 4⅜ | 4 11 5 | April and October | 4 5/16 | 4 3/16 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 125 | 130 | 4 14 0 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 10 | 2 0 0 | ... | 8⅜ | 8¼ |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 96 | 101 | 96 | 101 | 5 0 0 | ... | ... | ... |
| £143,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2⅜ | 3⅜ | 2⅜ | 3⅜ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4¼ | 4¾ | 4¼ | 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. xd | 99 | 101 | 99 | 101 | ... | ... | 100 | 98½ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23¼ | 23¾ | 22½ | 23 | 3 7 6 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅝ | 10⅞ | 10⅞ | 11 | 3 12 9 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 | 116 | 114 | 118 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ | 7 | 6½ | 7 | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 9½ | 10 | 9⅝ | 10 | 5 0 0 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 99⅞ | 101⅞ | 100⅜ | 102⅜ | 4 8 11 | ... | 101 | 100½ |
| 62,074 | 10 | 6/0 | British Elec. Trac. Ord. | 14½ | 15½ | 15 | 16 | 5 6 3 | ... | 15½ | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 4 | February and August | 12⅝ | 12⅜ |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 121 | 124 | 4 1 4 | ... | 124 | 121⅝ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | 1⅜ | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5⅝ | 6¼ | 5⅝ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5 | 5⅛ | 5 | 5⅛ | ... | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures xd | 104 | 107 | 103 | 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) xd | 96 | 99 | 95 | 98 | 5 2 0 | ... | 96½ | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) | 10⅞ | 11⅛ | 10⅜ | 11⅛ | 2 14 2 | ... | ... | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 103 | 105 | 104 | 106 | ... | ... | 106 | 105½ |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | 1⅝ | ... |
| 19?,980 | 10 | 2/6 | Central London Ordinary | 9½ | 9¾ | 9½ | 9⅝ | 2 16 5 | June and December | 9⅝ | ... |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5½ | 5¾ | 5½ | 5¾ | 4 10 11 | ... | 5½ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 100 | 103 | 3 17 10 | ... | ... | ... |
| £855,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 51 | 53 | 55 | 57 | 3 4 0 | February and August | 54 | 55 |
| 47,500 | 10 | 2/0 3/16 | Do. Ordinary (Nos. 22,501 to 70,000) | 4⅞ | 5⅛ | 5⅛ | 5⅜ | 2 3 6 | ,, ,, | 5⅛ | 5⅛ |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 134 | 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 | 127 | 122 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 111 | 116 | 111 | 116 | 3 9 2 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 | 14 | 12 | 13 | 5 0 0 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5¼ | | 5¼ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4⅞ | 5⅛ | 4⅞ | 5⅛ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 | 22½ | 22 | 22⅝ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15⅛ | 14½ | 15⅝ | 3 18 8 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 8½ | 8¾ | 8⅝ | 8¾ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13¼ | 13 | 13¼ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 13 3 | January and July | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 104 | 105 | 105 | 107 | ... | ... | 106½ | 105 |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11 | 12 | 11½ | 12⅜ | 1 12 0 | ... | ... | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 | 107 | 105 | 107 | 4 4 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 93 | 96 | 93 | 96 | 3 2 10 | June and December | ... | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 12. | | Price Wednesday, June 19. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending June 19. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | 102½ | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅛ | 4⅛ | 3⅛ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ,, ,, | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 54 | 57 | 53 | 56 | 5 12 7 | Feb., May, Aug., Nov. | 53 | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 97 | 99 | 98 | 100 | 6 2 0 | ,, ,, | 99½ | 98 |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 | 10½ | 10¼ | 10⅜ | 2 6 6 | ,, ,, | 10 7/16 | 10⅛ |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 18 3 | ,, ,, | 102½ | 101 |
| 15,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14½ | 15½ | 6 9 0 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ | 104⅞ | 100⅞ | 104⅞ | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10¾ | 10½ | 10¾ | 6 10 10 | Jan., Apr., July, Oct. | 10 7/16 | ... |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | 100 | 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary [1 to 1,200) (red.) | 140 | 145 | 140 | 145 | 4 17 0 | Jan., Apr., July, Oct. | 143½ | 142½ |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 90 | 93 | 90 | 93 | 3 15 8 | ,, ,, | 90½ | ... |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 114 | 109 | 113 | 3 11 1 | May and November | 112⅜ | 109 |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ | 14 | 13½ | 14 | 5 0 0 | Jan., Apr., July, Oct. | 13⅝ | 13⅜ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 116 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100⅞ | 103⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust | 9½ | 10½ | 9½ | 10½ | 5 2 5 | Jan., Apr., July, Oct. | 10 | ... |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 18 8 | ,, ,, | 14⅞ | 14⅝ |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen | 31 | 33 | 31 | 33 | 4 10 11 | January and July | 31 | ... |
| £32,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (w thn Nos | 100 | 103 | 100 | 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red. | 43 | 47 | 43 | 47 | 5 6 5 | May and November | 43½ | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 18 1 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | 7⅞ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 10 | ,, ,, | 125½ | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2 | 3 | 2 | 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 7 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ | ⅜ | ¼ | ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅜ | ⅜ | ⅜ | ⅜ | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | 10 0 0 | ,, ,, | 5½ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | 12 0 0 | ,, ,, | 3⅜ | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zil'n Submarine) | 13½ | 14½ | 13⅜ | 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | 13⅜ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 102 | 105 | 102 | 105 | 4 15 8 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | 102 | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3½ | 4 | 3½ | 4 | 5 0 0 | August | ... | ... |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 | 3/0 | 2/6 | 3/0 | ... | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¼ | ⅜ | ¼ | ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2 6 | National | 3½ | 3¾ | 3½ | 3¾ | 7 17 2 | February and August | 3 3/16 | 3¾ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11⅛ | 12⅛ | 11 | 12 | 5 0 0 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11⅛ | 12⅛ | 11 | 12 | 5 0 0 | ,, ,, | 11½ | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ | 4⅜ | 4⅛ | 4⅜ | 5 14 1 | ,, ,, | 4⅜ | ... |
| £2000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 87 | 90 | 89 | 92 | 3 13 9 | June and December | 90½ | 89 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 | 98 | 95 | 98 | 4 2 8 | ... | ... | ... |
| 171,504 | 1 | 0/2½ | Oriental | ⅜ | 1 | ⅝ | 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4 | 4⅛ | 5 | 5⅛ | 6 7 3 | July | 5 5/16 | 5⅛ |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 103 | 103 | 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ | ⅜ | ⅜ | ⅜ | 8 0 0 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 13/16 | 15/16 | 7/8 | 15/16 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | 11/16 | 13/16 | ¾ | ⅞ | 8 0 0 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 9⅜ | 10⅜ | 9⅜ | 10⅜ | 7 2 10 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5⅞ | 6⅛ | 5⅞ | 6⅛ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅞ | 5⅛ | 4⅞ | 5⅛ | 5 14 3 | ... | 4⅞ | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ | 1⅝ | 1⅜ | 1⅝ | 3 8 7 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2⅜ | Do. 5 per Cent. Pref. Non-Cum. | 2⅛ | 2⅜ | 2⅛ | 2⅜ | 5 1 1 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 104 | 101 | 104 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 | 15 | 14 | 15 | 5 0 0 | ,, ,, | 14½ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ,, ,, | 5⅜ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/2⅜ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 | 98 | 94 | 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ⅝ | 1⅛ | ⅝ | 1⅛ | 5 15 7 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ⅝ | 1⅛ | ⅝ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9¾ | Crompton and Co. (Nos. 1 to 54,000) | 3⅜ | 4 | 3⅜ | 4 | 5 12 7 | January and July | 3⅞ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 101 | 104 | 1 2 | 105 | 4 16 10 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1 | 1⅛ | 1 | 1⅛ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2 | 3 | 2 | 3 | 8 16 6 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 | 89 | 87 | 89 | 4 9 6 | June and December | 87½ | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 7 7 10 | Half-yearly | 5 1/8 | ... |
| 20,000 | 5 | 1/6⅛ | Do. 6% Cumulative Preference | 5⅛ | 5⅛ | 5⅛ | 5⅜ | 5 4 4 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 5 | ... | 103½ | 105 |
| 112,100 | 5 | 1/2¾ | Electric Construction Co. (Limited) | 1⅝ | 2⅛ | 1⅝ | 2⅛ | 5 6 8 | January and July | ... | ... |
| 25,000 | 2 | 2/9⅛ | Do. 7 per Cent. Cumulative Preference | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July | 2⅜ | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | 100 | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. xd | 9¼ | 10¼ | 9½ | 11 | 5 0 0 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 101 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15½ | 16½ | 15½ | 16½ | 6 1 3 | February and August | 16 | 15⅞ |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works xd | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | 21⅝ | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | 101 | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 36 | 39 | 36 | 40 | 5 4 11 | March and July | ... | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908 | 102 | 105 | 102 | 105 | 3 16 10 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary xd & bonus | 10½ | 11½ | 10 | 11 | 5 9 1 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | 5⅞ | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10⅜ | 11⅜ | 5 4 4 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6⅛ | 6⅞ | 6⅛ | 7 | 4 5 9 | ,, ,, | 6⅝ | 6⅜ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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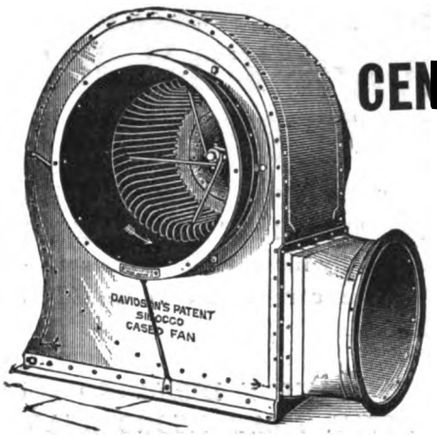
DAVIDSON'S PATENT

"SIROCCO"

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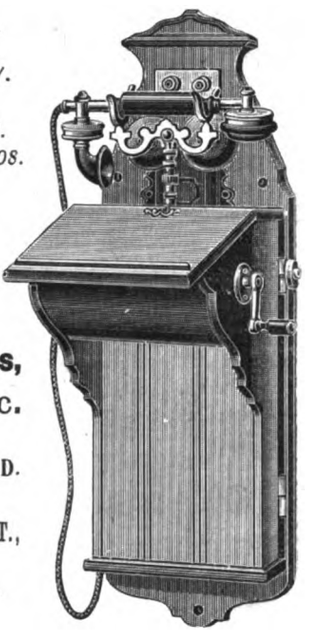

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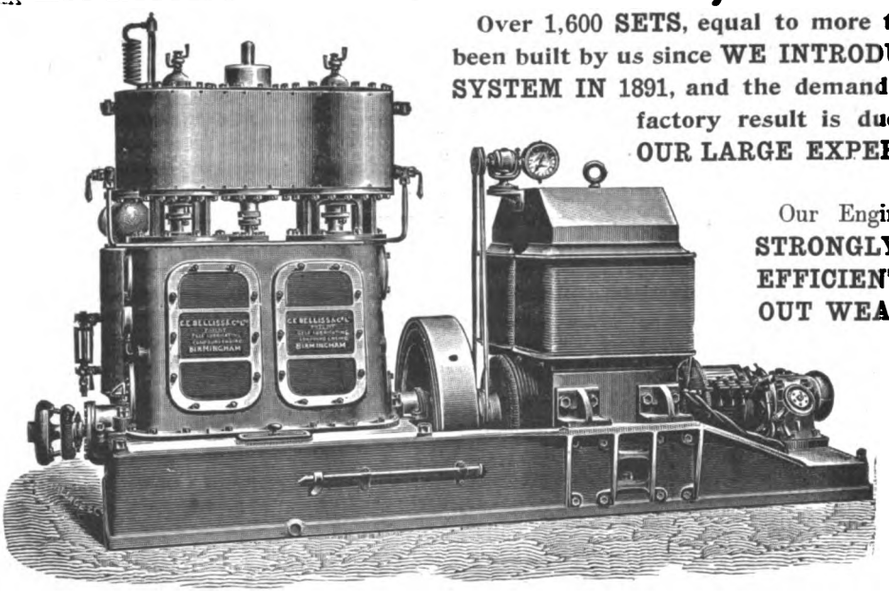

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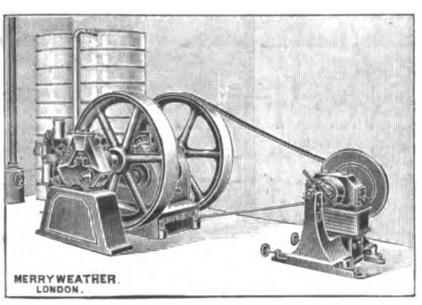


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On TUESDAY the 9th and WEDNESDAY the 10th JULY, 1901, upon their Premises, known as the Broadheath Engineering Works, Broadheath, near Manchester, on account of removal to Ponder's End, London,

The **PLANT** and **MACHINERY**, comprising 50 H.P. enclosed Vertical Steam Engine, by Browett, Lindley & Co., Ltd.; 8 H.P. Portable Engine, by Clayton and Shuttleworth; 30kw. Alternator, by Edison & Swan; two self-contained Drilling Machines; several Slide, Surfacing and Screw-cutting Lathes, by Muir, Pitts, Carter, Sons & Co., and Greenwood & Batley; Planing Machine to plane 18ft. by 6ft. by 5ft. 6in. high; Vertical and Horizontal Milling Machines; six screw Fly Presses; Screwing Machines; Lathe Beds; &c., &c.

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### DISCLAIMER.

WE REGRET that we have issued Circulars offering for sale Fuse Boxes as covered by the Letters Patent of Henry Reason, No. 5,863, dated 21st day of March, 1894, which Letters Patent are now the property of the Reason Manufacturing Co., Ltd., of Lewes-road, Brighton. This matter having been brought to our notice we have at once discontinued the sale of these Fuse Boxes, and in future will not accept orders for same.

(Signed), FRANCIS & SPILSBURY,
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24th June, 1901.

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## TENDERS INVITED.

### BOROUGH OF SOUTHWARK.
(PARISH OF ST. MARY NEWINGTON.)

**ELECTRICITY SUPPLY EXTENSION.**

CONTRACT No. 15.

The Electric Light Committee of the Metropolitan Borough of Southwark are desirous of receiving TENDERS for the SUPPLY and ERECTION of TWO ADDITIONAL PANELS to the MAIN SWITCHBOARD at their Electric Light Station, Penrose-street, Walworth-road, S.E.

Specifications and Forms of Tender can be obtained on and after the 26th instant at the Office of the Engineers, Messrs. Kincaid, Waller & Manville, 29, Great George-street, Westminster, S.W., on payment of a fee of Five Guineas, which sum will be returned on receipt of a bona-fide Tender.

The Corporation do not bind themselves to accept the lowest or any Tender, and the Contractor whose Tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the due fulfilment of his Contract.

Sealed Tenders, endorsed "Electricity Supply, Tender for Contract No. 15," to be sent to me on or before noon on the 10th day of JULY, 1901.

By order,
J. A. JOHNSON, Town Clerk.

Town Hall, Walworth-road, S.E., 25th June, 1901.

### STEPNEY BOROUGH COUNCIL.

**ELECTRIC LIGHTING.**

CONTRACTS Nos. 18 and 19.

The Electrical Committee of the Stepney Borough Council require TENDERS for the SUPPLY of the following Plant and Cables:—

Contract No. 18.—STEAM AND OTHER PIPE-WORK.

Contract No. 19.—PAPER INSULATED CABLES, EARTHENWARE CONDUITS, &c.

Contractors may Tender for both or either Contracts.

Copies of Specifications and Forms of Tender may be obtained by application to the undersigned on or about Thursday, July 4th, 1901, on payment of the sum of Two Guineas each Specification, which amount will be returned on receipt of bona-fide Tenders.

The Council do not bind themselves to accept the lowest or any Tender, and the acceptance of any Tender is subject to the consent of the London County Council being obtained to the borrowing of the capital monies.

Tenders, endorsed "Tenders for Electric Works. Contract No....," and addressed to the Chairman of the Electricity Committee, must be delivered at this office not later than 12 noon THURSDAY, July 18th, 1901.

ARTHUR WRIGHT, Consulting Electrical Engineer.

27, Osborn-street, E.

### CLECKHEATON URBAN DISTRICT COUNCIL.

**ELECTRICITY WORKS.**

The Council hereby invite TENDERS for the SUPPLY and ERECTION of the following Plant:—

Section A.—LANCASHIRE BOILERS, ECONOMISER, JET CONDENSER, FEED PUMPS, SUCTION PUMPS.
Section B.—MELDRUM'S DESTRUCTOR FURNACES.
Section D.—BALANCERS and BOOSTERS.
Section E.—ACCUMULATORS.
Section F.—CABLES.
Section G.—SWITCHBOARDS.
Section H.—TRAVELLING CRANE.

Tenderers are at liberty to Tender for the whole of the Sections or any one Section, but not for part of a Section.

Conditions and Specifications with Forms of Tender may be inspected at the Offices of Messrs. Gibbings & Baker, Piccadilly Mansions, 17, Shaftesbury Avenue, London, W., and Old Bank Chambers, Cheapside, Bradford, and may be obtained on application to the Clerk of the Council, Town Hall, Cleckheaton, on payment of the sum of £2 2s., which sum will be refunded on return of Specification with bona-fide Tender.

Tenders, sealed and endorsed "Electricity Works Plant, Section....," to be delivered at the Clerk's Office, Town Hall, Cleckheaton, on or before 6th JULY, 1901.

Each Tender must contain the names of two Sureties, who will be prepared to execute a joint and several bond for the due fulfilment of the Contract in a sum of £25 per cent. of the Contract sum.

The Council do not bind themselves to accept the lowest or any Tender.

J. ARMITAGE, Clerk to the Council.

Town Hall, Cleckheaton, 25th June, 1901.

### GLASGOW CORPORATION.

ELECTRICITY DEPARTMENT.

The Corporation of Glasgow invite TENDERS for the SUPPLY of **CONCENTRIC** and **SINGLE MAIN CABLES**, insulated with Paper or Fibre Impregnated with Oil, Bitumen or other substance impervious to moisture, or with Vulcanised Bitumen. Copies of Specification with Form of Tender may be had on application to Mr. W. A. Chamen, the Engineer, 75, Waterloo-street, Glasgow, upon payment of Two Guineas, which will be returned on receipt of a bona-fide Tender, and offers, marked "Tender for Cables, Electricity Department," must be lodged with the subscriber on or before TUESDAY, 9th July, at 10 a.m.

The Corporation do not bind themselves to accept the lowest or any offer.

J. D. MARWICK, Town Clerk.

City Chambers, Glasgow, 26th June, 1901.

**Contracts Open, Appointments Vacant, and other Official Notices, &c., can be received up to 6 p.m. on Thursdays for insertion in the current week's issue.**

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**See Advertisement Monthly on opposite page.**


## TENDERS INVITED—*continued.*

### BOROUGH OF SHOREDITCH.

**ELECTRICITY SUPPLY**—CONTRACT No. 28.

The Shoreditch Borough Council invite TENDERS for the SUPPLY and ERECTION of the work included in the above Contract for the new Generating Station at Whiston-street, the existing Station at Coronet-street, and the Sub-stations at Reeve's-place and Evelyn-street.

HIGH AND LOW-TENSION CONTINUOUS-CURRENT SWITCHBOARD AND INSTRUMENTS.

Specifications and Forms of Tender may be obtained on and after July the 1st, at the Office of the Council's Electrical Engineer, C. Newton Russell, Esq., Electric Light Station, Coronet-street, Hoxton, N., on payment of a fee of Five Guineas, which will be returned on receipt of a bona-fide Tender. A copy of the Specification may also be inspected (but not obtained) at the Offices of the Consulting Engineers, Messrs. Kincaid, Waller & Manville, 29, Great George-street, Westminster.

The Council do not bind themselves to accept the lowest or any Tender, and the Contractor whose Tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the fulfilment of his Contract.

Trade Union rate of wages and hours to be observed.

Sealed Tenders, endorsed "Electricity Supply—Tender for Contract No. 28," must be forwarded to me before noon on the 10th day of JULY, 1901.

By order,
H. MANSFIELD ROBINSON, Town Clerk and Solicitor.

Town Hall, Old-street, E.C., June, 1901.

### ROYAL BURGH OF KIRKCALDY.

The Corporation invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of the following Work :—

Specification No. 6.—FEEDERS, MAINS, and ROAD WORK.
Specification No. 7.—ARC LAMPS.

Copies of the Specifications and Drawings can be obtained from the undersigned on payment of £3 3s., to be returned on receipt by the Corporation of a bona-fide Tender.

The Specifications and Drawings can be seen at (but not obtained from) the Offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W.

Tenders must be sent in to the undersigned so as to be received by him before 10 a.m. on 20th JULY.

The Corporation does not bind itself to accept the lowest or any Tender, and no allowance whatever will be made for any expense incurred in the preparation of any Tender.

WM. L. MACINDOE, Town Clerk.

Town Clerk's Office, Kirkcaldy, 24th June, 1901.

### PONTYPRIDD UNION.

The Guardians are prepared to receive and consider TENDERS for the **LIGHTING** of the **UNION WORKHOUSE INFIRMARY** and other buildings in connection therewith by electricity. Tenders to be accompanied by detailed specifications. The lowest or any Tender not necessarily accepted. Tenders in sealed envelopes, and endorsed "Tender for Lighting," must be received by me on or before the 23rd July next.

Any particulars required will be supplied by me upon application.

WM. SPICKETT, Clerk.

Union Offices, Pontypridd, June 12th, 1901.


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## APPOINTMENTS VACANT.

### HULL MUNICIPAL TECHNICAL SCHOOL.

A **LECTURER** and **DEMONSTRATOR** in Electrical Engineering will be required in September next.

Salary, £150 per annum. Forms of application and further information may be obtained from Dr. J. T. RILEY, Technical School, Hull.

THE COMMITTEE of the MUNICIPAL SCHOOL of TECHNOLOGY, MANCHESTER, to be opened in September next, invite APPLICATIONS from gentlemen qualified to take the position of **HEAD** of the **PHYSICS** and **ELECTRICAL ENGINEERING DEPARTMENT.**

Stipend £500 per annum.

The gentleman appointed will have the title of Professor and rank as a Member of the Board of Studies. He will have the assistance of an efficient staff.

Acceptable Candidates, in addition to satisfactory theoretical attainments, must have had an efficient training and experience in some important branch of Practical Electrical Engineering.

Applications, with copies of a limited number of recent testimonials should be addressed, not later than JULY 6th, to the undersigned, from whom further information as to the conditions of the appointment may be obtained.

J. H. REYNOLDS, Principal.

Princess-street, Manchester, June 17th, 1901.

### COUNTY BOROUGH OF PORTSMOUTH.

MUNICIPAL TECHNICAL INSTITUTE.

The Technical Instruction Committee invite APPLICATIONS for the positions of **ASSISTANT LECTURER** in **MATHEMATICS** and **PHYSICS**, salary £125 per annum, and **WORKSHOP INSTRUCTOR** and **ASSISTANT** in **ENGINEERING**, salary £105 per annum.

Applications must be received by JULY 4th.

Further particulars may be obtained from the PRINCIPAL.

### CROYDON COUNTY POLYTECHNIC, CROYDON.

DEPARTMENT OF ELECTRICAL ENGINEERING.

The Committee require the services of an **ASSISTANT LECTURER** and **DEMONSTRATOR** in this Department. The person appointed will be required to attend on three evenings each week, and must be qualified to lecture in at least one branch of Electrical Engineering.

Salary £50 for the Session of about 30 weeks.

Applications, with copies of testimonials, must be sent to the undersigned, from whom further particulars of the appointment may be obtained, not later than WEDNESDAY, 10th July, 1901.

S. W. BICKELL, Secretary.

24th June, 1901.

***Official Announcements* continued on page xxiv.**


**PORTABLE ELECTRIC**
# SAFETY LAMPS
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GAS WORKS,
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Their Design, Organisation, and Management, including the Generation and Distribution of Electrical Energy. By CHAS. H. WORDINGHAM, A.K.C., M.Inst.C.E., M.Inst.Mech.E., late Member of Council of the Institute of Electrical Engineers, and Electrical Engineer to the City of Manchester.

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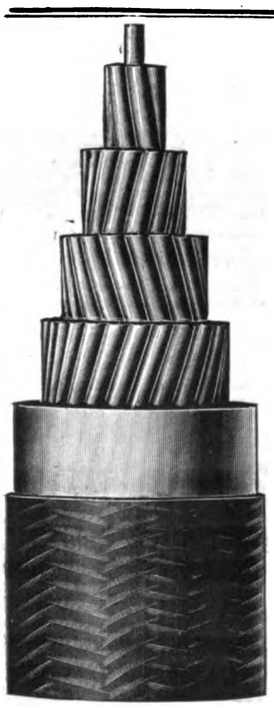

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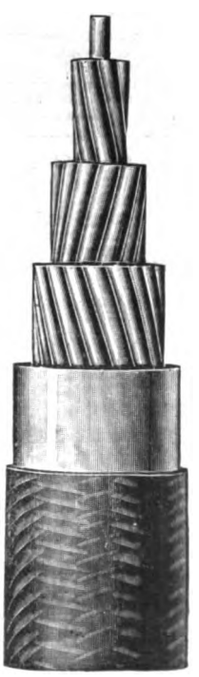

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## APPOINTMENTS VACANT—*continued.*

### COUNTY BOROUGH OF SWANSEA.

**RESIDENT ELECTRICAL ENGINEER.**

The Corporation of Swansea invite APPLICATIONS for the appointment of Resident Electrical Engineer, to take charge of their Electricity Works.

Applicants must have had experience in the management of a Central Electrical Supply Station.

Forms of Application can be obtained from the Town Clerk, Swansea, to whom applications, accompanied by copies of not more than three testimonials of recent date, must be sent not later than THURSDAY, the 11th day of July.

JNO. THOMAS, Town Clerk.

Guildhall, Swansea, 25th June, 1901.

### BOROUGH OF DEWSBURY.

**ELECTRICAL ENGINEER.**

The Corporation of Dewsbury invite APPLICATIONS for the APPOINTMENT of ELECTRICAL ENGINEER, to take charge of their Electricity Works, at a salary of £250 per annum, to be increased at the end of 12 months (subject to the satisfactory discharge of the duties by the candidate appointed) to £300 per annum.

Applications, endorsed "Electrical Engineer," stating age and experience and accompanied by copies of not more than three testimonials of recent date, must be sent addressed to me not later than THURSDAY the 4th July next.

G. TREVELYAN LEE, Town Clerk.

Town Hall, Dewsbury, 15th June, 1901.

**ELECTRICAL ENGINEER (TRAMWAYS).**

WANTED immediately, by the COUNCIL of the CITY OF WELLINGTON, NEW ZEALAND, a thoroughly qualified ELECTRICAL ENGINEER, who must have had special experience in carrying out and equipping Overhead Electrical Tramways and Power Stations. Full particulars and conditions may be obtained on application to Messrs. JOHN DUTHIE & Co., Ltd., 23, Lime-street, London, E.C., to whom endorsed applications must be delivered not later than noon on the 20th JULY.

### STEPNEY BOROUGH COUNCIL.

ELECTRICITY DEPARTMENT.

APPLICATIONS are invited for the following POSTS:—

**ENGINEER IN CHARGE OF STATION**, must have had thorough mechanical and electrical training, and have had previous charge of plant consisting of water-tube boilers, high-speed engines, direct-current dynamos, &c,

**METER AND GENERAL TESTING SUPERINTENDENT**, must have had at least three years' experience in meter testing and be acquainted with the testing and connecting of house services and general routine of central station testing and meter department.

**METER ROOM ASSISTANT**, must have had experience in meter and general testing and be acquainted with routine of meter department.

Applications in writing, stating age, experience and salary required, accompanied by copies of not more than three recent testimonials, must be sent to the undersigned not later than MONDAY, July 8th.

WM. C. P. TAPPER, Engineer and Manager.

27, Osborn-street, E.

WANTED, by the EALING DISTRICT COUNCIL, a gentleman to act as **CLERK** to the Electric Lighting Committee. Must have had experience in a similar capacity, preferably with a Corporation. He must be fully qualified to take full control of the accounts and the commercial department of the Electric Lighting Undertaking, prepare the necessary cost sheets, balance sheets, &c., and canvass for new business.—Apply, with full particulars of experience, age, and salary required, to THE CHAIRMAN, Electric Lighting Committee, Public Buildings, Ealing. Envelope to be endorsed "Clerk."

### CORPORATION ELECTRIC TRAMWAYS.

WANTED, **SWITCHBOARD ATTENDANTS**, for extra High-tension Sub-station, operating Electric Tramways. Previous experience in charge of High-tension Switchboards essential.

Applications, giving details as to age, previous experience, and present salary, to be sent to CORPORATION, *Electrician* Office, Salisbury-court, Fleet-street, London, not later than the 4th JULY, 1901.

### BOROUGH OF WALSALL.

ELECTRICITY DEPARTMENT.

WANTED an experienced **FITTER** to take charge of running machinery at the Generating Station during one shift. Electrical experience essential. Wages £2 per week, increasing to £2 5s. Applications, stating age and experience, and enclosing copies of two recent testimonials, to be sent to the undersigned not later than TUESDAY, July 2nd.

(Signed) ALEXR. WYLLIE, Borough Electrical Engineer.

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ASSISTANT WANTED on the Engineer's Staff of the London Electric Supply Corporation. Must have had a thorough training, also previous experience of Electrical Distribution.—Apply, stating age and experience, with copies of testimonials, to RESIDENT ENGINEER, 25A, Cockspur-street, London.

CANVASSER required in Ilford, to call upon Tradesmen and Residents, in regard to Electric Lighting, to give information and answer enquiries. Must have had previous experience. May also be required to read Meters when necessary. Salary £2 per week.—Applications, stating age and experience, and marked "Canvasser," must be delivered to Mr. W. J. WOODWARD, Electrical Engineer, at 7, Cranbrook-road, Ilford, not later than WEDNESDAY, July, 3rd, 1901.

MANAGING ENGINEER in large Cable Works is open to consider a change. Experienced in cable machinery, labour-saving tools, making and laying electrical apparatus and mains.—C. M. E., *Electrician* Office, Salisbury-court, Fleet-street, London.

A YOUNG GENTLEMAN, well educated, who has had a few years' experience in mechanical and theoretical engineering, wishes to get into Borough Electric Station for a year, under an Electrician.—Apply, R., *Electrician* Office, Salisbury-court, Fleet-street, London.

ENGINE DRIVER seeks place, accustomed to High-speed Engines, high or low tension, last employed Alternating Station, own repairs, good character.—A. WALLS, 38, Stanley-road, Tunbridge Wells.

YOUNG MAN (21), seeks EMPLOYMENT in Electric Power Station in or near London, no previous experience, willing to learn, good character.—E. H., *Electrician* Office, Salisbury-court, Fleet-street, London.

ADVERTISER seeks ENGAGEMENT as Electric Store and Bookkeeper, experience.—Apply, W. C. C., 21, Chivalry-road, Wandsworth Common, S.W.


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THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,206. [No. 10. Vol. XLVII.] FRIDAY, JUNE 28, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30c., or 70pf.


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## NOTES.

THE bogey of electrolytic corrosion of gas and water pipes has once more been lifting its head before a Parliamentary Committee, this time in connection with the extensions of the London United Tramway Co.'s trolley lines. In our columns this week will be found a lengthy and detailed account of these proceedings, which are of value as showing the present state of expert opinion on the question, and the utmost that can be said on either side. When the flood of evidence in favour of more stringent regulations than those now in force is analysed it is found to contain but a small trace of solid material; and it is, therefore, not surprising that, after patiently hearing evidence for several days, the Committee should take only a couple of minutes to arrive at its decision to pass the preamble of the bill as regards electrolysis. The effect of this will be to free these useful tramways, in the event of their being constructed, from unnecessarily irksome restrictions such as the "Sheffield clause," and to allow of their being worked in accordance with the ordinary and perfectly adequate regulations already enforced by the Board of Trade.

AMONG the experts whose evidence went to show that they are contented with the existing tramway regulations of the Board of Trade were Sir WILLIAM PREECE, Dr. S. P. THOMPSON and Mr. H. F. PARSHALL; the experts on the opposite side were the indefatigable and unconvincible Profs. AYRTON and PERRY, who adhered without flinching to the conclusions they had been brought to years ago by their experiments in the Clapham-road. These several experts on both sides brought forward a mass of evidence which it will well repay interested readers to peruse; yet it must be admitted that, in spite of the question being thus heavily threshed out, some valuable grains of information remain unwinnowed. In spite of Dr. THOMPSON'S calculations, he gave no information as to how much of the current entering or leaving a buried pipe can be regarded as electrolytic, and how much as conducting; apparently he assumed that it is all electrolytic. Nor are we informed as to the amount of corrosion which buried metal pipes undergo in circumstances which cannot possibly be due to electric traction. Why are not pipes remote from tramways dug up and compared either with the horrible example Prof. PERRY intended to show, or with the actual unoffensive example which he produced by mistake? Even when unmolested by unscientific tramway engineers, buried pipes cannot be altogether free from corrosive action of the soil. What is the amount of it? Too much importance, by the way, is being attached by the pipe owners and their assiduous advisers to the sins of the City and South London Railway in its unregenerate state. For years that railway was operated under no regulation whatever by the Board of Trade or any similar authority; moreover, we may remind Prof. AYRTON, it is only comparatively recently that it has been run on the three-wire system. The charges which are now being flung against the line relate to indiscretions it may have perpetrated in the unregulated, unbalanced two-wire days of its youth. To preach to tramway engineers on such a text is an insult to their profession.

IN his evidence before the Joint Parliamentary Committee on London Underground Railways, which we report in our issue this week, Col. YORKE stated his opinion that "signalling in tubes could only be confined to a very small space, and a very small curvature in the line or gradient would obscure the signal from the driver until the train came near to it. For that reason signalling in the tube railway could never be as satisfactory as in the open, . . . . which led him to form the opinion that junctions should not be made in these tubes." This is surely an unnecessarily severe view; it is certainly one with which we cannot agree. Although we should regard it as detrimental to the service of frequent trains for there to be numerous confluent junctions, we see no reason why a junction or any other section of a tube line cannot be as properly protected by signals as when the line is in the open air. There is undoubtedly a difficulty if the protection is to consist of a single

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signal, and especially if this signal is to be placed close to the protected section. A sharp curve would in such circumstances prevent the discovery of danger until the driver had taken his train right into it. But railway engineers are not tied to single signals; the whole difficulty would be overcome by the use of multiple signals, such as a series of lights ranging from the border of the danger area to a point as far remote from it as might be deemed necessary. Even if the driver should have passed the first of these before "danger" was shown, he would not advance many yards before perceiving one or more of the series; he would thus receive quite as prompt warning as if he were on the surface; possibly, indeed, even more prompt warning. If only Government Department officials would use a little more imagination, and try to perceive that altered circumstances can generally be met by altered methods, they would present less unnecessary obstruction to progress than they sometimes now do.

The Papers read at the thirty-seventh annual general meeting of the Incorporated Gas Institute dealt with the question of high pressure incandescent gas lighting. It is of the greatest importance that electrical engineers should keep in touch with all the latest improvements in gas engineering, in order that they may know the relative efficiencies and costs; and gas engineers are in the habit of gibing at a certain class of electrical engineer who compares the most modern of electric lights with an antiquated system of gas lighting. On the other hand, the gas engineer often does not seem to realise the improvements that have been taking place in electric lighting during the last 20 years. Mr. William Sugg, in his Paper, "High and Low Pressure Gas Incandescent Lighting," read before the Institute on the 11th inst., remarks as follows:—"I dare to say that the electric arc light is not suitable for street lighting for many reasons—the principal ones being its want of volume, and the apparent solidity of its shadows." He also remarked: "Many years ago the writer pointed out the difference between the volume and intensity of light, by the effect produced in lighting a coal wharf by means of the old-fashioned brazier filled with coal." "The light from the coal brazier, consisting principally of the red and yellow rays, is diffusive, somewhat like the light of the sun, while the rays of the electric light, of high refrangibility, emanate from a very small point." He then pointed out that the area of illumination in the case of the brazier was from 150 to 160 sq. in., while in the case of the arc the area was not more than half a square inch.

It is very amusing to an electrical engineer to read these remarks, as it would appear that Mr. Sugg has been looking so constantly at his experimental high-pressure gas lighting that he has blinded his eyes for seeing any street arc lighting during the last 20 years; otherwise he could not have failed to notice that the electrical engineer has made it his special study to render the arc light diffusive, and this result he has attained with great success by means of various forms of lanterns. At present therefore, the area of illumination from an arc lamp might often be taken as from 300 to 500 sq. in., not the ½in. mentioned by this gentleman. Again, if Mr. Sugg had inquired of any dressmaking establishment he would not have reiterated his remark of many years ago that the light from the brazier was somewhat like the light from the sun. He would have found that the light from an arc lamp more closely resembles that from the sun than any other artificial light, and that it is always used by shopkeepers to match colours that have otherwise to be seen by daylight. If Mr. Sugg had gone a step further, and inquired of somebody with a little scientific knowledge he would have discovered that the arc light is richer in red and yellow rays than is the sun. We can only suppose, however, that he mistook a gas light for the sun, as otherwise the mistake seems almost inconceivable. To compare diffusive arc lighting with point incandescent gas lighting it is only necessary to walk from the Thames Embankment to Whitehall.

Cable Communications Committee.—At the meeting of this committee on Thursday last evidence was given by Mr. Charles Bright.

The late Prof. G. F. FitzGerald.—In the current number of the *Physical Review* Dr. J. Larmor contributes an appreciative and interesting article on the work of the late Prof. G. F. FitzGerald.

Obituary.—We regret to announce the death, on the 21st inst., of Admiral Sir Anthony Hoskins, at the age of 74. He was at the time of his death, and had been some for years, on the board of the Telegraph Construction and Maintenance Co.

Cable Interruptions and Repairs:—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ... ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... | Mar. 2, 1900 ... | — |
| Cayenne—Pinheiros .. ..... | April 21, 1901 ... | — |
| Bolama ..... | May 20, 1901 ... | June 26, 1901 |

Erratum.—We have received a letter from Mr. E. Jona informing us that the name of his fellow-electrician is Mr. Pinelli—not Mr. Pirelli, as mentioned in *The Electrician*, Vol. XLVII., p. 338, line 10. The name of the firm, Messrs. Pirelli & Co., in the next line, is correct.

Society of Arts.—The council have awarded the Society's silver medal, amongst others, to the following readers of Papers during the session of 1900–1: F. B. Behr, for "The Proposed High-Speed Electrical 'Monorail' between Liverpool and Manchester," and to G. Marconi, for his Paper on "Syntonic Wireless Telegraphy."

Physical Society.—The meeting this evening will be held in the Wheatstone Laboratory, King's College, Strand, at 5 p.m. The following two Papers will be read:—(1) "The Effect of a High Frequency Oscillatory Field on Electrical Resistance," by S. A. F. White. (2) "The Spectrum of Cyanogen," by E. C. C. Baly and Dr. H. W. Syers.

Wireless Telegraph Apparatus for the Admiralty.—The Admiralty have just ordered 54 sets of wireless telegraphy gear, to be made according to their own specifications and system. The work, which has been divided among Messrs. Siemens Bros., Messrs. Newton and Mr. H. W. Sullivan, is to be completed within three months.

Lightning Flashes Down a Colliery.—Mr. Jacob Sharp recently read a note before the Institution of Mining Engineers on a flash of lightning at the Lambton Colliery, which was noticed by persons about 500yds. apart at a depth of about 300ft. Two flashes occurred within an interval of about 5 min., and the hauling-engineman, who was about 440ft. below the earth's surface, received a shock.

The Scott-Snell System of Gas Lighting.—Mr. C. Scott-Snell read a Paper, "Self-Intensifying of Gas Pressure by Means of Waste Heat," before the Incorporated Gas Institute at their recent annual general meeting, in which he describes his compressor system of obtaining pressure in the lamp itself. It is claimed that the lamp gives 38½ c.p. per cubic foot, the pilot light consumes in addition ¼ cubic ft. per hour, and lamps of 500 c.p. have been made.

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**Water Power in Norway.**—An electrical transmission scheme for utilising the falls on the Glomen at Askin, which has been under construction 18 months, is expected to be completed next year. The plant is designed for about 45,000 H.P. At present three Francis turbines coupled to three-phase 2,000kw. 8,000 volt dynamos are being installed. The pressure will be raised to 20,000 volts for transmission to Christiania. The work is being carried out by the Schuckert Company.

**Wireless Telegraphy in Canada.**—The Canadian Government is installing the Marconi wireless telegraph system in the Gulf of St. Lawrence, and the steamer "Tyrian" has been despatched to establish the first station at West Point (Anticosti). The "Tyrian" will also lay for the Government a cable 22 miles in length, connecting Belle Isle with the Government line to Quebec. This is a very speedy answer to Messrs. Elder, Dempster & Co.'s petition, published in our last issue.

**Röntgen Society.**—The annual meeting of this society will be held on Thursday next at 20, Hanover-square at 8:30 p.m. Mr. G. Bowron will exhibit an oscillometer for measuring the current and oscillations in the secondary circuit of an induction coil or similar apparatus. At this meeting, also, the officers for the ensuing year will be balloted for. The council's nominations are as follows:—*President:* Herbert Jackson. *Vice-Presidents:* Lord Blythswood, the Right Hon. Earl of Crawford, D. Ferrier, F.R.S., J. H. Gladstone, F.R.S., A. A. Campbell-Swinton and Dawson Turner. *Council:* Barry Blacker, J. Mackenzie-Davidson, J. H. Gardiner, A. W. Isenthal, E. Payne, C. E. S. Phillips, E. W. H. Shenton, J. J. Vezey, H. Snowden-Ward, J. Wimshurst, F.R.S., H. Walsham and Chisholm Williams.

**Newcastle Local Section of the Institution of Electrical Engineers.**—The report of the committee of this section covers a period from May, 1900, to June, 1901. The present strength of the section is 92 members of all classes. Five Papers were read, several of them being accepted by the council in London for reproduction in the *Journal*. The committee record their indebtedness to the Principal and Governors of the Durham College of Science for the arrangements they have made for the reception and comfort of the members. The committee for 1901-2 is constituted as follows:—

Mr. J. F. C. Snell (chairman), Mr. John Holmes (vice-chairman) The Hon. C. A. Parsons, Messrs. H. F. Friederichs, W. W. Heaviside, C. D. Burnet, W. C. Mountain, J. H. Barker, R. S. Dobbie, G. W. Money, Dr. Stroud, Mr. D. H. Kennedy (hon. sec.), and Messrs. W. D. Hunter and Alex Muir (hon. auditors).

**The Institution of Junior Engineers.**—The secretary (Mr. Walter T. Dunn) desires us to announce that the address of the Institution on and after July 1st will be 39, Victoria-street, Westminster, rooms having been taken there on the first floor for offices, reading-room, library, &c. On Saturday, July 6th, the Institution will visit the Staines reservoirs works, under the guidance of the joint engineers (Messrs. Walter Hunter and R. E. Middleton), the train leaving Waterloo at 1:25 p.m. We have just received the tenth volume, giving the record of transactions of the Institution of Junior Engineers for the session 1899–1900. It is a clearly printed and well got-up book of 255 pages, and the space, devoted to the electrical industry, both with regard to the Papers recorded and the large number of works visited, shows the great importance the "Junior Engineers" attach to that branch of the engineering profession.

**Telephony in Germany.**—On Friday, June 21st, the new chief trunk line exchange at Franzosiche Strasse, Berlin, for the exclusive inter-urban and international telephone communication was opened. The new trunk line exchange enables the combining of any trunk line wires, thereby providing the means of allowing telephonic intercommunication between not less than 17,000 towns all over Germany. The whole of the work has been carried out by Messrs. Mix and Genest, of Berlin. This trunk line exchange has been specially designed by said firm, and has had a preliminary trial at the trunk telephone exchange at Chemnitz, where, during the short time of its introduction, it has shown such superior reliability and such decided acceleration of service that the General Post Office decided upon its adoption on a larger scale for Berlin, and has now also ordered the trunk line exchange at Magdeburg and Halle to be fitted up after the same plan.

**Wireless Telegraphy in Germany.**—According to the *Standard* an inquiry into the various systems of wireless telegraphy has been made by order of the German Postmaster-General. The report concludes as follows:—

From the beginning of last April extensive experiments have been made at Bremerhaven with the Schäfer system of spark telegraphy. The Imperial Telegraph Administration sent an official specially trained in receiving telegrams by the sound to take part in the experiments, and the North-German Lloyd lent its steamer "Seeadler." The results were a perfect communication between the coast station near Bremerhaven and the ship, which steamed as far as Meyers Reef, a distance of 24km. from Bremerhaven. The experiments justify the hope that satisfactory communication between Bremerhaven and Rotherasand, a distance of 42km., may be achieved. The telegrams are received with a telephone. The signals can, however, be transferred to a Morse apparatus if desired.

From the present state of spark telegraphy in Germany, it may be said that the German systems can completely replace the Marconi one; but the incompleteness of practical experiments prevents any real decision as to the best German system.

**Electric Light and Power at a Preserve Factory.**—On June 25th the large new works of Mr. Wm. P. Hartley, at Green Walk, Bermondsey, London, were formally opened. The electric generating plant for light and power consists of two horizontal slow-speed engines, made by the Burnley Ironworks Co., driving by means of ropes two Schuckert multipolar dynamos, each having an output of 69kw. at 220 volts. The lighting of the factory is effected by some 700 incandescent lamps of 16 c.p. and 26 Thomson-Houston arc lamps of enclosed type. The wiring is carried out on the distribution system, each floor having its own distributing switch and fuse board. The wires are, for the most part, run in wood casing, but in the boiling rooms, and other portions where steam and acid vapour are present, they are protected by insulated conduits. The electric lifts, of which there are five, made by Messrs. Waygood & Co., are each of 1 ton capacity, the motors being of 17 H.P. Two Schuckert motors of 10 H.P. each are used for driving box-making and other machines. The ventilation of the boiling and similar departments is provided for by means of 17 electric fans by Messrs. Matthews and Yates (Ltd.), varying from 18in. to 30in. diameter, the motors being of ½ H.P. to 1½ H.P. The contractors for the work and makers of the switchboard were Messrs. Simpson Bros., of Hapton, Burnley, and the consulting engineer was Mr. R. J. Wallis-Jones.

**Electrochemical Laboratory at Owens College.**—Two electrochemical laboratories have been provided in the "John Hopkinson" wing of the new physical institute. Power is provided by a 25 H.P. Westinghouse motor run off the town mains and a 12 N.H.P. Crossley gas engine. These drive countershafting connected to eight dynamos of various pressures from 15 to 160 volts. There are also two sets of 30 storage cells—one of the two sets of cables from the dynamo house will carry 1,000 amperes. Two double benches occupy the centre of the larger room, and benches are also placed round the walls, the latter being provided with a stoneware glazed gutter, running into small sinks. A general reagent stand is provided in the middle of the room as well as small portable stands for the more common acids, &c. There are two series of circuits: the first consists of three sub-circuits which can be connected to give any desired pressure from 2 to 100 volts; the second consists of six wires directly connected to zinc storage cells, so that pressures of from 2 to 10 volts can be obtained for electrolytic work. Two crucible furnaces have been fitted up for work supplementary to the electric-furnace operations for which a large 600 ampere arc furnace of Prof. Moissan's type is available. The Victoria University already allow electrochemistry to be taken up as an "optional" subject in the honours degree in chemistry, and it is in contemplation to recognise technical electrochemistry as a permissible subject for the degrees of the University. Courses of lectures are given on the laws and theories of electrochemistry and technical applications of electrochemistry and metallurgy, whilst in the laboratory courses, leading on to research work in this subject, electrochemical measurements and preparations are taken up.

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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Cutaneous Thermocouples.*—In the course of some elaborate experiments on the thermal conductivity of the human skin, J. Lefèvre found it necessary to devise special forms of thermocouples for determining the temperature of the skin and the temperature 2mm. below its surface. The first type consisted of a small box of ebonite having a metallic lid sunk a little below the rim. The lid consists of a central circle of iron surrounded by a concentric circle of German silver. The two discs form the junction of a thermo couple. It is devised as described in order to enable the operator to find the temperature of a submerged portion of the skin. For the author carries out calorimetric experiments on human subjects on a large scale, the subjects being immersed in water and fixed in position so as to avoid convection of heat. To find the internal temperature of the skin the author employs a small pointed probe consisting of a concentric iron-German-silver couple, the projecting point being 2mm. long, and plunged into the skin until the handle is flush with the surface. The experiments so far go to show that at a temperature of 5deg. the conductivity of the skin is only one-sixth of what it is at 30deg. On the whole, the loss of heat is greater than would follow from Newton's law.

[J. Lefèvre, *Jour. de Phys.*, June, 1901.]

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*Point Discharges.*—Donle, after his experiments with an arrangement similar to Lecher's, put forward the supposition that very rapid electric oscillations favour the discharge of positive electricity. At greater distances between the point and the plate he found, however, that the plate was often negatively charged instead. Knoblauch (see *The Electrician*, Vol. XLVI., p. 381) showed that two different cones of discharge proceed from the point—a longer and outer one of negative electricity and a shorter inner one of positive electricity. It is only the latter that acts at short distances, while the former acts at longer distances. K. von Wesendonk was led to the idea that the excess of negative electricity from Tesla discharges might be only apparent. To test this he operated with large screens and with hollow metallic spheres surrounding the discharging point. With an ordinary influence machine, provided with its own condensers, the electrification received had invariably a positive value, so that it must be concluded that there was more positive than negative electricity given off by the point. The author believes that if there is any real prevalence of negative electricity in Tesla discharges, it is connected with their comparatively low frequency. He does not appear to consider the influence of light.

[K. von Wesendonk, *Phys. Zeitschr.*, June 8, 1901.]

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*Aluminium Rectifiers.*—C. Pollak has made his aluminium rectifiers available for currents of a voltage of 200. For this purpose he employs a slightly acid solution of potassium phosphate traversed by a continuous current. The aluminium plates are first macerated for some time in caustic soda, so as get rid of impurities. A crust is formed on them, consisting of oxides and other compounds of aluminium. This crust is necessary for their proper action. It remains unaltered in air, but gradually disintegrates in water, and must, therefore, be preserved when out of action by taking the plates out of the dielectric. When in action they must not be allowed to reach a temperature above 40deg., as otherwise they allow a considerable proportion of the current to pass both ways. This is avoided by making the column of liquid several times the length of the plates. Convection and radiation then bring about the proper cooling. It is thus possible to use an aluminium cell continuously for four hours without overheating. The life of a plate when used at the proper temperature is 500 to 800 hours. At the end at that time, the oxidised layer begins to crumble away, largely owing to the mechanical friction of the hydrogen bubbles. It is not practicable to employ several cells in series unless they can be made precisely equal.

C. Pollak, *Comptes Rendus*, June 10, 1901.]

*An Electric Fire-Damp Meter.*—The fire-damp indicators at present in use are based upon the aureoles shown by safety lamps when fire damp is about. They do not indicate its presence below at least 2 per cent. Pieler, by using an alcohol flame, reduced this limit to 0·25 per cent., and Chesneau, with a flame coloured by cuprous chloride, further reduced it to 0·1 per cent. Liveing's glowing wires, one of which is surrounded by air and the other by fire-damp, show about 0·5 per cent. of the dangerous gas by a difference of brightness. This has peen improved upon by G. Léon, who compares, not their brightnesses, but their resistances. The two platinum wires are heated to 1,000deg. by the same current, and one of them is encased in a glass tube full of air, while the other is surrounded by a double layer of wire gauze. The deflections of the Wheatstone bridge galvanometer are sensibly proportional to the amount of fire-damp contained in the air, and a deflection of four scale divisions corresponds to a proportion of 0·2 per cent. A maximum deflection is attained when the proportion of fire-damp is 10 per cent. It may, therefore, happen that a reading is ambiguous. It may be definitely determined by admitting some fire-damp to the protected wire, and noticing whether the deflection increases or diminishes.

[G. Léon, *Comptes Rendus*, June 10, 1901.]

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*Vibrations Due to an Influence Machine.*—If one of the poles of a Wimshurst exciter is connected with the end of a stretched wire which is insulated and contained in a tube, and the other pole of the machine is put to earth, the wire executes transverse vibrations. D. Negreano has observed that when the wire is watched in the dark it shows alternate dark and luminous portions. If the wire is attached to the positive pole of the machine the luminous portions are equidistant, and are wider in the centre than at the ends. On attaching the wire to the negative pole it is seen that the lines become equidistant luminous points. The experiments were made with a tube 2·5m. long and 6cm. in diameter, and a wire 2·5mm. in diameter. Somewhat similar experiments made by Bezold, Tommasina, and Viol have been explained on the supposition of mechanical vibrations, in which the luminous portions represent the nodes. The experiment succeeds very well when two wires are used, one attached to the positive and the other to the negative pole. The wires both show their characteristic light effects. If the two wires are close enough together the experiment succeeds equally well on attaching one wire to a pole, and connecting the other with earth. The two wires then, so to speak, form the armatures of a condenser.

[D. Negreano, *Comptes Rendus*, June 10, 1901.]

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*Frequency Indicators.*—A handy method of indicating alternate current frequencies is a great desideratum in central station work. A large number of different systems have been devised, and another is added to the number already available by R. Kempf-Hartmann. It is intended strictly as a workshop instrument, which is to enable the engineer to tell the frequency of the current at a glance, by reading it off in whole figures. Tuning-forks are not very suitable for this kind of work, as they resound to a strictly limited range of frequencies above and below their proper pitch; and to be certain of some resonance in a graduated series, it would be necessary to make their successive pitches differ by less than ½ per cent. The author therefore employs "reeds" of steel, weighted at the ends and actuated by an electromagnet excited by the current to be measured. Each reed is fixed in a clamp, having its frequency marked on it in a series such as 100, 101, 102. The amplitude at resonance attains as much as 3cm. At least three reeds correspond to each frequency, and their relative amplitude allows the observer to estimate the frequency to the first decimal place. By a suitable sub-division of the magnet it is possible to sound an "alarm" as soon as the frequency rises above the normal value or falls below it.

[R. Kempf-Hartmann, *Phys. Zeitschr.*, June 15, 1901.]

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# ELECTRIC POWER SUPPLY AT NEWCASTLE-ON-TYNE.

(*Continued from page 327.*)

## THE WALKER AND WALLSEND CO.'S SECTION.

The Walker and Wallsend Union Gas Co. purchases electric power at the Neptune Bank station, described in our last issue. It undertakes, therefore, the entire distribution over its own area. Part of this is effected by overhead wires, as shown in Fig. 10 in our first article, but the greater part is necessarily by means of underground cables, as shown in Fig. 12. The entire cable work within the gas company's area has been undertaken by Callender's Cable and Construction Co., who are also doing some important cable laying in the Newcastle area. Dealing in this portion of our article only with the Walker and Wallsend Co.'s area, we will describe the cable work this firm have carried out.

Underground Cables.—There are two essentially different types of mains employed:—(1) Those consisting of three-core cables intended to be used on the three-phase circuits; (2) those formed of single conductor cables, separately insulated, each one laid by itself on the solid system. The three-phase mains consist of a series of three-core cables, each branch having a sectional area of 0·15 sq. in. insulated by bitumenised paper. The three cores are stranded together and wound circular, and on the cable thus formed there is an additional thickness of bitumenised paper so as to bring up the dielectric to the same radial thickness between any conductor and earth as it is between the conductors themselves. The cables thus made are designed to comply with the Board of Trade regulations for working at 6,000 volts effective, even if with no point earthed. The cables are then covered with a heavy tube of lead, and are laid on the solid system in cast-iron troughs supported on wooden bridges, and run in with Trinidad bitumen. The trough is finished by a wrought iron lid consisting of ¼in. plate, so as to give the greatest possible mechanical protection in case of accident from the outside. In order to reduce the possibility of interruption to a minimum, two separate and distinct lines of high tension mains are run from the power-house, occupying throughout separate trenches. Where they both make use of the Hadrian-road one set of mains is laid on the north side and the other on the south side, but in all other streets in the district the duplicate mains are carried in separate trenches. One three-phase main goes to the sub-station at the North-Eastern Marine Engineering Co.'s yard (Fig. 9). Another similar main is carried to the sub-station at the Tynemouth end of the district, whilst a third main is laid with connections to both these sub-stations, so that it can supply current from the generating station to either or both, or be used as an interconnecting main between the two sub-stations. Spare ways are laid wherever high tension mains are put down, and in addition there is a series of telephone and test cables, so that any sub-station is in direct communication with headquarters and with its neighbour.

The low tension network consists of the Callender Company's standard make of vulcanised bitumen cable. The mains are on the three-wire, consisting for the greater part of 0·5, 0·25, 0·5 sq. in. conductors, but in some cases 0·5, 0·5, 0·5 sq. in. is used. Each cable is laid in an earthenware trough by itself, supported on bitumenised wood bridges, and run in solid with refined Trinidad bitumen, being completed by a covering of hard bricks, which are set in the molten bitumen. These mains run from the generating station along the Hadrian-road to the North-Eastern Marine Engineering Co.'s sub-station. They are also laid in Station-road, Wallsend, and along the high road, looping back into the main distributing line between the power-house and the sub-station. In addition to this line there is a network of similar low-tension mains in the Willington Quay district, and low-tension connection is made between networks by means of vulcanised bitumen feeders running from the North-Eastern Marine Co.'s sub-station along the North-Eastern Railway line, crossing the Willington Gut viaduct, and there joining the Willington Quay district.

There are several branch distributors of smaller section, and, practically speaking, it may be said that the system is laid out so as to supply any of the factories with either high or low tension current, as they may wish.

A series of iron pipes has also been laid along the North-Eastern Railway between the power-house and Sir W. G. Armstrong, Whitworth & Co.'s works for the purpose of supplying them and others with high-tension three-phase current.

Supply Arrangements.—In order to relieve manufacturers who are taking power from all responsibility and trouble in connection with questions of design and supervision during the actual installing of the apparatus required, the associated companies are prepared to supply and superintend the laying down of all the plant free of first cost to the consumers on their agreeing to pay a fixed rental per annum. In addition to this, all maintenance in connection with the plant is being carried out by the companies on an additional sum per annum being paid. As the class of works within each company's area varies to such a great extent, it has been impossible to adopt one system of supply throughout, and on account of some manufacturers preferring the continuous current system, arrangements have been made for supplying either this or three-phase current, or both, as may be found necessary.

FIG. 12.—LAYING CALLENDER CABLES.

Owing to a considerable quantity of continuous current being required, mains had to be laid throughout most of the district, and as this system is preferable for the purpose of arc lighting, it was convenient to use it for lighting throughout. In this way, as continuous current is supplied through motor-generators, the necessity for regulating the three-phase voltage to within 1 or 2 per cent. has been avoided.

Where the question of deciding whether the three-phase or continuous current systems should be adopted has been entrusted to the companies' engineers, as has been done in the majority of cases, they have recommended the three-phase system, more especially for constant speed work.

Whenever a manufacturer decided to adopt electric power in his works, it was important to have the new plant installed as quickly as possible, as the preliminary negotiations usually extended over a considerable period. For this reason it was difficult to adopt one design of standard apparatus throughout, as delivery became an important factor. Now, however, the majority of the apparatus used has been standardised and a considerable stock is kept in hand. This includes switch-

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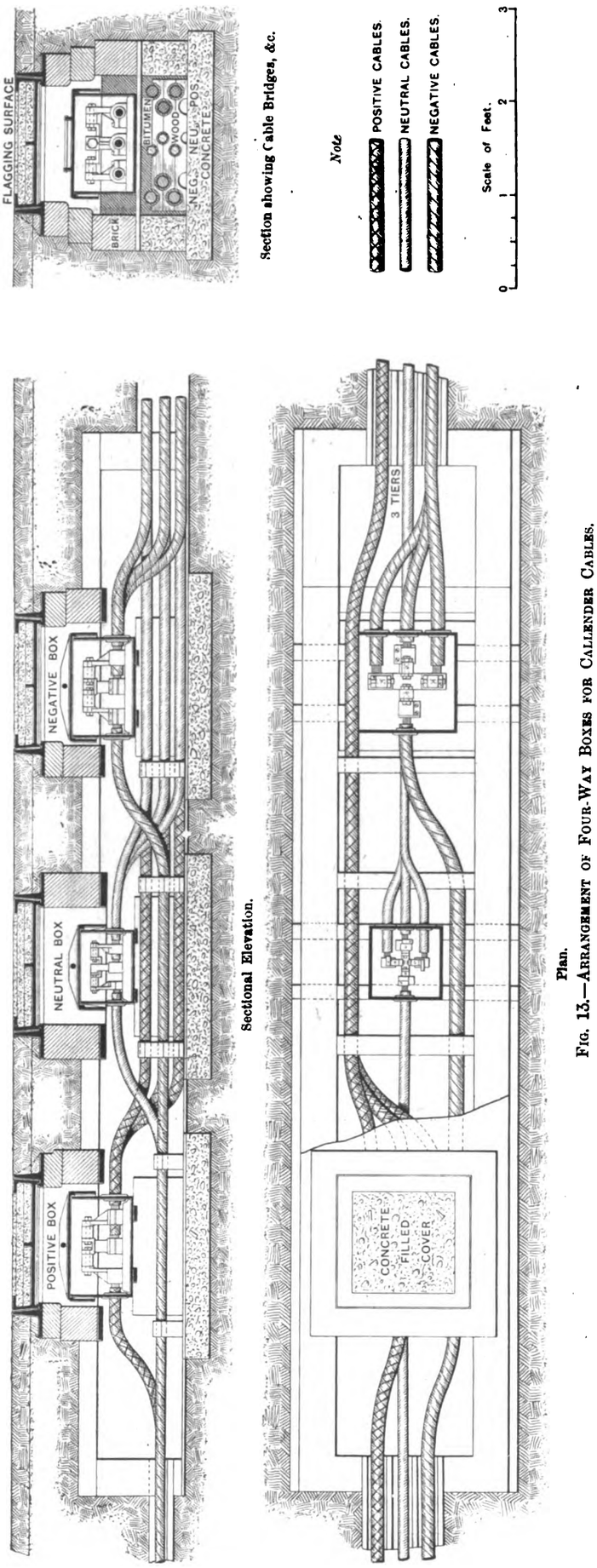


FIG. 13.—ARRANGEMENT OF FOUR-WAY BOXES FOR CALLENDER CABLES.

board panels, distribution boxes and switches, motors, arc lamps and all lighting fittings.

Owing to several of the yards which are supplied with power being a considerable distance from the company's generating station or main sub-stations, it has not been possible to transmit to them low-tension currents, and in these cases a separate sub-station has been built, in which 5,500 volts is transformed down. Power is now being supplied to several of the largest engineering works and shipyards within the company's area, and in the majority of cases the three-phase system has been adopted.

Messrs. Wigham, Richardson & Co's Installation.—The installation of Messrs. Wigham, Richardson & Co.'s engineering and shipbuilding works (Fig. 10) consists of both power and lighting. At present some 500 H.P. in motors is being put down, and in addition to this 50 arc lamps and over 500 incandescent lamps have been installed. The sub-station in this yard consists of a brick building measuring 56ft. by 18ft., and is isolated from the main building. The high-tension switchboard, transformers and motor generator were manufactured by Brown, Boveri, of Baden, and supplied by Messrs. Richardsons, Westgarth & Co. Messrs. Reyrolle & Co., of London and Hebburn-on-Tyne, supplied the low-tension apparatus. The motor generator consists of a 75kw. asynchronous motor wound for 5,500 volts, coupled to two direct-current compound-wound generators all mounted on one bed-plate, the total output of each direct-current machine being 37½kw. The high-tension feeder and transformer board consists of two-feeder, three three-phase transformer panels and one motor-generator panel, each panel being mounted with a triple-pole oil-break switch, three fuses and one ammeter. The low-tension board consists of 18 panels, including transformer, three-phase circuit, direct-current main, power, lighting and meter panels. The three-phase transformers have each an output of 110kw., the full-load efficiency being not less than 97 per cent., with a power factor of unity.

The motors in this yard are of the British Westinghouse Co.'s and the British Thomson-Houston Co.'s manufacture, and are all of the three-phase induction type, with the exception of those on the engine works travelling cranes, which are of the continuous-current railway type. Four three-motor cranes have been installed capable of lifting 14, 10 and 6 tons respectively, the motors being arranged to work on a 480 volt circuit. The controllers are so arranged that the motions of the cranes and hoisting gear follows the direction in which the controller handles are moved, this excellent arrangement greatly simplifying the work of the operator. In the majority of cases the cables throughout the yard have been run overhead (Fig. 10), but where they are likely to be injured by falling spars, &c., they are run underground. Inside buildings, where exposed to mechanical injury, the cables are run in iron pipe.

All distributing boxes are of cast-iron, and can be mounted with either power or lighting panels, as may be required, the dimensions of the two classes of panel being identical. Boxes equipped with fuses of over 5 amperes capacity are single-pole, and thus the risk of a serious short-circuit has been guarded against. The lighting is carried out on a two-wire 240 volt continuous-current system. The arc lamps are all of the Angold 5 ampere enclosed long-burning type. Where these are mounted outside, special couplings have been provided on the various poles, so that no slack cable is necessary to allow of the lamps being lowered for trimming purposes. The whole installation in this yard has been carried out by the British Thomson-Houston Co.

Sub-station for the North-Eastern Marine Engineering Co.'s Works.—This sub-station is illustrated in Figs. 9 and 14. It is equipped with two motor generators built by the British Thomson-Houston Co. to receive three-phase currents and deliver continuous current at 500 volts to a three-wire network. Each set (Fig. 14) consists of one synchronous motor wound for 5,500 volts direct-coupled to two continuous-current machines, one at either end. The output of each machine is 150kw. when running shunt at 400 revs. When compound wound the machines give, at full load, 257 volts, but only 265 volts as shunt machines. The combined commercial efficiency

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running at normal full load is not less than 87 per cent., and the temperature rise after 10 hours' run at full load does not exceed 40°C. above the surrounding air, as measured by the thermometer. The high-tension switchboard (Fig. 9) was built by Messrs. Ferranti (Ltd.) and contains five panels—viz., three feeder and two motor-generator panels. Each panel contains one ammeter, three switches, and three fuses. Duplicate mounted with one ammeter, three switches, and three fuses. The low-tension switchboard, built by Messrs. Reyrolle & Co., contains seven panels—viz., two transformer, one meter, four three phase circuit panels. The transformer and three-phase circuit panels are mounted with three fuses, one ammeter, and a triple-pole switch. There are seven British Thomson-Houston transformers, each of 50kw. single-phase, with a

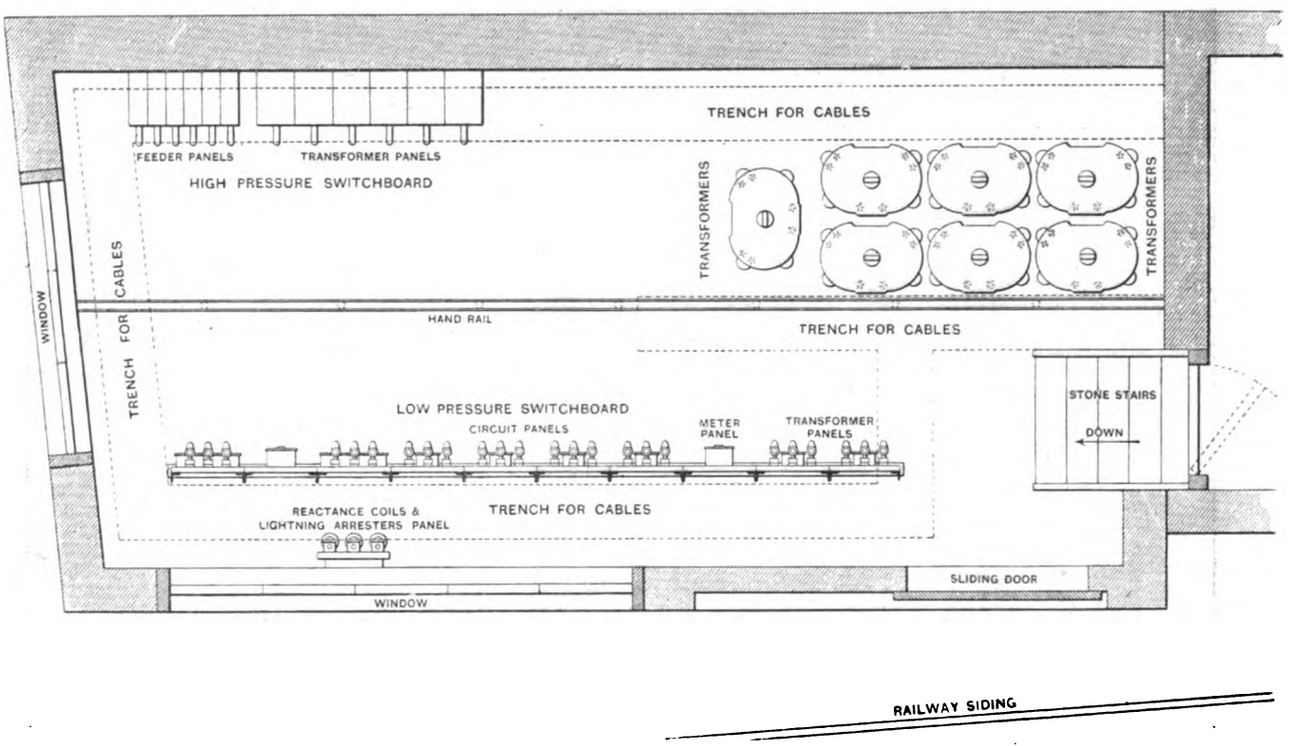


FIG. 15.—SIR W. G. ARMSTRONG, WHITWORTH AND CO.'S WORKS SUB-STATION.

synchronising gear is mounted on the board, and any one panel can be disconnected from 'bus bars while alive by means of insulated tools. The low-tension switchboard was built by Messrs. Reyrolle & Co., and contains seven panels—viz., one positive, one negative, one neutral, two test, and two starting panels. On the main board the machine switches and ammeters are at the bottom, and the feeder and distributing mains at the

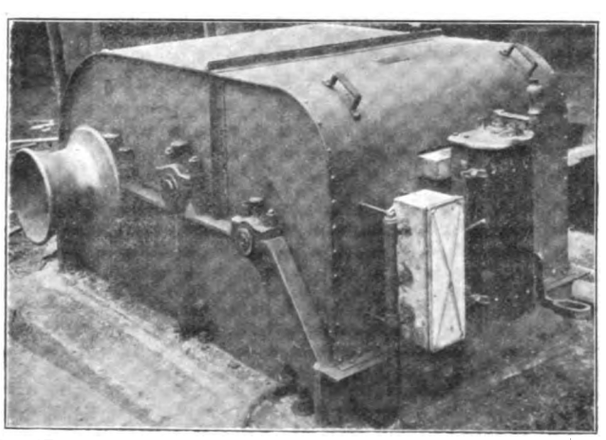

FIG. 17.—THREE-PHASE THREE-TON ELECTRIC WINCH WITH COVERS IN POSITION.

top. This sub-station is provided with a 7½-ton travelling crane manufactured by Messrs. Morris and Bastert.

Sir W. G. Armstrong, Whitworth and Co.'s Shipyard Installation.—*Sub-Station.*—These works are provided with a special sub-station, shown to scale in Fig. 15. The high-tension switchboard, built by Messrs. Ferranti (Ltd.), contains four panels—viz., two feeder and two transformer panels, each ratio of 5,500 to 440 volts. Six are in use and one is for spare. They are connected up "Delta," as in this way the failure of one does not stop supply. The efficiency at full load is not less than 97 per cent.

Throughout the works the motors are of the British Thomson-Houston Co.'s three-phase induction type. Three patterns are used—viz., one having a short-circuited rotor, and the others are form-wound rotors. The first are started by combined oil-break switches and compensators. Of the other two patterns, one has resistance mounted inside the rotor itself, this being cut out by means of a sliding handle passing through the hollow rotor spindle; the other is provided with slip rings, used in conjunction with a controller, for variable speed purposes.

The distributing boxes are of cast-iron, and of special design, made in different sizes suitable for taking from three to nine panels each, and are equipped with either power or lighting circuit panels according to requirement. The overall dimensions of the various classes of panel are identical. To guard against risk of a short circuit in a power-distributing box, *i.e.*, any box equipped with fuses of over 5 amperes capacity, single-pole boxes are used. The erection of all the electrical plant in this yard was carried out by the British Thomson-Houston Co.

Installation at the Northumberland Shipbuilding Co.'s Works.—These works are by far the most remote as yet supplied, as will be seen by reference to the map (Fig. 2). The sub-station motor generator, of 75kw., was supplied by Messrs. Richardsons, Westgarth & Co., and was manufactured by Messrs. Brown, Boveri & Co. It consists of an asynchronous motor, coupled direct to a 240-volt continuous-current generator. All the switchboards were built by the British Thomson-Houston Co. The high-tension switchboard has six panels—viz., three feeder and three transformer panels, each mounted with three fuses and triple pole oil-break switch, the latter with high and low-tension fuses. The low-tension



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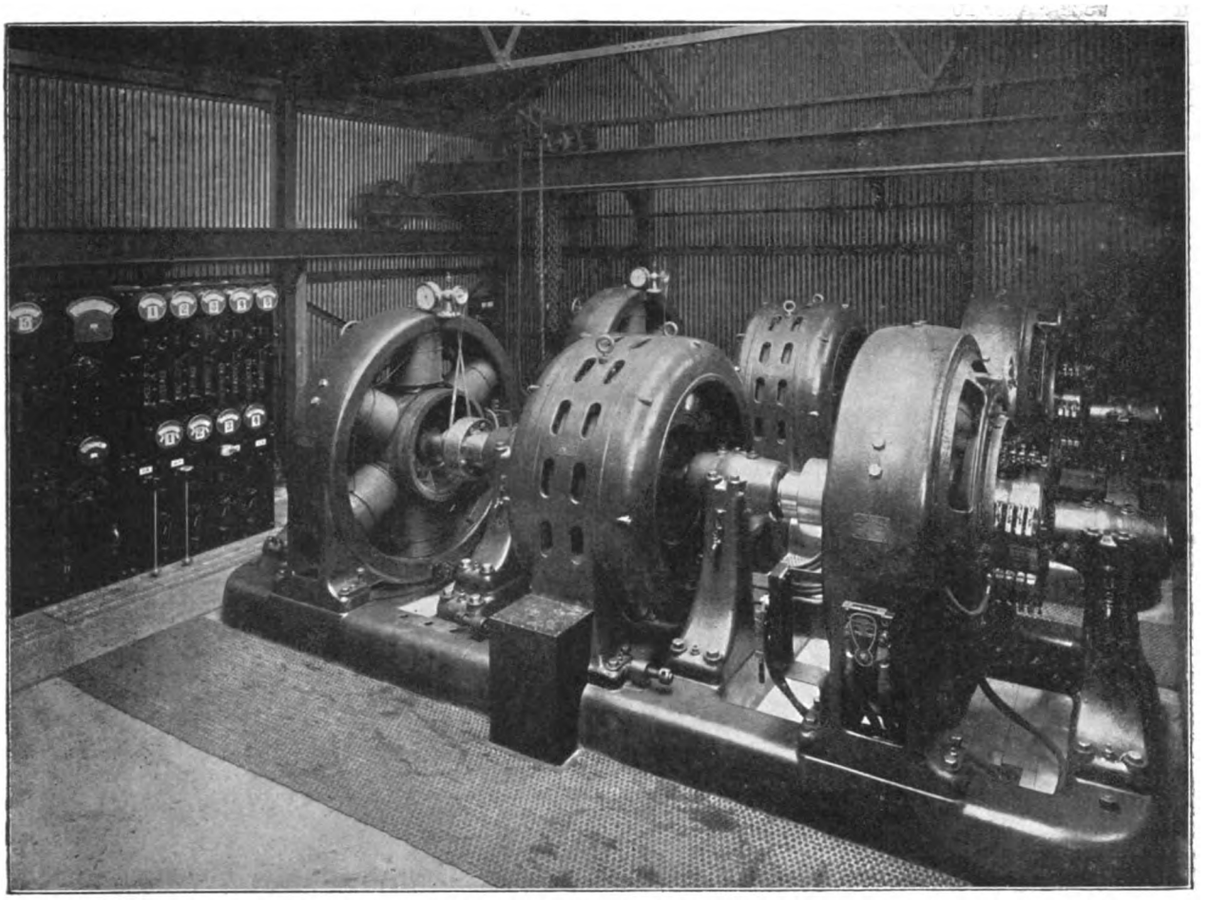

FIG. 14.—300KW. MOTOR-GENERATOR IN THE NORTH EASTERN MARINE ENGINEERING CO.'S SUB-STATION.

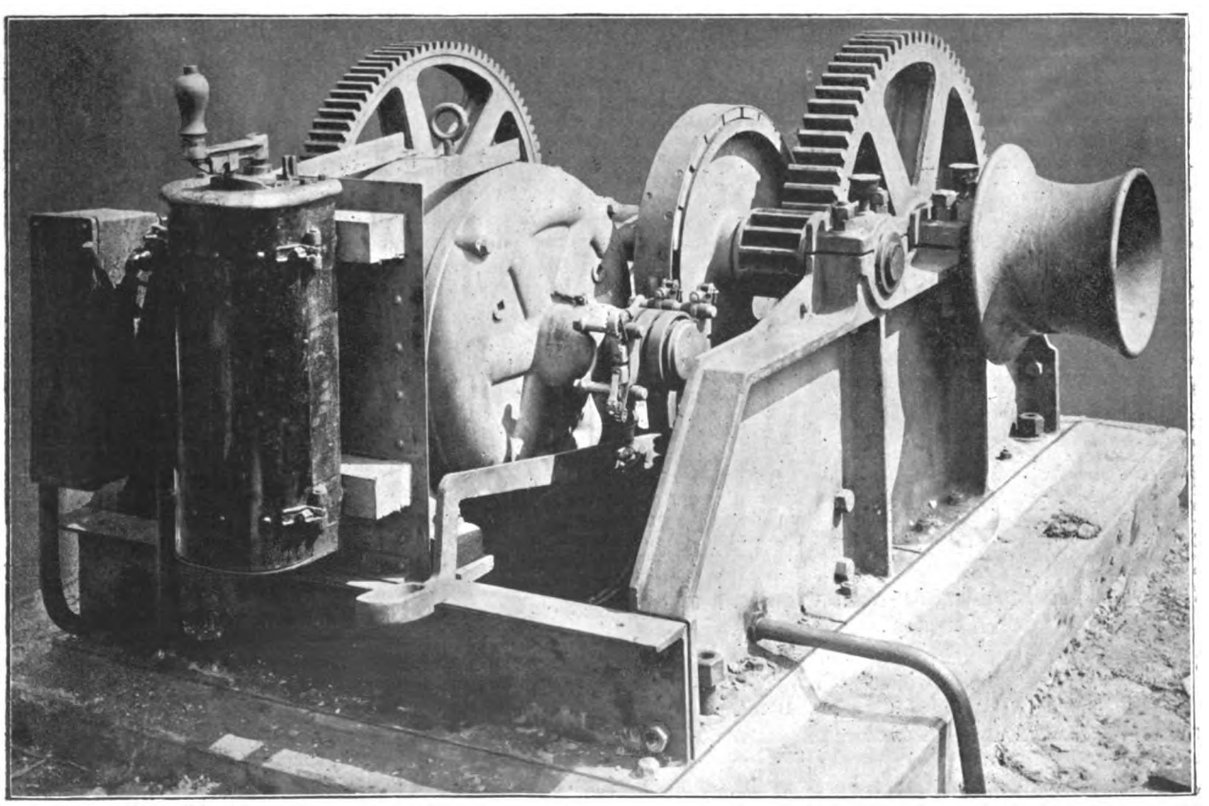

FIG. 16.—THREE-PHASE THREE-TON ELECTRIC WINCH, WITH COVERS REMOVED.

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switchboard has eight panels—viz., four three-phase circuit, one three-phase motor generator, one direct-current motor generator, and two lighting circuit panels. The transformers were supplied by the British Electric Transformer Manufacturing Co. Each of the four has a capacity of 75kw.

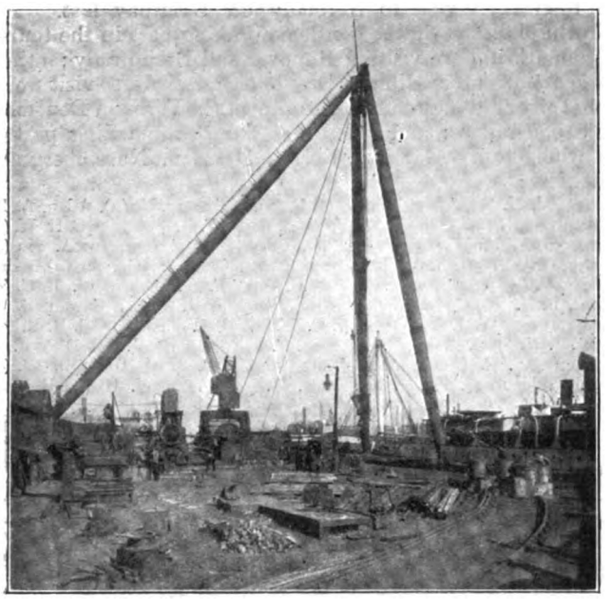

FIG. 18.—EIGHTY-TON ELECTRIC SHEAR LEGS.

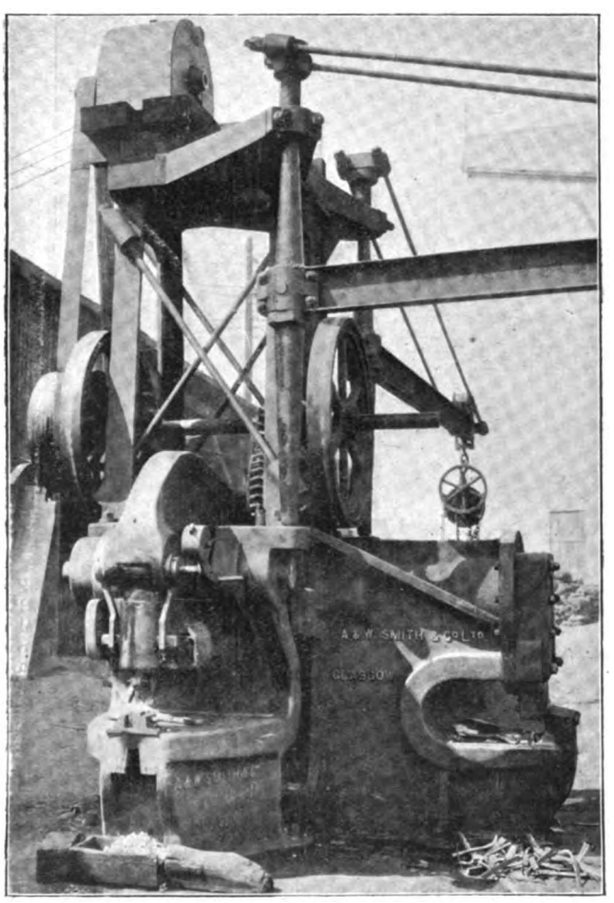

FIG. 20.—ELECTRICAL PUNCHING AND SHEARING MACHINE.

single phase, the ratio being 5,500 to 440 volts. Three are in use, and one is for spare. The efficiency at full load is not less than 97·9 per cent.

The motors throughout the works were built by the British Thomson-Houston Co., and are of their three-phase induction type. There are eight spur-driven winches, with the British

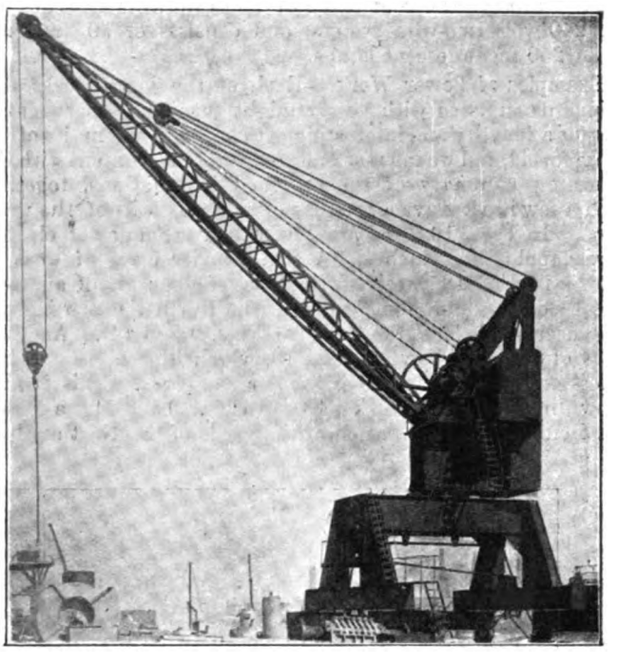

FIG. 19.—TWENTY-TON THREE-MOTOR ELECTRIC CRANE.

Thomson-Houston Co.'s electrical equipment, consisting of a three-phase induction motor, with necessary controlling

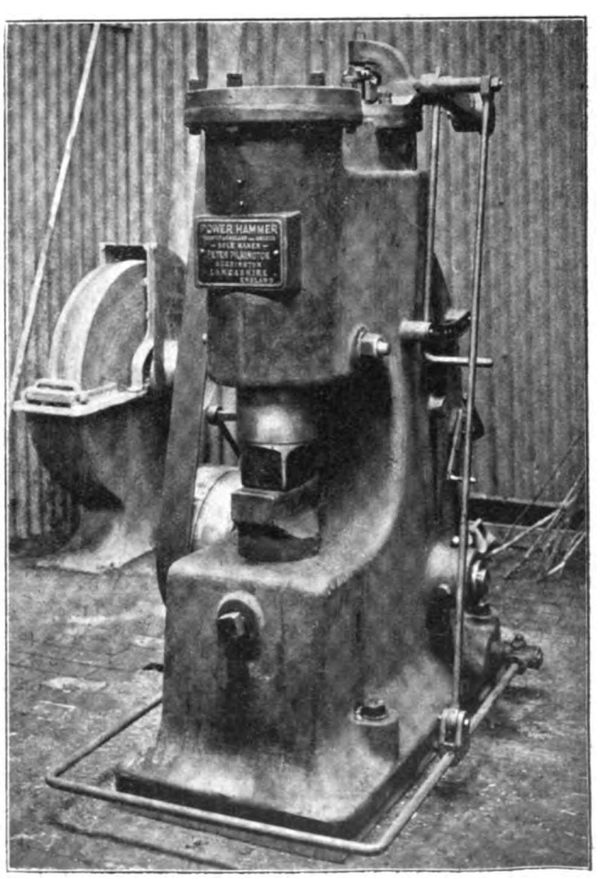


FIG. 22.—ELECTRICALLY-DRIVEN COMPRESSED AIR POWER HAMMER.

gear and resistances. One of these is shown in Fig. 16 with its cover off. When in use the whole gear is totally enclosed by sheet-iron covers, as shown in Fig. 17. Each winch is

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capable of lifting 8 tons at 50ft. per minute, and of running in either direction at varying speeds, all motions being controlled by one handle. The cables to the various winches are laid underground, in wood troughing, run in with bitumen to guard against injury. The lighting of these works is arranged on the 240 volt two-wire system, and consists of 50 arcs and about 250 incandescent lamps.

Examples of Power Work.—Each of the large works and shipyards supplied with power might furnish a separate subject for a lengthy and interesting article. But the limits of our space forbid, and we must ask our readers to be content with the foregoing summary of the principal installations, together with a few illustrative examples of actual details of the work done. In Figs. 16 and 17 we have had examples of electric power applied to winches. A still heavier piece of work is shown in Fig. 18, which is from a photograph of an electrically driven 80-ton shear-legs at the North Eastern Marine Engineering Co.'s works (see also Figs. 9 and 14). Another class of crane is shown in Fig. 19, which illustrates a 20-ton three-motor electric crane at the same works. This is also shown in the distance in Fig. 18. In Figs. 20 and 21 are shown two items of the installation at the yards of the Northumberland Shipbuilding Co., Fig. 20 being a separately driven punching and shearing machine, and Fig. 21 being a 7½ H.P. motor-driven rolling mill. An useful tool, especially where steam has been abolished, is the compressed air-driven power hammer shown in Fig. 22. By means of an electric motor attached to an air compressor the plant is made readily available wherever electric power can be obtained.

*(To be concluded.)*

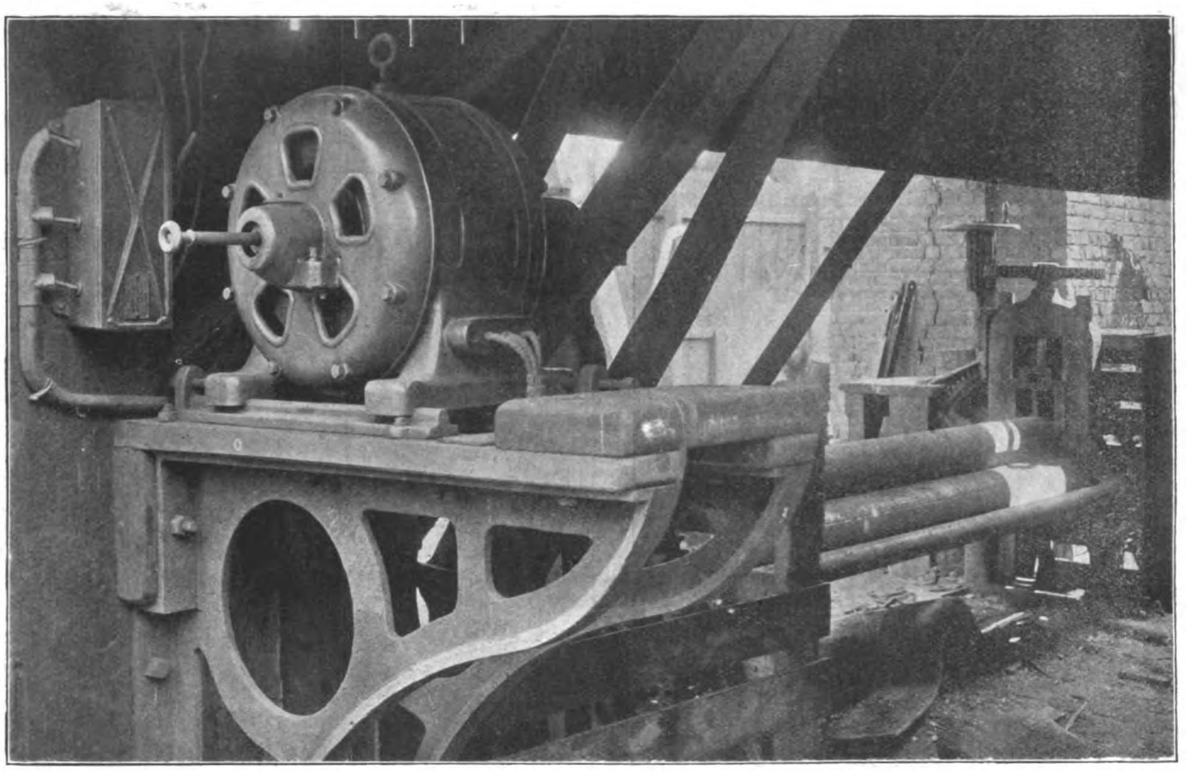

FIG. 21.—ELECTRICALLY DRIVEN ROLLING MILL.

Automobilism.—The *Automotor Journal* for June describes a 94¾-mile run on an electromobile with one charge. The weight of the vehicle was 39cwt., of which the battery of 50 cells weighed 22cwt. The car carried four people, the average speed being about 12 miles an hour. The total charge before starting was 300 ampere-hours, the voltage at the start 101, and at the finish 80, or less.

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

About 150 members, accompanied by 80 ladies, started on the Institution visit to Germany on Saturday last. The following is a list of the gentlemen taking part in the tour—those marked *a* are visiting Hanover and Berlin only; others marked *b* are proceeding to Dresden afterwards, to visit works in that city and to attend the meeting of the Verband Deutscher Elektrotechniker; and a large section, *c*, are taking part in the whole tour—Hanover, Berlin, Dresden, Nuremberg and Frankfort:—

Adam, J. H. (*a*), Addenbrooke, G. L. (*a*), Alabaster, H. (*a*), Allen, A. H., (*a*), Andrews, L. (*b*), Atchison, A. F. T. (*c*), Baily, F. G. (*c*), Biggs, C. H. W. (*b*), Blackburn, A. B. (*a*), Blair, G. C. (*c*), Borns, H. (*c*), Boschan, A. von (*b*), Braulik, G. (*a*), Brown, W. (*c*), Byrn, K. (*a*), Chauvin, G. von (*a*), Clirehugh, S. V. (*a*), Clothier, H. W. (*c*), Clough, F. H. (*a*), Coates, M. C. (*c*), Collins, B. H. (*a*), Constable, A. D. (*c*), Cottam, G. H. (*a*), Cowan, E. W. (*a*), Crampton, W. J. (*b*), Crawley, C. W. S. (*c*), Crompton, Col. R. E. (*a*), Davies, J. H. (*c*), Dawson, P. (*c*), Day, C. (*c*), Denham, J. (*a*), Dick, J. R. (*a*), Digby, W. P. (*a*), Dixon, W. (*c*), Dobbie, R. S. (*c*), Duddell, W. (*a*), Eck, J., Edgcumbe, K. (*b*), Edmunds, H. (*b*), Esson, W. B. (*a*), Eugene-Brown, E. (*a*), Eurich, H. D. (*c*), Fawcus, W. P. J. (*c*), Ferranti, S. Z. de (*c*), Foster, J. A. (*c*), Fowkes, F. (*c*), Foyster, A. H. (*b*), Friedlander, P. R. (*c*), Gee, W. (*a*), Gibbons, J. (*a*), Glegg, A. (*c*), Glover, F. A. (*a*), Graham, E. V. (*a*), Hadley, A. E. (*c*), Hammond, R. (*a*), Hardy, W. E. (*c*), Harling, W. (*c*), Harris, A. F. (*a*), Hatton, R. J. (*a*), Hawkins, C. C. (*c*), Hawkins, T. (*a*), Heap, A. C. (*c*), Heaviside, A. W. (*b*), Heilborn, A., Hirst, H. (*a*), Hodgkin, J. E. (*a*), Jenkin, B. M. (*a*), Jenkin, C. F. (*c*), Laidler, W. C. (*c*), Leggat, J. (*a*), Lind, E. G., Lord, F. A. B. (*a*), Lorrain, J. G. (*c*), Luke, P. V., C.I.E. (*b*), McCann, A. F. (*a*), McGeoch, W. (*a*), McMillan, W. G. (*c*), Madgen, W. L. (*a*), Mance, Sir H., C.I.E. (*a*), Marr, W. B. (*c*), Massey, W. H. (*c*), Mavor, H. A. (*a*), Mawdsley, H. St. H. (*a*), Meares, J. W. (*c*), Melms, G. J., Miller, H. W. (*a*), Moll, O. (*a*), Money-Kent, J. M. V. (*a*), Morris, Dr. D. K. (*c*), Morris, J. T. (*c*), Moul, H. E. (*a*), Mountain, W. C. (*c*), Neale, J, (*c*), Nisbett, G. H. (*a*), Nixon, C. B. (*c*), O'Gorman, M. (*b*), Peake, A. H. (*a*), Perry, H. H. (*a*), Plumtree, J. S. (*c*), Preece, A. H. (*a*), Pyne, A. P. (*c*), Quin, R. C. (*c*), Ralph, G. (*c*), Raphael, F. C. (*c*), Raworth, J. S. (*c*), Roberts, R. C. (*a*), Robertson, R. (*c*), Roget, S. R. (*a*), Rolph, W. M. (*a*), Russell, S. A. (*c*), Sadler, A. (*c*), Sandberg, A. O. F. (*a*), Sankey, P. W. (*a*), Schultz, G. (*a*), Scott, E. K. (*c*), Seaman, A. G. (*c*), Sellon, R. P. (*a*), Sheardown, P. S. (*a*), Short, S. H. (*c*), Siemens, A. (*c*), Sillar, A. M. (*a*), Smith, C. F. (*a*), Smith, R. H. (*b*), Snell, A. T. (*a*), Snelus, P. W. (*c*), Stansfield, H. (*b*), Steinitz, J. J. (*a*), Stottner, J. (*a*), Thompson, E. (*a*), Thompson, E. A. (*c*), Thompson, Silvanus P. (*b*), Tschendörfer, F. W., Tomlinson, H. J. (*a*),

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Tree, R. (c), Turney, A. T. (a), Tweedy, R. N. (b), Whalley, A. (b), Whitlock, A. A. (a), Wilkinson, G. (c), Williams, W. (c), Williamson, A. D. (c), Wilson, D. (c), Wilson, H. W. (a), Wilson, J. G. (c), Wood, A. P. (c), Woolf, J., jun. (c), Wyld, W. (c).

Arriving at Hanover at about half-past four on Sunday afternoon, the Institution party was met at the station by representatives of the Corporation of Hanover and of the electrical society of the town, in evening dress, who escorted a number of members to Messrs. Körting Bros. works, at Körtingsdorf, and to the Hanover municipal electric lighting station. Owing to a delay occasioned by a hitch in Messrs. Cook's hotel arrangements, only a short time was left for these visits, the time in Messrs. Körting's works being chiefly spent in the erecting shop, shown in Fig. 1, where the large double-acting gas engine, seen in the foreground of our illustration, cost of upkeep of the cells has proved too serious an item, and even those among the Hanover electrical engineers who were originally most enthusiastic in favour of this method of working, now confess that it was a mistake. The cars carry two sliding-bar contacts, and these are lowered in the town streets in which the cars are run from the cells with which they are loaded. On the way to Körtingsdorf, a few of the span-wires carrying the trolley wire were fastened on the one side to the iron telegraph posts, a fact which should interest our own Postmaster-General. Some of the tramway lines are supplied with current from a three-phase high pressure station 12 miles from the town; the current is conveyed by overhead wires and converted into continuous current by means of synchronous motor-generators.

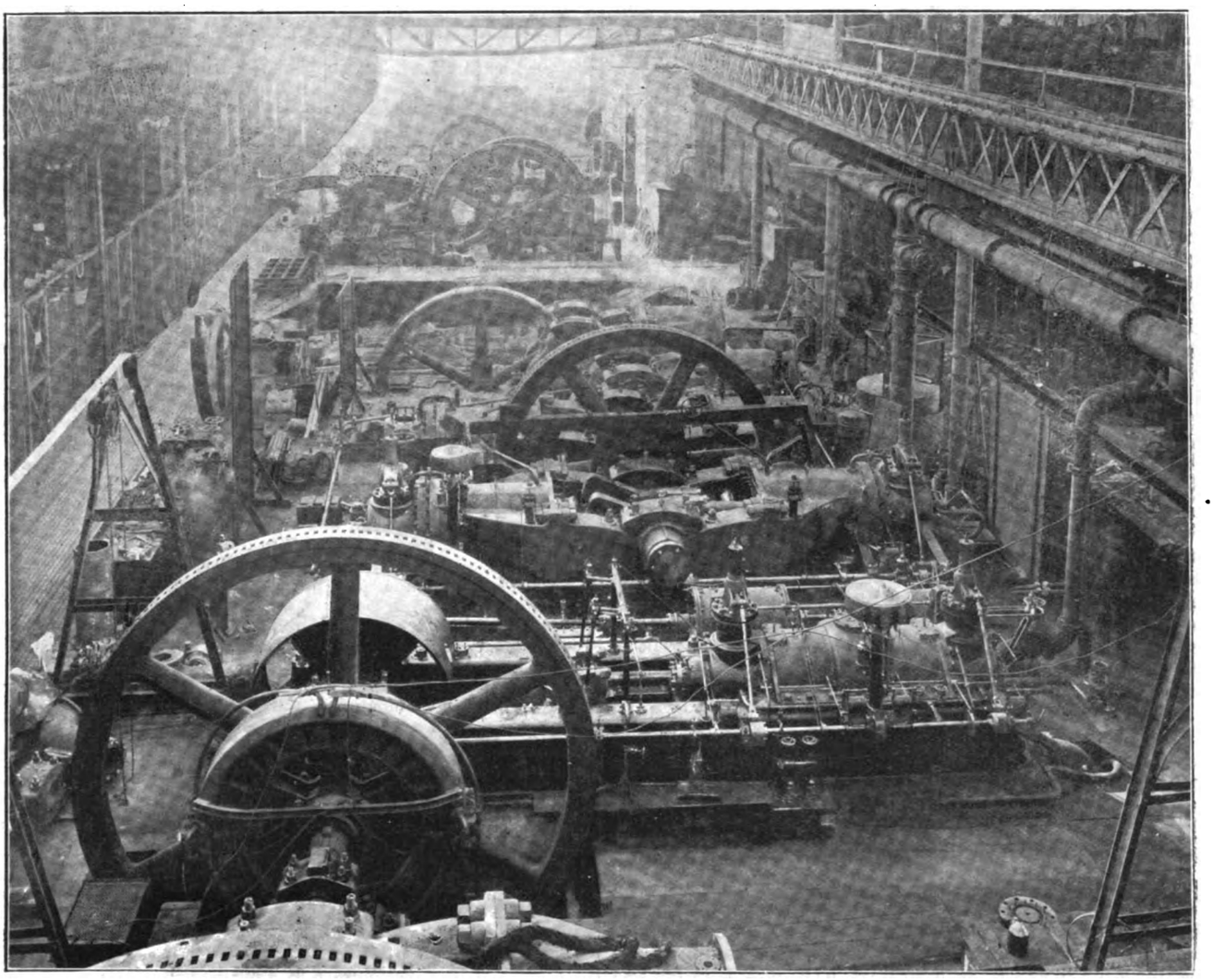

FIG. 1.—LARGE ERECTING SHOP IN MESSRS. KÖRTING BROS. WORKS, SHOWING 400 H.P. DOUBLE-ACTING GAS ENGINE IN FOREGROUND.

was in operation, and evoked considerable interest. This engine was described in *The Electrician*, Vol. XLVI., p. 544, and its main feature, it will be remembered, is that the gas is led to the cylinder ready mixed and compressed, and that firing takes place on both sides of the piston. The firm is making a speciality of gas engines of large power, the one shown in action being rated at 400 B.H.P., and larger ones up to 1,000 B.H.P. being in course of construction. In addition to gas engines, condensers and other engineering plant, Messrs. Körting manufacture electrical plant, but this department of the works was not visited.

A word may be said about the Hanover tramways, which, I believe, to have been the pioneer "mixed" system, using accumulators and overhead construction. In spite of the favourable reports during the early period of operation, the

The lighting station which the party visited is a continuous current 2 by 110 volt one, and has been in operation 10 years. At present it supplies all the needs of the town for electric light and power purposes (exclusive of tramways), but it is shortly to be superseded by a 5,000 volt three-phase station outside the town. Thus the present generating works are chiefly of historical interest, but two points in connection with them may be referred to. First, the original switchboard is still standing, in spite of the fact of its being built of varnished wood. Secondly, the enormous provision of secondary batteries was appalling. There are in the station three batteries (one quite recently put in) of large Tudor cells with lead-lined wooden boxes, the aggregate capacity of the three being no less than 7,000 ampere-hours (rated at about a three-hour discharge). In realising what this figure means it should be

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borne in mind that the dynamo capacity of the plant is only 2,000 H.P., and the lamps and motors connected to the network represent a total of about 4,000kw.

In the evening the visitors were most hospitably entertained at dinner by the Corporation of Hanover.

Hanover was left at 7.30 on Monday morning, and the visitors reached Berlin soon after noon. The first visit there was to the offices of the Allgemeine Elektricitäts Gesellschaft, where an exhibition of the Nernst lamp was made. The form of lamp now being put on the market is that described in detail in *The Electrician*, Vol. XLVII., p. 16, and the company hope for considerable success in the direction of a high candle-power lamp taking a fairly high pressure—400 to 500 volts—for street lighting, and to replace small arcs and incandescent gas lamps.

Some of the Berlin electricity supply works, built and worked by a company affiliated to the Allgemeine Elektricitäts Gesellschaft, were next visited, beginning with the Luisenstrasse-Schiffbauerdamm works, which are the largest within the town. A move was next made to the Moabit works, in the suburbs, which is a three-phase high-pressure works, built on the most modern German lines, supplying current to sub-stations within the town, one of these being also inspected. A fuller description of these works is reserved for a future article. In the evening the staffs of our two hosts, the Allgemeine Elektricitäts Gesellschaft and Messrs. Siemens and Halske, entertained all the guests at supper in the grounds of the exhibition of apparatus for life-saving and fire protection, where a very pleasant time was spent The speech of the evening was made by Herr Rathenau, managing director of the former company, who bade us a hearty welcome in an eloquent speech delivered in English, and Mr. Alexander Siemens responded suitably in German.

The weather, which had hitherto been fine and almost oppressively hot, underwent a change on Tuesday morning, and the journey to Messrs. Siemens and Halske's cable works by steamer was completed in pouring rain. By the time we left the works, however, the rain had ceased, and sunshine predominated during the remainder of the day, a pleasant luncheon hour being spent on the steamer on the way from the cable works to the Charlottenburg works of Messrs. Siemens and Halske, where dynamos and other heavy plant are manufactured. Descriptions of these works, as also of the extra high-pressure three-phase railway, in which current at 10,000 volts is led directly to the car, must be reserved for a future issue.

On Monday night the Institution and two engineering firms sent to Emperor William a telegram expressive of their deepest respect and profound admiration. A telegram expressing the Imperial thanks was received back on Tuesday evening.

*(To be continued.)*

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Blast-Furnace Gases.—Mr. Adolphe Grenier, in a recent Paper before the Iron and Steel Institute, drew attention to the difference in the amounts of dust in blast-furnaces gases, depending on whether the works were producing hæmatite pig iron from hard ores in lumps, when the dust is heavy and is deposited in the pipes and chambers, or, on the other hand, if the works dealt with oolitic ores, when large quantities of fine dust is carried to great distances. At Seraing, where the former condition holds, researches have shown that not more than 0·25 to 0·50 grammes of dust are present per cubic metre, and a 200 H.P. engine driving a dynamo has been running day and night for three years without being stopped down for cleaning the cylinder. On the other hand, at Differdingen, where oolitic ores are treated, after three weeks' running of a 600 H.P. engine, fatal results were experienced, and it was found that the gas contained 4 to 5 grammes of solid matter per cubic metre. The gases have since been cleaned by means of a centrifugal fan, through which the gases are passed. Water is also supplied through a pipe opening into the axial portion of the fan, and it was found that gas containing 4 grammes of dust left the fan with only 0·25 gramme. The total outlay for treating gas for six 600 H.P. engines was £400.

## PHYSICAL SOCIETY.

Ordinary meeting, held June 14, Prof. S. P. Thompson, president, in the chair. A Paper on

### "Herr Jahn's Measurements of the Electromotive Force of Concentration Cells,"

was read by Dr. LEHFELDT. Prof. D. Jahn has recently published measurements of E.M.F.s of concentration cells, from which he has endeavoured to show that the law of dilution is applicable to strong solutions. The author points out that his conclusions are based on argument in a circle because Ostwald's law is assumed in the formula used by Jahn for calculating degrees of concentration. The formulæ of Nernst and Arrhenius do not yield consistent results, and it is suggested that the former is suitable for calculating concentrations and the latter for calculating osmotic pressures.

A Paper on

### "The Mechanism of Radiation"

was read by Mr. J. H. JEANS. This Paper contains an attempt to obtain answers to two questions: (1) What inferences can be drawn as to the mechanism by which radiation is emitted from an examination of the formula of physical objects? and (2) is it possible, with the help of these inferences, to frame any conception of matter which will give a consistent account of the various optical phenomena? Starting with general spectroscopy, the author has written down the radiation due to a single rotating molecule vibrating harmonically. The effect of a number of molecules is deduced, and it is shown that the condition that the continuous banded spectrum shall be absent is that either the period of rotation must be large compared with the period of vibration or the radiation from a molecule must be spherically symmetrical. Passing on to dispersion, even if the radiation is continuous between collisions, there will be a discontinuity at every collision, and the train of waves will be no longer regular. It is customary to assume that the vibrations of a dispersing medium are sympathetic with the irregular incident light. The author has calculated the ratio between forced and free vibrations in a prism or grating, and finds that if the disperaion is to be regular the vibrations must be only slightly influenced by collisions, and this requires, as in the former case, that either the period of rotation is large compared with the period of vibration or the radiation is spherically symmetrical. As this is not the case with molecules, the author thinks that the line spectrum is emitted by atoms, that these atoms must be dissociated, and that the shape of these atoms is one of spherical symmetry. It is shown that if an atom is an electromagnetic system, similar to a planetary system, then the periods of such an atom would not be fixed, and there would be no reason for a line spectrum. The normal atom is therefore regarded as an electrostatic system, with some law of force, other than the inverse square law, holding at interionic distances. Such an atom when at rest would give a pure line spectrum. Rotation of such an atom causes the lines of the spectrum to shift towards the red, and as the rotation is different for different atoms, the lines will not only be shifted but broadened. To calculate the periods of vibration of an atom, the author has assumed it to consist of an infinitely great number of infinitely small ions. The spectrum of this consists of a collection of spectrum series, each possessing a definite head and capable of explaining doublets, triplets, &c. It is shown that under the action of a magnetic field a line may separate out into approximately equidistant lines, the central lines maintaining its position. In conclusion, the author points to many other physical phenomena which can be explained by the theory described.

The CHAIRMAN then submitted some

### Specimens of Jena Glass.

In describing these, reference was made to a diagram showing the refractory index, dispersion between the C and F lines, and the reciprocal of the dispersive power of any piece of glass. For this latter quantity the symbol "V" is used, and it was suggested to call it the achromatic refractivity of the glass. The introduction of barium increases the deviation, but leaves the dispersion unaltered. It is possible now to get crown glass with a higher refractive index than flint glass, and this makes it possible to construct an achromatic lens which will also give a flat field. It is usual in making achromatic objectives to make them accurately achromatic for the red and violet rays. A better effect can be obtained by having approximate achromatism throughout the length of the spectrum. This is achieved by matching the irrationality of one glass by means of another, and then constructing an achromatic pair with these two glasses. "Telescope crown" and "telescope flint" are two glasses which give similar spectra and approximate achromatism from the red to the violet.

The Society then adjourned until June 28, when the meeting will be held, by the invitation of Prof. W. G. Adams, in the laboratory of King's College.

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# PARLIAMENTARY INTELLIGENCE.

## LONDON UNDERGROUND RAILWAYS.

The Joint Parliamentary Committee on London Underground Railways met again on Friday last, Lord Windsor presiding.

Mr. CHAS. BOOTH, well known as a writer on the housing question, said he considered the means at present provided for railway communication in London very inadequate, and electric traction gave an opportunity of having a more adequate service. At present London was very much behind, not only the American cities, but some of our provincial cities. What he wished to see was a general extension of the means of communication, so that people could get about more easily, rapidly and cheaply.

The CHAIRMAN: Therefore, what you wish to see is a complete scheme of tube railways covering the area around London?

WITNESS thought a complete scheme was desirable, in order that what was done might be brought into general harmony.

The CHAIRMAN: And you think the facilities could not be well provided by any other power of locomotion than electricity?

WITNESS replied that it was certainly immensely superior to any other. The provision of these railways would afford more scope for people to choose houses. The Great Eastern Railway had done much more than any other railway in the direction of cheap fares, and they had seen the population grow in their districts very rapidly, whereas railway communication towards the south-west was notoriously insufficient, and the population had not grown so much. As to the Inner Circle Railway, he thought the line would be of immense value with an effective electric service, and would act as a feeder for the outer lines, which he imagined would remain as now. As regarded fares, he thought a twopenny system over the whole of London would be practicable and profitable. He thought services of electric trams at the termini of the tube railways would be of great value. A more general system of allowing London to expand would be far more successful than isolated efforts to provide for particular patches of population displaced in districts by railway companies. The present obligation of the railway companies to provide housing accommodation for a displaced population stood in the way of public improvements generally. He thought the London County Council would be by far the best authority to undertake a large scheme for the extension of locomotion, especially in the matter of surface electric locomotion. Underground tubes should only be undertaken by such an authority, he thought, where they formed a great public convenience which private enterprise would not carry out, but the London County Council should have powers of initiation under the control of a central authority.

Col. YORKE, Chief Inspecting Officer of Railways to the Board of Trade, said the essence of tube railways was in the direction of rapidity and regularity of service. He strongly held that the arrangements for working such railways should be of the simplest character. The result of a collision in a tube might be of a very appalling character, and he thought there were risks connected with tube railways worked by electricity which were not in existence upon an ordinary open-air railway. The particular risks he referred to were those connected with the confined space and the impossibility, in case of a collision, of the cars moving laterally out of the way, say, of a colliding train, rendering them liable to be wedged against the side of the tube with possibly very disastrous results. There was also danger due to the presence of highly-charged electric conductors, which, apart from any possible injury it might cause to passengers who came into contact with it, was also liable to cause fire and, what was worse, smoke. A very small fire, which in the open would be of no importance, might create a volume of smoke in a tube which might be of the most dangerous character. Special care should be taken, therefore, in the regulations for working tube railways, and he urged that confluent junctions should be as far as possible avoided. As soon as the railways came into the open, however, he did not see the same objection to those junctions. His experience showed that the safety of a junction depended as a general rule on two factors—the block working and signalling. To attempt to carry out the block system on a line in which trains were likely to be so numerous as on tube railways would be hopeless, as it entailed a considerable reduction in the number of trains. He entirely agreed with Sir Alexander Binnie that a confluent junction was incompatible with a rapid train service on any line, whether tube or otherwise. Signalling in tubes could only be confined to a very small space, and a very small curvature in the line or gradient would obscure the signal from the driver until a train came near to it. For that reason signalling in the tube railway could never be as satisfactory as in the open. It would, therefore, not form a satisfactory protection for the junctions, which led him to form the opinion that these junctions should not be made in the tubes. Separate and distinct systems were preferable for safety, regularity and rapidity of service. Interchange stations should be provided where lines crossed each other or near to each other. With regard to loops, the question depended so much on local circumstances that it was difficult to lay down fixed rules, but in his judgment it was not necessary to make provision in all cases for loops, although in a large number of cases they seemed to be desirable. He thought that by the multiple unit system the desirability of loops would be somewhat modified as there would be no delay due to the detaching of one engine and the attaching of a second engine. In such cases the question of a loop depended on other circumstances, such as the length the train would have to run, the positions of the cross-over roads and signals, the mode of working the terminus, and, finally, the cost. As to points and crossings, however perfect they might be in details, and however careful as to signals, there were always spots on the railway where derailment was more likely to occur than elsewhere. The only derailment in curves of the Central London Railway had been caused by shunting trains at terminal stations through the points from one line to another. Of course derailment of that kind blocked the system all round. He did not think the loops formed any obstacle to other lines passing through the same neighbourhood. There were considerable advantages in single line loops. If used for passenger trains, as proposed, at the city end of the Central London Railway, the radius of the curvature should not be less than 5 chains. He thought that radius could be given without hesitation, inasmuch as it already existed on the City and Waterloo Railway.

Replying further to the CHAIRMAN, Witness said he could see no objection to lines being constructed in tubes where necessary, and emerging into the open, worked by electricity. He thought the sooner the line got into the open the better, as it would be more economical of construction. In the interests of simplicity the shuttle system was probably the best. He thought departmental or municipal control would have the effect of retarding enterprise. Uniform fares should be made where possible. He was afraid an all-night service of trains was absolutely impossible on tube railways, as it was essential that the line should be patrolled and examined every night, and that would take, at least, three or four hours.

Mr. MOON, counsel for the Islington and Euston Railway, on Tuesday addressed the Committee and uttered a caveat against the adoption of uniform fares, which, he contended, would not suit all the lines, and certainly would be ruinous to the City and South London line, which had tried the system and had since had to modify it.

Mr. BALFOUR BROWNE, K.C., on behalf of the King's-road, West and South London Junction, North-East London, Hammersmith and Charing Cross and Piccadilly and City Railways, said: On the question of close circuits as against through routes, the close circuit was undoubtedly wrong in principle. The consensus of opinion, leaving out Sir Alexander Binnie, was certainly in favour of the through shuttle system. A close circuit entailed all the difficulties as to confluent junctions, which were apparently condemned. He agreed as to the danger of confluent junctions in tunnels, but where there was such a junction, as they proposed to put at Upper Clapton on the North-East London, with a fly-over junction, there could be no objection to it, if far enough out. He contended that emphasis should be given to the report of the Committee on Electric and Cable Railways. That Committee had reported on the question of sub-soil, and expressed the opinion that in the case of private property not in the public streets, it appeared desirable that the companies should be allowed to acquire a wayleave instead of purchasing the freehold of the land, subject to the terms of the Land Clauses Act as to compensation. In the case of public streets, the Committee thought it expedient that a company should be empowered to pass under a street at sufficient depth without payment of compensation for the wayleave, but that the company should be put under the obligation of furnishing an adequate number of cheap and convenient trains. The promoters of the scheme he represented were quite prepared, where they came under private property, to pay for wayleave.

Lord KNUTSFORD: Does payment of a wayleave put you in a different position as regards compensation for damage after construction?

Mr. BALFOUR BROWNE: No; it relieves us from the obligation to take the whole property, but at the same time the wayleave would be given subject to the terms of the Land Clauses Act as to compensation. By those terms, if a person can show he is injuriously affected, either by the construction or by the working of the railway, he can get compensation. Therefore, if I get a wayleave under the street and he can show there is any depreciation of his property or vibration he can certainly get compensation. Counsel proceeded to explain the law as regarded negligence in not using the best possible means of avoiding damage. Suppose, he said, it was shown by Lord Rayleigh's Committee that the multi-motor system of working railways was the right one, the Central London Railway could not, he thought, defend an action if they continued to work on the old system by means of locomotives.

Lord KNUTSFORD: As long as they work as well as they can with present knowledge and experience, then a man cannot recover compensation for damage?

Mr. BALFOUR BROWNE: They could recover from damage in construction, but not during the working.

The CHAIRMAN then said the Committee considered they had concluded the evidence, but counsel for owners, lessees and occupiers thought they were insufficiently protected against damage and annoyance, and the Committee were prepared to hear them.

The Committee then adjourned until July 2.

## LONDON UNITED TRAMWAYS BILL.

Before the Select Committee of the House of Commons presided over by Sir John Kennaway consideration of this bill was resumed on June 21, when evidence was called for the promoters.

Prof. S. P. THOMPSON (examined by Mr. Balfour Browne, K.C.) said he had studied the questions arising from the effects of electric currents flowing in conductors and of those flowing from one conductor to another, and he had a familiar knowledge of the circumstances under which electric current flowing out of or into a metal conductor produced corrosion and other chemical action. So long as the electric current flowed along in a metal conductor and was confined to that conductor it produced no chemical action. To produce electrolysis the electric current must pass out of the metal conductor into some liquid or moist soil. A different chemical action was produced on the current re-entering the metal. Electrolysis only occurred at the place where the current left or entered the metal. The action differed, however, in the two cases. Corrosion or solution of the metal occurred at the surface on exit; at the surface on re-entrance, instead of solution or corrosion, there was a tendency to deposit. There was no deposit or corrosion so long as the current flowed in metal.

What does the amount of corrosion depend upon?—The strength of the current and the time the current is flowing.

Now, in a place where electric current may be leaving an iron tramroad rail embedded in moist soil, what effect would a current of 1 ampere pro-

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duce in a given time?—A current of strength 1 ampere lasting for one hour, under the most favourable circumstances, would remove about 15 grains of iron from the rail.

Does saline water form a better conductor than ordinary fresh water?—Certainly. Any salines or alkalines or acids increase the conductivity and increase the electrolytic action.

Now, as to the figure of 15 grains an hour. You would not expect to find that occur in connection with any tram-rail in a street?—It might; but that is the worst that could happen.

You can show this by a very simple experiment which will illustrate the fundamental point of the case?—Yes. I have prepared two glass tanks. [The tanks were placed on the table before witness.] One tank contains sand and salt water. There are embedded in it at a distance from one another two pieces of common iron gas pipe, and a current introduced by wire into one is caused to flow from the first piece to the second. It will be found when taken out that the piece of metal by which the current entered the moisture is corroded, and the other where the current entered the metal is not. [Witness demonstrated this to the Court.] In the second tank there is also sand and salt water and some other pieces of pipe, but they were bonded together with metal. On a current being sent into one and taken out of the other there was no corrosion of either, the reason being that the current did not leave the pieces of pipe, but passed from one to the other by means of the metal bond.

In the case of current returning through an iron tramway rail it has to pass along a long length of rail, and there is inevitably produced a fall in potential between the two ends of the rail?—Yes.

Is that due to the resistance offered to the passage of the current?—Yes. The rail offers a certain amount of resistance. The higher the resistance the greater the fall of potential. Unless special devices are provided, the rails at the part of the line most distant from the generating station will be of higher potential by a few volts than the rail at the other end, and if you have a higher potential at one end than at the other the tendency is to leave that which is high and to get at that which is low. In order to prevent a large departure of electricity from the conductors the fall of potential must be kept small, and it is limited by Board of Trade regulation to 7 volts, the object of the restriction being that the tendency to leak or stray may be minimised. If the fall of potential were excessive between any two points in a rail a large fraction of the current, instead of going back to that rail, would leave the rail and find for itself stray paths through the earth.

And in taking stray paths through the earth it might chance upon a conductor, such as a water pipe, and come along that?—Certainly, and where it went into that pipe, if it did anything, it would deposit something. It certainly does not take anything from the pipe where it enters the pipe. There is no corrosion where it enters the pipe.

In your view, not alone, but taken in connection with the other regulations of the Board of Trade, does that give protection to the water pipes?—It would not give protection alone, but with the other regulations it does. The other regulations amount practically to this—that though a 7 volt drop in the potential may be allowed on the system as a whole, there must not be a greater drop on one line than something a great deal less than 7.

Witness read regulations 6 and 7 of the Board of Trade relating to tramways and light railways,* as follows:—

> (i.) The current passing from the earth connections through the indicator to the generator shall not at any time exceed either 2 amperes per mile of single tramway, or 5 per cent. of the total current output of the station. (ii.) If at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return.

Regulation No. 7 is:—

> When the return is partly or entirely uninsulated a continuous record shall be kept by the company of the difference of potential during the working of the tramway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limits of 7 volts the company shall take immediate steps to reduce it below that limit.

That fixes the absolute minimum quantity of electricity that can return to a given mile of tramway. It also fixes another thing. The current allowed to stray back through the earth is not to exceed 5 per cent. of the total output of the station. No. 2 really provides to an inspector a simple experimental means of testing, by using a galvanometer and a Leclanché cell, whether there is or is not an amount of fall of potential likely to cause damage. That can be carried out quite easily in a very few minutes. All you require is to connect one wire with the rails, and to carry the other to something in connection with the gas or water main—say a tap.

Are there different methods by which it is easy to prevent any deleterious electrolytic action upon gas or water mains?—Yes. The first is by reducing the resistance in the rails by bonding.

Besides that, is it quite possible by means of a bond from the pipe carrying the current to take back the current to a negative pole at the generating station?—Yes.

If that were done there would be no corrosion at all?—Not if that were done suitably. I do not think that is necessary to be done if you are working under the Board of Trade regulations; but it can be done, and it would be an absolute protection at the place where corrosion is most likely to occur.

The CHAIRMAN: To do that you would have to put a conductor somewhere in all the water pipes near your generating station or the chief main?—At the nearest point at the generating station you would have to make a metallic connection with the water-pipe by a good copper bond, which would carry the current back to the station.

Mr. BALFOUR BROWNE: Then you have a metallic track back from the rail to the station?—It is provided for in clause 8 of the Board of Trade regulations.

Besides that, can you also facilitate the return of the current without damage to the pipe by what are called return feeders?—Yes, that is regularly done. In order that the whole of the current shall not have to flow along possibly some miles of rails back to the generating station, it is usual to provide at certain points at distant parts of the line return feeders. You tap the returning current, draw it off, and bring it back. The rails would carry nearly all, but there would be such a fall of potential if all the current came back by the rails that there would be a tendency to leak.

There is also one other means by which it could be prevented—a negative booster? Yes, a negative booster is an electrical device which sucks away automatically the returning current to a feeder and enables you to lower the potential to any extent that you please. [Witness exhibited a model consisting of two lines of brass rails embedded in a moist bed of blotting paper wetted with brine and an iron pipe laid on the same bed along side the rails, and, by passing an electric current through the rails, showed how electrolytic action on the iron pipe was produced by the passage of the current from the rails through the bed of blotting paper to the pipe.]

Mr. BALFOUR BROWNE: Have you been able to discover any electrolytic corrosion in pipes in connection with tramways which are worked under the Board of Trade regulations?—I have known of no case.

In your view are the Board of Trade regulations sufficient for the protection of the water companies?—I think they are.

Mr. PEMBER, K.C. (in cross-examination): We need not bother ourserves on any question about deposit on entering. We seem to be agreed that the question is what happens on the current leaving?—Yes.

There is one question that seems to cover a good deal of ground, Taking the Board of Trade regulations as you have described them, do they prevent a current entering, flowing along, and leaving a water pipe in the neighbourhood of one of your tramways?—They do not prevent it; they minimise the amount that can so act. They keep it within bounds.

You said you do not know an instance of electrolysis where anything in the nature of a tramway like this has been worked under Board of Trade regulations, I ask whether you have heard of one instance in the Clapham-road where, quite lately, I think in May of this year, a gas pipe was found to be corroded owing to the action of the currents from the South London tubular railway?—You are speaking of a railway, not a tramway on the surface.

The same regulations affect that railway as affect the tramways. Do you know that instance?—No.

Mr. BALFOUR BROWNE: I am instructed they are not the same regulations as are applicable to the South London railways. I will put in a witness who will tell you the difference.

Mr. PEMBER: In the meantime I suggest that acting under the Board of Trade regulations in the Clapham-road, in consequence of the working of the South London Railway, a gas pipe has been absolutely corroded through.

Mr. BALFOUR BROWNE: We do not know when the corrosion took place, but we do know that for eight years that railway was worked without any regulations whatever.

WITNESS agreed that one great difficulty in discovering what damage was being done was the difficulty of getting at the pipe to inspect it.

Mr. PEMBER quoted from evidence given by the late Sir Courtenay Boyle to the effect that it was absolutely impossible for the electrical adviser to the Board of Trade to conduct anything like a general inspection of the tramways of the country, and asked witness if, supposing one of the London water companies' pipes was corroded through and burst, the first appearance on the scene of the Board of Trade inspector would not be when the damage was done.

WITNESS agreed, and also that the damage would affect the people of London generally very seriously. Bonding was not too expensive for it to be done always. Whether compulsory or not under the Board of Trade regulations, he was certain no company would avoid it. Return feeders were not compulsory except in the sense that in a very long line it would be absolutely necessary to use them in order to comply with the regulations about the maximum of fall of potential not exceeding 7 volts. Return feeders were generally but not always placed under ground. Negative boosters also were not compulsory, but they were things which a company willingly adopted when it was necessary to reduce the potential; and they were above ground. The joints on the water companies' mains differed immensely in their conductivity.

Is there not a tendency, wherever there is one of these joints which is a poor conductor, for the current to jump the joint?—Whenever there is a resistance of any kind in the bond there is a tendency for the current to leak round that place. He agreed that although the joints might not make good metallic connections between the pipes, they might still be perfectly good joints from the water companies' point of view. At a joint of high resistance there would certainly be a tendency for the current to leave the pipe and stray round through the earth to the pipe again.

Whenever that occurs this corrosion will go on at the point where it leaves to make the jump?—I said there would be a tendency to leave, but I do not say it would actually occur.

Will you tell me your idea of the lowest pressure at which it would bring that about on iron pipes?—I think it would require something greater than one-sixth of a volt. The smallest potential I have found capable of doing that is one-sixth of a volt.

Would you not get a current through ordinary tap water with one-hundredth part of a volt?—Not continuously, because the very first moment the current begins to flow it deposits a film of hydrogen on re-entry and that blocks the way.

* See "The Electrician" Electrical Trades' Directory and Handbook, 1901, pp. 196—200, for the full set of these regulations.

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Supposing there is a high resistance at one of the joints, would there not also be a tendency for the current to leave the pipe and go into the water inside?—Yes, if the joint was electrically bad.

If that were so, going into the water inside the pipe, it would leave the inside surface?—It might.

Then the corrosion would be inside?—If corrosion occurred it would be inside.

And, of course, it would not be found out until it had gone right through the pipe?—Yes. He agreed also that there might be an enormous number of joints in the portion of a pipe in which electrolytic action might occur. One ampere producing 15 grains of corrosion per hour worked out to 14lb. of iron per year.

Re-examined by Mr. BALFOUR BROWNE: On the South London Railway the current was far greater than would be used for tramway traction.

With regard to legal penalties: As I understand, the Board of Trade is not the guardian angel of the water companies; they must look out for themselves. Under regulation 6 have they not every opportunity of finding out whether any damage is being done or not?—Yes.

Would not the difference of potential at once suggest the necessity of inquiry?—It would. The Board of Trade regulations and the fact that the tramway company would be responsible at common law if they acted outside them, afforded full protection to the gas and water companies. Further, although the Board of Trade did not inspect, yet the tramway companies were compelled to keep a continuous record of the fall of potential, and if there was an abnormal fall it was *prima facie* evidence for injury.

All the Board of Trade regulations are to prevent a great fall of potential?—Yes.

If the potential were kept up absolutely there would be no damage whatever?—That is so.

Do you know that the drop in potential of the South London Railway was shown to be 20 volts?—I thought it was higher.

The CHAIRMAN: Is that as compared with the seven laid down by the Board of Trade?—Seven is the maximum laid down by the Board of Trade, and it means, therefore, an average of about three.

In further re-examination, Witness said that if there many bad joints along a line of pipes, the conductivity would be reduced. It was because the pipe, taken as a long length, was a conductor that it drew to itself stray currents. If there were a series of bad joints the current would not travel by the pipe at all.

Sir WILLIAM PREECE, examined by Mr. Lewis Coward, K.C., said he had devoted considerable attention to electrical disturbances in the earth for the last 40 years, first in connection with telegraphs and submarine cables, then with railway signals, lightning protectors and telephones, and more recently with magnetic observatories and with water and gas pipes. There were always electric currents flowing through the crust of the earth, sometimes acquiring great magnitude, especially when the sun's disc was affected by spots, and also when atmospheric electricity was excited. At certain periods—when we had the aurora borealis—the crust of the earth was filled with electricity, which affected all telephone wires when they used the earth. He had known the whole telegraphic service of the country broken down by occurrences of this character. These currents entered into and flowed through complete metallic conductors, which were in contact with the ground, metal pipes conducting so much better than the earth. Cables were damaged, and the ground connection of lightning rods destroyed. Railway signals had been reversed, and magnetic records rendered useless. He had also known iron and lead pipes to be seriously corroded. It was easy to tell how far these effects were due to natural earth currents, atmospheric currents, induction, or contact with or leakage from industrial mains. He had given evidence before Lord Cross's Committees in 1893 and 1896. Those Committees had come to the conclusion that electrolysis was due to faulty construction, which they thought could be reduced to a minimum by improvement in this direction. They had said that the Board of Trade should make regulations to secure the best system of working electric tramways. The Board of Trade had, after conference with representatives of the water, gas, and tramway companies, and of all parties interested in electrical enterprise, made such regulations in March, 1894. Those rules and regulations had entirely fulfilled their purpose, and were complied with by all electrical industries. The Board of Trade regulations admitted the adventitious use of the earth in the distribution of electric energy, but they mitigated any injurious action due to such use so as to make it practically negligible. At the present moment these rules were not carried out. Official tests should be made all over the country periodically. He had discussed the matter with the late Sir Courtenay Boyle, and that gentleman had objected to his proposal on the ground that it would add very much to the number of the Board of Trade staff, but witness felt that, in the present state of the tramways of the country, one additional inspector, with another appointed in the course of a few years would be all that would be required, and would enable the Board to see that the regulations were properly carried out. The object of the tests under the Board of Trade regulations was to give the water companies and gas companies the simplest possible means of testing for themselves whether or not the regulations were carried out.

There is no difficulty in getting returns?—None whatever.

No one, I suppose, can claim a monopoly of the earth?—No, the telegraphs have always used the earth, and the electric light and tramway undertakers are allowed to do so under the Board of Trade regulations. Anyone can and does use the earth if he pleases. All injurious disturbances arising from this use of the earth are remediable, but the absolute remedies are too costly, and must check progress and enterprise. It is purely a question of £. s. d.; the evil can be cured, but the question is, can it be cured at such expense as to justify the steps requisite.

It is plain from the regulations that not only the undertakers themselves, but the complainants, can ascertain whether or not they are being complied with?—That is so. I might add that they are not fixed rules and regulations. They are elastic, and are subject to reversal or alteration at any time by the Board of Trade, who are always ready to listen to representations as to defects in their system. The Board of Trade regulations indicate the existence of disturbances, and define the mode for their removal. Even admitting that in a few exceptional cases the existing regulations of the Board may not give absolute security, the proper course would be to lay the special circumstances of the case before the Board of Trade, with a view to obtaining suitable modification. The electrical corrosion of pipes depends simply upon the direction in which the currents flow. If they flow into the pipes there can be no corrosion, but if they flow out there will be corrosion.

What are the remedies for this state of things?—There are several. The first is rather a drastic one. It is to get all the pipe systems into one conducting mass, and remove all bad joints from the gas and water pipes. Of course, with thousands of miles of pipes laid down it is quite out of the question to do this with the old pipes, but in all new undertakings it should be done. I think the gas and water interests see the advantage and necessity of making perfect joints, and the bulk of them now are using lead in the joints, which makes a perfect joint. I know it is a perfect joint in a water system, as the tests we made at the Post Office show there is no fall of potential when that is done. The second remedy is to connect the conducting mass to the negative pole at the power-house. The third is that adopted by the Board of Trade—the reduction of the potential difference between the terminals of the uninsulated return to the lowest limit. The Board of Trade allows 7 volts, but in practice it is much less than this. The seven might be made five. The 7 volts was adopted at the suggestion of one of the representatives of the water companies. No company has ever found the smallest difficulty in meeting that regulation. The drop of potential as a rule is very much less than 7 volts, and the Board of Trade might well reduce the volts to five.

The fall of the potential is the matter to be decided?—Yes. The fourth remedy is a proper control of the direction of the current. If we find that the current is leaving the water pipe, it is not difficult to reverse it or change its direction. That can be done by what was referred to by the last witness—a negative booster or a positive booster. Then we have the use of insulated returns, and there is another certain cure for all these troubles, and that is the use of alternating currents; but with our present experience the use of these currents for tramways is out of the question—it is impracticable. Lastly, the whole principle which underlies the maintenance of all these things, so far as the evils and dangers are concerned, is prevention rather than cure—periodical testing and recording. You do not want to wait till the pipes are corroded to remove the cause of the corrosion.

Cross-examined by Mr. BAGGALLAY, K.C.: You are not satisfied with the Board of Trade regulations?

WITNESS: Yes, I am.

Then why have two pages in the act of 1898 for the special protection of the Postmaster-General—sec. 44 of the act of 1898. Is that unnecessary?—Certainly not.

The telegraphs and telephones of the Post Office require protection outside the Board of Trade regulations?—They do.

Mr. BALFOUR BROWNE: But that is not in reference to electrolysis.

Mr. BAGGALLAY: It is for protection from stray currents in working electrical undertakings.

Mr. BAGGALLAY (to Witness): But you have given us a number of remedies. For what?—To mitigate the effects of electrolysis on water or gas pipes.

Then you think there are further remedies necessary?—I said the whole of the regulations of the Board of Trade were to mitigate the evils.

Is it the fact that there is at present an evil that has not been sufficiently coped with?—No. I have said that the Board of Trade regulations are quite sufficient. I have given a list of possible remedies, but I have pointed out why some of them are impracticable.

If you could bind the old joints in the pipes you would recommend that to be done?—Yes. In new works it should be done.

In 1898 you said there was one difficulty which, up to that time, had not been entirely removed, and that was in connection with "the working of tramways by trolley wires as they were called." You said, "there are these currents running about wildly, affecting water pipes and gas pipes," and you went on to say that they had, in three or four instances, affected very seriously the lead-covered cables which you were using now in England for telegraphic and telephonic purposes. You said that the remedy for this had not yet been applied, and that gas explosions had occurred through these stray currents?—Yes.

That was four years after the Board of Trade regulations had been made?—Yes.

And, notwithstanding that evidence of yours, no alteration has been made in the regulations?—No. My point is that the Board of Trade regulations were not fully carried out, and that the Board of Trade should see that they were.

You say they are not sufficient for the trolley wire system?—Well, I can answer that question better now than I could then. In the last part of my answer about lead covering I had a Clapham Junction case in my mind. There we had several currents escaping and passing through the pipes. Owing to lightning or some other cause a spark fired an accumulation of gas.

Unless you have insulated returns there is an uncertain quantity of electric current escaping, and it is exceedingly difficult under the existing regulations to know what damage is being done?—I have stated distinctly that it is under control.

Then why do you want these two pages of regulations for the Post Office?—Witness was understood to say that the regulations were adhered to because they were in the old form. It was true that the Post Office insisted upon them in all bills. Special precautions were taken in the laying of leaden pipes. The joints were leaded and did not require bonding.



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You are careful to do that which the water and gas companies cannot do with their pipes?—We do that which we want the water and gas companies to do in the future.

Mr. BAGGALLAY: Sir Courtenay Boyle said that the Board of Trade regulations could be amended——

Mr. BALFOUR BROWNE: And he added that they had been.

Mr. BAGGALLAY (to Witness): Sir Courtenay Boyle said that water and gas companies were innocent users of the road, and could not protect themselves. Do you agree with that?—They are innocent users, but they can protect themselves.

That is so with regard to new pipes that they may lay down now, but not as to the old pipes?—Practically, the trouble exists not with water but with gas pipes.

Witness, in further cross-examination, said that they could not tell whether electrolysis was taking place without uncovering the pipes—and could not always tell even when they were uncovered. In the case of water pipes, formerly the joining was done very imperfectly, and an electric current reaching the main would go along the metal or through the water. If it went through the water he could not see where the corrosion would come in. But the whole thing had been grossly exaggerated. The Board of Trade regulations admitted a loss of 2 amperes per mile of tramway, but if it were double that—4 amperes per mile—it would take 10,000 years to destroy the water or gas mains.

But you have said in evidence on a previous occasion that the pipes have been corroded, and that there has been an escape from them?—That has been from fusion—from absolute sparking. To my mind, the Board of Trade require strengthening in the inspecting department, to see that their regulations are properly carried out.

Re-examined by Mr. BALFOUR BROWNE, Witness said that sec. 44 of the Act of 1898, which was for the protection of the Post Office, had nothing to do with electrolysis. It had to do with induction and leakage, which would disturb telegraphing and telephoning, but which was not calculated to eat away pipes.

As a practical man, do you think that the Board of Trade regulations are sufficient for the protection of these companies?—I do.

Do you know of a single case of damage to a water pipe through electrolysis?—No. I have to gas pipes, but that has been owing to abnormal circumstances.

The CHAIRMAN: What occurs to me is this: It is admitted that there is some danger to the mains from the action of the electric current, but how much is entirely speculative. We may have evidence that damage will not be done in 10,000 years or that it may be done at any moment. It seems to me that in this way the inquiry might go on *ad infinitum*. Is not it the fact that you want these regulations strengthened? I do not know whether pipes that have been corroded are to be produced.

Mr. BAGGALLAY: Yes, we are going to produce some.

The CHAIRMAN: I think we have it clearly before us how, possibly, danger may arise.

Mr. BALFOUR BROWNE: If the water companies can prove it to you they would have proved it to the Board of Trade.

The CHAIRMAN: The only question is whether the Board of Trade regulations require strengthening.

Mr. HELM: It would save time of the Committee if counsel would confine themselves to addressing such arguments to us as will compel us to grant powers which cannot be obtained under the present Board of Trade regulations.

Mr. PEMBER said he was asking for more than Board of Trade regulations. He maintained not only that it did not require 10,000 years to effect electrolysis under the Board of Trade regulations, but that it had already been brought about.

The CHAIRMAN: Yes, we have it before us that damage is done from time to time. Is it worth while going further into the matter?

Mr. PEMBER said that for the petitioners he would not call lengthened scientific evidence. The ground was cleared to a large extent, for Prof. S. P. Thompson admitted that damage occured whenever the current temporarily escaped from the metals.

Mr. BALFOUR BROWNE: He does not admit that it takes place where the difference of potential is under 7 volts.

Mr. HORACE F. PARSHALL said: As consulting engineer I have had a long experience in connection with electric traction, and have advised, in this capacity, the Central London Railway, the Dublin United Tramways, the Glasgow Corporation Tramways, and others. I am also consulting engineer to the London United Tramways, and I am advising this company in regard to its electrical arrangements. In none of the installations I am connected with, nor in any other with which I am acquainted in this country working under the Board of Trade regulations, has there been any indication of electrolysis. Electrolysis would be as dangerous to the different tramway companies working by electricity as to the gas or water companies, since the cables for working the tramways are laid parallel and near to the rails, are uninsulated from the earth, and have metallic sheathing comparable with gas and water pipes in electrical conductivity. In both St. George's power station, Bristol, and the Dublin-Dalkey installations, which have now been installed for a number of years, lead-sheathed, high-tension armoured cables are laid parallel to the track, and were there a difference of potential between the cables and the track sufficient to produce electrolysis the iron armouring and the lead sheathing would have been eaten away and the cables rendered useless. When the lead sheathing of a cable is punctured, it is only a matter of a few hours before the insulation of the cable fails, and the cable becomes useless. The cable sheathing in both of the above cases has been examined from time to time, and there has been no evidence whatsoever of electrolysis or corrosion of any form. The same applies to the rails and bonds, since, if the current left the rails at sufficient potential to produce electrolysis, the rails and bonds of the company would deteriorate. Such deterioration has not occurred. In the great majority of installations lead sheathing is used drawn into ducts and insulated from the earth. Thus in Bristol there are some hundreds of miles of cables drawn in in this way. Since the Dublin installation was started, there have been generated some 28 million ampere-hours, which would be sufficient to deposit some 70 or more tons of lead, or twice the amount on all the cables were electrolytic action happening. Yet the most careful investigations have shown that the lead sheathing, which is continuous and of high conductivity, and on account of its nature more subject to electrolysis than gas or water pipes, has not suffered. In Bristol three separate investigations have been made by the water company, two of these by Dr. Fleming, and he has been unable to find any trace of electrolysis. The water mains entering the power station would be particularly subject to electrolysis, since the current would naturally gather round these pipes in the vicinity of the station. I have examined such pipes, and have found no evidence of electrolysis. The results of all this indicates that the earth acts as a conductor of current, and not as an electrolyte. The distinction in practive amounts to this: that current flowing through conductors does not produce electrolysis. For the production of electrolysis it is necessary for a current to flow from one conductor to another, through a suitable electrolytic solution. It would be unfair to subject the undertaking to a special clause entitling the existing companies to the right of litigation, since the company is already burdened with a large capital expenditure in order to comply with the Board of Trade regulations and to give that amount of protection required by the Board of Trade, which has clearly been proved to be ample. The additional cost as regards sub-stations, track feeders and boosters to comply with the Board of Trade regulations throughout the London United system will not be less than £50,000, which sum, if placed at interest, would be more than sufficient to provide against any litigation or damage which could be proved as having been caused by electrolysis were the installation worked in the ordinary way. A certain amount of corrosion of pipes takes place at all times, and in litigation which has heretofore occurred where the installation has been put down without any rules or regulations, it has been found extremely difficult to separate natural corrosion from electrolytic action.

The CHAIRMAN asked for what purpose the cables were used.

WITNESS: To carry electricity from the power-station to remote parts.

Cross-examined by Mr. PEMBER, Witness said that no doubt if no one had any interest in the matter but the tramway company themselves, they would have a much freer hand. He thought when they had complied with Board of Trade regulations they had done enough to make other people safe.

You are the agressors in this matter. The water companies pipes were there first, and their pipes are quite passive and innocent.—We are as innocent of injury to them as they are to us. I do not say that electrolysis cannot take place under any circumstances, but I say that under no circumstances where lines are worked under Board of Trade regulations can it occur.

Have you heard of the Liverpool instance?—I have heard of it, but if they are killing people there I do not see how they can be working according to the Board of Trade regulations. No doubt the lines are worked by responsible people—the Corporation. The Corporation were the gas and water as well as the highway authority, and they would hesitate to ruin property which had cost them millions if there was danger under the Board of Trade regulations. In Dublin they had return feeders to pick up 90 per cent. of the return electricity. About 20 per cent. came back in the lead sheathing of the cables. The rails had been laid in those parts of Bristol where electrolysis was most likely to occur about seven years.

Mr. JOHN R. SALTER, C.E., said he was connected with extensive systems of tramways in West London, Bristol, Stockton-on-Tees, and other places. During the time he had been connected with the London United Tramways he had given special attention to the subject of leakage currents from electric tramways owing to the proximity of the Kew Observatory, and he had been responsible for carrying out tests and measurements with Prof. J. Perry, Dr. Glazebrook, and Mr. A. P. Trotter of the Board of Trade. During the reconstruction of the Bristol system he had frequently examined the gas and water pipes which had been laid open, but in no case had he been able to see any sign of damage or corrosion which could be attributed to electrolysis, nor had he ever heard of any pipe being injuriously affected by any leakage currents from a tramway working under Board of Trade regulations. With regard to making the tests required under the regulations it was a very easy thing, because all one had to do was to connect a testing instrument with the rail, and form a connection by means of the hand with either a lamp-post or standpipe, or anything of that sort.

Mr. PEMBER: You would not be able to tell if there was current in the pipe?—A good indication would be obtained if there was the least current. He had seen tests applied to open pipes in London in a district where the tramway was run by horses, and he had observed from 2 to 5 amperes of electricity in them. This was a natural earth current. He had heard of the Clapham-road experiment, but that was in connection with the London tube railway which, of course, ran under different conditions from tramways. It would therefore seem that in any conducting system laid in the earth there must necessarily be considerable earth currents, and it would appear that the water companies have as much to fear from electrolytic damage from these earth currents as they had from a well-designed electric tramway working under Board of Trade regulations.

Mr. STEPHEN SELLON, C.E., said he had had considerable experience in the construction of tramways, being interested in some 250 miles of line. He represented the Municipal Corporations Association and the Tramways Institution of Great Britain before the Joint Committee in 1893. He represented also about 3½ millions of capital invested in tramways in this country. He also represented the London Chamber of Commerce, and was especially deputed to represent them in all cases where the question of electrolytic action was raised. He represented these institutions at the conference with the Board of Trade. He stated emphatically that no case of electrolytic action in gas or water pipes had

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been brought to his knowledge on the systems for which he was responsible. He thought that any clauses similar to that inserted in the Sheffield bill would have a serious effect on the tramway enterprise of the country. As a man of experience he did not think that anything more was required than the Board of Trade regulations. In the Swansea case the company, when they arrived at the inquiry, found that the Corporation had given the gas and water companies protection similar to that now asked for. The company objected to it, and the Light Railway Commissioners struck it out, after hearing arguments on both sides, leaving the company subject merely to the Board of Trade regulations. The Light Railway Commissioners had either refused to give this clause when it was asked for or struck it out when it had been put into a scheme.

Cross-examined by Mr. PEMBER, Witness said that in the case of the Finchley tramway the Sheffield clause had been accepted, but he imagined that the present promoters intended to clear out and leave the result to be faced by other people.

Mr. PEMBER said that if the witness's contention was right, that the tramways would do no harm to the gas and water pipes, why should they object to being made responsible for any damage?—There were certain things which would occur to pipes beyond those which were brought about by electrolytic action.

But the *onus probandi* would lie upon us?—No doubt, but there would be serious litigation, and the object of a company is to pay dividends to its shareholders, and not to spend its money on lawyers.

But does not that also apply to water companies?—They have a great deal more money than we have, and then again there are many small companies with a capital of £20,000 or £30,000, and in their case litigation would mean ruin. If the clauses were inserted here this case would become a precedent.

If you do damage, should you not pay for it?—Not if we comply with the Board of Trade regulations. If you will relieve us of the Board of Trade regulations we will agree to your terms; but I say they are an absolute safeguard. When a statutory company got an Act of Parliament it was always relieved from the payment of compensation unless negligence was proved against it. To adopt the proposal of the petitioners now would be to alter the statutory law of the country. It would not be possible to say that an electric current which caused electrolysis was a current which came from the tramway or from some other source.

Mr. BALFOUR BROWNE said that was the case for the Tramway Company.

Prof. W. E. AYRTON, examined by Mr. Baggallay, K.C., for the petitioners, said he was of opinion that the recommendations of the Joint Committee of 1893 to the Board of Trade had not been carried into effect by the Board. It was "that a return conductor, if in contact with the ground, shall be of such section and resistance as to have no difference of potential sufficient to set up injurious leakage currents in the earth." Nothing in the Board of Trade regulations prohibited an electric tramway or railway sending a large electric current through a gas or water pipe. The Board of Trade rules specified the maximum electric pressure the company might bring back to their dynamo by means of their own earth plates, and the electric pressure the company might produce between their rails and a pipe, and the maximum pressure the company might set up between the ends of their uninsulated rails, but nowhere was it stated that any rule was infringed if the current sent through a gas or water pipe by an electric traction company exceeded any particular value. The tramway promoters contended that if these rules were complied with it would follow as a necessary consequence that the current in the pipe would be small and the electrolytic damage negligible, and they argued that no appreciable current had been detected in gas or water pipes caused by a tramway working under Board of Trade rules. He had maintained over and over again that this was illusory. The Board of Trade regulations would prevent the destruction of pipes occurring at a rapid rate, but there was nothing in them to prevent considerable currents being sent by electric traction through pipes. In conjunction with Prof. Perry he had, since the hearing of the Bexley bill, carried out experiments in the Clapham-road to measure the actual currents sent into the pipes by the City and South London Railway; in the Chiswick High-road by the London Electric Tramways; in Liverpool by the electric tramways, and so forth, and in each case he found that these currents were much larger than the tramway companies were aware of. Witness described the experiments he had made in the Clapham-road. He found there that when the traffic was slack, at 3 to 4 p.m., on the City and South London Railway the current in a pipe under test reached 10 amperes; between 5 and 6 o'clock it reached 12 amperes; and between 6:30 and 7 the current went up to actually 14 amperes, in spite of the fact that there were in the same road various other pipes, and that the railway was enclosed in an iron tube some 50ft. below the surface of the road, and that the City and South London Railway was worked on what was known as the "three-wire system"—that was to say, the rails in the tube brought back an electric current equal to only the difference between the currents used to drive the trains on the up line and the trains on the down line. That the current on the rails was of the same magnitude as the current on the rails of a street electric tramway. Such currents flowing at present under the streets of London were unsuspected in the hearing of the bills before the Committee recently, as was pointed out in an editorial note in *The Electrician* of January 11, 1901. One ampere flowing continuously in a wet soil would remove 14lb. of iron per year. Of course, he did not say that the current flowed continuously. The pipe in the roadway opposite No. 193, Clapham-road was eaten away on the side nearest the generating station, which was where the current would tend to leave in order to return to the generating station. He did not say that the whole of the eating away of the pipe was produced since the line had been worked under the Board of Trade regulations.

You found certain eating away, you cannot show absolutely that that eating away was within any given period when the Board of Trade regulations were in force, but the test showed that the current at the time the regulations were in force was sufficient to eat away largely?—That is exactly it. The current which was flowing on May 14 of this year was quite sufficient to produce the eating away in a comparatively short time. The condition as to not more than 7 volts was certainly being fulfilled when our tests were made.

It is put forward, on behalf of the promoters, that there is no instance of electrolytic damage having been caused to a pipe where the tramway traction company has been working under Board of Trade regulations. Do you concur?—No. I consider that is erroneous. When the Clapham pipes were produced it was said they had been affected before the Board of Trade regulations were applied to that line. It seemed wise, therefore, to take a town were the tramlines had been running for only a few years, and the town selected was Liverpool. Our openings were made in the road, and at each current was found. Those places corresponded more with the middle of an electric system; they were not places where he should expect the current to enter to leave, but where he should expect to find it flowing. The next thing was to consider where damage was likely to be found, and witness and Prof. Perry, who was acting with him, asked the chief engineer of the gas company to open the road in only one part of the town. The gas engineer made two openings fairly close together, and in both there was distinct evidence of eating away of the pipes. The eating away formed a pitting—not actual corrosion of the outer surface of the pipe, but actual pieces picked out of the pipe. In one case the pipe had been laid a long time, and in the other only since August, 1899. In one case the outside of the pipe was soft instead of being hard like iron and could be scraped away with a knife. Electric trams had been running in that street since 1898. At some expense the gas company cut out the pipe bodily and it had been brought to that room for the Committee to inspect. [The length of pipe was here produced and exhibited to the Committee, an official stating that it had been laid since 1871.] Since the hearing of the Bexley case, witness had also made some experiments in the Chiswick High-road along which tramways were worked by the promoters. Openings were made in the road at several places, and they found that the current was at a maximum of about 6 amperes, the same practically as the current at Liverpool.

By the COMMITTEE: There would be more risk of action at a joint of a water pipe than at a joint in a gas pipe. The current might do harm where it left the pipe or at a joint which electrically was a non-conductor. If the pipe was in very dry ground and had no water inside, a bad joint would tend to stop or diminish the current very much. But if there was water in the pipe there would be less tendency to stop the current because the water had more conductivity.

Mr. BAGGALLAY: In the case of a gas pipe, I take it the gas is so dry it does not form a conductor?—That is so. In the case of a gas pipe, if there were electrolysis it would nearly always be shown on the outside.

The actual damage is simply a question of time in relation to the magnitude of the current?—Certainly.

If the current is passing through any part of the pipe and leaving it at any point, electrolysis is surely going on?—Yes. It would be much greater with some kinds of soil, less with others.

Do you know that in America a large number of tramways worked by the overhead system have insulated returns?—Yes.

Is 1½ volts necessary to produce electrolysis?—Not at all.

Is it merely a question of prolonging the time?—Certainly. It depends on the metals and the liquid with which the earth is moistened. If you have a soft solution, you may get electrolysis with the eating away of iron when the electric pressure between two pieces of iron is far less than 1½ volts. Iron may be eaten away if it is in earth or sand moistened with saltish water—water much less salt than sea water—when the pressure between the rail and pipe is far less than that allowed by the Board of Trade. A soil containing cinders or pyrites, in conjunction with iron, would set up electrolytic action. If the pipe was in the soil containing nothing of that kind, it would last for a very long time, unless the current was supplied from some outside source, because there would be no galvanic battery formed. Generally, natural soil would not be this sort of material. The best conditions for producing electrolysis rapidly by means of an outside current would be an iron pipe laid in the soil containing a certain amount of sewage saline, because that soil would be conductive, and the salt of the iron would be dissolved easily and be carried away as chloride of iron. It had been urged that if electrolysis were taking place on gas or water pipes a corresponding electrolysis would be found on the rails at the point where current left the rails. He had been very much interested in connection with that to discover why the rails were not damaged. The explanation was this: the surface of a tramway rail exposed was very great indeed, being some 50,000 sq. ft. per mile of tramline. The rails being laid comparatively uniformly—in this case with concrete, wood blocks, and granite sets the whole way—the tendency of the current to leave the rail was not very marked in one place, but was about the same over a considerable area. The result was that even if there was a considerable current leaving the rails the amount per square inch was very small. In the case of the Chiswick line the amount of electrolytic damage to the 90lb. rails was less than the ordinary wear of the running of the tramcars, and, therefore, it probably was quite true that there was no evident electrolytic removal of the steel from their rails. But that was absolutely no evidence whatever that a current was not leaving the rails and entering the pipes. The interesting fact which had been brought before the Committee—namely, that before electric trams started in Chiswick large currents were said to be flowing in the rails—was brought up last year, it being maintained then by Mr. Parshall that the variation in these currents in the rails proved conclusively that they were due to other electric traction systems. If that was so it was a very powerful argument against the use of uninsulated returns.

(PARLIAMENTARY INTELLIGENCE *continued on page 376*).

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The Oldest Electrical Journal (established as a weekly Journal, 1861—1876).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

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We are glad to be able to congratulate our municipal engineering friends upon the success of their meeting at Glasgow and Edinburgh, for the programme included a visit to the capital on the second day. The attendance of members and friends appears to have been unusually large, and everyone was satisfied with the general scheme of the convention. We regret, however, that we are unable on the present occasion to congratulate the Association upon the quality of the Papers; on this point many, we know, were far from being satisfied. Some there were, including, we believe, the able president, Mr. W. A. Chamen, who regretted the scarcity of Papers for discussion; but with this complaint we have little sympathy. The number of Papers sent in was sufficient to provide two Papers for each morning sitting of about three hours' duration, and that rate cannot usefully be exceeded. If a Paper will not develop an hour-and-a-half discussion among two or three hundred municipal experts, it is unfitted for the purpose of being read at such conventions. Comparing it with previous years, we regard the so-called scarcity of Papers as a distinct advantage. But it is to the quality of the Papers read that we take exception; not so much, indeed, to the quality of the individual Papers regarded separately, as of the character of the *tout ensemble*. Taken conjointly as a complete programme, it must be admitted that they dis-

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placed the leading questions of the hour by a number of comparatively trifling matters of detail. Matters of broad principle or practice were entirely ignored; the nearest approach made to them was in Mr. TITTENSOR'S Paper on "The Equitable Allocation of Costs in Combined Lighting and Traction Stations." Of the six Papers read, two dealt with details of tramway work, two with the petty matters of ash and coal conveyors and refuse destructors, one with a problematical question of station accounts, and one with platitudes concerning street lighting. We suggest to the Council of the Association the advisability of making provision for a better programme of Papers beforehand. In all other matters due forethought and care are exercised, the places to be visited are arranged, and the dinners and luncheons are planned. Why should the subjects for discussion be neglected? In annual meetings of this description it is the subjects of the Papers that are of supreme importance; the contents of the Paper are of quite secondary value. It is upon the subject selected that the scope of the discussion mainly depends. Why, then, should not the Council take this matter into its own hands and settle beforehand the subjects on which Papers are to be written, instead of leaving the matter to the caprice of members, who may or may not send in Papers on good subjects? Let them meet some time before the annual convention and draw up the programme of subjects, and then undertake among themselves and with other members of the Association to write short introductory Papers on those subjects. By selecting the crucial questions of the year, the debates at the annual conventions could be made productive of much greater benefit. This course, on the other hand, need not be made so rigid as to preclude the possible acceptance of a really valuable Paper contributed apart from the Council's preliminary programme.

A word with regard to the discussions, and we shall conclude. There is here also a point of practice open to criticism. Mr. CHAMEN is to be complimented upon the able manner in which, when occupying the chair, he conducted the meetings and regulated the debates. The matter we wish to criticise has no relation to his chairmanship; it concerns not only the debates of the present year, but of past sessions also. We refer to the great preponderance and priority of speakers who are members of municipal authorities over speakers who are municipal engineers. There is apparently a fixed desire on the part of the Association to bend the knee and bow the head to the bailie, the alderman and the town councillor, to say nothing of mayors and my lords mayors. This may or may not be a tolerable form of idolatry when no engineering or technical matter is under consideration; but, at any rate during technical debates, it is a compliment to local authorities for which the Association pays no small price whenever it elects to bestow it.

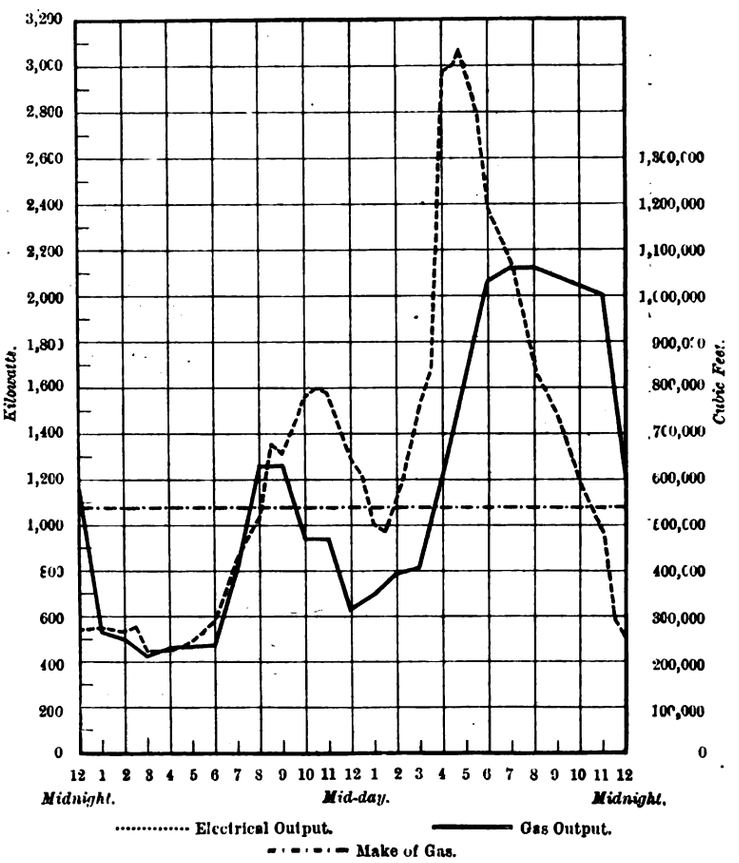
## THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION AT GLASGOW.

(*Concluded from page 332.*)

The report which we published last week of Mr. W. A. Chamen's presidential address omitted to give the curves with which he illustrated his remarks on the comparative consumption of gas and electricity in Glasgow. The illustrations were not at the time available to us, but we supply the deficiency in our present issue. The accompanying figure is self-explanatory; it shows two curves, one representing the load curve of the electricity works and the other the corresponding load curve of the municipal gas works. It will be seen that the latter have a much better load factor.

*Thursday, June 20th.*

Arrangements were made for the Association to travel by special train in the morning to Edinburgh, where the Papers for the day were read and discussed. The building selected for the purpose was the Freemasons' Hall, a somewhat less suitable place than the Institution of Engineers and Shipbuilders in Scotland, at Glasgow, at any rate from an acoustical point of view. Proceedings commenced at about 10 o'clock, when Bailie Mackenzie, of Edinburgh, welcomed the members in a genial speech. Mr. W. H. Tittensor, of Dundee, then read his Paper on "The Equitable Allocation of Costs in Combined Lighting and Traction Stations." This Paper proved to be the most important in the programme for the convention, and it led to a lengthy and perhaps useful discussion. As we shall shortly publish a fuller report of these discussions, it is unnecessary to enter into a detailed account in this summary. The speakers divided themselves into three classes:—(1) Engineers and councillors controlling lighting stations selling current to tramways; these all advocated a good safe price for supply and, in some cases, a price giving a margin of profit; (2) engineers and councillors of




tramway committees buying current from lighting committees; these all thought they were being "rushed," and that they themselves were paying the money that came out as profit on the entire undertaking; and (3) councillors on both tramway and lighting committees, who were perplexed as to what was really truth and justice. A second Paper, entitled "Braking Apparatus for Electric Cars," by Mr. A. L. C. Fell, of Sheffield, was taken as read and received practically no discussion.

*Friday, June 21st.*

Returning to Glasgow on Thursday evening, the Association held its meetings on Friday in the same building as on Wednesday. At the morning meeting the first Paper read was on "Refuse Destructors in Combination with Electric Power Stations," by Mr. J. S. Highfield, of St. Helens. This Paper expressed a clear and temperate attitude towards the question, Mr. Highfield being neither a hot-headed enthusiast nor a violent opponent. His experience with this class of

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plant at St. Helens leads him to believe that it is suitable and useful in certain circumstances. Summarising the discussion, we may remark that Mr. Wordingham favoured the use of destructors placed at intermediate points along the tramways, as at Liverpool; he also seemed to favour hand-firing for small plants, as at Rochdale, and the use of steam blast instead of fan draught. Mr. Clegg, of Darwen, employed destructors without producing dust nor smell, but his steam blast consumed 12 per cent. of the steam generated by the destructors. Mr. McCowen, of Belfast, said it was difficult to get really reliable data; he advocated the use of batteries in conjunction with destructor plants. Mr. Schofield's experience at Shipley led him to assert that refuse might contain water varying from 90 to only 5 per cent. Ald. Bridges, of Eastbourne, preferred to use destructors in conjunction with air compressors for sewage pumping; and Mr. J. H. Rider advised electrical engineers to have nothing whatever to do with them. The final Paper, entitled "Coal and Ash Conveying Gear," was read by Mr. R. A. Chattock, of Bradford; it presented a useful synopsis of current practice. The discussion turned mostly on the advisability of using such apparatus, having regard to capital cost and the amount of labour saved. There was considerable diversity of opinion.

In the evening the Association held its business meetings, as announced. We give below an abstract of the annual report of the council;—

In presenting the sixth annual report the council is pleased to be able to record the continued growth and development of the Association. During the past year 24 electricity committees have been elected members; one committee has resigned; the number is now 99, an increase of 23; 37 chief engineers have been elected; seven members have resigned on leaving municipal service, and one has died, there being now 114 members in this class, an increase of 31; three associate members and six associates have been elected. There are now 49 associates as against 53 last year. The total membership in all classes is now 268.

**Wiring Rules.**—The council has had under consideration the advisability of issuing wiring rules, but in consequence of the Institution of Electrical Engineers having appointed a committee to amend its existing rules, and the Association being represented on the committee by Mr. C. H. Wordingham, a past president, it was deemed undesirable to take further action in the matter. Subsequently, however, the Institution of Electrical Engineers invited the Association to appoint a representative to sit on the committee, and the council accordingly appointed Mr. H. Faraday Proctor.

**Board of Trade Regulations.**—The council was asked if it would support the London electricity companies' appeal to the Board of Trade for an alteration of the proviso to clause 6, section B, of the regulations dated March 4, 1896, relating to change of pressure. The matter was one of great importance to all undertakers, as it was impossible to make any alteration in the pressure of supply if every consumer did not consent, no appeal to the Board of Trade or for arbitration in case of disagreement between the consumer and the undertakers being provided for. A special meeting of the Association was held in London in November, when a resolution was passed to support the appeal. A lengthy public inquiry was held in London by the Board of Trade, as the result of which the clause has been altered in the manner desired.

**Incorporation of the Association.**—A special general meeting was held in London on November 20, 1900, to pass resolutions relating to the incorporation of the Association, and to authorise the hon. solicitor (Mr. G. Pearson) to take the necessary steps in applying to the Board of Trade for licence to omit the word "limited." After negotiation, extending over some months, the Association was incorporated and finally registered on April 15 last.

**Benevolent Fund.**—In consequence of the treasurer of this fund, Mr. C. H. Wordingham, having resigned his membership on leaving municipal service, Mr. J. H. Rider was asked to undertake the duties, and has consented to do so. Donations and subscriptions to this fund at present only amount to £45. 9s. 6d.

**Prize Scheme.**—The council regrets that the response to its offer of a prize of five guineas for a Paper was so small that it did not feel justified in proceeding with the matter, and considers the associates, to whom it should appeal, do not properly recognise the advantages to be derived from competing, whether successfully or not, but it is hoped that this will be more fully recognised in the future.

**Telephone Wires and Overhead Trolley Wires.**—Urgent representations have been made to the council that it should invite members and other electrical engineers in charge of electric tramways to meet and discuss the question of formulating a set of rules for observance by the police in cases of emergency.

**Repayment of Loans.**—The council have under consideration the question of endeavouring to obtain an alteration in the method of repayment of loans so as to relieve local authorities from being compelled to pay the annual instalment on a given loan for the first three years. The matter is still engaging the attention of the council, and a sub-committee has been appointed to deal with it.

It has been decided to hold the next annual meeting of the Association in London, with Mr. J. H. Rider, Chief Engineer to the London County Council, as President. Below is a complete list of the newly-elected council for 1902:—

EXECUTIVE COUNCIL, 1902.

*President.*

J. H. Rider (Chief Engineer L.C.C. Tramways).

*Vice-Presidents.*

J. F. C. Snell (Sunderland), T. P. Wilmshurst (Derby).

*Past Presidents.*

H. Faraday Proctor (Bristol), W. A. Chamen (Glasgow), A. B. Mountain (Huddersfield).

*Council.*

L. Andrews (Hastings).
A. S. Barnard (Hull).
J. E. Edgcome (Kingston-on-Thames)
A. Ellis (Cardiff).
J. S. Highfield (St. Helens).
Bailie A. D. Mackenzie (Edinburgh).
F. A. Newington (Edinburgh).
Dr. Panton (Bolton).
R. C. Quin (Blackpool).
Councillor J. P. Smith (Barrow-in-Furness).
C. D. Taite (Pendleton).
Councillor Worthington (Wigan).

*Hon. Solicitor*—Ald. G. Pearson (Bristol).

*Hon. Treasurer*—J. H. Rider (Chief Engineer L.C.C. Tramways).

*Hon. Secretary*—E. T. Ruthven Murray (Willesden).

*Secretary*—C. McArthur Butler (St. James's Hall, Piccadilly, W.).

*Saturday, June 22nd.*

At the invitation of Mr. J. H. Rosenthal, a large party of members and friends of the Association visited the works of Messrs. Babcock and Wilcox at South Renfrew, and were afterwards entertained at luncheon on a steamer which took the party for a pleasant cruise on the Clyde. On arrival at the works the party were conducted by guides who explained the character of the work carried out in the various departments. The first place visited was the "pipe shop," an array of buildings in which is carried on not only the manufacture of the steel steam pipes, which are a speciality of the firm, but also their other specialities, such as mechanical stokers and superheaters. It was observed that this department, which might well be called a works within a works, was fitted with every labour-saving and other appliance calculated to produce the best workmanship. Screwing machines and hydraulic riveters for fixing flanges on pipes, hydraulic presses for curving pipes without unduly straining the material were pointed out, and finished steel pipes so neatly bent that they appear as accurate as if cast in a mould. An array of the firm's mechanical chain grate stokers in various stages of erection enabled the engineers of the party to understand every detail of them. The pattern and box-making shop in which the machinery for planing and sawing is driven by electric motors was next visited on the way to the foundry. The foundry is one of the largest in Scotland, and is fitted up for machine moulding, and with three cupolas with blowing engines, hoists, &c. Stoves in which the firm anneal their own malleable castings were also to be seen at work.

Crossing the yard, in which large stacks of parts of boilers were to be seen ready to be despatched, the party came to the boiler and engine room, in the latter of which were electric dynamos, pumping engines and ordinary engines, the boiler house containing four Babcock and Wilcox boilers fitted with chain-grate stokers and superheaters. From this the machine shop was reached, an immense building covered entirely with glass to ensure that the work is carried out under the healthiest conditions for the men and with the best light. The machine tools are too numerous to describe in detail: There were special machines for facing the flanges of pipes, so arranged that right-angled pipes would be machined in a mathematically accurate manner; there were multiple machines for accurately machining the headers which form part of the boilers, and multiple machines for the various operations on the various other component parts of the boilers. In the erecting bay were seen feed-water heaters in course of manufacture, the expanding of the sections for the boilers, and a plant of Babcock and Wilcox water-tube marine type boilers already erected ready for despatch to Shoreditch for the new electric lighting station, and others in course of erection for the Hastings electricity works.

The next department to be visited was what is called the forge department, in which the headers and other forgings are made. Welding of headers at one operation, huge furnaces

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and hydraulic presses fill this department. In the next department the steam and water drums of the boilers are manufactured. Every process was shown through which the plates, as they come from the mills, pass before being turned out and despatched. The overhead cranes handling the plates, the machines for planing the edges, the automatic machines for drilling the rivet holes, the hydraulic riveters and testing appliances and pneumatic caulking tools, all formed points of interest to indicate that every appliance for the best workmanship and for the manufacture of high pressure boilers was available.

Crossing a portion of the yard, in which innumerable drums were stored ready for despatch with the order numbers all neatly painted on, the marine department was reached. This is a large new building, well ventilated and lighted, constructed of steel and fitted with electric cranes throughout. This department is just being put to work for the completion of large orders that the firm have received for boilers for H.M. Navy. At the end of this department the electrical engineers had an opportunity of seeing the commencement of a fine electrical power station, from which it is intended to further increase the distribution of electric power throughout the whole of these works. The firm intend to discard completely the use of small steam engines in various departments throughout, and from what was stated it is anticipated that this will be one of the most complete and up-to-date electric power plants in existence for factory-driving.

The works cover nearly 34 acres of ground, and are capable of an output of 300,000 H.P. of marine boilers per annum and an output of four boilers for stationary purposes a day, besides an immense quantity of steam pipes, mechanical stokers, superheaters and various specialities for the generation of steam. Throughout, one could not help being struck with the cleanliness, order, method and organisation that was apparent, irrespective of the fact that the large amount of work in progress testified to the high appreciation of the manufactures of the firm by the engineering world.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

**A Century of Copper.** Part II. By NICOL BROWN and CHARLES CORBETT TURNBULL. (London: Effingham Wilson.) 5s.

It will be remembered that the first part of this book dealt in an interesting manner with the statistics of copper production and sale during the past century. The second part is divided into four chapters, the first of which sketches the gradual expansion and change in the methods of copper production. During the first 60 years of the century, the cost of production was actually greater than the average selling price during the remaining 40 years of the period. When the increase in production set in 40 years ago, lowering the market price, things looked very black for the copper mining industry and several of the smaller mines whose ore was not of the richest went under. Everything has been changed, however, by the enormous demand for electrolytic copper, chiefly for electrical conductors, during the last few years; and the necessity of immediate delivery has been a more important consideration than low cost of production, so much so, in fact, that the authors think it necessary to sound a note of warning to those mines working at an output in excess of that with which their plant can deal efficiently and economically. The second chapter deals more specifically with the question of cost of extraction, briefly alluding to the several methods of extraction, but referring the reader to other works for fuller technical particulars. With regard to electrolytic refining, the authors state that, including casting and melting, but not the previous extraction processes, the cost of this handling is between £5 and £8 per ton of copper. They point out, therefore, that if there were no demand for high conductivity copper in excess of the supply on the market, it would not pay to subject the metal to electrolytic refining unless it contains this value of gold or silver.

A short chapter on the uses of copper follows. In 1870 the annual consumption of copper in the world amounted to 90,000 tons. It is estimated now that for electrical requirements alone 300,000 tons is employed per year, and 170,000 tons for other purposes. A note by Mr. Rennie as to the probable future demand for copper, estimates what would be required for the conversion to electric traction of the railways of the United Kingdom. He reckons that converting 1,000 miles of double track per year would increase our annual copper consumption by some 20,000 or 25,000 tons. In the concluding chapter on the distribution of ores, the present sources of the metal are shortly described and an attempt is made to show, inferentially, where copper supplies of the future are likely to be obtained. As, on Mr. Rennie's basis, some seven million tons of copper would be required to equip electrically the existing railways in the world, it is as well to know where it is to come from.

**The Inspector and the Trouble Man.** (Chicago: The Electrical Engineering Publishing Co. 1900.)

This volume is reprinted from the *Telephone Magazine*, a Chicago "independent," or anti-Bell Company publication. It is intended to instruct the reader in practical construction and repairing work—particularly the latter—in connection with a small telephone exchange system. The contents of the book are in the form of a narrative, it being supposed that an omniscient inspector is breaking-in and educating a raw hand, whose experience at the outset consists merely in being able to "carry a wire up a pole and tie it on." A couple of extracts will best convey the original method of treating the subject:—

"Say," said Will, coming in two or three days afterwards, "there was a trouble this morning on 411 I could not find. The man's bell would not ring, and I took down some salammoniac and renewed the battery, but it didn't seem to make any difference, though I could call Central and talk all right."

"Well, you are a peach!" said George, sarcastically. "How in the —— did you ever come to think of fixing up the battery to make the bell ring? Well, you are a good one."

"Now, here we have the Williams bridging bell, which is intended to be non-infringing (Fig. 17). In the first place, just notice that fiber block shown at the left. Those four springs, *a b* and *a' b'*, cover the bottom of a push button which is not shown. The two springs *a b* rests on a metal plate, *c*, which connects them, while the two other springs, *a' b'* are normally open. See?"

"Now, if you trace that circuit you will see that the generator and ringer are in series. Do you get that? Now, then, when that button is pushed, the springs *a b* are lifted off the plate *c*, and connected straight through with *a' b'*. Now, how is it?"

"Why, let me see; that puts the generator and ringer in multiple, doesn't it?"

"Right you are," said George. "Now, remembering that the generator box has six binding posts on the bottom, let me see if you can draw a diagram connecting that circuit in."

Will took the diagram home with him, worked it out in about 10 days, and finally brought back the plan shown in Fig. 18, which should be the correct way to make connection, whether it is done that way or not.

The author of this praiseworthy attempt to combine instruction and amusement is Mr. A. E. Dobbs. His name is omitted from the title page, but is mentioned in the preface.

**Elektrische Verbrauchsmesser der Neuzeit.** By JOHANNES ZACHARIAS. (Halle: Wilhelm Knapp.) 1901. 15m.

A good book on meters, written by a meter user, and describing the various patterns of meters now employed with an impartial review of their idiosyncrasies, would be of great value; the work before us, however, falls far short of this ideal. It is chiefly devoted to German meters, and the descriptions appear to have been supplied largely by the makers themselves or their engineers. The prepayment meter—called a Selbstkassirender Zähler—is passed over with a few lines on a device of Prof. Aron's, and an illustrated description of the Long-Schattner meter; this is to be regretted, as a detailed account of all that has been done up to the present in the development of these instruments would have been of considerable service. On the Continent, the need of a cheap meter for small consumers with a few lamps which are usually alight all at once is met by a simple time-meter, recording merely the time during which the current is on. Some of these instruments are described; but the Wright maximum demand indicator is thought by the author to be an accessory to this system, and he has thus an entirely wrong conception of the Wright tariff. The latter half of the book is taken up with abstracts of all the German meter patents which have been issued from 1881 to 1900.

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# CORRESPONDENCE.

## TEST-ROOM METHODS OF ALTERNATE CURRENT MEASUREMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the most interesting Paper of Mr. A. Campbell, in your last week's issue, on test-room methods of alternate current measurement, in the latter part of which he deals with a thermal method, it gives me pleasure to give some account of similar experiments which might be of some interest, and were performed by me some time ago in the physical laboratory of the Eidgenössisches Polytechnikum in Zürich.

My work has been directed specifically to getting out a complete method for the measurement of very small alternating currents. The instrument, built up expressly for this purpose, consisted of a thermopile with 600 elements carefully enclosed in a thick copper casing to protect them from variations of the external temperature. The wires used for the thermopile were of iron and constantan, having a diameter of 0·12mm. and 0·1mm. respectively. This combination gives a relatively high E.M.F. for a given difference of the temperature at the junctions, and affords the further advantage that this E.M.F. is within wide limits absolutely proportional to the difference of temperature which produces it. This latter circumstance is indispensable if the galvanometer connected with the pile shall give deflections proportional to the square of the effective value of the current.

The heating conductor consisted of a tape of constantan, not thicker than 0·02mm. and 1·5mm. long, wound in zigzag on an ivory frame. The ohmic resistance of it was about 1,200 ohms. With this instrument no sluggishness in the regaining of the zero point was to be remarked if the current was not allowed to flow longer than the time necessary for reading the galvanometer deflection. A current of $10^{-4}$ amperes caused a deflection of about 30mm. when the distance of the scale from the mirror was 1,800mm., and by using a more sensitive galvanometer still better results may be obtained.

To investigate the distribution of the magnetic induction in iron as caused by alternate currents, I sometimes found it preferable to use a heating wire of lower resistance. For this purpose I constructed another frame with a similar tape of copper windings, which had a resistance of but 24 ohms. With this arrangement I was able to measure E.M.F. down to a 0·01 part of a volt.

The calibration was easily performed in an exact manner by means of a standard cell or a constant source of continuous current. The heating wire being practically free of self-induction, the instrument standardised with continuous current was reliable also for measurement of alternating currents.—Yours, &c.,

(DR.) E. TREICHLINGER.

Berlin, June 19.

# PARLIAMENTARY INTELLIGENCE.

## LONDON UNITED TRAMWAYS BILL (*continued from page 371*).

Prof. W. E. AYRTON, cross-examined by Mr. FITZGERALD: He was not a tramway engineer, but was very familiar with the working of tramways. For the time being the Board of Trade regulations were a fixed quantity, and they had been a fixed quantity since 1894, as far as he was aware.

The point is this, that the Board of Trade, as Sir Courtenay Boyle pointed out, are quite prepared to alter their regulations from time to time if a proper case is made out. Now you have given a great deal of interesting evidence; have you put that evidence on previous occasions before the Board of Trade?—No. The last time I appeared before the Board of Trade was in connection with the Wakefield order. After hearing the evidence, Sir Courtenay Boyle decided that he would give no decision whatever until Parliament had decided with reference to some of these bills on this very point of electrolysis. It was in the evening of that very day that I wrote and said it was absolutely necessary that we should be put in possession of indisputable evidence as to whether there are or are not currents in gas and water pipes, and as to whether damage had been caused by working under the Board of Trade regulations. I have had no opportunity of putting this information before any public body before to-day

The water and gas companies this year, a very short time before the Bexley bill was heard, did approach the Board of Trade and ask them to alter their regulations?—They did.

If they did not avail themselves of your services then and enable you to put whatever you had to say before the Board of Trade, that was their own fault?—They did avail themselves of my services, but I had none of this information then to put before the Board of Trade.

You think that the representations which you made to the Board of Trade on that occasion would be considerably strengthened by the information you have obtained since?—We have a great deal of information since that date.

Does it not occur to you that as the Board of Trade are perfectly authorised to alter their regulations, and have told you they are willing to do so whenever it is proved to them that their regulations are deficient, your proper course is to put your information before the Board of Trade?—It is not for me to say what is the proper legal course to be adopted by the gas and water companies.

Supposing this bill were to pass in the shape in which it was introduced, it does not in the least prevent the gas and water companies going before the Board of Trade and asking them to alter their regulations to meet the case which they think they have made out?—Certainly not.

But if the clause is inserted in the bill which the water companies are asking for it would decide the question entirely in your favour?—I do not quite follow you.

You are asking that there should be insulated returns in every case?—In this case, not in the case of lines far removed from town.

If that was inserted in the bill it would become a positive enactment by which the company would be bound?—Certainly.

That would leave no discretion to the Board of Trade.

The CHAIRMAN: That is a legal point.

Mr. FITZGERALD: It is a common-sense point.

In further cross-examination, Witness said they adopted the system of insulated returns which the London County Council had adopted after their engineer, Dr. Kennedy, had visited America.

Mr. BAGGALLAY (in re-examination): It is suggested that an alteration of the regulations by the Board of Trade will be made when it is proved that the present regulations are insufficient. When it is proved that these regulations are insufficient, will there not probably have been an enormous amount of damage done to the mains of the gas and water companies?—It depends on how soon the Board of Trade see fit to alter the regulations. There is no change which will absolutely protect the gas and water companies except insulation. That is the simplest way to do it.

On Monday Prof. AYRTON was recalled with reference to the statement that considerable currents, due to natural causes, were found to flow in pipes miles away from electric tramways, and in the rails of a tramway prepared to be worked electrically at a period when they were worked by horse-power. In consequence of this statement it seemed most important to ascertain whether any mistake had been made in regard to the currents of electricity which witness had found flowing in pipes in the Chiswick High-road. Between Friday and that (Monday) morning, therefore, witness, with a competent staff, had gone very fully into the matter. They started testing the current in the rails of the promoting company's electric tramway at 10 p.m. on Saturday, and went on continuously for six hours until 4 a.m. on Sunday. At first, while the trams were running, the current was large—130 to 140 amperes in the four rails together. They tested all the way from the generating station to Kew. As the traffic died away and the cars stopped running the current in the rails diminished, but curiously enough, when all the cars had stopped running and all had been shut down for the night, at 2.30 a.m. on Sunday, there was a current in the rails of even more value than Mr. Salter mentioned in his evidence. Mr. Salter said he found 15 amperes of earth currents on that road; witness found as much as 20 amperes. That was very startling. If that were due to natural causes, as had been stated, presumably those natural causes would operate not merely between Chiswick and Kew. As the rails were laid and bonded miles west of Kew ready for the electric tramways, but were not yet working, it suggested to witness to go further west, beyond Kew-road to Brentford. As he went west of Kew the current became less and less, until when they got to Brentford there was hardly any current in the rails at all, and what little current there was was flowing in the opposite direction—towards Kew. If this was due to natural causes probably there would be a current in the pipes. If, on the other hand, these 20 amperes were due to what he might call unnatural causes, it would not be big enough to produce any leakage. If not due to that cause, probably they would not find any current in the pipe. They examined a hole they had opened by Chiswick fire station at 3:30 a.m. on Sunday, and there was absolutely no current that they could find in that pipe. It appeared, therefore, that whatever causes were producing currents in the rails, they only produced currents east of Kew. The conclusions he was brought to were that there was a current in the rails which did not go beyond Kew, although the rails went beyond Kew, and that there was no current in the pipes. Then they went east towards the generating station, and found the current was flowing to the generating station. When they passed the generating station, the current was flowing the other way—east towards Hammersmith and north-east towards Shepherd's Bush. He could not help coming to the conclusion that the current was leaving the generating station, so that the sun-spots and aurora borealis seemed to be located there even during the night. On Sunday afternoon at 3:30 at the same place, and with the same pipe, there was a current which was certainly not less than 40 times as large as the current which was flowing at 3:30 a.m. The current was about 4 amperes, whereas there was not $\frac{1}{10}$th of an ampere before. The dry weather recently no doubt diminished the leakage.

Mr. FITZGERALD (in cross-examination): These stray currents which are found in the earth are not constant?—The currents we found on

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Sunday were absolutely constant, but hour by hour they diminished. Natural currents are currents which alter and do not remain steady.

There is nothing inconsistent between what you are now stating and what Mr. Salter stated?—There is a great deal that is inconsistent. The inconsistency arises from the fact that the currents radiate even during the small hours of the morning from the tramway generating station at Chiswick.

Mr. Salter found the current in existence before the tramway station had ever begun to work?—Before the trams began to run.

Before the station existed?—One single accumulator attached to the rails would produce the whole of the currrent that we found, which was more than the current found by Mr. Salter. I do not say there was an accumulator used.

One accumulator or 10 accumulators make no difference if the station is not working?—It is not necessary to have a station.

The rails were there, but there was no accumulator attached to or communicating with the rails. There were no generators in the generating station at all, therefore the suggestion you make is not based on fact?—I do not say a generator was there, I say the quantity we found could be produced by one single accumulator.

The suggestion you make is that the current that Mr. Salter found there was produced in some way by the generating station?—I do not know what Mr. Salter found; I say the current we found was larger than the current Mr. Salter found. It came out through the rails at the generating station.

Do you suggest that Mr. Salter did not find the current he says he found?—I have never said so.

Do you suggest it came from the generating station?—I do not know; I was not present when he made those experiments.

Mr. PEMBER (in re-examination): All you are concerned to say is that if Mr. Salter's evidence was for the purpose of showing that the tramways do not cause currents in the pipes, your experiments are conclusive that they do?—My experiments show that you can have, from any cause you like, a larger current than that mentioned by Mr. Salter flowing in the rails at night without any current flowing in our pipe, and therefore the cause which produces the current at night in the rails is not a cause which operates to produce a current in our pipes, whereas in the day-time, when the currents in the rails are many times as large, there are unquestionably currents in the gas and water pipes under the Chiswick High-road. The thing which produces currents in the rails during the night does not produce currents in our pipes.

Mr. PEMBER, in reply to the Chairman, said he asked for both a compensation clause and an insulated return clause.

Mr. GILL, engineer to the Chelsea Waterworks Co., gave details of the places at which the proposed tramrails would be in close proximity to the water mains of his company. The company's mains (he said) lasted for an indefinite period. They had had one very bad break which caused a considerable amount of damage. They could not account for it; they saw no sign of any flaw or of electrolysis in the main. The company received claims for several thousands of pounds in connection with this accident.

By Mr. FITZGERALD: The company paid nothing, escaping all liability on the ground that there had been no negligence on their part.

Mr. WILLIAM KING (examined by Mr. Pember) said he was engineer to the Liverpool United Gas Co., which have about 814 miles of mains. His attention had been called to the question of the electrolytic action on gas mains, and the subject had been brought forward by the Gas Companies' Protection Association. Openings were made in certain streets of Liverpool, which were traversed by tramways, the streets selected being those where the trams had been longest at work. Two were made on the oldest line, which was brought into operation on November 14, 1898, and had worked continuously and increasingly since then under the Board of Trade regulations on the trolley system. The openings were about 50 yds apart. The gas mains would be about 8ft. from the nearest tramrail. There was an 8in. main with a thickness of about 0·45in., which was laid in 1871, 3ft. below the surface, and a 6in. main, 0·4in. in thickness, laid in 1875, at a depth of 2ft. 8in. In connection with the building of a church the ground near the 6in. main subsided, and the main was fractured. In August, 1899, a new length was, therefore, laid there. The recent excavation related to a portion of the old and to a portion of new pipe. When the ground was opened to repair the fracture the pipe was in good condition, there being no corrosion. When the two openings were recently made the pipes had a very unusual appearance, pittings being plainly visible to the naked eye. These pittings varied in depth from $\frac{1}{16}$in. to $\frac{1}{8}$in. In the 8in. main there were more than 30 pittings. There was only a short length of the other main exposed, but along it there was a deep double pitting about $\frac{1}{4}$in. in depth, so that the corrosion would be about one-third of the thickness. Practically, the whole surface of the pipes exposed was affected. With regard to the 6in. pipe, there were a number of spots different in colour from the body of the pipe filled with a substance which could be easily removed by a penknife. These excavations were made at a spot about 350yds. from the nearest generating station.

Have you ever before observed any corrosion of the character you have just referred to?—No. It was very different from the corrosion produced by ordinary rust, and I drew the conclusion that it was due to some new cause.

By the COMMITTEE: Openings were also made in St. James'-road, Vauxhall-road, and Clapham-street in order that the electrical expert might test the current of electricity flowing along the pipes. The soil in St. James'-road was very dry sandstone rock, in the other places it was ordinary sandy clay and soil.

Further examined: The ground at Liverpool was remarkably good for the preservation of pipes. He considered that mains laid in it were practically indestructible. Where the corrosion was discovered the soil was good ordinary ground, slightly damp.

Was there anything in the soil there or the dampness to account for these unusual and eccentric pittings?—Nothing at all.

Was there anything in the character of the pipe to explain the peculiar appearance?—No.

Can you account for this effect by anything else than electrolysis?—I must certainly look for some cause beyond those to which I have been accustomed for so many years to account for the effect produced.

Have you ever had to take up a pipe in your experience in consequence of corrosion of the ordinary kind?—No.

Cross-examined by Mr. FITZGERALD: There was not a great deal of made ground in Liverpool. He was not able as an electrician or as a chemist to tell what had caused the corrosion.

Am I right in saying that the policy the Liverpool Gas Co. have adopted is to oppose every bill containing electrical powers for working a tramway where there are gas pipes in the neighbourhood?—No.

Have you not been opposing practically every bill for the purpose of electric traction?—Yes.

And putting as much pressure as you possibly can on small promoters with a view to obtaining parliamentary precedents?—If there is anything which we considered injurious to our interests we should ask to be protected.

It is a prominent member of your association who led the opposition to the Bexley Tramways Bill—Mr. Livesey?—Yes.

And after three days' hearing of scientific evidence the Committee rejected the clause which Mr. Livesey asked them to introduce?—That is so.

Your association pursued the same course, did they not, in the South Lancashire Tramways Bill?—I think so.

And there again that clause was rejected?—I believe so.

Mr. PEMBER (in re-examination): You are a society for protecting gas interests?—Precisely.

And one of the greatest dangers you know of, and which you wish to protect yourself against, is these tramways and their electrolytic action on your pipes?—We think so.

Mr. CHARLES CARPENTER (examined by Mr. Pember) said he was chief engineer to the South Metropolitan Gas Co., which had about 1,000 miles of mains. About a year ago one of the company's inspectors called his attention to an escape of gas in the 4in. main which supplied the generating station of the City and South London Electric Railway at Stockwell. He found the main ruined, and in the condition which has been described, and it was renewed. He produced a piece of the 3ft. high-pressure gas main from which the 4in. main was supplied. It was extensively pitted, and in a manner which was quite new to his experience. Practically, the company never had to renew a gas main because it was worn out. Sometimes it was necessary to substitute a larger main for a smaller one, owing to the growth of the gas consumption; in that case the smaller mains would be re-laid in another part of the district.

If damage by electrolysis extends with the increase of electric traction, the danger from loss of gas to life and limb will be very serious?—We regard it as very serious after the experience we have had at Clapham.

Mr. FITZGERALD (in cross-examination): Your suggestion is that the escape of gas is caused by electrolytic action?—Yes.

Why do you not produce the piece of 4in. pipe?—I produce a piece of the 3ft. main.

How long had that been down?—10 years.

Both these pieces are close to the City and South London Railway?—Yes.

Your suggestion is that the damage was caused by electrolytic action from that railway?—Yes.

That railway not being under the Board of Trade regulations?—Not until a year ago.

It has been working how many years?—Eight or nine.

Are you prepared to say that there is any evidence at all in regard to electrolytic action on the 4in. main?—Certainly. I have been connected with the South Metropolitan and other companies for 25 years, and at one time I had charge of the main-laying, and I have never seen anything like that action.

How do you explain the fact that the water pipes in the immediate neighbourhood of that main show no trace of that kind of pitting?—The water main in the immediate neighbourhood of that main was in one place so soft that I could scratch it with my nail, and my nail went in below the surface.

Can you produce any place in your district where the Board of Trade regulations have been in force and where electrolytic action has been caused?—We have nothing in South London.

The CHAIRMAN (interposing): Is not this question a matter of equity and justice now, not a matter of science? We can get any number of witnesses to say that there is this danger of holes being made in pipes. Shall we get any further by proving fresh cases?

Mr. PEMBER: On the assumption that you consider the whole question of the scientific results of electrolysis are before you, I do not think it would be fair of me to call more evidence at length. I am very soon satisfied with scientific evidence, but I think Prof. Perry and Prof. Dewar would like to be called to say that they agree generally with Prof. Ayrton, and if you will allow me I will put the evidence in that way.

Prof. J. PERRY said he adhered to a statement which he made in his inaugural address at the Institution of Electrical Engineers, viz.: "If we do not insulate our returns, electricity will certainly return by gas and water pipes, and the amount of harm done to those pipes is merely a question of time." He agreed with everything Prof. Ayrton had said. To insulate the returns on a tramway working on the trolley system would cost about £400, certainly not more than £600, per mile

Supposing it to be a fact that the corrosion of pipes in that part of London which is affected by the City and South London took place before the working of the Board of Trade's regulations, have you any doubt that the electric current now flowing into the gas mains in Clapham is sufficient to produce electrolysis?—It is sufficient to produce an effect.

In cross-examination, Witness disagreed with the assertion that it would cost £2,000 per mile to insulate the returns.



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By the COMMITTEE: He thought the regulation of the Board of Trade with regard to bonding the connections between the pipes of the gas and water company and the electric station very wrong indeed, and Mr. Parshall, one of the witnesses on the other side, agreed with him. In a Paper which he read before the Institution of the Electrical Engineers in 1896 Mr. Parshall said that if the pipe and rails were bonded together to keep the current at the same potential, stray currents would flow from one part of the system to another at such a tension as to cause electrolysis. Witness did not think the Board of Trade, when they framed their rules, had in mind the great resistance of joints in pipes. If a water pipe were connected with a rail at the generating station, it was a great deal easier for the current to pass along that pipe elsewhere; the real danger was at the joints. If there was resistance at the joints, the current would jump them, and that was a very serious thing indeed. He did not think that could be remedied by bonding the joints with copper. If they did bond with copper or any other metal, there would be corrosion, because of the proximity of the two metals to one another. If there were two metals close together in moist soil they would attack one another.

Prof. J. DEWAR said it was since the date of the commission on London Water Supply that the question of electrolysis had become acute. No actual cases of corrosion had occurred in this country or America, but he then stated that if currents did circulate in gas or water pipes damage must follow. He had pointed out that the damage would not be the equivalent of the attack upon iron merely due to the current itself, but the increased natural corrosion caused by the current making the surface of the iron more easily attackable. There was a double attack on a pipe when it was electrolytically affected. He agreed with Prof. Ayrton and Prof. Perry in their views with regard to electrolysis. The only absolute protection would be an insulated return. The more they diminished the current circulating in the pipe, the less danger there would be of electrolysis.

The CHAIRMAN: Supposing a compensation clause was inserted and damage was done, would it be easy to fix the author of the evil? Might there not be a good many currents besides that from the electric car?—I do not think so. I think the only known cases of the pitting of pipes, such as you have seen, arises from the action of acid subsoil where there is sulphuric acid generated from pyrites and where therefore the attack on the pipes is a local electrolytic action. That occurs when there are abnormal conditions in the subsoil, usually when the subsoil is artificially made. An electrolytic attack in an ordinary subsoil could not occur from that cause. Undoubtedly the company that causes the circulation of the current is causing electrolytic damage.

You say it would be easy?—I do not say it would be easy. You would require legal powers to suspend traction for a time for the purpose of an experiment in order to ascertain who originated the currents circulating in the pipes.

Further examined Prof. DEWAR said he did not think anything other than electrolysis could have caused the mischief to the pipes at Liverpool. The subsoil of Liverpool was good, and if there was anything abnormal in the condition of the pipes it must have been due to some abnormal cause. With regard to water pipes, it was customary to try to guard them by immersing them in pitch—Angus Smith's composition—the object being to make them last longer. The joints were all made with this composition, it was therefore easy to understand why the resistance at the joints varied so much. There might be no actual contact between the lead and the iron at the joints owing to there being a thin layer of this substance between. That would limit the attack of the current.

Mr. PEMBER: You have seen these various bits of pipe. Have you any doubt that they are the result of electrolysis?—I have no doubt whatever.

The CHAIRMAN: You think the regulations of the Board of Trade are not sufficient to protect the interests of the gas and water companies?—No. They should insist on far less current circulating in the pipe. Instead of making it some volts it should be a fraction of a volt.

Would it be possible to work the tramways then?—Yes. It would be an approach to an insulated return.

This closed the evidence.

Mr. PEMBER then addressed the Committee for the petitioning water companies. He said he was raising a most important question of principle, in respect of which he was appealing on behalf of the Chelsea Water Co., who practically were representing all the London water companies with the exception of the East London and the Kent Companies, whose mains were not affected by the proposals before the Committee. The Committee had heard enough to warrant the statement that no one in his senses could doubt the extreme importance of the principle involved. What was at stake was the security of the London water supply. He did not hesitate to say that it was far better to have no electric tramways at all in London than to chance having the water supply interrupted by the bursting of one or more of the great water mains. As to the danger, or the origin of danger, to the water pipes, there seemed to be no longer any real doubt. Where uninsulated earth returns were used, whether for tramways or underground railways, the loose unguarded currents would find their way to their source by any conductor they chanced to meet on their way. Of course, the water pipes constituted such a conductor on a very large scale, and it had been demonstrated experimentally that electricity availed itself of them. One of the suggestions made on the other side was that the currents in the water mains might be only natural currents arising from divers causes; but, if that were true, he thought it also fair to say that, if currents of natural electricity were flowing to and from the main pipes, there would have been a catastrophe in connection with the pipes of the London water companies years ago. Sir William Preece's declaration that 10,000 years at least would be required to corrode a water main sufficiently to cause a catastrophe might be dismissed with a word. One of the witnesses he had called had showed that in the course of only two or three years underground pipes had become so pitted by electrolysis that holes might be scraped out of them with the point of a penknife. The Clapham-road experiment was clear enough. At the time the City and South London Railway Co. was working under Board of Trade regulations the currents were found rampant during the working hours of the railway, and ceased proportionately at midnight when the trains ceased running. And there was the experiment at Chiswick. While the tramway was running great currents were found to exist in the rails, and there were currents in the pipes, but directly the cars ceased to run exactly what one would expect was found to prevail—that was to say, there was a falling off of current taking place, and by a well-recognised transition from strength to weakness it eventually died away altogether. And at that time there was also found to be no current whatever in the pipes. It was evident that the current was in existence during the working hours of the tramway, and ceased when the working of the tramway ceased. Two suggestions were put forward on the part of the tramway company in relation to the Clapham-road experiment—first, that the tubular railway dispensed a larger amount of electricity than the tramway, and, secondly, that the damage which might have been done to the water and gas pipes by the City and South London Railway was done when that railway was not working under Board of Trade regulations. But these arguments were disposed of by the Liverpool experiments. Supposing a larger amount of electricity were dispensed by a tubular railway than by an electric tramway—which he very much doubted, seeing that the tube encasing the railway itself would carry the current away—that would only affect the Clapham case, and would have no bearing upon that of Liverpool. In Liverpool there was, obviously, only one offender—viz., the tramway.

Mr. BALFOUR BROWNE said there was an electric railway running all round the docks in Liverpool.

Mr. PEMBER said that was true, but the pipes which were found to be corroded were all in a different part of the town, and there was no suggestion that they were affected by the electric railway. The electrolysis in the Liverpool gas pipes was clearly caused by the tramway, nor was there any suggestion to the contrary made. Moreover, the tramway was working under the Board of Trade regulations which disposed of the argument that the damage at Clapham might have been done when the railway was not working under Board of Trade regulations. It was said that if the joint was coupled up near the generating station, or there were a connection between the pipe and the generating station, that would get rid of the difficulty. But that was not the case. No doubt it would get rid of the difficulty so far as the joint was concerned, but it would not affect the thousands of joints in the miles and miles of pipes which existed elsewhere. Wherever there was a faulty joint the current jumped, and that occurred from 600 to 1,000 times in the course of a mile. Though a joint might be perfectly watertight it might be a bad electrical conductor. The pipes were some of them very old, and they had been laid down as water pipes, and not with the object of making each line of pipes an electrical conductor. To make them a good electrical conductor would mean enormous expense, and would involve work quite outside the business of the water companies. According to S. P. Thompson one ampere of electricity removed 15gr. of iron per hour from a pipe, which would mean 14lb. in the course of a year. If that amount of iron were removed in the course of a year it would carry a great many things into the air, amongst others the 10,000 years which Sir William Preece said it would take to do any damage to a pipe. And it must be borne in mind that this erosion took place underground. The first self-expression of the mischief which would come from the pipe would take the shape of a terrible disaster. He did not see how they were to get out of that. Would not the Committee safeguard the public against such a disaster, or would it shield itself behind the Board of Trade regulations? The Board of Trade attempted no inspection of the tramway system of London. As the late Sir Courtenay Boyle had said years ago, the growth and extension of that tramway system over an expanse of hundreds of miles would make any attempt at such inspection absolutely futile. However competent any army of inspectors might be, they never would be able to find out the damage that was going on underground, and which was occurring very likely at hundreds of places at the same time. Mr. A. P. Trotter, of the Board of Trade, had been examined in the Bexley case, and he had said, "In this inspection of the tramways I do not, as has been suggested, make it in order to see whether the Board of Trade regulations are carried out or not." But although inspection took place, the inspectors could not see what was taking place, even if the Board of Trade regulations were carried out, and even if those regulations were sufficient. The Board of Trade had no knowledge of how, and why and to what extent their regulations were insufficient. If they were carried out and were insufficient, not only as the law at present stood, was there no damage occurring to the tramway companies who were carrying out the regulations; but, furthermore, there was no protection to the public whatever. Sir Courtenay Boyle had told them plainly that all the inspectors could do was to make themselves acquainted with the condition of the tramways, and go down to any place where an accident occurred. Supposing the bursting of a main occurred, and the Board of Trade, taught by their sad experience, came to the conclusion that there should be insulated returns where, under the Board of Trade regulations was there power to insist on such returns being constructed? The model clause of the Board of Trade said, in the first paragraph, "The company shall employ either insulated returns or uninsulated metallic returns of low resistance."

The CHAIRMAN: Is that not sufficient?

Mr. PEMBER: Certainly not. It was in the working of the regulations that the water companies said all this mischief as to electrolysis had arisen.

The CHAIRMAN: What returns do you want?

Mr. PEMBER said the water companies wanted insulated returns. By clause 12 of the bill the tramway company were to take all "reasonable precautions." In sub-section 3, the clause said "the electrical power shall be used only in accordance with the Board of Trade regulations, and in such regulations, provisions shall be made for preventing fusion or electro-

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lytic action of or on gas or water pipes," &c. But this regulation did not prevent fusion or injurious electrolytic action.

The CHAIRMAN: Outside this bill you say that the Board of Trade has not power to require insulated returns?

Mr. PEMBER: None whatever. The whole of these powers were in the direction of uninsulated returns. Nearly all their knowledge of electrolysis was subsequent to the sitting of Lord Cross's Committee. Although the water companies were present at that Committee, and although they even called Prof. Dewar, this matter, so far as they were concerned, was only gone into very cursorily. Prof. Dewar, with true scientific insight into the future, prognosticated some of the evils which had since occurred. The truth was that the water companies had very little part to take in the inquiry of 1893, the inquiry not being sufficiently directed to their case, but, on the contrary, specifically directed to another matter altogether. It was only in a kind of side fashion that the question of electrolysis was raised at all, and then only at the last moment. The inquiry really arose out of the relations existing between the National Telephone Co. and the tramways. The Telephone Company had obtained protective clauses in many instances against electric tramways, and these clauses were of a most absolute character. The tramway companies said it was owing to the extreme delicacy of the telephone company's wires that the necessity for the telephone company interfering arose, and that their claim for absolute protection was practically a claim for a monopoly of the earth. The contest was one which was renewed year after year, and which brought about Lord Cross's committee, and the main business of that Committee was to settle that question. In the course of the investigation the Committee discovered that the telephone company for its own sake ought to adopt the double wire system or overhead return, and not depend on the underground return. Lord Cross and his colleagues came to a thoroughly sensible conclusion, that though they ought not to be driven to it by the tramways being left uncontrolled, if the telephone system found they could not subsist with an underground return they must protect themselves. The establishment of the Board of Trade regulations was a compromise between the two electrical industries – telephones and tramways. But the water companies were not in an analogus postition. The question here was not with the tramway company—a question as between industry and industry. The mains of the water company were in the ground. There they must lie. There was no reason why they should move them. They had no remedy as the telephone company had, and if they were injured it would be by the tramway company. The tramway company were the aggressors. The water companies were indispensable to London and its 6,000,000 inhabitants. London could do without tramways; it could not do without water. The question between the water companies and the tramway company was only one of £ s. d. —the cost of insulating the return. If the overhead system were retained the cost would be from £400 to £600 per mile. If the conduit system were used the cost would be greater, but in neither case would the cost be prohibitive, because already more than one tramway company had submitted to an absolute compensation clause. The London County Council were doing so in connection with all their schemes which were on the conduit system which was by far the most expensive of all to render innocuous. In this respect the trolley system was far cheaper than the conduit system.

The CHAIRMAN: Mr. Trotter said that in the case of this system the conduit traction was prohibitive.

Mr. PEMBER said that the London County County Council did not think so or they would not be adopting it. No doubt the London County Council had the rates at their back—and that was one reason for allowing that public body or some other public authority to make the tramway. There were three methods by which the Committee could give the water companies protection—first, the Board of Trade regulations; secondly, compensation; and thirdly, insulation. The Board of Trade regulations had been proved to be insufficient. Regulations could not be framed of the far-reaching character necessary. Compensation had been countenanced by the House of Lords to a substantial extent. They say that unless there was perfect insulation there must be risk to the mains, and they had more than once insured the water companies by a compensation clause. The water companies would have a certain amount of remedy given to them by the clause, though it was a clumsy way of proceeding to allow the damage to be done and then give compensation for it. The third course was to insist upon insulation.

The CHAIRMAN: If the Board of Trade regulations were out of the way would you have a remedy at common law?

Mr. PEMBER: No. The promoters were under statutory powers, and special negligence would have to be shown in the carrying out of these powers. The clause was not a satisfactory protection for the public. It had been several times before Parliament. First in the Croydon bill last year in the House of Commons. The Lambeth company asked for the clause, but it was refused. That bill was promoted by the Croydon Corporation, and only a small amount of the mains of the Lambeth company were affected, whilst the Corporation, who were the Croydon water authority, had a large system of mains under the tramway. The Committee might have thought that the Corporation would take care of their own mains, and in taking care of them would take care also of those of Lambeth. The next instance was the bill of the London County Council asking for powers to work their tramway by electricity. The Lambeth company came before the Commons for a clause, and it was refused. But it was known that the London County Council were going to adopt the conduit system, and the Committee might have thought that the Council would make them so safe that a compensation clause was unnecessary. In the House of Lords, however, Lord Camperdown gave them the compensation clause, and notwithstanding that the London County Council took the bill. A power distribution bill followed in which the clause was accepted by the promoters. This year the Sheffield Corporation bill had the clause in it, and it was made retrospective. The bill was unopposed. In the Bexley bill the clause was asked for, but the company was a small one, and the cost was thought disproportionate to the capital. But the Earl of Ducie had put the clause in the South Lancashire Tramways Bill. The promoters of the Finchley and Hendon Tramways Bill had put the same clause in voluntarily. The London County Council in all their bills this year had voluntarily put in the clause.

The CHAIRMAN: The Board of Trade would have power to put in a compensation clause.

Mr. PEMBER: In an order. Finally, he submitted that to leave the water companies to the Board of Trade regulations would be an injustice.

Mr. BALFOUR BROWNE, in replying on the whole case, said Mr. Pember had stated that this was a matter of great importance. It was a matter of far greater importance than even Mr. Pember seemed to understand. The whole principle of legislation was that a body which was authorised by Parliament to do something in the public interest was not to be liable to compensate any body unless that body was negligent. That was fully borne out by the Select Committee of 1898. Mr. Pember, for the water companies, had, all the way through, asked the Committee to put upon the promoters the obligation to use insulated returns; but in not a single case which he quoted were insulated returns put upon the promoters. Against that he would put the statement in the report of Lord Cross's Committee of 1893, that "the Committee, having regard to the evidence before them, are of opinion that it is not, in the present state of electrical science, in the interests of the public to insist upon electrical tramways using an insulated return conductor, and that such insistance would retard the development of electric traction." The whole question of electrolysis was gone into very fully upon that Committee, contrary to Mr. Pember's assertion that it was a mere side issue between the telephone and electric traction companies. Sir F. Bramwell, Dr. Hopwood and Prof. Dewar were before that Committee, and supported the view that there should be insulated returns; but the Committee did not agree with them. They said there might be a difficulty about the electrolysis. They said "The danger from fusion or electrolytic action appears to the Committee to have arisen from a faulty system of constructing electric tramways, and they are of opinion that it can be reduced by improved methods of construction so as to be practically negligible. The Committee therefore recommend that the Board of Trade shall, in virtue of the powers to be conferred upon them by each act or order, make regulations to secure the best system of working electric tramways or railways, having regard to the expense incurred by the carrying out of such regulations, and to the effect thereof on the commercial success of the undertaking." These very words were the words of the clause which was now in the bill. After that recommendation the Board of Trade had to consider how to carry it out. In 1894 the Board of Trade called a conference at which every interest was represented, and at which the regulations were drawn up.

Mr. HELME: Would you, on behalf of the promoters, admit that if, in future, the Board of Trade developed stricter conditions they would be retrospective—that the powers granted by this bill would necessarily fall under the new regulations?

Mr. BALFOUR BROWNE: Absolutely. Counsel went on to point out that Mr. Pember had not understood that the Board of Trade could put the promoters under obligations even to have insulated returns if they though fit. They had that power, though he (Mr. Balfour Browne) did not think they would give such a direction because it was not necessary. The Board of Trade had almost absolute power, because it was provided by incorporating a clause in a former act, in the bill that the carriages used might be worked by animal or by mechanical power, but in the last case subject to the condition that such power should not be used except with the consent of, and according to a system approved by, the Board of Trade; and if the company did not comply with the Board of Trade regulations the Board could absolutely make them cease using mechanical power. The Board of Trade had in effect said, and quite rightly, that if anyone could show that the present regulations were defective they would make them effective, but that no case had been made for alteration. The Committee had been to some extent misled in this case by comparisons with the South London Railway. The regulations with regard to tube railways were entirely different from those with regard to tramways. It was a very extraordinary thing that the only two cases in which the petitioners said there was electrolytic action due to electricity was one at Clapham road and another at Liverpool. Sir William Preece, representing the Post Office, was asked by the Joint Committee in 1898: "Are you satisfied with the clause which the last Joint Committee put in?" Sir William answered, "Yes, and it has been carried out in all subsequent Acts. We are quite satisfied that it is working, and the only case where we suffer at all is in the case of the City and South London and the Liverpool Overhead Railway, which were exempt from that clause because they were constructed prior to the meeting of your Committee" The only pretended cases of electrolysis were in Clapham-road on the City and South London, and in Liverpool. Counsel then referred to the evidence of Mr. A. P. Trotter and Sir Courtenay Boyle, who had stated that the regulations of the Board of Trade were sufficient to deal with the case of electrolysis, that there had not been a single case of corrosion under those regulations, and, further, that the Board of Trade had not been furnished with proof of electrolytic action having occurred in a single case. In these circumstances would the Committee set aside the very careful work of Lord Cross's Committee, the careful protection given to these companies by the Board of Trade regulations, and give protection, in addition—protection which no one at present had—against a statutory company? There was not a single case in which a committee of the House of Commons had given more than Lord Cross's clause, and he asked the present Committee to act in the same way.

The CHAIRMAN: Is clause 12 of your bill the revised model clause drawn up by Lord Cross?

Mr. BALFOUR BROWNE: Yes.

Mr. HELME: Then the two systems—the existing and authorised lines and the proposed extensions—would fall under the same regulations of



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the Board of Trade, provided the Committee accept the view you are now stating?

Mr. BALFOUR BROWNE: Yes, absolutely.

The CHAIRMAN: The Committee are of opinion that the preamble of the bill is proved in regard to clause No. 12.

The clauses were then adjusted, and the bill ordered to be reported.

## METROPOLITAN DISTRICT RAILWAY BILL.

The Select Committee of the House of Commons presided over by Sir John Kennaway on Tuesday sat to consider the bill of the Metropolitan District Railway Co., to authorise an agreement entered into between the Railway Company and the Metropolitan District Electric Traction Co. (Ltd.) for equipping the railway electrically.

Mr. PEMBER, K.C., said the bill was to sanction an arrangement come to for introducing electric traction on the lines of the Metropolitan District Railway Co. so far as the Inner Circle was concerned. The company were first authorised to use electric traction by the Act of 1897, and subsequently—in 1900—they obtained an act giving them more complete powers. Most of the questions now to be fought were fought out on one or other of the bills to which he referred. For many years past it had been felt that it would be a vast improvement, in the underground service of the metropolis, if the Metropolitan Railway and the Metropolitan District Railway could, both of them, be converted to electric traction. The increase in comfort by the use of electricity had, by the working of the Central London Railway, been emphasised in everybody's mind. The promoting company had to provide themselves with that which was necessary for carrying out electric traction, but the financial conditions of the Metropolitan District Railway was extremely necessitous. There had been no dividends paid on the ordinary stock for some time and the preference dividends were only partly paid. Moreover, since the opening of the Central London Railway the Metropolitan District Company had found their traffic reduced to the extent of £600 per week, or £21,240 in 24 weeks. During the last two years experimental electrical working had been carried on on a small piece of the Metropolitan District Railway, and the system which had been in use there was one which had had a thorough trial in America and was the one it was proposed to have adopted. Then came the difficulty of raising the capital. The financial position of the company was such that it would have been impossible for them to have gone into the open market to raise money in the ordinary way, and therefore Mr. Perks, M.P., a large holder of shares in the company, put himself into communication with a gentleman of great wealth and financial power in the United States—Mr. Yerkes—and who had great financial experience in these matters. An arrangement was finally entered into between them, and there was no doubt the money would be forthcoming; £600,000 had already been subscribed, and Mr. Yerkes would tell the Committee, if they thought it desirable to see him, that he was not only personally able but was willing to be bound to find the rest of the capital up to £1,000,000. The new company which was to bring about this change on the District Railway was formed but not formally registered yet. The site of the railway would remain the property of the Railway Company, but the new company would have a lien on it. Ultimately, the railway would be handed over by the mortgagees on a lease of 999 years at cost price. The Traction Company were to have £500,000 of ordinary stock and £166,000 4 per cent. debenture stock.

Mr. JAS. STAATS FORBES, chairman of the promoting company, pointed out, as a test of the sincerity of the financiers forming the new company, that they had agreed to take over £1,250,000 of the Railway Company's stock out of a total of £2,250,000. The system of traction to be adopted on the Inner Circle was that known as the Ganz system. The system to be used on the District Railway was the Yerkes system. His company would require anyone who ran over their system to use the same system of traction as they did themselves. They could not have two systems of traction on the same railway. He did not think the Metropolitan District Company did or would approve of the Ganz system. The bill would give his company power to run their electric trains over part of the Metropolitan Company's system.

Cross-examined by Mr. LITTLER, K.C.: Do the London and North-Western run over your system—a half-hourly service of 34 trains per day—for which they have paid you £100,000?—Yes.

And you would compel them to adopt your system of traction?—That is so. The point is whether our millions of passengers are to be inconvenienced because we cannot come to an agreement with the London and North Western Railway Company. They have got for the £100,000 the right to use our line and use our stations, and they have at the Mansion House a station which it would have cost them half a million to build.

Mr. Freeman, K.C., for the London County Council, claimed the right to cross-examine witness in regard to the financial provisions of the bill, but to this Mr. Pember objected, denying the *locus standi* of the petitioners, and explaining that the question could not be submitted to the Court of Referees, as the agreement with the new Traction Company was not part of the original bill, but took the form of an additional provision.

Sir WM. PREECE explained the proposed system of traction. The system on the District was continuous current, that on the Metropolitan Railway alternating current. The latter was the Ganz system. The continuous or Yerkes system was the kind of traction which had been originally adoped, and had been worked almost continuously in this country. He had no objection to raise against the Ganz system. In the case of the Metropolitan Railway Co. that system had been accepted as the lowest priced and best system. In these matters he regarded the financier as controlling the engineer.

In reply to the CHAIRMAN, Witness said that the Ganz system was one which would most nearly meet the requirements of the Board of Trade in regard to the prevention of electrolysis—a question of interest in the matter of tramways.

Mr. PERKS, M.P., said the required million had all been subscribed, with the exception of £113,000, which Mr. Yerkes had offered to take up himself.

Mr. YERKES gave an account of his connection with electrical undertakings in America, and said he he was ready to carry out the agreement which had been referred to. For some years he had had his eye on the Metropolitan and Metropolitan District Railways. In America they thought that the way the railways were run was somewhat of a disgrace, and his idea was to see if he and his friends could not possess sufficient of the stock of the District Railway to make it worth while to make the proposed change. They meant business in this matter, and would carry out the agreement they had entered into if they were permitted to do so. They had decided to act if they did not meet with too much opposition, as they did not want to interfere with anyone's business. They did not mean to make money out of reconstruction. They intended to get everything done as cheaply and well as they could, in England by preference, but if not, in America. He did not condemn the Ganz system, but would not put a dollar in any concern worked under that system. Time and experience was required in the adoption of a new system. He had met the Metropolitan Railway people, and they had agreed to differ as to the adoption of a common system of traction. Mr. Hopwood, of the Board of Trade, had discussed with him the system he proposed to adopt, and had offered no objection.

This concluded the case for the promoters.

Mr. LITTLER, for the Metropolitan Railway Co., called

Col. MELLOR, deputy-chairman, who said that the electric traction question had been under discussion for the past two years. It was of immense importance to both the District and the Metropolitan Railway. The Metropolitan Company in 1897, by agreement, had power to run over the District Company "in the present manner." In 1898 they obtained powers to use electricity, and a similar right was reserved to the District Company. The present trouble was that the District Company, by their bill, would require the Metropolitan Company to work on the section of the line common to both companies by the Yerkes system. If the Yerkes system were adopted it would bar out the adoption of the Ganz system through the whole of the Inner Circle. It was obvious that there could be only one system in the Circle. The question was which was the best. They were most anxious to come to an agreement with the District, but they did not see their way to having a system which they had not investigated forced upon them. They wanted to raise the money themselves, and to employ the most effective method both as to equipment and construction. Mr. Forbes had always said the Metropolitan Company could apply the Ganz system on his lines in the Inner Circle, but the Metropolitan Company knew they would not be allowed to do so. Both companies ought to put their heads together, agree on a system, and then work it loyally. He preferred the Ganz system simply because it had been so strongly recommended by the company's own engineers and by Sir Wm. Preece, and because he was assured it was both the cheapest and the best. With reference to the statement regarding the risk of the overhead cable breaking at a time of very high voltage, the witness stated that there was an arrangement by which, if the cable did break, it would cease to be a live wire.

Yesterday (Thursday) Mr. PEMBER stated that the London and North-Western Railway Co, who had petitioned against the bill, and cross-examined witnesses, had withdrawn counsel and abandoned their petition.

Col. MELLOR, deputy-chairman of the Metropolitan Railway Co., re-called, stated that the Metropolitan and District Railway Companies had worked amicably together on the traction question until the American deal, when Mr. Yerkes came on the scene with the attraction of a million sovereigns. The joint committee on traction appointed by the two companies had practically agreed to the Ganz system when Mr. Forbes stated that he had entered into an agreement with Mr. Yerkes, and that he intended to have the American system of traction, not only on their own line, but on that part of the Inner Circle worked jointly. Mr. Forbes had announced to his shareholders that £400,000 would be allocated to the erection of a generating station on land belonging to the District Railway Co., whereas the joint committee on traction had tenders for a generating station to cost £200,000. His company strongly protested against any system of traction being forced upon them which would put them to that grievous expenditure.

Cross-examined by Mr. PEMBER: Is is not true that the Ganz Company only tendered for the Inner Circle?—Yes.

What does it matter to you what traction system the Metropolitan District use on their western extension?—It does not affect us if it does not prevent our working the Ganz system on the Inner Circle.

How is it relevant to the inquiry that you should be so anxious to tell the Committee that Mr. Forbes included the adoption of his system over the whole line?—He says he is going to carry his system to the Mansion House, and if he does that he will bar any other system from being adopted.

Supposing an accident happens and the conductor on the Ganz system gets broken, is it not the fact that if the conductor falls on the carriages the voltage being so high they would get burnt up?—It can be made absolutely safe. I am advised that if the conducting cable is fractured it ceases to be a live cable.

Is it not the fact that the direct current system is the one in vogue on all electrical railways except one or two mountain roads?—It is in vogue on the great majority of railways, I believe. But our case is a new departure. You might just as well say that because wireless telegraphy is new, it should not be made use of.

Well, I think it should not be made use of too hastily. Does your estimate of £200,000 for a generating station include the cost of the land?—No; with the land it would be £210,000.

Is it not the fact that there is great urgency for electrification of your line as well as ours?—There is, and I cannot put it too strongly.

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You have heard there has been a great diminution in our receipts—£800 a week—since the opening of the Central London Railway?—Yes; but we have been hit harder than you have.

The Ganz system is a system in an experimental stage is not it?—It is working on some railways. I may say that we do not object to the District Company getting this bill, but we do not want to be debarred from working our traffic on the Inner Circle by our own system. The Inner Circle is 13 miles in extent, of which the Metropolitan Company have 9 miles and the District 4 miles. We do not want to be compelled to use your system over the whole of that.

Would you be content with an alteration in clause 13 by which the words "on a system to be prescribed by the company" would be omitted?—That is a very important point going to the whole gist of the matter.

A copy of an agreed clause was here handed in.

Mr. PEMBER (to Witness): I have made a suggestion to you which you can consider at your leisure. I would go farther and make a proposal in the interests of both sides. I would propose that within a month of the passing of this bill, as amended, there should be a settlement in the terms of the clause I will read. But first, the preamble would have to be amended as follows:—

"Whereas it is desirable to provide for the continuous working of the Inner Circle Railway by the Metropolitan Co. and the District Co. in accordance with the provisions of the Metropolitan and District Railways (City Lines and Extensions) Act, 1879, and also to secure that the Inner Circle railway, as well as the City lines and extensions of the two companies, shall, when worked by electrical power, be worked upon a uniform system."

The clause I propose is:—

"Be it therefore enacted that, notwithstanding anything contained in the above-mentioned act, or in the Act of 1897, or in the Act of 1900, or in the Metropolitan Railway Act, 1898, unless within one month after the passing of this act the District Company and the Metropolitan Company shall have agreed to adopt the same system for the working by electrical power of the portions of their respective railways forming part of the Inner Circle railway, and also for the working by electrical power of the City lines and extensions railways, either company may refer the question to the Board of Trade, who shall forthwith hear the parties and determine what system of electrical working shall be applied on the portions of each company's railway forming part of the Inner Circle railway, and also on the City lines and extensions railways, and each of the two companies are hereby required forthwith to apply such system to the City lines and extensions railways."

We shall pay the total cost on our own line proper, and you will pay the total cost on your line, and the cost of the lines owned jointly will be defrayed half-and-half.

The CHAIRMAN: The point is, that if the two companies came to an agreement and were ready to adopt a system jointly, there would be no occasion to refer to the Board of Trade. If you each have different systems on your own line, the Board of Trade is to decide what system is to be adopted, and you will have to abide by that decision.

Mr. PEMBER: That is so.

The CHAIRMAN: We will adjourn until to-morrow morning, to give time to consider how this point shall be dealt with. I may say that the Committee would be anxious to support the dictum of the Board of Trade, for there ought to be one system, and one system only, on the Inner Circle, and they would be loth to assent to anything else.

Mr. LITTLER (for the Metropolitan Railway Co.), said that, so far as his clients were concerned, they would not be able to accept the clause indicated by Mr. Pember.

Mr. PEMBER read the clause agreed upon by the promoters and the London and North-Western Railway Co., which was to the effect that if, in running from Kensington to the Mansion House, the London and North-Western Company should be required to use electric traction and adapt their rolling stock to such purpose the District Railway Co. should bear the extra cost, any dispute to be settled by arbitration.

The Committee then adjourned.

## SOUTH LANCASHIRE TRAMWAYS BILL.

In our issue of May 17 we reported the proceedings before Lord Ducie's Committee of the House of Lords on this bill, and on Tuesday a Committee of the House of Commons presided over by Mr. Holland, considered the bill. The petitioners against the bill were the Lancashire Electric Power Co., the Newton-in-Makerfield Urban District Council, and the National Telephone Co.

Mr. E. MOON, for the bill, said it was one to confer further powers on the South Lancashire Tramways Co. The company had last year obtained the sanction of Parliament for the construction of a very large number of important tramways, amounting to some 49 miles in length, to be operated by electricity, and coupling up a great number of towns in Lancashire, such as Wigan and Bolton, and, with others in connection, provide electric traction between Manchester and Liverpool. The act the company was now seeking was a sequence of last year's measure. The bill also provided for some new tramways, about 18 miles in length, running through Knowsley, Hayton-in-Roby, Newton-in-Makerfield, Winwick-in-Hulme, Worsley, Little Hutton, Bolton, Little Lever, and Leigh. The National Telephone Co. asked for further protection for their wires, and the Lancashire Electric Power Co. took exception to one clause in the bill. When the promoters were before Parliament last year the local authorities made it a condition of their consent to the tramways that the company should light the streets through which they passed, and a clause was inserted protecting the local authorities from competition by the tramway company in regard to the supply of electricity. A question having arisen as to whether under the act of last year the tramway company could supply electricity in bulk to the local authorities or others, a clause was inserted in the present bill giving such power. He could not say that anything in the act of last year specifically enabled the company to supply electricity, but that it was in contemplation was shown by sec. 85, protecting the local authorities from competition without their consent. The local authorities desired to be able to take electricity from the tramway company in bulk, and that proposal was in the bill as it went to the House of Lords. The clauses as to the conditions of supply were not in the bill, but were inserted by the Lords Committee at the suggestion of the Lancashire Electric Power Co. By those clauses the tramway company could only supply electricity to authorised distributors. The Lancashire Electric Power Co. had obtained power to supply the whole county of Lancashire, south of the Ribble, with the exception of certain large towns, their area being one of about 1,200 sq. miles. When before Parliament the power company had professed themselves willing to meet all competition that might be brought against them, but they were now complaining of the action of the promoters in asking to be allowed to supply electritity in bulk, although the local authorities desired them to do so. The House of Lords Committee had required the tramway company to be under the same restrictions as the Lancashire Electric Power Co., and clauses to carry out that decision were now in the bill. The opposition was one based on fear of competition, because the power company had not done a single thing to carry out its powers, and those powers would, unless something substantial was done, lapse next year. At the present moment they were not in a position to compete with the tramway company in this area, and were asking Parliament to prevent others from supplying electricity there.

Sir JNO. WILLOX, M.P., chairman of the South Lancashire Tramways Co., said their tramways spread over a very large portion of the Lancashire Electric Power Supply Co.'s area. The act of last year was not primarily for the supply of electricity. In the time which had elapsed since the passing of the bill incorporating the South Lancashire Tramways Co. they had let contracts for the rails and plant of the line which ran through the heart of the district, and which constituted half the scheme contemplated under the act. The amount of money represented by the contracts which had been let was, he should say, between £150,000 and £200,000. It had been found that the South Lancashire Light Railway Co. and the South Lancashire Tramways Co. (of both of which he was chairman) could not be effectively and economically administered except by fusion, and so they had been merged into the South Lancashire Electric Traction Co., which was carrying out the works authorised by the Act of Parliament of last year.

Mr. WALLER, C.E., engineer to the scheme, said the promoters relied, in regard to their right to supply electricity under the Act of 1900, upon clauses 42 and 85. The first of these clauses gave them power to lay apparatus for the purpose of working their tramways or transmitting electricity, and the second protected the local authorities against the company supplying electricity without their consent. It would be to the public advantage if power was given to the tramway company to supply electricity to the district in competition with the Lancashire Electric Power Co. He did not know of any tramway company to whom such powers had been granted, but this company was in a very exceptional position for a tramway company.

Mr. PEMBER, K.C., for the Lancashire Power Company, asked that the electric supply clauses of this bill should be struck out. The bill of the Lancashire Electric Power Co. was most carefully considered last year by the Hybrid Committee of the House of Commons, presided over by Sir James Kitson. The bill of the South Lancashire Tramways Co. was not sent to that Committee because it was distinctly understood that it was a tramway bill. There was no suggestion that it was a bill for the supply of electricity, and it was obvious that nothing of the kind was intended. But the introduction of clause 85 into the tramways company's bill for the protection of the local authorities formed an excuse for that company to tell the public, in asking for their money, that they had powers of supply. In regard to clause 42 of their bill, in which the words occurred, "or the transmission of electric energy for the purposes of this act," it was perfectly clear it must be shown that the purposes of the act included the supply of electricity in bulk. The fact that the company were forced to light their standards, owing to the danger arising from them at night, cleared up the meaning of the words of the clause. The present bill was one to justify the assertions made to the public and to obtain for the tramways company powers they had not. The principle of competition was of the essence of the Electric Lighting Acts. They said that the granting of one order should not be a bar to the granting of another if experience of one company showed the expediency of introducing a second set of purveyors, but it was quite another thing to introduce competition in the way this bill sought to do it. The competition would not be on fair terms, as the power company would have the adjunct of a very lucrative tramway business. They were twitted with not having raised their capital, and with the amount which the promoters of this bill had raised. But every shilling of the promoters' capital had been raised for tramway purposes, and the notice of the present bill in Parliament had hampered the Lancashire Electric Power Co. in raising theirs. Two such bills for the same area should never have been granted at the same time, as competition was a thing to be relegated to the time when experience showed its desirability. If the present bill was passed as it stood, the result would be to prevent the Lancashire Electric Power Co. getting their capital, and so would stifle a company called into existence by Parliament for a specific purpose for the sake of a company which Parliament had called into existence for another purpose.

The Committee decided that, as the tramways company had power to provide electricity for their own use in lighting the roads through which their tramways passed, and in view of the Lancashire Electric Power Co.'s act of last year, they must, for the present, defer the granting of powers to the South Lancashire Tramways Co. for supplying the public with electric energy. Should the Lancashire Electric Power Co. fail to commence and make substantial progress with their work within two years

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from the passing of their act, then a new situation would have been created which could be suitably dealt with by Parliament when it arose.

Mr. E. MOON then referred to the petition of the National Telephone Co.

Mr. POPE, K.C., explained that the telephone company did not oppose the preamble of the bill, but considered that they were entitled to bring up a clause for their protection against liability for damage which was not actually and primarily caused by themselves. Tramway companies of necessity used a current and carried it in their ordinary wires, which was dangerous to the public, and accordingly the Board of Trade provided that they should effectually keep and maintain a guard wire in order that there might be no liability of other wires coming in contact with theirs and being rendered dangerous. If that were done no danger could arise, but it undoubtedly sometimes happened that a tramway company did not perform this duty, and that a guard wire, either through wear or other cause, failed to prevent a falling wire coming into contact with the trolley wire. In that case the current which was dangerous in their wire, and which would not hurt anybody if kept in their wire passed into the smaller wire and became dangerous to the public. In a recent serious case of falling wires at Liverpool the injured parties sought their remedy against the telephone company, although they had no control over the agency which did the mischief, and acting on advice the telephone company paid what damages were sought against them, because they, being the immediate agency of the mischief, felt that the fall of their wires might be held to be the direct cause of the mischief. The result was the case was not taken to a court of law. They were thus subjected to this extraordinary state of things, that they could not recover against the Corporation because they were equally with the telephone company *tort feasors*, or occupiers by legal right. But that was exactly the mischief that the petitioners wanted to protect themselves against, and the clause they proposed for insertion in the present bill was :—

"Where the tramway company place any electric line above ground they shall, notwithstanding anything contained in this act, or in any act incorporated herewith, be responsible for all damage and injury caused by the escape of their electric current through any wire or apparatus of any other party, and the owner and user of any such wire and apparatus shall not be liable for any injuries caused by the escape of such electric current through his wire or apparatus, unless it be proved to the satisfaction of a court of competent jurisdiction—(1) that the escape of such current was due to the wilful default of the person by or through whose wire or apparatus such current escaped ; or (2) that the person by or through whose wire or apparatus such current escaped was also using a dangerous electric current."

The contention was that where the mischief could only be caused by the liberation of a dangerous current, the persons using the dangerous current, and not protecting it, ought to be liable for damage caused by its liberation. The telephone wires were perfectly harmless, and, if in consequence of the tramway company not properly guarding their current, the telephone wires became dangerous, the telephone company ought not to be held responsible.

Mr. MOON said the effect of the proposed clause would be that, however negligent the telephone company might be in the maintenance of their wires, the tramway company were to be liable. If it was only a question of the tramway company being bound to maintain a guard wire, he should not object to a clause which would throw upon them the obligation to pay damages for accidents which resulted partly from the negligent maintenance of their guard wires.

Mr. POPE thought that was not unreasonable. If the guard wires were maintained accident was impossible, and the telephone company did not seek to make the tramway company responsible for their negligence.

The Committee then adjourned on the understanding that the parties would agree upon a clause to be submitted to the Committee.

Yesterday the CHAIRMAN declared the preamble of the bill proved, subject to any clause that might be inserted.

Mr. FORBES LANKESTER, for the National Telephone Co., said the parties had been unable to agree upon a clause. He then submitted a modified clause, to which, however, exception was taken by Mr. MOON on behalf of the promoters, who said the proposal was more important than it seemed. The National Telephone Co. were seeking for the first time to obtain a clause of this kind, and if they succeeded they might ask to have it inserted in every tramway bill brought before Parliament. So it was a matter which could not be dealt with as merely affecting this particular bill. What was suggested was that where both parties were negligent, and the telephone wire broke owing to the negligence of his company, and came across the wire of the tramway company, instead of the companies sharing any damage that might be recovered against the one or the other company, the tramway company should bear the whole of the damage, although caused by joint negligence. He justified that by alleging that the telephone company's negligence was an innocent one, but no damage could be wrought by the trolley wire of the tramway so long as it was not interfered with. It would be by the falling of the telephone wire that communication would be set up likely to cause damage.

The CHAIRMAN said that the Committee had carefully considered the clauses submitted. They, however, preferred the proposed clause should read as follows :—

"If the tramway company place any electric line above ground the National Telephone Co. shall not be liable for any damage or injury which may be caused by the escape of electric current from the company's said electric line through any wire or apparatus of the National Telephone Co., unless it be proved to the satisfaction of a court of competent jurisdiction that the escape of such current was due to the default or negligence of the National Telephone Co., in which case the companies shall be jointly liable."

The clauses of the bill were then disposed of, and it was ordered for report and third reading.

## SOUTH-WESTERN AND ISLE OF WIGHT JUNCTION RAILWAY BILL.

This bill, which has already been sanctioned by the House of Lords, came before a Committee of the House of Commons yesterday (Thursday) as an unopposed measure, and was remitted to the Chairman of the Committee of Ways and Means for formal proof of the preamble.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 228.*)

LECTURE IV.—ELECTRIC WAVES.

Having reviewed briefly the mode of production of electric oscillations and discussed some of the chief properties of dielectric media, we must turn attention in this fourth and last lecture to the production of electric waves in dielectrics by means of electric oscillations. There are one or two questions connected with wave production in general, concerning which a little preliminary discussion may be useful. One physical characteristic of wave motion is that by it energy is conveyed entirely away from the wave-creating body and exists for a time stored up in a surrounding medium. Consider, for instance, the production of a compressional wave in air. If I move my hand or a fan to and fro the mere production of this motion or change of motion in the material body absorbs energy. When it is so moved in a fluid such as air the moving solid sets up vortex or rotational motions in the surrounding air similar to those whirls which are seen on moving an oar or the hand through water, and these fluid motions also take up energy to produce them. If a fan is moved slowly through the air all that happens is that the air in front passes round behind it, and in so doing air vortices are created. Energy is, therefore, absorbed not only in making changes in motion of the solid, but also is taken up in the surrounding medium in creating this vortex motion or movements in the air which cling to and surround the moving body.

A large part of the resistance to motion which a solid experiences in passing through a fluid is due to this form of energy absorption by the fluid. A perfect fluid, or one without any quality of viscosity, could not have these motions so set up in it, and hence offers no resistance to the motion through it of a solid. If the solid oscillates or moves slowly through a fluid, the energy never dissociates itself entirely from the moving solid or from the fluid in its immediate neighbourhood. The energy, so to speak, travels with the vibrating body and exists where it is, or in proximity to it ; when its motion ceases the energy of motion of the fluid is frittered away into heat.

It is quite different, however, if a body is moved or vibrated very rapidly so as to bring into play the inertia quality of the fluid. If, for instance, instead of moving somewhat slowly through the air, the fan or other body, such as a tuning-fork, is made to vibrate with considerable speed, the inertia and compressibility of the air come into play, with the result that we have a true wave produced. The air has not time to get out of the way of the moving solid, and thus, instead of moving round to the back of the vibrating body, it is suddenly compressed and subsequently rarified and started into oscillations. Each portion of the fluid takes up successively the oscillatory motion or changes of pressure, and energy is conveyed entirely away from the moving body and its neighbourhood, and continues to exist in the medium as a wave long after the vibrating body which started has come to rest. Some at least of the energy imparted to the solid to set it in vibrtion is taken from it and handed on from point to point through the air.

The characteristic of a true wave is that in each portion of the medium the energy so being conveyed exists alternately as energy of strain or configuration and energy of motion, or in some form equivalent to these types of energy. Moreover, at equal distances, called a *wave length*, similar energy changes are taking place at the same time. The total energy of a true wave of any kind can be shown to be at any moment half potential or configurational and half kinetic or motional. At each point in the medium cyclical changes of energy take place, and the disposition of either kind is periodic in space.

The term *wave motion*, therefore, has reference to this peculiar mode of transferring energy from place to place, and, as we have seen in the second lecture, waves can exist in any medium which possesses two essential qualities. The first of these qualities is that some kind of vector or directed change made in it must tend to disappear if left to itself ; and not only so, but in being created must call forth an opposition or resistance to its creation. In the second place, in disappearing, the change, whatever its nature, must tend to overshoot the mark and be reproduced in the opposite direction ; in other words, there must be a persistence or inertia-like quality in connection with the change of deformation.

There may, therefore, be as many different kinds of waves as there are possible modes of deformation in extended media. Take, for

* Cantor Lecture delivered before the Society of Arts, Dec. 17, 1900.

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instance, the case of water. If the water has a free surface this is a level surface and tends to remain level. If the water is heaped up in one place and left to itself it begins to regain its level, but it possesses inertia, and in so doing it overshoots the mark and creates a depression in the surface. From this point, therefore, surface waves spread out, which are changes in level, periodic in time and space. Again, a free water surface possesses what is called *surface tension*. The surface of any liquid offers a resistance to stretching like a sheet of indiarubber. If, therefore, a surface of water is slightly heaped up the surface is stretched and tends again to become level in virtue of this surface tension. Hence, we can have not only what are called *gravitational waves* on the free surface of water, but ripples or *surface tension waves*. These latter may be seen to be formed when a fishing line or thin rod is moved through water perpendicularly to the surface. Furthermore, water resists compression, and hence we can have produced in it *compressional waves*, not on the surface but in the mass. Such waves are produced in water by an explosion taking place beneath the surface.

In every case, however, the velocity of propagation of the wave is measured by the square root of the ratio of two quantities, one being of the nature of an elasticity, and the other the density or mass per unit of volume. Moreover, in all wave motion the velocity of the wave is measured by the product of the wave length and the number of complete oscillations per second executed by any part of the medium through which the wave motion is travelling. If V represents the wave velocity, $n$ the frequency, and L the wave length, then we have the relation $V=nL$ as a fundamental equation connecting wave length and frequency.

In the case of solid bodies, we can have another kind of wave not capable of being produced in liquids, namely, a *distortional wave*. The special characteristic of a solid substance is that it resists shearing or being changed in shape. If, for instance, we give a twist to a rod of steel it resists this kind of torsional deformation, but we cannot put a twist of the same kind upon a thread of honey or column of water.

Accordingly, we can have a great variety of waves in material

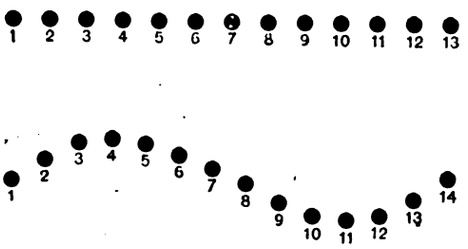


FIG. 1.—Diagram representing the Formation of a Distortional Wave in a Material Solid Body.

media depending upon the fact that their parts possess inertia, and that they resist some kind of relative displacement. Thus, for example, we may have:—

Gravitational or surface waves in liquids—due to the resistance of the surface to being made unlevel.

Capillary waves or ripples on the free surface of liquids—due to the resistance of the surface of the free liquid to stretching.

Compressional waves in the mass of a gas, liquid, or solid—due to the resistance to change of bulk or volume elasticity.

Distortional waves in solid bodies—due to the resistance to shearing, twisting, or other changes of a form of any element; in other words, to shape elasticity.

These preliminary remarks will pave the way for a consideration of the nature of *electric waves*.

Every dielectric possesses, as we have seen, two properties. It can have a physical state produced in it at any point called the electric displacement, and this corresponds to the production of a deformation or strain in an elastic solid. The medium resists by an elastic reaction the creation of this displacement, and when the electric force creating it is withdrawn the displacement disappears; but as a displacement requires an energy expenditure to produce it, the law of conservation of energy necessitates that the displacement in disappearing shall give rise to energy in some other form. This it does by the creation of magnetic flux in a direction at right angles to itself, and the flux in turn in disappearing gives rise again to a displacement at neighbouring points in the same direction as that displacement, the vanishing of which gave rise to the flux. Hence, we detect in this operation an analogy with the case of a vibrating solid where mechanical stress gives rise to elastic strain, and strain in disappearing creates velocity or sets matter in motion, and hence reproduces the strain energy in a kinetic form. This again, in virtue of inertia, re-creates a new strain in an opposite direction.

We may illustrate this point by a diagram as follows:—Consider a row of particles representing the molecules of an elastic solid (see Fig. 1). If one of these is drawn on one side this mechanical displacement is resisted by the intermolecular forces of cohesion. Hence, when the molecule is released it begins to return to its mean position. Its inertia, however, carries it on beyond this point, and in so moving it compels adjacent molecules to move with it, but the displacement calls forth a restoring force which finally destroys the displacement again. Hence we have a periodic state in which displacement, and therefore energy of strain, alternate with motion, and, therefore, kinetic energy. Each molecule in turn passes through the cycle of changes, and hence a wave of mechanical displacement is propagated from point to point. Consider, in the next place, the mode of production of a wave of electric displacement. Imagine a dielectric cut up for convenience of illustration into tubes which are slightly separated (see Fig. 2). Consider that along one tube we make an electric displacement away from the reader, represented by the black circle or big dot in the middle tube.

By Maxwell's principle this displacement *whilst increasing* or diminishing is in effect an electric current, and creates round it a magnetic flux represented by the arrows. The action of this flux is to call forth a displacement in adjacent tubes of the dielectric and to tend to annul that already created. Hence it is easy to see that the operation of making an electric displacement along any line in a dielectric, which is then left to itself, must be to propagate out in the surrounding region a wave of electric displacement. Each portion of the medium successively and periodically sustains an electric displacement, and this, whilst increasing, creates an embracing magnetic flux the operation of which is to annul the displacement which gave rise to it and re-create the displacement at points lying beyond.

The process of alternating electric displacement and resulting magnetic flux repeated cyclically from point to point through the dielectric, constitutes an electric wave, and the velocity of this wave is measured by the value of $1/\sqrt{K\mu}$ for that dielectric. By the velocity of the wave is meant the quotient of wave length by the periodic time.

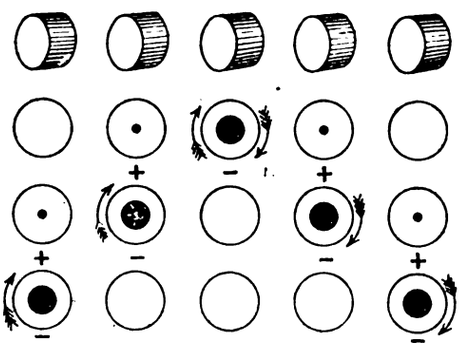

FIG. 2.—Diagram representing the Formation of a Displacement Wave in a Dielectric.

In considering these matters the question necessarily arises: What is it that constitutes an electric displacement in a dielectric? Maxwell never committed himself to any opinion as to the exact nature of the physical change which he called the electric displacement. Mr. Oliver Heaviside remarks paradoxically that the more general or more vague a physical theory, in one sense the more likely it is to be true, or perhaps we should say the less likely it is to be untrue. This vagueness, however, in this case is felt by some to be unsatisfactory; they want to know whether an electric displacement is an actual motion or a stretch, squeeze, or rotation of an æthereal medium or of the material dielectric. If told that not only do we not know, but that all theories on this matter are most probably wide of the mark, they are apt to feel a degree of disappointment. Yet we are on safer ground when we are content not to demand too much detail at present. Mechanical analogies are helpful as a guide, but we may easily become slaves to an analogy or a catch phrase. In order that we may create an electric wave we have, however, to cause an electric displacement in a dielectric and to release that constraint very suddenly, just as to produce a compressional wave in air we have to produce or release very rapidly an air compression.

All these ideas had been grasped with some degree of clearness prior to the publication of Hertz's work, but to him we are indebted for a new departure on the subject which brought it at one stroke within the region of experiment. Hertz equipped the secondary terminals of an induction coil with a species of Leyden jar or condenser, which is now known as a Hertz radiator. This consisted of a pair of metallic plates, or sometimes balls, having attached to them short rods ending in knobs placed a fraction of a centimetre apart. These knobs were connected to the secondary circuit of the coil. Hence, as the secondary E.M.F. accumulates the plates are brought to a difference of potential, and lines of electrostatic displacement stretch out from one part of the oscillator, which we will call the positive side, to corresponding points on the negative side. We have thus a strong electric displacement created along certain lines of electric force.

*(To be continued.)*

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# LEGAL INTELLIGENCE.

## Uppingham Gas Co.—Enlargement of Powers.

In the Chancery Division, before Mr. Justice Byrne, the petition was heard of the plaintiff company for the sanction of the Court to the substitution of a memorandum and articles of association for the original deed of settlement under which the company was constituted. Under the original deed it was a company of proprietors for supplying the town of Uppingham with gas, and for lighting the streets and other places in the town. By the memorandum and articles now submitted for confirmation the objects were to manufacture and supply light, heat, and motive power in the town of Uppingham and elsewhere in the county of Rutland; to carry on the business of an electric lighting company, and to lay down and carry out all electrical works and generators of electricity, and to carry on the business of electricians; and for the purposes usually connected with a gas-making and supply undertaking.

Mr. Justice BYRNE thought the proposed memorandum covered a very large large area, and went far beyond the original objects of the company. It included dealing in electrical carriages and motor carriages. He thought that ought to go out, as it seemed unnecessary to the main object. The company had, without such powers as he had mentioned, the generation and distribution of electric current for lighting and motive power in all its branches. In the end his lordship sanctioned the electric lighting and supply of motive power portion of the memorandum and articles, but disallowed the manufacture and dealing in motor carriages and the like. With some further modifications the substitution of the memorandum and articles for the deed of settlement was sanctioned.

## Liverpool Mortgage Insurance Co. v. British Electric Works Co. (Ltd.).

In the Chancery Division on Saturday Mr. Justice Cozens-Hardy heard this action.

Mr. EVE, K.C., said the action was brought by the trustee of a debenture trust deed, suing on behalf of himself and all other debenture holders in the defendant company. The debentures had become enforceable by reason of the company having passed a resolution for voluntary winding up. Another reason for the principal moneys becoming due was that the defendant company had failed to keep up the value of its cash in hand, book debts, and stock-in-trade, to £30,000, and the trustees had certified that there had been default in that respect. It transpired that the company could not go on unless further money was found. Shortly after the action was commenced Mr. Justice Farwell appointed a receiver and manager, and no defence to the action had been put in.

His LORDSHIP expressed surprise that the company did not appear to the action.

Mr. EVE said the proceedings against the company were perfectly regular.

His LORDSHIP thought the plaintiffs were entitled to the order they asked for, and made the common form decree in a debenture-holder's action.

Mr. EVE then proceeded to open a summons asking the Court to sanction a conditional contract which had been entered into for the sale of the company's property to Vickers, Sons and Maxim (Ltd.). Counsel said that the price to be paid under the contract was £60,000, and the purchasers undertook certain liabilities to the extent of £6,000, and acquired, amongst other things, the book debts and the cash of the company. The summons also asked for payment of a commission of 2 per cent. to the late managing director of the company, who had negotiated the sale.

His LORDSHIP thought that that commission seemed extortionate.

Mr. EVE said he had to bring the matter before the Court, but the feeling of all parties was that that gentleman was the only man who had sufficient knowledge of the company's business and the quarters in which it could be disposed of. The terms were that if the managing director found a purchaser he was to have 2 per cent. commission. If the contract was sanctioned, the price realised would be sufficient to pay off the whole of the creditors and leave a balance for the shareholders.

His LORDSHIP said that made it all the more extraordinary that the company was not represented by counsel.

ONE of the LIQUIDATORS of the company made a statement to the effect that at the meeting at which the resolution was passed for voluntary winding-up two liquidators were appointed, and they, although perfectly friendly, were unable to agree upon solicitors who should act for them. A meeting of shareholders had been called in Liverpool for Wednesday next, and if the summons stood over no doubt counsel would be instructed.

Mr. EVE was anxious that the summons should be speedily heard, because, in order that the works should be kept going, it was necessary to tender for large Government orders. The purchase would be completed one month after the sanction of the Court to the contract, or at the latest by July 31.

His LORDSHIP adjourned the summons until to-day (Friday), and made an order continuing the receiver and manager until Aug. 10.

## River Plate Construction Co. (Ltd.), James Capel & Co. and Charles Bright (an Arbitration).

This matter again came before Mr. Justice Farwell in the Chancery Division on Saturday last on a motion on behalf of Mr. Chas. Bright to set aside an award made on March 11, 1901. It will be remembered that on March 30 last Mr. Bright moved to set aside the award on various grounds, and Mr. Justice Farwell dismissed the motion, and on appeal by Mr. Bright the Court of Appeal affirmed this decision. Both cases were reported in *The Electrician*.

Mr. BRIGHT now moved to set aside the award on the following grounds:—(1) That the submission to arbitration was made and the award given under the mistake of fact that the agreement of Aug. 10, 1899, was a valid and subsisting agreement, whereas, in fact, it was not a valid and subsisting agreement and was never executed by the River Plate Construction Co. or signed by any duly authorised agent on their behalf; (2) that the arbitrator had no power to hold the arbitration or make the award; (3) in the alternative that the award was *ultra vires* and beyond the jurisdiction of the arbitrator. On behalf of Mr. Bright it was urged that he had only within the last 14 days ascertained the facts that entitled him to maintain the present application. The respondents took the preliminary objection that the matter was *res judicata*, and

His LORDSHIP upheld the objection and dismissed the application with costs.

Three other actions to which the River Plate Construction Co. were parties have come before Mr. Justice Farwell this week. These were without electrical interest.

## Howell's Simplex Anti-Inductive Telephone Syndicate (Ltd.).

This matter came before Mr. Justice Wright, in the Winding-up Court on Tuesday, on a summons by the liquidator dealing with the claim of Mr. T. J. Howell. The liquidator asked for directions as to dealing with the claim, which was for cash and shares in connection with the sale of his patents to the syndicate.

Mr. J. BLACK, who appeared for Mr. Howell, said the latter in 1893 invented valuable improvements in telephones. Not having sufficient capital to exploit them, he was introduced to a Mr. J. Gordon McIntosh, and agreed to receive £600 in cash and one-third of the shares in a syndicate which McIntosh was to form. McIntosh then entered into a fresh agreement to sell to the syndicate the patents for £2,500 in cash and 5,450 ordinary shares. That agreement was adopted by the syndicate, which, it was submitted, also adopted the agreement between Howell and McIntosh, and so got Howell's patent rights for Great Britain and abroad. The capital of the syndicate was £12,000. The syndicate was now being voluntarily wound up, and Howell having failed to obtain the price agreed upon from McIntosh, sought to prove in the liquidation. He was, however, in the unfortunate position that his solicitor had absconded with his most valuable documents. His client was totally blind, but notwithstanding that infliction he had made valuable electrical inventions, which were being sought after by the General Post Office and the principal railway companies; but he could not deal with them, as the syndicate had his patents, for which they had not paid.

Mr. HOWELL said he had been totally ruined by the action of McIntosh, the syndicate and others, and had been so destitute as to be without shelter. He claimed £1,230 damages for breach of agreement and the return of his patents. All he had received was £270.

Mr. RUSSELL, for the liquidator, said that if Mr. Howell would return the £270 he had received he could have his patents.

Mr. HOWELL said he was quite destitute.

His LORDSHIP said it appeared to him that Mr. Howell had been very badly used by Mr. McIntosh, but in the documents before him there was no evidence of any contract between him and the syndicate. He thought, however, that he might be found to have some title to the patents held by the syndicate on the ground of fraud and conspiracy, if he could find money to fight the case.

Mr. RUSSELL said the liquidator was investigating the proceedings of the directors, and, if necessary, he would take proceedings.

His LORDSHIP adjourned the hearing of the summons until July 9.

## Foote and Milne v. Silcock.

Mr. Justice Ridley, in the King's Bench, on Wednesday, heard an action in which plaintiffs' claim for £100, the amount of an unpaid bill (with interest), which had been given by defendant in connection with some electrical work carried out at the Star and Garter Hotel, Putney, and flats adjoining. Defendant pleaded that the plaintiffs had not completed the work under their contract, and that consequently consideration for the bill failed. The signature on the bill being admitted,

Mr. T. TERRELL, K.C., for defendant, said Mr. Silcock was building this hotel and a considerable block of flats. Originally tenders had been sought for engines, dynamos, wiring – in fact, the complete electrical installation; but the proposals were modified, and the plaintiffs, on June 13 last year, by letter contracted to supply only the necessary mains, distribution boards, switches, wiring, &c., for 440 lamps for £475, or, if they were to do the cutting away, £485. The terms of payment by contract were to be by acceptances at three months, to be given when work of that value was completed; and it was further provided that "for the purpose of calculating, the value of the work done, the branch wiring shall be taken at 19s. per light." What the plaintiffs had not done was: (1) They had not put in seven distribution boards to go with the mains, the value of which was estimated by defendant's electrical engineer at £51. 2s.; (2) they had not put in 76 lights, which, at 19s. per light, making allowance for the mains laid, left work valued about £58. 18s. to be done. Other parts of the work not absolutely completed would cost £7s. 10s., and there was a switchboard for the assembly rooms which would cost £3. Also, there were six arc lamps, with brackets and fixing, which would cost £57, and the wiring and boards for the same, £6, yet to be put in. What the plaintiffs had done beyond the contract was to put in extra lights, which at 19s. per light would amount to £53. 4s. Taking the balance of the account, the plaintiffs had actually work done representing £344, and they had already been paid £330, not counting the £100 on this bill now sued for, and in respect of which his case was they had not done the contract work which alone made the money due.

Mr. RAWLINSON, K.C., for plaintiffs, said the fallacy in his friend's argument was that the work was not complete. Plaintiffs were ready and willing to complete the entire work as soon as they had been paid as under

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the contract—viz, 19s. in respect of the branch wiring of each light. They had put in 476 lights, on each of which the payment of 19s. was due.

Mr. Justice RIDLEY: Unless you can show, Mr. Terrell, that the work has not been done, I do not see that you have any answer to the case.

Mr. TERRELL pointed out that the mains were not complete, or the distribution and switchboards. Was he to pay the entire contract price, which this 19s. per lamp worked out to, when the work had been only half done, merely because plaintiffs had put in the branch wiring?

Mr. Justice RIDLEY: Yes, that is what the contract says. You may have made an improvident bargain, but there it is.

Mr. TERRELL argued that the construction his lordship was putting on the contract was an improper one, and gave the plaintiffs right to payment for the entire contract, though they had completed only a part of it.

Mr. Justice RIDLEY: I think they are entitled to say, "We have done the branch wiring of so many lights. Therefore you must give us the full amount."

Mr. TERRELL: That means I have got, in your lordship's view, no defence.

Mr. Justice RIDLEY: That is so.

The case was therefore decided on the point of law on the construction of the contract, and his lordship entered judgment for plaintiffs for £100 and costs.

In a second action in respect to a bill of exchange for £30 judgment was also given for plaintiffs. Execution was stayed, with a view to appeal, on the money being brought into court.

### Coventry Gas Fitting, Electrical and Engineering Co. (Ltd.)

In the Chancery Division, on Tuesday, Mr. Justice Wright sanctioned the arrangement set out in our issue of May 3 for the reconstruction of this company.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The committee of the Manchester Municipal School of Technology (to be opened in September) invite applications for the position of head of the physics and electrical engineering department. An advertisement contains further particulars, and applications should be sent to the principal (Mr. J. H. Reynolds), Princess-street, Manchester, by July 6.

A lecturer and demonstrator in electrical engineering will be required at the Hull Municipal Technical School in September. Forms of application, &c., from Dr. J. T. Riley. See advertisement.

The Portsmouth Technical Instruction committee invite applications for the positions of assistant lecturer in mathematics and physics and workshop instructor and assistant in engineering for their municipal technical institute. Applications by July 4. See advertisement.

The committee of the Croydon County Polytechnic require an assistant lecturer and demonstrator in electrical engineering. An advertisement contains further particulars. Applications to the clerk (Mr. S. W. Beckell) by July 10.

Swansea Corporation require a resident electrical engineer. An advertisement contains further particulars. Applications to the town clerk (Mr. John Thomas), Guildhall, Swansea, by July 11.

Wellington (N.Z.) Municipal Council require an electric tramway engineer. Particulars may be obtained from Messrs. John Duthie & Co., 23, Lime-street, London, E.C., to whom applications must be delivered before noon of July 20. An advertisement contains further particulars.

Stepney (London) Borough Council require an engineer-in-charge, a meter and general testing superintendent, and a meter-room assistant. Applications to engineer and manager (Mr. Wm. C. P. Tapper), 27, Osborn-street, E, by July 8. See advertisement.

Dewsbury Corporation require an engineer to take charge of their electricity works. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. G. Trevelyan Lee) by July 4.

An assistant is wanted on the engineer's staff of the London Electric Supply Corporation. Applications to resident engineer, 25A, Cockspur-street, London, S.W. See advertisement.

Ealing District Council require a clerk to the Electric Lighting committee. An advertisement contains further particulars. Applications to the chairman, Public Buildings, Ealing.

Switchboard attendants are required for extra high tension substation operating electric tramways. Applications by July 4. See advertisement.

A demonstrator of physics is required for the South-Western Polytechnic, Manresa-road, London, S.W.

Rathmines (Dublin) Technical Instruction committee require a principal for their technical schools. Applications by July 8.

Mr. F. A. Wilkinson, the assistant engineer at Salford, has been appointed electrical engineer to the Walthamstow District Council.

**Aberdeen.**—The Harbour Board have voted 50 guineas to the city electrical engineer (Mr. J. Alex. Bell) for services rendered in connection with the electric lighting of the quays.

**Barnstaple.**—It has been resolved to apply for a loan of £27,000 for electricity works.

**Bath.**—An inquiry was held yesterday (Thursday) into the application of the Council to borrow £4,000 for additional land for extending the electricity station buildings.

**Blackrock (Dublin).**—Dublin Corporrtion have informed the District Council that they will be in a position to supply electric current in the district on the completion of the Pigeon House power station in a little over 12 months.

**Cheltenham.**—An inquiry was held here on Tuesday into the application of the Council to borrow £25,000 for electric lighting extensions. The town clerk (Mr. E. T. Brydges) said the loan would be employed as follows:—£3,170 for extension of station buildings, £8,950 for additions to generating plant, £700 for extensions of mains and sub-stations, £9,280 for street and private lighting extensions, £1,700 for two feeders from the electricity works to the Manchester-street sub-station, leaving £1,200 for contingencies. Technical details were supplied by the borough electrical engineer (Mr. Hamilton Kilgour) who said that on March 31, 1896, they had 101 customers taking current equal to the equivalent of 6,150 8 c.p. lamps, in 1897 the figures were 157 and 9,650, in 1898 246 and 14,900, in 1899 302 and 18,980, in 1900 384 and 23,420, at March 31, 1901, 491 and 30,030, while at present there were 510 customers and 31,540 8 c.p. lamps connected for private lighting with 263 arcs and 19 incandescents for street lighting. The units sold had advanced from 47,000 in 1896 to 653,000 in 1901. The present capacity of the station was about 1,000kw. At the conclusion of the inquiry the town clerk asked the inspector to urge the Local Government Board to expedite the application, and mentioned that he had only that morning received sanction to the loan of £6,000 applied for in October last.

**County Councils and Electric Lighting Orders.**—At the meeting of the executive of the County Councils' Association on Wednesday, the Lancashire Council notified that their dispute with the Board of Trade as to the insertion of clauses for the protection of county councils under electric lighting provisional orders had been decided in their favour. At first the Board refused to insert the clauses, but they were inserted when the confirmatory bill came before the Chairman of Ways and Means. The Board has since intimated their willingness to give facilities for the insertion of similar clauses.

**Devonport.**—The electric tramways were opened for traffic on Wednesday.

**Ealing.**—The following recommendations, made by the Electric Lighting committee after consideration of the report of the consulting engineer (Mr. B. H. Jenkinson) on the present position of the electricity undertaking, were adopted by the Council last week:—

(*a*) That the question of free wiring be postponed for the present; (*b*) that a business manager be appointed, to be paid by salary and commission; and (*c*) that Mr. Jenkinson be authorised to test, at a fee of £5. 5s., the boilers at the station, in order to ascertain the advantages or otherwise of mechanical stokers.

**East Middlesex Electricity Bill.**—The costs incurred in the promotion of this bill, which was dropped in consequence of the adverse votes of two of the districts concerned amounted to £1,205. 17s. 8d., of which each of the five districts (Tottenham, Edmonton, Enfield, Wood Green, and Southgate) will pay its share. A conference of the councils of these districts takes place at Wood Green to-night (Friday) to consider the question of taking other steps in connection with electric lighting. The clerk to the Edmonton Council points out that his Council have a special protecting clause in their new act to protect them against outside encroachments, which most other district councils have not.

**Electric Traction in Spain.**—Several of the Madrid journals have attacked the tramways company of Madrid on the subject of the unsuitability of the electric cars during hot weather. There has been a great heat spell, and the traffic on the electric cars is said to have fallen off considerably owing to the great heat inside the vehicles. To obviate this the old open mule cars with garden seats have been attached to the motor cars as trailers, the motor cars being used only as locomotives. It is urged that the incident again shows the necessity, if foreign trade is not to pass out of the hands of British manufacturers, of studying the special requirements of the different places for which rolling stock may be required. The need for a car which can be converted into an open one in summer and a closed one in winter is imperatively shown. Even on our own electric cars in West London the question of better ventilation for the inside of the cars on very hot days is one of pressing importance, as it is generally found the outsides of the cars are crowded and, except on rush days, the insides comparatively empty.

**Electricity Supply in Lancashire.**—The directors of the Lancashire Electric Power Co. will erect their first generating station at Little Lever, near Bolton, to supply an area within a radius of

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12 miles, and embracing various towns and districts with a united population of over a million. It is expected that the works will be capable of supplying current by March, 1903, at latest. Under the act four generating stations are authorised. The second will be in the neighbourhood of Wigan, and the others are to be at St. Helens and Trafford Park. The company is prepared to negotiate for a supply of current to local authorities on terms 20 per cent. below the maximum rates in their act.

**Falkirk.**—An offer has been received from Messrs. Crompton & Co. to take a transfer of the Falkirk provisional order. The Town Council have appointed a deputation to visit the electricity works at Ayr, Edinburgh, Leith and Perth to obtain information and report.

**Glasgow.**—In a report to the Tramways committee on Wednesday the general manager (Mr. J. Young) stated that satisfactory progress was being made at the Pinkston power station, and that the machinery was working well. The consulting engineer (Mr. H. F. Parshall) also reported that the electrical machinery in the sub-stations, and all the underground cables, had proved satisfactory. The boiler-house arrangements at the station were approaching completion, and the coal-handling machinery had been tested and found satisfactory. The first economiser had been put into working order, and the second one was well forward. The outside coal-handling machinery had been tested and proved satisfactory. Generally, everything in connection with the boiler-house was working well. The two Stewart engines, which had been working for some weeks at about half-load, were taken out of work on June 14, and one handed over to the Stewart Company for general overhauling, the second being held as a stand-by for the working of the auxiliary power plant in case of failure of supply from Dalhousie. He had asked the Stewart Company to make arrangements to enable him to use the engines under usual working conditions. The little trouble at first experienced from warm pins with the Allis engines had disappeared. As regarded the Musgrave engines, the first commenced working on Monday. There had been some trouble from heating, but not more than might reasonably be expected in starting a new engine. The engine would be put on artificial load on Saturday, and it was expected it would be in satisfactory working order for car load in a week from that day. The cranes were being overhauled and the condenser and auxiliar plant generally were working satisfactorily, and had given no unusual trouble from the beginning.

**Gloucester.**—The first year's working of the electricity department has proved very satisfactory, no loss having been sustained. It has been resolved to reduce the price of current from 7d. to 6d. per unit, and to give new customers a month's consumption free.

**Guildford.**—The dispute between the Guildford Electricity Supply Co. and the Corporation in regard to the company's cables on the Town Bridge has been settled amicably. The Corporation agree to pay the expenses of the company, and the latter to waive their right to certain notices.

**International Telephonic Communication.**—The Italian Parliament on Wednesday voted a credit of 51,000 lire for the construction of a telephone line between Italy and Switzerland. If the bill passes this will be the second international telephone trunk line established in Italy, the first being in course of construction at the present time between Italy and France.

**Isle of Thanet Tramways.**—At Margate, last week, a Board of Trade inquiry was held by Major Pringle, R.E., into the accidents which have occurred on this line.

Dr. NICHOL stated that during the previous week nine cars left the rails at the corner of Athelstan-road and Ethelbert-terrace. The derailments all occurred at one spot. No injury was caused by any of the derailments.

The INSPECTOR said it was obvious that accidents would always happen of the type of some of those included in the list. Of course, horses shied when the trams first commenced. The bulk of these accidents were derailments, which seemed to show that there was something wrong with the permanent way, the cars, or the drivers. He thought there was ground for inquiry.

The MAYOR of RAMSGATE stated that the scheduled speeds at certain places were exceeded. He lived near one of the points, and the noise created was simply intolerable.

On behalf of the Margate brake owners it was alleged that the drivers of the tramcars were incompetent, and that neither the drivers nor the conductors wore uniforms or badges.

For the company Mr. F. MURPHY submitted that there had been a great deal of exaggeration as to the danger and a great deal of unnecessary alarm as to what would happen in the future, and he only wished to draw attention to the fact that compared with other tramways the number of accidents had been small. The line had been open 10 weeks; the number of passengers carried had been 700,000, and the number of miles run was 140,000. During the 10 weeks there had only been one case of real personal injury—that in which a lady broke her arm. The men employed were skilled men, and persons were brought over from Dublin to train them.

Mr. J. E. WALLER, engineer to the scheme, said he had analysed all the accidents given in the list sent in by the town clerks of Ramsgate and Margate. As to the runaways, he found there had only been three since the line opened, and they all occurred shortly after the opening of the line. He thought there was a decided improvement in matters now. There appeared to have been five collisions, and of these only one was between two cars, which occurred on June 1. The practice was, when opening a new tramway, to get experienced drivers to teach inexperienced men. That was a process which must be gone through, as the number of electric tramways was not very large. When they first commenced running a few years ago there was not an experienced man in England, and they had to be brought from America.

The INSPECTOR said it seemed to him the place was one where the cars ought not to stop. It was a place where there should be a stringent regulation, or where the lines should be taken up and replaced by an interlacing line.

Mr. WALLER (continuing) said there were two cases of broken axles, which were undoubtedly due to defective steel. They were arranging for all the axles on the small cars to be replaced, and to a large extent that had been done. The axles were being replaced by those of English make. He was of opinion that slipper brakes would not be an advantage on the tramway, though they were in cases where there were long continuous gradients. He was not prepared to say it was the practice on all other tramways to have them.

Mr. PAGE, traffic superintendent of the line, said he had had experience in Cleveland (U.S.A.), and large cars were employed there. He was of opinion that it was more difficult to drive a big car than a single truck. A man who had been driving a single truck might not be able to drive a double truck well until he had had a little experience.

**Lancaster.**—The Council have adopted the scheme of the electric tramway engineer (Mr. Tester) for the construction of an electric tramway from Dalton-square to Scotforth (1¾ miles), and from the Pointer to the Golgotha entrance of the Williamson Park (1¼ miles), at an estimated cost, including cars and car shed, of £26,960. Negotiations for the acquisition of the local tramway company's undertaking are to be re-opened.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Barrowford, the Nelson, and the Colne and Trawden Light Railway Orders, 1901.

The permanent way of the Cheltenham-Cleeve light (electric) railway was inspected on Wednesday.

**London County Council.**—At Tuesday's meeting it was agreed to loan Hampstead £12,500, Islington £3,236, and Stepney £26,507 for electric lighting purposes.

The report of the Highways committee, recommending that application be made to Parliament next session for powers for the construction by the Council of various new tramways (the main particulars were given in last week's *Electrician*), 28 miles 5 furlongs 67 chains in length, at a total cost of £1,323,307, was carried.

**Madrid.**—Owing to several accidents which have happened on the electric tramcars in this city, steps are being taken to compel the company to provide fenders to the cars. It is stated that the Queen Regent has taken a strong interest in the matter, and has herself prepared a translation from the German of an article showing the designs of fenders used with good results on the Berlin tramways.

**Manchester.**—The permanent way of the Rochdale-Bury New Road electric tramways was inspected yesterday (Thursday) by Lieut.-Col. von Donop. Mr. A. P. Trotter has intimated that his recent inspection of the electrical equipment on the Cheetham Hill route obviates a visit on his part to Manchester at present.

**Mersey Railway.**—It has been definitely decided to adopt electric traction on this line, and it is anticipated that the work of conversion will be completed by the end of 1902.

**Pacific Cable.**—The surveying party has located the landing site of the British Pacific telegraph cable (connecting Canada, with the Australian Confederation) on Kelp Bay, near Banfield Creek 7 miles from the entrance to Barclay Sound, and over 100 miles from Victoria. The location is described as admirably adapted for the purpose—a good harbour, 12 fathoms of water close to the shore, so that vessels of 10,000 tons can find safe anchorage. The harbour is landlocked, and has a bottom of ooze that it is said will furnish good protection for the cable. The cable is to be about 8,200 nautical miles in length, and a ship is now being specially built for the purpose of carrying and laying the longer section. The cable will run from Vancouver island to Fanning island, a distance of 3,337 miles (and will thus be the longest submarine cable in the world), thence to Fiji Islands, Norfolk Island and Queensland. The first instalment of cable, including the sections from Queensland to Norfolk, Fiji and Fanning islands, is expected to leave London in January, 1902, and the longest portion in August, 1902, to come direct to Vancouver Island, and be laid from Barclay Sound to Fanning Island. The whole cable has to be laid and working by January, 1903, and those engaged in the work believe this great enterprise, costing £2,000,000, will be completed well within the time.

**Perth.**—The Council have decided to offer the Perth and District Tramway Co. £20,000 for their undertaking. When the tramways have been acquired by the Council it is proposed to convert them to electric traction.

**St. Pancras (London).**—At Wednesday's meeting of the Council the chairman of the Electricity committee (Dr. W. Smith) stated that there was only just sufficient machinery at the stations to meet next winter's demands, and it was, therefore, necessary to look ahead. As

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a site had not yet been selected for a new generating station it had been impossible to proceed with the extension of feeder mains at a cost of £30,000, which was sanctioned some time ago. Mr. Baynes states that a point has been reached when the connection of consumers in the northern and southern districts must either be discontinued or the design of the mains be so modified as to enable them to work for the extension of either the generating station in the King's-road or for the new works in Harwood-street. He recommends that three-core cables suitable to work three-phase current at 7,000 volts be put into sub-stations in the southern and northern districts, and that a sub-station be provided in the Prince of Wales'-road, to which two similar mains would be laid. The total cost would not exceed £29,390, already authorised. The consideration of the report was postponed.

**Ship Lighting Instruction.**—The Technical Education Board of the London County Council are about to provide practical instruction in the use of nautical instruments and in marine engineering at the Poplar Technical Institute, and a building is being designed to provide accommodation for instruction in marine engineering, naval architecture and navigation, metal plate work, &c., and practical classes are to be formed in electrical engineering, with special reference to ship lighting.

**Smoke Nuisance.**—At West London Police Court last week the magistrate (Mr. Rose) heard an adjourned summons against the Central London Railway Co. for an alleged nuisance caused by permitting black smoke to issue from two shafts at their power station at Shepherd's Bush. The summonses stood adjourned pending a decision by the High Court on an appeal against Mr. Rose's judgment in other cases on the ground that the company possessed statutory powers exempting them from the operation of the act. As the magistrate had found that there was neglect, the High Court dismissed the appeal with costs. In the present cases negligence was also alleged, but the company urged that the best appliances were used to prevent nuisance. Mr. Roskill (for the company) said that the smoke was due to the enormous quantity of coal used. Mr. Rose thought the case was strong against the company, and imposed a penalty of £5 on each of 12 summonses, with £5. 5s. costs.

**Southend.**—The new electric tramways will be officially inspected next week.

**Telegraphic Communication with Italy.**—Reuter states that owing to the growth of telegraphic communication between Genoa and Milan and London, the British Post Office asked the Italian Administration in 1897 to arrange for the establishment of a connection between those cities, but financial considerations caused a postponement of the enterprise until 1899, when the proposal was renewed, and the Chamber has voted a credit for erecting two lines from Genoa and Milan to the French border, so that telegraphic communication between Genoa and Milan and London can be established.

**Telephones at Tunbridge Wells.**—Now that the Tunbridge Wells telephone department has practically exhausted the sum placed at its disposal by the Corporation, the National Telephone Co. are adopting severely competitive rates. By a circular just issued subscribers to the National Company's system are offered, for £4 per annum, payable quarterly, a direct metallic circuit line from any address within the borough of Tunbridge Wells, or within 1 mile radius of any exchange in the Tunbridge Wells area. This sum includes a local service up to 5,000 calls per annum and unlimited service for inward calls. Calls in excess of 5,000 are charged at 6d. per hundred extra. On the "party line" system unlimited service is given for communication over the whole area, on a 10-party arrangement at 2s. 6d. per month per subscriber, or on a 2-party arrangement at 5s. per month per subscriber. The £4 per annum payment takes the place of the company's previous charge of £8 per anuum, and compares with the present £5 rate of the Corporation. It now remains to be seen whether the funds at the disposal of the municipal department will enable it to go "one better," or whether the ratepayers will be disposed to meet the company's competition by providing further funds.

**Wallasey.**—The ceremony of laying the first rail in connection with the Council's electric tramway scheme was performed on Wednesday.

**Wireless Telegraphy off St Kilda (Victoria).**—On the occasion of the departure of the "St. George" and "Juno" from St. Kilda, Mr. H. W. Jenvey, telegraph engineer and Government electrician, succeeded, with hastily-improvised apparatus, in transmitting and receiving messages to and from the "St. George" up to a distance, it is stated, of 37 miles. About 40 messages to and fro are said to have been received with satisfactory clearness. Marconi instruments are installed on both warships. The "Ophir," not similarly equipped, received a farewell message, and dispatched a reply thereto.

**Presentation.**—The outdoor staff of Messrs. Drake and Gorham's Manchester branch presented Mr. William Cotsworth, on Thursday last, with a testimonial and silver salver as a tangible token of their esteem. Mr. Cotsworth is resigning his post as manager to take up duties as engineer to the Calico Printers' Association (Ltd.).

# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Shoreditch* (London) Borough Council invite tenders for the supply and erection of high and low tension continuous current switchboards and instruments. Specifications after July 1 from the electrical engineer (Mr. E. Newton Russell), Coronet-street, N. The specifications may be also inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders to Dr. H. Mansfield Robinson, town clerk and solicitor, Town Hall, Old-street, E.C, by noon July 10. An advertisement contains further particulars.

*Southwark* (London) Electric Light committee invite tenders for the supply and erection of two additional panels to the main switchboard at their electricity station. Specifications of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W., and tenders to the town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, London, S.E, by noon, July 10. See advertisement.

The Electrical Committee of the *Stepney* (London) Borough Council invite tenders for steam and other pipework, paper insulated cables, earthenware conduits, &c. An advertisement contains some additional particulars. Specifications from the consulting engineer (Mr. Arthur Wright), 27, Osborn-street, E., on or about July 4 Tenders to chairman by noon July 18.

*Cleckheaton* District Council require Lancashire boilers, economiser, jet condenser, feed and suction pumps. An advertisement contains further particulars. Specifications of Messrs. Gibbings and Baker, Piccadilly Mansions, 17, Shaftesbury-avenue, London, W, and Old Bank Chambers, Cheapside, Bradford. Tenders to the town clerk (Mr. J. Armitage), Town Hall, Cleckheaton, before July 6.

*Kirkcaldy* Corporation invite tenders for feeders, mains and roadwork and arc lamps. Specifications from the town clerk (Mr. Wm. L. Macindoe), to whom tenders by 10 a.m. July 20. Specifications can also be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. An advertisement contains additional particulars.

*Glasgow* Corporation invite tenders for concentric and single main cables. Further particulars are given in an advertisement. Specifications from the chief engineer (Mr. W. A. Chamen), 75, Waterloo-street, and tenders to the town clerk (Sir J. D. Marwick) by 10 a.m. July 9.

*Mansfield* Corporation require boiler and engine house plant, condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains and arc lamps, posts and accessories for public lighting, mains and workshop equipment. Tenders to town clerk by 4 p.m. July 12.

*Nelson* Corporation invite tenders for a steam engine and dynamo, balancer, two Lancashire boilers, feed pumps, economisers, &c., condenser and steam pipes, cables and switchboards. Tenders to town clerk by noon July 1.

*Bradford* Corporation require electric motors (enclosed type) of 4½ H.P., 7 H.P., and 10 H.P. for 12 months. Tenders to town clerk by July 4.

*Pontypridd* Guardians invite tenders for the electric lighting of the union workhouse, infirmary and other buildings. Tenders to the clerk (Mr. W. Spickett) by July 23. See advertisement.

*Darlington* Gas and Electric Lighting committee invite proposals for "free" or "assisted" wiring. Applications to town clerk by July 16.

*Poplar* Borough Council require condensing plant, boiler feed pump, and steam and water piping, &c. Tenders to town clerk by July 1.

*Wallasey* District Council require machinery and tools for their electric tramways department. Tenders to Mr. H. W. Cook, Public Offices, Egremont, Cheshire, by July 18.

*Bermondsey* (London) Borough Council require electricity meters, demand indicators and main fuses. Tenders to town clerk by noon July 1.

*Birkenhead* Corporation require 15 electric tramcar bodies and electrical equipments and trucks and trolleys for 15 cars. Tenders by July 16.

*Manchester* Tramways committee require 5,000 cast-iron bases, 5,000 pairs cast-iron collars, 5,000 cast-iron finials, 5,100 cast-iron plates and 400 rosettes. Tenders to chairman by July 8.

*Manchester* Tramways committee also require tenders for rail bonds. Tenders to chairman by 5 p.m. July 1.

*Dudley* Electric Light and Tramway committee require tenders for a steam engine and dynamo. Tenders by noon July 6.

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*Hackney* (London) Electric Lighting committee invite tenders for mechanical coaling apparatus. Tenders by 4 p.m July 4.

*Taunton* Corporation invite offers for wiring premises free of initial cost to consumer. Tenders by noon July 1.

The Municipal Council of *Riaza* (Segovia, Spain) invite tenders until July 9 for the concession for electric lighting for 20 years. Particulars from and tenders to El Secretario del Ayuntamiento.

Tenders are invited by the municipal authorities of *Wisby* (Sweden) for the erection and equipment of electricity works.

## TENDERS RECEIVED AND ACCEPTED.

Poplar (London) Borough Council have received the following tenders for the supply of a storage battery :—

| | | | |
|---|---|---|---|
| Hart Accumulator Co. (*accepted*) | £1,200 | 0 | 0 |
| Ditto | 1,100 | 0 | 0 |
| D.P. Battery Co. | 2.040 | 0 | 0 |
| British Power Traction Co. | 1,851 | 10 | 0 |
| Chloride Electrical Storage Syndicate | 1,765 | 0 | 0 |
| Tudor Accumulator Co. | 1,587 | 0 | 0 |
| Electrical Power Storage Co. | 1.529 | 16 | 0 |

with an annual payment of £90 for five years for maintenance.

Among the tenders received by the West Ham Town Council for the supply of tramway generating plant and machinery are :—

| | | | |
|---|---|---|---|
| Veritys Limited | £13,998 | S. Z. de Ferranti (Ltd.) | £12,700 |
| Thames Ironworks, &c., Co. | 13,200 | General Electric Co. | 12,700 |
| John Fowler & Co. | 12,885 | Brush Co. | 12,270 |
| Siemens Bros. & Co. | 12,774 | Witting Bros. | 11.790 |

The tenders have been referred to a committee for consideration and report.

Messrs. Craven Bros. (Ltd.) have received an order from the British Westinghouse Electric and Manufacturing Co. for eight electrically-driven overhead travelling cranes for their new workshops at Trafford Park. Each crane is to lift a safe working load of 50 tons, and is to be built for a span of 90ft.

Dundee Corporation have accepted the tender of Messrs. J. McAdam & Sons for the construction of new tramways and the reconstruction of existing lines, &c., at £13,687. 9s. 6d. There were 13 tenders received, and the amounts varied from that of the accepted tender to £19,141. 10s. 8d.

The Brush Company have recently obtained several large contracts for switchboard work, including the whole of the sub-station high and low tension switchboards required for the extensive three-phase installation at Dublin, the complete high-tension switchboard for the new station at Leicester, and the traction board for Middleton.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the Premier Electric Lamp Syndicate (Ltd.) will be held at 5, Fenwick-street, Liverpool, on Aug. 13, to receive an account of the winding up.

Claims against James Brown, electrical engineer, &c., lately residing at 278, High-street West, and trading at Silksworth-row, Sunderland, must be in by July 6 to Mr. J. A. Longden, 25, John-street, Sunderland.

Alfred Sharp, Lane Head, Rastrick (formerly electrical and mechanical engineer, 27, Westgate, and 24, Peel-street, Barnsley). has been adjudicated bankrupt. The first meeting of creditors will take place on 28th inst. at Town Hall Chambers, Halifax, and the public examination on July 15 at the County Court House, Halifax.

**Sale by Auction.**—Messrs. Wheatley Kirk, Price & Co. have received instructions from the Edison and Swan United Electric Light Co. (Ltd.) to sell by public auction, on Tuesday and Wednesday, July 9 and 10, at the Broadheath Engineering Works, Broadheath, near Manchester (on account of removal to Ponder's End, London), some plant and machinery, finished and unfinished stock. Further information is given in an advertisement, and full particulars can be obtained from the auctioneers, Albert Chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

**"Morning Calls."**—The International Electric Co., 55, Redcross-street, London, E.C., have designed a special electric alarum system, intended to serve the purpose of a morning call for servants. The system, which has been patented, can be adapted to existing bell installations by the introduction of a resistance coil, a reply signal and a closed circuit push. The entire outfit is supplied in neat cardboard box, with instructions for fitting.

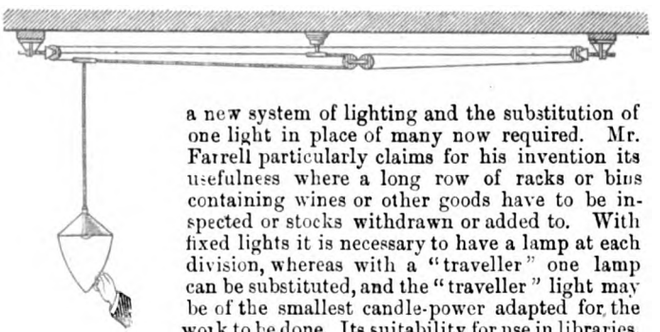
**B.T.H. Plant.**—A series of pamphlets, Nos. 98, 99, and 100, issued by the British Thomson-Houston Co. treat of "Lever Station Switches," "Magnetic Blow-out Automatic Circuit Breakers," and "Direct-Current Fan Motors."

**Engine Sheet.**—Messrs. Cole, Marchent and Morley, Bradford, Yorks, recently issued a wall card showing a standard horizontal Corliss engine for electric traction, and now issue a similar card showing one of the two vertical engines recently supplied and installed by the firm for the Sheffield Corporation for working at their tramway generating station on Kelham Island. We understand these engines are being built in both horizontal and vertical types to standard designs.

**Novelties List.**—Messrs. Julius Sax & Co., 51, Rupert-street, London, W., have a new list ready of electrical novelties, fitted with "J.S." dry batteries, including the "Washington" pocket lamp (size 5½in. × 3in. × 1in., and weighing 8oz.). Other novelties include a watchstand lamp, a night-light lamp, a button-hole lamp and a bull's-eye lamp. There should be a good demand for these novelties.

**Electrical Supplies List.**—Messrs. S. N. Wolff & Co., of Wevelinghoven, Germany, have prepared a special list of electrical goods for the British markets. The list comprises opal glass, green and white, enamelled iron and fancy shades, glass ware for watertight fittings, arc lamp globes, battery jars, accumulator boxes, insulators, &c., Geissler tubes, incandescent lamps, a variety of porcelain goods, metal and wood ware, electric trembling bell sets, induction coils, switches and switch bases, &c., and particulars of the "Zwerg" telephone for domestic use. Copies of this wholesale list can be obtained by the trade free on application.

**"Traveller" Lights and Apparatus.**—The illustration below shows a new form of traveller light, patented by Mr. H. O. Farrell, of 106, Princess-street, Manchester, by which he claims to introduce



a new system of lighting and the substitution of one light in place of many now required. Mr. Farrell particularly claims for his invention its usefulness where a long row of racks or bins containing wines or other goods have to be inspected or stocks withdrawn or added to. With fixed lights it is necessary to have a lamp at each division, whereas with a "traveller" one lamp can be substituted, and the "traveller" light may be of the smallest candle-power adapted for the work to be done. Its suitability for use in libraries, stables, &c., is also advocated. The apparatus, as the illustration shows, is supplied with a "run." This can be had of any length up to 50ft., longer lengths being obtainable where specially required. The fitting consists of two brackets with grooved pulleys, fixed to the ceiling or wall at a suitable distance apart, and a running block. The flexible insulated wire carrying the current is led from a ceiling rose in the usual way, and is connected to a draw cord. The wire and the draw cord are passed round the pulleys and block in such manner that the pendant light can be drawn along by the hand to any position between the two brackets, while the wire and the cord are always kept taut and out of the way. The pulleys are not rigidly fixed to the brackets, but connected by ball joints, so that if the cord is pulled towards one side in moving the light the pulleys swing into line with it. Means of adjustment are provided for stretching the cord taut should it become slack with use.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 19 to June 25, with the ports of destination :—

*Africa*—Alexandria, £77; Cape Town, £1,243 (including £652 telegraph instruments and material); Chinde, £10; Durban, £232 (including £133 telegraph apparatus); East London, £610 (including £534 telegraph material). *Australasia*—Adelaide, £220; Fremantle, £581; Melbourne, £1,443 (including £1,275 telegraph wire); Sydney, £601. *Belgium*—Ostend, £50. *Canada*—Vancouver, £203. *Ceylon*—Colombo, £80. *Chili*—Santiago, £20; Valparaiso, £75. *China*—Shanghai, £196. *Gibraltar*—£12. *Holland*—Amsterdam, £215; Flushing, £26. *India*—Bombay, £181; Calcutta, £2,074 (including £454 telegraph cable); Madras, £258. *Malta*—£36. *North Atlantic*—£1,000 (telegraph cable). *Portugal*—Lisbon, £202. *Siam*—Bangkok, £162. *Straits Settlements*—Penang, £98 (including £26 telegraph material); Singapore, £213. *Sweden*—Stockholm, £177 (telegraph wire). Total, £10,295, against £30,515 in the corresponding week last year (June 20 to 26).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

March 11, 1901.

5,088. J. D. Russell. Liverpool. "Simplex" trolley-head for electric tramcars.

5,098. G. H. Nisbett. Liverpool. Improvements in multiple conductor cable terminal or analogous fittings.*

5,121. P. M. Justice. London. Improvements in insulating strips or cores for rheostats, electric heaters and similar devices. (The Erie Exploration Co., United States.)*

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3,134. C. A. W. HULTMAN. Liverpool. Improvements in conduits for electric cables and the like.*
5,158. J. W. T. CADETT. London. Improved means for increasing the efficiency of electric incandescent lamps.
5,164. J. CARPENTIER. London. An improvement in breaks in induction coils.
5,165. SIEMENS BROS. & CO. (LTD.) and M. HIRD. London. An improvement in switches for varying electrical resistance.

March 12, 1901.

5,171. W. DU BOIS DUDDELL and T. MATHER. London. Improvements in non-inductive resistances.
5,172. G. CHARLTON and W. E. BARTON. Leicester. Electric thermal device for working switches, registering apparatus, and the like.
5,175. R. M. TYRER. St. Helens. Self-lubricating pulley for electric car trolley head.
5,194. O. SANSOME. Burnley. Improvements in and relating to gramophones, graphophones, phonographs, and the like, part of which improvements is applicable also to other uses.*
5,213. T. H. STEVENS. London. Improvements in and relating to phonographs.
5,220. C. L. MOSHER. London. Improvements in electric bi-polar dilator. (Date applied for under Patents, &c., Act, 1883, sec. 103, Aug. 25, 1900, being date of application in United States.)*
5,227. C. A. W. HULTMAN. Liverpool. Improvements in or relating to the arrangement of electrical cables or groups of conductors.*
5,247. A. G. BLOXAM. London. Improved switch for controlling electric motors. (Helios Electricitäts Actien Gesellschaft, Germany.)*
5,260. A. C. KRAUSE. London. New or improved apparatus for automatically registering the time during which an individual telephone instrument has been in actual use.
5,263. A. WRIGHT and THE REASON MANUFACTURING CO. (LTD.). London. Improvements in receivers for electric demand indicators.
5,265. J. F. WEBB, J. E. LILLEY and J. CHAPMAN. London. Improvements in and relating to the recovery of precious metals by electrolysis.

March 13, 1901.

5,292. E. W. COWAN, A. STILL and T. L. MILLER. Manchester. Improved system of guard wire protection for electric trolley or other high-pressure uninsulated wires.
5,305. E. VOLKERS. Görlitz, Germany. Improvements in micro-telephones.*
5,306. R. C. SAYER. Bristol. An improved means of picking up positive electric pressure from a closed tubular rail or subway, without a longitudinal slot or a surface contact, by a wheel suspended over it and returning the negative current to the tube.*
5,332. A. W. COURTNEY. London. Improvements relating to electro-therapeutic apparatus.*
5,343. A. WRIGHT and THE REASON MANUFACTURING CO. (LTD.). London. A method of and apparatus for actuating devices on public electric supply or distribution systems.

March 14, 1901.

5,391. J. H. BOSWORTH and G. MAJOR. Birmingham. An improved switch for electrical lamp holders and the like.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

23,878. BLAKE and MORSCHER. Process of and mechanism for separation of conductors from non-conductors.
23,890. PEUST and APEL. Insulating and protective coatings especially applicable to electric conductors.
23,892. STURM. Magneto-electric device for igniting explosive mixtures.
23,903. VOELKER. Electrical glass furnace.

1901.

467. LAING and FERRY. Attachments for telephones.
471. THE BRITISH THOMSON-HOUSTON CO. (LTD) (Priest). Electric motors.
484. LAKE (Globe Electric Co.). Secondary electric batteries.
659. JOHNSON. Machines for recording and reproducing sounds.
668. JOHNSON. Sound boxes for sound-recording and reproducing machines.
672. JOHNSON. Sound-recording and reproducing machines.
640. SIEMENS BROS. & CO. (LTD.) (Siemens and Halske Aktiengesellschaft). Electric safety fuses.
776. MEISSNER. Electrically-operated ploughs.
886. F. W. PEISKER, F. SCHLOMKA, and H. KAUTZ. Phonographs and like instruments.
1,394. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Davis). Acceleration limiting and recording devices.
1,439. MILLS (National Phonograph Co.). Method of and apparatus for duplicating phonographic records.
1,440. MILLS (National Phonograph Co.). Composition for phonographic records and phonographic record blanks.
1,471. BOGIA. Electric arc lamps.
1,485. BALL. Electrical measuring instruments.
1,966. ROSE, HALIFAX, and ANTROBUS. Positive rods for secondary electric batteries.
2,117. ABEL (Gasmotoren Fabrik Deutz). Mechanism for actuating electrical igniters for internal combustion engines.
2,118. HOPKINSON. Systems of electrical distribution.
2,272. EDWARDS. Means and apparatus used for propelling boats by electricity.
2,472. MELLETT and HENDERSON. Transmitters for telephones.

# COMPANIES' MEETINGS AND REPORTS.

## British Electric Traction Co. (Ltd.).

The directors' report for the year to March 31 states that the profits, including £43,783. 18s. 10d. brought forward, amount to £157,382. 17s. 7d., not taking into account the premiums (£128,855. 2s. 5d.) received on new share and debenture capital, which have been carried to reserve. Deducting proportion of general expenses chargeable to revenue, and expenses incurred in connection with schemes not proceeded with and written off, contributions to superannuation and interest on debentures, there remains net profit £116,947. The directors propose a reduction of goodwill account, licenses and testing of new systems account, and furniture account, absorbing £5,366. 14s. 6d.; dividend on the 6 per cent. preference shares, including amount paid in February and proportion payable Aug. 15, requiring £34,256. 7s. 11d.; dividend at the rate of 12 per cent. per annum on the ordinary shares for the half-year, making 9 per cent. for the year, requiring £55,866. 12s.; carrying forward £21,457. 5s. 7d.

A large part of the capital expenditure on construction of new lines and other works has only lately commenced to earn revenue, over 45 miles of new or reconstructed tramways and light railways having been opened for traffic since the interim report in November last.

The directors issued in June, 1900, 15,000 ordinary and 10,000 preference shares at £13 per ordinary and £11 per preference share, and in February last 30,000 preference shares were offered to the public at £11. 10s., and were fully subscribed. A further 2,074 ordinary shares were issued as fully paid to holders of 15,555 ordinary shares of the Brush Electrical Engineering Co., in exchange for their shares in the Brush Company. There has also been issued £250,000 5 per cent. perpetual debenture stock. The total premiums received, after deducting expenses (£128,855. 2s. 5d.), has been added to reserve, which now stands at £338,520. 13s. 4d. The subscribed share and debenture capital is now £2,120,740, made up of 62,074 ordinary and 90,000 6 per cent. cumulative preference shares of £10 each, and £600,000 in 5 per cent. perpetual debenture stock. There remains unissued 37,926 ordinary and 10,000 preference shares of £10 each, but Messrs. J. S. Morgan & Co. and the Electric and General Investment Co. have signified their intention to exercise their option to take up the whole of the unissued capital, which will make the issued capital £2,000,000 in shares and £600,000 in debentures, with power to issue a further £400,000 in debentures.

The total amount expended under the head of "contracts and undertakings," after deducting cost of undertakings transferred, and writing off expenses in respect of schemes not proceeded with, but including a proportion of general expenses, is £626,333. 13s. 11d. The total expenditure in investments, after deducting cost of securities sold, is £1,349,130. 8s. 5d., made up of consols (cost) £102,901. 10s. 3d., loans and advances to associated companies and others £73,105. 10s. 10d.; mortgages, debentures, and shares of associated and other companies (including £24,940 in the B. E. T. (Pioneer) Co., Ltd.) (cost) £1,173,123. 7s. 4d. There are certain contingent liabilities in respect of some of these investments.

*British Electrical Superannuation Fund.*—This fund was established on July 1 last, but it is only since Jan. 1 that it has been a condition of service that all new members of the company's staff shall join. The membership of this fund is over 60, while 23 associated companies and undertakings have signified their intention to contribute to the fund on behalf of their salaried staffs. £1,117. 14s. 10d has been contributed by the B. E. T. Co. up to March 31.

*Associated Companies Sinking Fund.*—The directors have had under consideration the question of facilitating the best investment of sums set aside by the associated companies and undertakings to provide sinking funds against eventual loss of capital upon compulsory purchase and for renewals of permanent ways and plants, and recommend the establishment of an associated sinking fund, to be under the control of trustees nominated by the B. E. T. Co., who will deposit with the trustees interest-bearing securities sufficient to produce at specified dates a sum equal to the amount set aside, together with compound interest at a rate to be agreed, not exceeding 3½ per cent. Arrangements will also be made with insurance companies under which associated companies desiring to have the additional security of an insurance company's policies can obtain the same, the rate of interest allowed in such cases being smaller.

# NEW COMPANIES, STATUTORY RETURNS, &c.

**A. G. BEAVER & CO. (LTD.)**—Reg. June 17, capital £5,000 in £1 shares, to acquire the business carried on by W. E. Sotheby, under the style of A. G. Beaver & Co., to generate, produce, accumulate and distribute electricity, and to carry on the business of electricians, mechanical engineers, manufacturers of electrical apparatus, insulators, conductors, phonographs, bells, &c. The subscribers are G. J. G. Lothian (electrical engineer), H. P. C. Kelland, F. J. Pearce, H. F. Birch, E. C. de Segundo (consulting engineer), H. J. Jack, and T. N. Manks (mining engineer). The first directors are G. L. Nicholson, H. P. C. Kelland, and E. C. de Segundo.

**HIRAM MAXIM LAMP CO. (LTD.)**—Reg. June 17, capital £70,000 in £1 shares, to adopt an agreement with C. M. Downie, to carry on the business of electricians, mechanical engineers, producers and suppliers of electricity, manufacturers of and dealers in all electrical apparatus, &c. The subscribers and first directors are C. V. de Falbe (electrical engineer), L. A. S. Wood (electrical engineer), C. M. Downie (electrical engineer), B. Stokes, G. W. Nagle, F. B. Brown, and W. W. Jordan.

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**C. AND A. MUSKER (1901) (LTD.)**—Reg. June 22, capital £100,000 in £1 shares (50,000 preference), to acquire the business of C. and A. Musker (Ltd.), and to carry on the business of electrical, mechanical, and hydraulic engineers, manufacturers of electrical and other machinery, tool makers, boiler makers, millwrights, &c. The first directors are C. and A. Musker.

**TADCASTER ELECTRICITY CO. (LTD.)**—Reg. June 15, capital £6,000 in £5 shares, to adopt an agreement between H. Ingleby, J. Bromet, and W. Addinell to establish stations and works, and to generate, purchase, and distribute electrical energy for all purposes. The first directors are John Bromet, William Addinell, and Frank Thorman.

**THOMAS SUDRON & CO. (LTD.)**—Reg. June 22, capital £25,000 in £1 shares, to carry on business as electrical, mechanical and general engineers, boiler makers, &c.

**WARREN, BEATTIE & CO. (LTD.)**—Reg. June 22, capital £10,000 in £5 shares, to take over and carry on the business of Messrs. J. W. F. Warren and J. Beattie, electricians, mechanical and electrical engineers, manufacturers of electrical apparatus and appliances, suppliers of light, power, &c. The subscribers are J. W. F. Warren (electrical engineer), Joseph Beattie (electrical engineer), C. Bertram (electrical engineer), S. N. Warren (electrical engineer) and John Beattie, J.P. (each with 40 shares), and Mrs. K. Warren and A. H. France (each with one share). The first directors are J. W. F. Warren, Joseph Beattie, C. Bertram, S. N. Warren and John Beattie, J.P.

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**ALLIANCE ELECTRICAL CO. (LTD.)**—The annual return to May 16 gives the capital as £120,000 in 50,000 ordinary and 70,000 preference shares of £1 each, all of which have been taken up. £1 per share has been called up and paid on the preference. The 50,000 ordinary shares are considered as fully paid. No mortgages or charges.

**BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)**—According to the annual return to April 9 the capital is £150,000 in 7,500 ordinary and 7,500 preference shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges, £70,000.

**BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)**—In the annual return to March 14 the capital is £300,000 in 40,000 ordinary and 20,000 preference shares of £5 each, of which 20,000 ordinary and 20,000 preference have been taken up. £5 per share has been called up on 19,000 ordinary and 15,722 preference, and nothing on 4,278 preference shares. £173,610 has been received. £5,000 is considered as paid on 1,000 ordinary shares. Mortgages and charges £21,743.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—The annual return to April 4 gives the capital as £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each, of which 40,000 preference and 70,595 ordinary have been taken up. £10 per share has been called up, and £1,105,950 has been received. Mortgages and charges £600,000.

**DOVER ELECTRICITY SUPPLY CO. (LTD.)**—According to the annua return to April 17 the capital is £75,000 in £5 shares (5,000 preference), of which 10,000 ordinary and 343 preference have been taken up. £5 per share has been called up. Mortgages and charges, £25,000.

**FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)**—According to the annual return to April 13 the capital is £50,000 in 10,000 shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges £25,000.

**LONDON ELECTRIC SUPPLY CORPORATION (LTD.)**—The annual return to May 7 gives the capital as £850,000 in 200,000 ordinary shares of £3 each and 50,000 preference shares of £5 each, of which 111,000 ordinary and 49,840 preference have been taken up. The full amount has been called up, and £585,940 has been received, including £3,740 paid on 1,950 forfeited shares. Mortgages and charges, £375,000.

**NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)**—The annual return to March 14 gives the capital as £300,000 in 30,000 preference and 30,000 ordinary shares of £5 each, of which 23,750 preference and 18,739 ordinary shares have been taken up. £2 per share has been called up on 20,000 preference and £5 per share on 17,922 ordinary shares, and £141,871. 10s. has been received, including £12,261. 10s. paid in advance. £22,835 is considered as paid on 3,750 preference and 817 ordinary shares. No mortgages or charges.

**POTTERIES ELECTRIC TRACTION CO. (LTD.)**—The annual return to April 2 gives the capital as £400,000 in 20,000 preference and 20,000 ordinary shares of £10 each, all of which have been taken up. £10 per share has been called up and paid on 20,000 preference and 13,334 ordinary shares. £66,660 is considered as paid on the remaining 6,665 ordinary shares. Mortgages and charges, £200,000.

**SOUTH LONDON ELECTRIC SUPPLY CORPORATION (LTD.)**—The annual return to April 10 has been filed. The capital is £325,000 in 65,000 shares of £5 each, all of which have been taken up and paid for. No mortgages or charges.

**WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)**—In the annual return to April 10 the capital is given as £50,000 in £1 shares, all of which have been taken up. £1 has been called up and paid on each of 49,500 shares. 450 shares are considered as fully paid. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27 7/16d. per oz. (June 27). Consols (2½ per cent.) 93⅛—93⅜ for money, 93⅛—93⅜ for account; 2½ per cent. 93⅛—94⅛ (June 27). Consols Pay Day, July 3; Stocks and Shares Continuation Days, July 15 and 27; Ticket Day, July 16; Pay Days, June 28 and July 17; Mining Share Carry-over Days, July 12 and 26.

**BRITISH THOMSON-HOUSTON CO. (LTD.)**—The General Electric Co. (U.S.A.) has acquired a controlling interest in this company through the purchase of the French and German holdings of stock. Mr. C. A. Coffin and Gen. E. Griffin join the British board, making the number of directors of the General Electric Co. on the board three out of 13, Mr. W. J. Clark, manager of the foreign department of the General Electric Co., having been on the British directorate for the past two years.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed June 27 as a special settling day in the provisional certificates (fully and partly paid) for £250,000 4 per cent. debenture stock of the *Charing Cross and Strand Electricity Supply Corporation (Ltd.)*, and has ordered the same, together with the further issue of 6,400 non-cumulative 5 per cent. £10 fully-paid preference shares (Nos. 39,601 to 45,000) of the *British Columbia Electric Railway Co. (Ltd.)*, to be quoted in the official list.

**UNITED RIVER PLATE TELEPHONE CO. (LTD.)**—The directors' report for the year ended March 31 states that the gross receipts in the River Plate were £109,540. 13s. 4d., against £101,169. 17s. 4d. for the previous year, and the working expenses in London and the River Plate £55,514. 11s. 9d. After deducting debenture interest and interim dividends and adding transfer fees and interest on investments, there remains a profit of £34,929. 16s 3d., added to £5,019. 5s. 6d. brought forward, leaving an available balance of £39,949. 1s. 9d. After writing off the whole of the cost of the last issue of preference shares and transferring £15,000 to reserve, the directors recommend a final dividend of 4½ per cent. on the ordinary shares, making, with the interim, 7 per cent. for the year; £6,058. 16s. 9d. is carried forward. Extensive re-building in Buenos Aires, especially in the central part of the city, has occasioned exceptional expense in the transfer of lines and maintenance. The underground plant, which will effect a great improvement in the service, is making satisfactory progress.

**URBAN ELECTRIC SUPPLY CO. (LTD.)**—An abridged prospectus on another page gives particulars of an issue of 30,000 5 per cent. cumulative preference and 30,000 ordinary shares of £5 each offered for subscription at par in this company, which was formed in 1898 to obtain parliamentary powers to work electric light and tramway undertakings in England and Scotland. The prospectus contains particulars of a number of lighting and tramway ventures of which the company has control, the estimated requirements as to capital for these being £315,000. The share capital of the company is £500,000, in moieties of preference and ordinary shares. Edmundson's Electricity Corporation has subscribed for and been allotted 4,000 of the ordinary shares, and undertakes the construction of the works and the supervision and general management of the same until Dec. 31, 1910, and also guarantees 5 per cent. dividend on the preference and not less than 5 per cent. on the ordinary shares for a period of about 10 years. Mr. F. E. Gripper, M.I.E.E., is chairman of the Urban Company, and the directorate includes Mr. W. Page, of the Brompton and Kensington Company, and Mr. J. C. Wigham, of the Woolwich District Company. Mr. F. H. Medhurst is consulting electrical engineer, and the secretary and offices of the company are Mr. C. H. Jones, Broad Sanctuary-chambers, London, S.W. The list closes not later than Saturday, June 29.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | June 22 | 728 | + 16 | 3 | 2,182 | + 16 |
| *Birmingham Tramways | ,, 22 | 4,538 | − 22 | 24 | 104,299 | + 2,160 |
| *Blackburn Corporation.. | ,, 21 | 487 | + 5 | 25 | 11,583 | + 1,041 |
| Blackpool Corporation... | ,, 20 | 775 | + 13 | †12 | 8,478 | + 1,830 |
| Blackpool and Fleetwood | ,, 22 | 592 | − 91 | 25 | 9,016 | − 386 |
| Bolton Corporation ..... | ,, 23 | 1,311 | + 51 | 12 | 18,007 | + 2,713 |
| Bradford Corporation... | ,, 23 | 927 | + 468 | 12 | 12,290 | + 6,334 |
| Brisbane Trams ..... | May 8 | 2,093 | + 238 | 18 | 36,511 | + 3,790 |
| *Bristol Trams & Carriage | June 21 | 4,377 | + 1,176 | 24 | 102,440 | + 30,370 |
| *Buenos Ayres & Belgrano | May 26 | 2,796 | + 242 | 21 | 38,680 | + 10,408 |
| Calcutta Trams. Co. ... | June 22 | R19,698 | + R1,326 | ... | ... | ... |
| Carlisle Trams. Co. ..... | ,, 22 | 184 | ... | 25 | 3,623 | ... |
| Central London Railway | ,, 22 | 6,352 | ... | 25 | 155,132 | ... |
| City & South London Ry. | ,, 23 | 1,900 | + 400 | 25 | 48,971 | + 16,736 |
| Cork Elec. Trams ..... | ,, 20 | 510 | + 21 | 24 | 10,391 | + 1,328 |
| Dover Corporation ..... | ,, 22 | 225 | + 9 | 12 | 2,616 | + 196 |
| Dublin & Lucan Rly. .. | ,, 22 | 111 | + 1 | 25 | 2,341 | + 132 |
| Dublin United ..... | ,, 21 | 3,834 | + 103 | 25 | 74,728 | − 723 |
| Dublin Southern Dist... | ,, 21 | 931 | − 25 | 25 | 19,893 | |
| *Dundee Corporation ... | ,, 19 | 668 | + 241 | ... | ... | ... |
| *Glasgow Corporation ... | ,, 22 | 11,898 | + 2,125 | 3 | 34,916 | + 4,660 |
| Halifax Corporation..... | ,, 23 | §2,049 | + 457 | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 22 | 988 | + 270 | 12 | 10,611 | + 2,213 |
| Hull Corporation..... | ,, 22 | 1,633 | + 286 | 51 | 76,310 | + 36,291 |
| Liverpool Corporation... | ,, 15 | 9,125 | + 1,029 | 24 | 202,839 | + 28,810 |
| *Liverpool Overhead Rly. | ,, 23 | 1,572 | − 34 | 25 | 39,285 | + 3,465 |
| Manchester Corporation | ,, 22 | 882 | ... | ‡2 | 2,241 | − 83 |
| Perth (W.A.) Elec. Trams | ,, 21 | 830 | + 491 | 51 | 34,864 | ... |
| Portsmouth Corporation | ,, 22 | 677 | − 224 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 23 | 3,568 | + 1,238 | 25 | 80,084 | + 29,364 |
| Southampton Corporat'n | ,, 20 | 735 | + 210 | ... | ... | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding week last year.
* Partly electrical. † Minus 3 days. ‡ Plus 2 days. § Fortnight.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 19: | Price Wednesday, June 26. | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done during Week ending June 26. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | | |
| 100,000 | 1 | ... | Hl'ekh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ ⅝ | ⅜ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 75 | 70 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ 12½ | 11½ 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | 10⅛ | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 103 106 | 103 106 | 4 6 9 | ... | ... | ... |
| 19,561 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. | 7⅜ 8⅛ | 7⅜ 8⅛ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅛ 9 | 8⅛ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7 7⅛ | 7 7⅛ | 2 6 8 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 10 0 | February and August | 9⅛ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 5⅜ | 5⅛ 5⅜ | 3 18 3 | ,, ,, | ... | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5⅜ 6⅛ | 5⅜ 6⅛ | 4 8 0 | March | 6⅛ | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 113 | 109 113 | 4 0 4 | June and December | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8⅛ 9⅛ | 8⅛ 9⅛ | 4 4 3 | February and August | 8⅜ | 8⅛ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12⅛ 13⅛ | 12⅛ 13⅛ | 4 12 2 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 123 127 | 3 19 8 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 102 104 | 102 104 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8⅛ 8⅞ | 8⅛ 8⅞ | 4 4 3 | ... | 9⅛ | 9 |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11⅛ 12⅛ | 12 13 | 4 13 4 | March and September | 12⅛ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 105 109 | 105 108 | 4 5 1 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5⅛ 5⅜ | 5⅛ 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/8 | Hove Electric Lighting Ordinary | 7⅜ 8⅛ | 7⅜ 8⅛ | 2 15 5 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11⅛ 12⅛ | 11⅛ 12⅛ | 4 4 0 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅛ 7 | 6⅛ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 102 105 | 101 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 104 | 102 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ 1⅜ | 1⅛ 1⅜ | ... | ... | ... | ... |
| 49,840 | 5 | 5/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 100 | 96 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13⅛ 14⅛ | 13⅛ 14⅛ | 4 2 9 | April and October | 14⅛ | 13⅞ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13⅛ 14⅛ | 13⅛ 14⅛ | ... | ... | 13⅞ | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 99 | 96 99 | 3 11 5 | ... | ... | ... |
| 8,652 | 10 | 8/0 | Notting Hill Electric Ordinary | 15⅛ 16⅛ | 15⅛ 16⅛ | 4 13 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅞ 6⅛ | 5⅞ 6⅛ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | 9/16 11/16 | 9/16 11/16 | 10 18 2 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'st'n, Ltd., 5% 1st Mor. Deb. | 65 75 | 65 75 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 104 | 102 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric, Ordinary | 15 16 | 15 16 | 4 10 8 | February and August | 15⅜ | 15⅛ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 9 10 | 9 10 | 3 10 0 | ,, ,, | 9⅜ | 9⅛ |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 101 | 98 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2 | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2⅜ 3⅛ | 2⅜ 3⅛ | ... | ... | ... | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 12 13 | 12 13 | 4 0 9 | March and September | 12⅛ | 11⅛ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4⅛ 4⅜ | 4⅛ 4⅜ | 4 11 5 | April and October | 4⅝ | 4⅜ |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 125 130 | 125 130 | 4 14 0 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 10 | 8 10 | 2 0 0 | ... | 9⅛ | 9 |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 96 101 | 96 101 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2⅛ 3⅛ | 2⅛ 3⅛ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4⅛ 4⅜ | 4⅛ 4⅜ | ... | ... | ... | ... |
| £400,000 | Stock | 84/7 | Do. 4½% Deb. Prov. Certs. | 99 101 | 99 101 | ... | ... | 100⅛ | 100 |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 22⅛ 23 | 22 23 | 3 15 0 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ 11 | 10⅜ 10⅝ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 116 | 113 115 | 3 9 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6⅛ 7 | 6⅛ 7 | ... | ... | 6⅛ | 6⅛ |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9⅛ 10 | 9⅛ 9⅞ | 5 2 7 | May and November | ... | ... |
| £230,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅞ 102⅞ | 100⅞ 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 6/0 | British Elec. Trac. Ord. | 15 16 | 14½ 15½ | 5 9 8 | ... | 15⅞ | 15⅛ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 13 | 12 13 | 4 12 4 | February and August | 12⅝ | 12⅜ |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 121 124 | 123 125 | 4 0 10 | ... | 124 | 123 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅛ 1⅜ | 1⅛ 1⅜ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 4⅛ 5⅛ | 5⅛ 5⅝ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5 5⅛ | 5 5⅛ | ... | ... | ... | ... |
| £210,000 | Stock | 5% | Do. 5 per Cent. Debentures | 102 105 | 102 105 | 4 15 3 | ... | ... | ... |
| £12,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 95 98 | 96 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) | 10⅛ 11⅛ | 10⅛ 11⅛ | 2 14 2 | ... | 10⅜ | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 104 106 | 104 106 | ... | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1⅜ 1⅞ | 1⅜ 2 | ... | ... | ... | ... |
| 19,980 | 10 | 2/6 | Central London Ordinary | 9⅛ 9⅜ | 9⅛ 9⅜ | 2 16 5 | June and December | 9⅜ | 9⅜ |
| £69,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs | 113 113 | 113 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5⅛ 5⅜ | 5⅛ 5⅜ | 4 13 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 103 | 101 103 | 3 17 10 | ... | ... | ... |
| £355,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 55 57 | 55 57 | 3 4 0 | February and August | ... | ... |
| 47,500 | 10 | 2/0 | Do. Ordinary (Nos. 22,501 to 70,000) | 5⅛ 5⅜ | 5⅛ 5⅜ | 2 3 6 | ,, ,, | 5⅜ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 5% | Do. (1896) | 132 137 | 132 137 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 111 116 | 111 116 | 3 9 2 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 12 13 | 12 13 | 5 0 0 | ... | 12⅜ | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5⅛ | 5⅛ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4⅞ 5⅛ | 4⅞ 5⅛ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 22½ | 22 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ 15½ | 14½ 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 114 | 111 113 | 3 19 2 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'st'n 5% Pref. | ... | ... | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 8⅛ 8½ | 8⅛ 8½ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 13½ | 13 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 18 3 | January and July | ... | ... |
| £350,000 | Stock | 3/4 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts (fllypd) | 105 107 | 106 103 | ... | ... | 107 | 106 |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 3⅛ | 3 3⅛ | 5 14 4 | ... | ... | ... |
| 60,000 | 5 | 0/0 | Do. 6 per Cent. Cumulative Preference | 4⅛ 5 | 4⅛ 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11⅛ 12⅛ | 12 13 | 1 10 9 | ... | 12⅛ | ... |
| 20,000 | 10 | 0/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 11 | February and August | 10⅛ | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 107 | 105 107 | 4 4 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6 0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 2% | Waterloo and City Ordinary | 93 96 | 93 96 | 3 2 10 | June and December | ... | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 19. | | Price Wednesday, June 26. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending June 26. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3½ | 4½ | 3½ | 4½ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 | 56 | 53 | 56 | 5 12 7 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 | 100 | 98 | 100 | 6 2 0 | " " | 93½ | 93 |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10¼ | 10¾ | 10 | 10½ | 2 7 7 | " " | 10½ | 10⅛ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 18 3 | " " | 102½ | 101½ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 5 12 6 | February and August | 7 | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14½ | 15½ | 6 9 0 | " " | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10⅝ | 10⅛ | 11 | 6 7 3 | Jan., Apr., July, Oct. | 10⅛ | 10⅛ |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | 103 | 103 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 140 | 145 | 140 | 145 | 4 17 0 | Jan., Apr., July, Oct | 143½ | 142½ |
| £1,836,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 90 | 93 | 90 | 93 | 3 15 8 | " " | 91½ | 90 |
| £1,482,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 109 | 113 | 109 | 113 | 3 11 1 | May and November | 110⅝ | 110 |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ | 14 | 13½ | 14 | 5 0 0 | Jan., Apr., July, Oct. | 13⅞ | 13½ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 114 | 3 9 3 | February and August | ... | ... |
| £200,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 100% | 103% | 100% | 103% | 3 17 10 | May and November | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust | 9½ | 10½ | 9⅞ | 10⅛ | 5 2 5 | Jan., Apr., July, Oct. | 9⅛ | 9⅛ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14⅞ | 15⅛ | 3 19 8 | " " | 15⅛ | 14⅛ |
| 150,000 | 10 | 20 0 | Great Northern of Copenhagen | 31 | 33 | 30 | 32 | 4 13 9 | January and July | ... | ... |
| £625,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos | 100 | 103 | 100 | 103 | 4 8 8 | June and December | ... | ... |
| 17,000 | 25 | 37 6 | Indo-European [1 to 1,200) (red. | 43 | 47 | 43 | 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 18 1 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 10 | " " | 125½ | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2 | 3 | 2 | 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 7 | March and September | ... | ... |
| 20,008 | 2½ | ... | West Coast of America | ⅛ | ⅛ | ⅛ | ⅛ | ... | " " | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 18 1 | January and July | ... | ... |
| 88,211 | 10 | 6d. | West India and Panama | ⅛ | ⅛ | ⅛ | ⅛ | ... | May and November | ... | ... |
| 34,563 | 10 | 5/0 | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | 10 0 0 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | 12 0 0 | " " | 2½ | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 207,980 | 10 | 3/0 | Western Telegraph (late Br zil'n Submarine) | 13⅞ | 14⅛ | 13⅞ | 14⅛ | 4 18 3 | Mar., June, Sept., Dec. | 14⅛ | 13⅞ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 102 | 105 | 102 | 105 | 4 15 8 | June and December | ... | ... |
| £946,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅞ | 4 | 3⅞ | 4⅛ | 4 14 2 | August | 3⅞ | 3⅞ |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 | 3/0 | 2/6 | 3/0 | ... | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ | ⅛ | ⅛ | ⅛ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | " " | ... | ... |
| 590,000 | 5 | 2 6 | National | 3⅛ | 3⅜ | 3 | 3⅛ | 8 9 2 | February and August | 3⅛ | 3⅛ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 12 | 11 | 12 | 5 0 0 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 12 | 11 | 12 | 5 0 0 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ | 4⅜ | 4 | 4⅛ | 5 17 8 | " " | 4⅛ | ... |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 89 | 93 | 89 | 92 | 3 13 9 | June and December | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 | 98 | 96 | 99 | 4 2 3 | ... | 93 | 93½ |
| 171,504 | 1 | 0/3½ | Oriental | ¾ | 1 | ¾ | 1 | 6 0 0 | April and October | ¾ | ... |
| 58,000 | 5 | 2/6 | United River Plate | 5 | 5½ | 5 | 5½ | 6 7 3 | July | 5⅝ | 5½ |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ | 5¼ | 4¾ | 5¼ | 4 15 8 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 14 9 | June and December | 105½ | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ | ⅜ | ⅜ | ⅜ | 6 13 4 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅛ | ⅛ | ⅛ | ⅛ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ | ⅜ | ⅜ | ⅜ | 8 0 0 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 9⅝ | 10⅛ | 9⅝ | 10⅛ | 7 2 10 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5⅞ | 6⅛ | 6 | 6⅛ | 4 12 4 | January and July | 6⅛ | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅛ | 5⅛ | 4⅛ | 5⅛ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅝ | 1⅞ | 1⅝ | 1⅞ | 3 6 7 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2⅛ | 2⅜ | 2⅛ | 2⅜ | 5 1 1 | " | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £135,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 104 | 101 | 104 | 4 8 3 | January and July | ... | ... |
| 80,000 | 5 | 10 0 | Callender's Cable Construction Ord. | 14 | 15 | 14 | 15 | 5 0 0 | " " | 14⅞ | ... |
| 40,000 | 5 | 2/6 | Do. 6 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 2 | " " | 5⅝ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 109 | 113 | 109 | 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 | 98 | 94 | 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ⅜ | ½ | ⅜ | ½ | 5 15 7 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ⅜ | ½ | ⅜ | ½ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅜ | 4 | 3⅜ | 4 | 5 12 7 | January and July | 3⅜ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 102 | 105 | 104 | 107 | 4 15 8 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ⅜ | ½ | ⅜ | ½ | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£5 paid) | 1 | 1⅛ | 1 | 1⅛ | 10 12 0 | February and August | 1⅛ | 1⅛ |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2 | 3 | 2 | 3 | 8 15 6 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 | 89 | 87 | 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 7 7 10 | Half-yearly | ... | ... |
| 20,000 | 5 | 1 6¼ | Do. 6% Cumulative Preference | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 5 4 4 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 5 | ... | ... | ... |
| 112,100 | 5 | 1/2½ | Electric Construction Co. (Limited) | 1⅜ | 2⅛ | 1⅝ | 2⅛ | 5 6 8 | January and July | 1⅝ | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 3⅛ | 3 | 2⅝ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | ... | ... |
| 18,000 | 10 | 2 10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅛ | 10 | 9⅛ | 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 10/0 | Henley's Telegraph Works Ordinary | 15½ | 16½ | 15½ | 16½ | 6 1 3 | February and August | 16½ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 23 | 21 | 22 | 4 13 0 | " " | 21½ | 21⅛ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | 103 | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 38 | 40 | 38 | 40 | 5 4 11 | March and July | 39 | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908 | 102 | 105 | 102 | 105 | 3 16 10 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 5 9 1 | ... | 10½ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | 6 | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 5 4 4 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ | 7 | 6½ | 7 | 4 5 9 | " " | 6½ | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,207. [No. 11. Vol. XLVII.] FRIDAY, JULY 5, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30c., or 70pf.


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## NOTES.

We bring to a close this week the series of articles descriptive of the electric power supply undertaking conjointly operated by the Newcastle-upon-Tyne Electric Supply Co. and the Walker and Wallsend Union Gas Co. It may fairly be claimed that this is the first of the so-called "electricity in bulk" schemes to make a practical start in the supply of electric power. Older undertakings, some of them larger and more important, had previously, it is true, commenced supply on a large scale for motive power in conjunction with the ordinary lighting load; but, both from a commercial and an engineering point of view, the Newcastle power scheme comes under a different and a novel category. Indeed, whether from an engineering, a commercial or a politico-economical point of view, there is much in the constitution of the Newcastle scheme which is highly instructive. The engineer may learn on British ground the easy, if disputed, adaptability of the three-phase system of generation and transmission to the varied requirements of the consumers of power and light; the commercialist can discover therein an object lesson on a means to the reduction of works costs in all classes of factories and works consuming steam power; and the political economist may, on the one hand, perceive that private enterprise can as usefully be employed in public works of this description as could ratepayers' money, while, on the other hand, he cannot fail to discover in this method of factory working a powerful aid to the amelioration of the people in industrial centres. May works of this description, as soundly constituted and as honest in their purpose, speedily increase and multiply in the land.

The visit of the Incorporated Association of Municipal and County Engineers to the Falcon Works of the Brush Electrical Engineering Co. at Loughborough, on Friday last, will, we trust, inaugurate an era of renewed prosperity for a company which was one of the pioneers of the electrical industry in this country. Only last year we described the extensive new works of the English Electric Manufacturing Co. at Preston. The design and laying out of these last-named works showed that at last the English manufacturer had awakened to the necessity for standardisation of parts and specialisation of machine tools, if he were to compete successfully with his American *confrères* in the production of the machinery and plant for the equipment of that rapidly-growing industry—the electric tramway. The Brush Electrical Engineering Co. have been rather more hampered by being in possession of older buildings for their tramway department, but during the last few years they have been building completely new workshops on the most modern and approved lines, and they are now able to turn out every description of tramway plant, including engines, dynamos, switchboards, and cars, complete with trucks, motors, and controllers.

It was impossible from the somewhat hurried inspection of the works to minutely criticise the various items of machinery, but it could be seen that the machine tools installed were of the latest designs, and the large number of milling machines was a conspicuous feature. Although it is of the utmost importance in these days of keen competition to carry out work with the greatest of speed, there is one operation in car building that must be done slowly to be done successfully—viz., the seasoning of the timber, and we were glad to see that a store for a two years' output was kept in stock. We also noted the very complete arrangements now made for testing every class of machinery that leaves the works. The habit of costly and unnecessary experimenting also appears to be absent from the works, whilst at the same time American practice has not been rigidly adhered to, and alterations have been made to suit the English conditions of use and climate. We hope to deal more fully with this subject in a later issue.

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We are constantly hearing from the United States of developments of electrical engineering which make even the largest undertakings in this country appear rather puny. A recent number of the *Electrical World* of New York describes the extraordinarily high potential line spanning the Carquinez Straits in California, in connection with the Yuba River–Oakland 140-mile power transmission. The span is 4,427ft. Nineteen-strand galvanised steel cables have been used, the diameter of the strand being $\frac{7}{8}$in., and the total weight of each span 7,080lb. A clearance of 200ft. had to be provided for vessels to pass underneath, and the line pressure of 60,000 volts was employed. It will be seen that considerable skill had to be called into requisition to design insulators to withstand the strains, electrical and mechanical. From the account before us this appears to have been successfully done by means of strain insulators built up of steel and micanite fixed in special anchor houses, where a strain of 12 tons per cable is exerted. From the anchors the cables are taken over saddle insulators fixed on steel towers, one of the towers being 225ft. high. Each saddle is composed of six porcelain petticoat insulators, each insulator weighing 75lb. and measuring at the outer petticoat 17in. diameter. We cannot but admire the energy and engineering skill which has resulted in such a magnificent electrical suspension bridge, but at the same time we feel safer when steaming out of the Thames during a gale to know that there is not a 60,000 volt cable swinging gently overhead.

Obituary.—As we go to press we learn of the death, yesterday morning, of Prof. P. G. Tait, at the age of 70 years.

Institution of Junior Engineers.—The next visit of this Institution will be to the Millwall Lead Works, at 8 p.m. on Saturday the 13th inst.

French Telegraph Enterprise.—The Chamber of Deputies on Thursday last adopted without discussion the bill relating to the establishment of new French submarine cables, to which reference has been several times made in these columns.

Latimer-Clark Electrical Library.—With reference to our note on page 242 (June 7th), we learn that Mr. A. Carnegie has presented to the American Institute of Electrical Engineers a sum for the housing and cataloguing of the Latimer-Clark Library.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Bali—Lombok | July 3, 1901 |

Appointment.—At a meeting of the council of Cardiff College on the 1st inst., Lord Windsor presiding, it was unanimously decided to invite Dr. Isambard Owen to undertake the duties of principal of the college in succession to the late Principal J. Viriamu Jones.

Los Angeles Power Transmission.—According to the *Electrical World* of New York, besides four kinds of city light and power service, an important part of the company's business is that of supplying power for irrigation pumping. Last summer 30 to 40 pumps of 80 H.P. to 40 H.P. were in operation. The present summer a load of 2,500 H.P. is anticipated. These farmers' pumping plants are supplied from a 16,000 volt line. The rate for irrigation pumping is $1\frac{3}{4}$c. per horse-power-hour. The pumps are cut off from 5 p.m. to 9 p.m. to accommodate the lighting peak.

The Incorporated Association of Municipal and County Engineers.—The annual conference of the Incorporated Association of Municipal and County Engineers at Leicester brought its three days' proceedings to a conclusion on Saturday. Mr. E. G. Mawby, borough engineer for Leicester, was elected president for the year. Amongst other Papers Mr. W. H. Smith read a Paper on "The Construction of Permanent Way for Electric Tramways." Mr. E. Manville contributed a Paper on "The Methods of Safety for the Overhead Electric Trolley System."

American Telephone Patents.—We are informed that a decision was rendered on June 7th in favour of the Western Electric Co., in the United States Circuit Court of the Eastern District of Missouri, on patent No. 438,788, and that in the same court a decision was rendered upholding the Seely patent on the employment of answering spring-jacks in multiple switchboards. The apparatus found to infringe patent No. 438,788 is the carbon plate protector manufactured by the Sterling Electric Co. The apparatus found to infringe the Seely answering jack patent is the multiple switchboard built by the Kellogg Switchboard and Supply Co., of Chicago.

International Association for the Advancement of Science, Arts and Education.—The International Association for the Advancement of Science, Arts and Education will hold its second international meeting at Glasgow, in the University and in the International Exhibition, from July 29th to September 27th. The various national groups which co-operated last year at Paris will again be represented at Glasgow; and their lectures and conferences, &c., will include pure and applied physics and chemistry, electricity and engineering, agriculture and forestry, geography and colonisation, hygiene, Scottish history and archæology, fine art, &c. In electricity Prof. Baily and others will lecture on the history of electricity, on electrical measurements, on illuminants, on the heating and chemical action of electricity, &c. Appropriate visits will be arranged. The general secretary is M. Liard, Permanent Secretary of State for Higher Education, Paris, assisted by Prof. Patrick Geddes.

Arc Lighting Plant in the United States.—The *American Electrician* for June describes the arc lighting plant of the Hoboken Division (United Electric Co. of New Jersey), in which the power is taken from the generating plant which supplies current for the incandescent lighting. The arc light dynamos, which are modern type series Brush machines, are driven by two-phase synchronous motors, each motor being directly coupled to two 125-light dynamos, whilst the motor is brought up to speed by a 15 H.P. direct-current motor supplied with current from the tramway system. Two of the sets have been lately tested by the graduates of the Stevens Institute. Eighteen readings for each set were taken over a period of an hour and a-half. In the case of the first set the maximum efficiency registered was 80·1 per cent. and the minimum 76·9 per cent., mean 77·9 per cent. With the second set the mean efficiency was 75·8 per cent. The power-factor of each motor was 0·93 and the full load efficiency of the alternator 95 per cent.

Personal.—At Tuesday's meeting of the London County Council the resignation of Sir Alexander Binnie, the Council's chief engineer, was announced. The resignation takes effect at the end of the year, when Sir Alexander will establish himself in private practice as a consulting engineer at Westminster. Expression was given at the meeting to the regret of all the members at Sir Alexander's resignation after twelve years' service.

Mr. G. B. Stacey, superintendent of the Capetown station of the Eastern and South African Cable Co., recently came home for a holiday. Before leaving Capetown Mr. Stacey, who has been nearly 50 years in telegraphy, was presented by his staff with a piece of plate, which took the form of a silver salver.

Mr. H. G. Cheesman has returned to England after a visit of inspection, which has extended over 16 months, to the Western and Pacific and European Telegraph Companies' stations.

Gas Engine Efficiency Tests.—In a Paper read at the recent Milwaukee meeting of the American Society of Mechanical Engineers, Mr. C. H. Robinson gives the results of efficiency tests of a 125 H.P. Westinghouse gas engine. The average thermal efficiency of the engine was 20·05, the highest being

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28·24 cent.; the figures correspond to 171·66 and 226·13 B.T.U. per I.H.P. per minute, respectively. The mechanical efficiencies corresponding to these tests were 79·89 and 89·05 per cent. respectively. The gas consumption per I.H.P. became as low as 9·7 cubic ft., and per B.H.P. 11·29 cubic ft., the averages for the tests with respect to these two items being 10·62 and 13·69 cubic ft. respectively. Tests were made to determine the distribution of heat in the engine. At the lowest H.P. of the series the percentages equivalent to I.H.P., the exhaust and the jacket, were 10, 82 and 58 respectively. At the highest H.P. (164 indicated) these figures became 26, 44 and 30 per cent.

**A Gas Power Plant in Mexico with Electrical Distribution.**—In a recent number of the *Engineering and Mining Journal* of New York a description is given of the power plant at the Great Pilares Copper Mine, in Sonora, Mexico, where two Loomis generators have been installed, each being capable of producing gas sufficient for 1,000 B.H.P. Two qualities of gas are made alternately, as the fires are supplied with steam or air, one gas holder having a capacity of 5,000 cubic ft. for water gas and the other 15,000 cubic ft. for producer gas. With the Loomis system the fuel is charged through an open door in the top of the generator, and the gas is exhausted from the bottom of the fire, thus converting all tarry and volatile matter in the bituminous coal and wood into a fixed gas, which is then drawn through an ordinary water spray scrubber by the exhauster and delivered to the holder. Coal is shovelled into the top doors as needed. Wood is thrown in, in lengths of 2ft. or 3ft. and ordinary cordwood diameters. The fires are cleaned but twice a week. The water for the scrubber is cooled by a simple tower and used over and over again. So far, eight Crossley engines have been installed, each belted to a 260 volt 65kw. dynamo. The consumption of fuel is less than 1½lb. of New Mexico bituminous coal per B.H.P. or about 3lb. of wood for the same unit.

**Electrical Engineers (R.E.) Volunteers.**—We have received the following communication from head-quarters, Regency-street, Westminster, S.W.:—

*Electrical Engineers Royal Engineers in South Africa.*

The head-quarters are at Johannesburg. "A" Company have taken over all the electrical work in the Transvaal south of Pretoria. "B" Company are looking after the work in the Orange River Colony. The following shows the general distribution of the two companies (the names are given where known):—Major A. Bain, Capt. J. J. F. O'Shaughnessy, and 2nd Lieut. T. Rich at Johannesburg; Capt. the Hon. R. C. Craven Bloemfontein; Lieut. E. H. Leaf Vereeniging; Lieut. J. E. Pearse near Johannesburg; C.S.M. J. H. Field and four men at Simon's Town; No. 1 section "B" Company at Bloemfontein; No. 2 section "B" Company at Vereeniging; three men (2nd Corp. Pepper, Sappers Thomas and Venables) on armoured train running between Bloemfontein and Pretoria; "A" Company, one N.C.O. and two men (2nd Corp. Bell, Sappers Bayley and Peck) running search lights at Springs; Corp. Rogers and two men running search lights at Krugersdorp; two men running search lights at Randfontein; two men running search lights at Forest Hill; four men (Corp. Shaw and three sappers) running search lights at Klerksdorp; one officer and 14 men erecting steam plant and running lights at No. 13 general hospital at Henry Vourse Mine, near Elandsfontein; one man in charge lights No. 6 hospital, Johannesburg; two men running lights at Crown Reef Mine. The entire lighting up, including laying down and fitting plant, of the fort at Klerksdorp to be taken over shortly. No 13 hospital and Forest Hill lights were entirely erected by our own men, and the latter work was done in record time. Three men were in hospital, but were all recovering, and are probably back at duty before this.

**Electrical Development in Boston.**—The progress of the electric supply industry in the United States of America is well brought out in the historical and descriptive article by Mr. E. S. Mansfield, published in the *Electrical World* of New York for May 18th, dealing with "The Edison System in Boston: Its Development and Present Status." The plant which formed the nucleus of the company in 1886 consisted of one 90 H.P. engine driving two Edison dynamos. The first generating station was started in June, 1887, and consisted of belt-driven dynamos, each engine driving two 125 volt generators furnishing current to the three-wire system. When completed the station held 19 150 H.P. engines driving 38 60kw. dynamos. By December, 1887, a second station was started to supply the demands of the business section of Boston north of that furnished by the first station. The equipment was almost a duplicate of the former—12 150 H.P. engines, driving 24 dynamos on the floor above. In 1890 Mr. Edgar, the station engineer, visited Europe, and it resulted in the third station situated in Atlantic-avenue, which now generally supplies the whole current, except during periods of heavy load in the winter. In this station seven direct-driven sets had been installed last year of an aggregate capacity of 6,240 H.P. An extension to the station was then started, and two 2,400 H.P. sets have been fixed, and there is space left for four 4,000 H.P. sets. About 45 miles of cable have been laid, mostly insulated with rubber, drawn into cement-lined or vitrified duct. In the alley leading from the third district station 120 separate ducts have been put down. So far the equivalent to 243,800 16 c.p. lamps have been connected, and the increase of load has been greater for the last two years than at any time previously. About 48 per cent. of the current generated at the Atlantic Avenue station is used in that district, about 40 per cent. is fed into the sub-stations having auxiliary steam plant, and about 12 per cent. goes to battery sub stations in the outlying districts. The switching arrangements are in a separate room—the largest switches being designed to carry 7,000 amperes—and are opened and closed by 2¼ H.P. motors worked by pressing a button on the operating table.

**Electrical Transmission in a Packing House Factory.**—The *Western Electrician* of Chicago, in a recent number describes the electrical plant of the Cudahy Packing Company at Kansas City, Mo. In all there are 22 buildings covering 10 acres. One 350kw. and one 200kw. machines have been installed, generating at 230 volts and distributing to about 40 motors ranging in size from ¼ H.P. to 75 H.P. A 3 H.P. motor is used to drive three oleo presses, while a 35 H.P. machine drives six tallow-cooking vessels, six lard-cooking vessels and three fat hashers. The killing-house has a 20 H.P. motor, which drives the friction hoists and cattle beds, and a 15 H.P. machine runs two elevators, two cripple hoists and one hide hoist. The "Ferris Wheel" used in hog slaughtering and the travelling table of the hog scraper are driven by a 15 H.P. motor, a hog-hair machine by one of 50 H.P. and a hog conveyor by a 3 H.P. motor. The largest motor is of 75 H.P. capacity and operates three Anderson blood driers and pickers and a bone mill. On the cutting floor a beef conveyor is driven by a 5 H.P. motor, a "back-fat" machine, a grindstone and rotary tables by a 3 H.P. motor, and four band saws by two 5 H.P. motors. Two hog conveyors in the hog-chill rooms are operated by a 3 H.P. and 5 H.P. motor respectively. In the lard refinery a 15 H.P. motor drives a set of lard rolls, and an agitator and a 3 H.P. one drives a lard agitator alone. Of the machinery in the sausage department five hashers, a spice mill and three mixers are driven by a 35 H.P. motor, a capping machine by a 5 H.P. motor, four elevators by a 35 H.P. motor and a sewing machine by a ¼ H.P. motor. In the ice plant a 15 H.P. machine drives an ice crusher and one elevator. The coal crusher is operated by a 25 H.P. motor, while the two conveyors are handled by two 15 H.P. motors. A 50 H.P. motor belted to a power pump is in use for general water supply. This is located in the engine room, as well as the two 35 H.P. motors and one 25 H.P. motor which operate brine pumps. The machine shop has a 10 H.P. motor which drives the machine tools, &c., used in the company's repair work. The glue house contains a 3 H.P. motor for driving a glue slicer, and a 50 H.P. motor connected to three 60in. fans for an air blast used in drying glue. The box factory has a 10 H.P. motor driving circular saws and nailing, grooving and sand-papering machines. In the canning house a 25 H.P. machine drives a 60in. ventilating fan, a 15 H.P. inverted motor operates two elevators, a 15 H.P. machine drives capping machines and can conveyors, while a 35 H.P. motor operates five vacuum pumps, a washing machine, three cooking machines and a cooling machine. In a separate boiler house, which is used exclusively to furnish steam for the cooking and packing processes, is located a 10 H.P. motor driving a 60in. ventilating blower. In the chill rooms two 60in. exhaust fans used to exhaust the animal heat from the rooms are driven by a 25 H.P. motor.



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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Anti-Coherers.*—A. Neugschwender, known as the inventor of the first "anti-coherer," criticises the explanation given by Marx of the action of the so-called Schäfer plate (see *The Electrician*, Vol. XLVI., p. 611), which consists of a silver-on-glass deposit gapped with a razor and covered with a layer of celluloid. He points out that the action of this "dry" anti-coherer is probably as much of an electrolytic action as that described in his own device, which consisted of a similar gap moistened by breathing upon it. Marx's instruction to exhaust the air about the anti-coherer and re-admit it is inconsistent with the "absolute dryness" of the plate, and the fact that at a very low pressure the action of the coherer becomes nullified is probably explained by the absence of moisture in that case. The re-establishment of the tree-structures on the cessation of the electric waves cannot be due to any mechanical action or precipitation, since the metal would probably only be precipitated in an oxidised state. Indeed, when the mirror is made of gold or platinum, the anti-coherer fails, though a metallic deposit might be expected to take place in the gap. The true explanation is that these metals are so insoluble in the traces of moisture that no solution is formed from which trees of gold or platinum can be deposited.

[A. Neugschwender, *Phys. Zeitschr.*, June 15, 1901.]

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*Simplified Liquid Interrupter.*—D. A. Goldhammer and J. J. Ariston describe a new arrangement of Simon's interrupter which appears to have some distinct advantages. The porcelain diaphragms are represented by the walls of porcelain beakers. The wall is bored down until it is thin, and then a small hole is punched into it by a light tap with a hammer on a needle. This gives holes from 0·2mm. to 4mm. wide, with walls a few tenths of a millimeter thick. The durability of the porcelain is something quite extraordinary, and indicates porcelain as the ideal material for interrupters of this kind. The beakers used by the authors are 10cm. wide and 10cm. high. This ensures that for ordinary currents there is very little heating of the liquid. To still further reduce the heating the authors employ two or more cells in parallel, joining the inner vessels with a siphon. If the current passes in opposite directions in the interrupters any change of level in one of the inner vessels will be compensated by a rise or fall of the liquid in the other. As a further advantage, the resistance of the interrupter is diminished. No cooling device is needed in this arrangement. The liquid is covered with a layer of vaseline oil. The cost of the apparatus is trifling

[Goldhammer and Ariston, *Phys. Zeitschr.*, June 22, 1901.]

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*Electric Dissipation at High Altitudes.*—The presence of ions in the air was suggested by the phenomena of photo-electric discharges observed by Elster and Geitel, and has been explained on the basis of the ultra-violet rays in sunlight. Observations made on mountain tops are complicated by the increased electric density inseparable from points and eminences, and these complications can only be removed by measurements made in balloons. H. Ebert undertook two balloon ascents for the purpose of determining the conductivity of air at high altitudes. One of them was undertaken in the hot summer, and the other in winter, with snow on the ground. Even in the case of a balloon ascent a new complication might conceivably be introduced by a proper charge of the balloon itself, but the author made sure against that by bringing the inflated balloon into the neighbourhood of the electrometer, which showed no disturbance in consequence. The general observation made was that as the altitude increased the ratio between the rates of discharge of negative and positive electrification became more and more like unity, and at the same time both rates of discharge showed a notable increase. But the excess of positive over negative ions may often be felt at altitudes as great as 8,000ft.

[H. Ebert, *Ann. der Physik*, No. 7, 1901.]

*Electromagnetic Theory of Mechanics.*—The leading ambition among electrical theorists has been to reduce electromagnetics to mechanical conceptions and principles. This tendency is probably due to the notion that mechanical actions are somehow more real, palpable and intelligible than the play of electrical and magnetic forces. This idea is, of course, quite erroneous, since the intimate mechanism of a simple contact or impact is quite as mysterious as the attraction of two oppositely electrified bodies. The attempt made by W. Wien to reduce mechanics to electromagnetic conceptions and principles is, therefore, of great interest. He assumes, with Lorentz, that gravitation is due to the attraction between the ions composing the material bodies, and that the attraction between positive and negative ions surpasses the repulsion between ions of the same class. The ether is supposed to be at rest. Gravitational force must be propagated with the velocity of light, and must be modified by the motion of bodies. This, in the case of the fastest cathode rays, would involve a modification of 7 per cent. The other fundamental property of matter—viz., inertia, would be based upon electromagnetic inertia. These speculations open up wide vistas in mechanics, which will put the theory to a very severe test.

[W. Wien, *Ann. der Physik*, No. 7, 1901.]

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*Absorption of Waves by Resonators.*—If a substance, characterised by a strong and well-marked absorption band, is dissolved in various colourless liquids, the position of the absorption band varies in many cases according to a definite law, expressed by "Kundt's rule." The band is displaced towards the red end by an amount proportional to the refractive and dispersive powers of the solvent. According to Garbasso's observations a system of resonators transmits an incident electric radiation the less the more its own period coincides with that of the incident radiation. If, for instance, a number of parallel metallic strips are pasted on a glass plate such a "resonator" behaves towards electric rays in much the same manner as a body with surface colours does towards rays of light. When such resonators are built in three dimensions it is even possible to demonstrate a prismatic refraction and dispersion of the rays. E. Aschkinass and C. Schaefer make their resonators of strips of copper strung on threads in a frame, which could be immersed in a bath of benzol, ether, or acetone. They noticed a decided displacement of the maximum absorption, which was at a resonator length of 4·7cm. in air, 3·1cm. in benzol, 2·3cm. in ether, and 1cm. in acetone.

[Aschkinass and Schaefer, *Ann. der Physik*, No. 7, 1901.]

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*Dissipation of Electric Charges.*—J. Elster and H. Geitel found some time ago that the conductivity of air for charges dissipated from a metallic body gradually increases in a confined space, tending towards a limiting value. Since it is known that air free from dust conducts these charges better than dusty air, the authors suspected that the increase of conductivity in question might be due to the gradual laying of the dust in the confined space. They, therefore, made special experiments with artificially cleaned air, which was either sucked through wadding or cleaned electrostatically. The attempt to produce the limiting conductivity by this process failed entirely. The time at which the maximum conductivity was attained could not be perceptibly shortened in this manner. The authors next investigated the effect of moisture. But even such large variations of percentage moisture as from 91 per cent. to 7 per cent. did not produce a decided result. The authors, therefore, suggest another and a very interesting explanation. It is that all substances either contain traces of radio-active bodies or are themselves slightly radio-active, and that the maximum conductivity is attained when the rays have had time to produce their full ionising effect upon a certain quantity of air. The high conductivity of the air in closed cellars and in caves would tend to confirm this.

[Elster and Geitel, *Phys. Zeitschr.*, June 22, 1901.]

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# ELECTRIC POWER SUPPLY AT NEWCASTLE-ON-TYNE.

(*Concluded from page 364.*)

Since the publication of our first article on the Newcastle-upon-Tyne power supply system (*The Electrician*, June 21) we have been favoured by Mr. Charles Merz, the consulting engineer, with a detailed scale drawing of the Wallsend Slipway & Engineering Co.'s vertical triple-expansion 1,400 H.P. steam engine at the Neptune Bank station. This we now reproduce in Fig. 23; our readers will find a description of the engine in the earlier article.

## NEWCASTLE ELECTRIC SUPPLY CO.'S SYSTEM.

**Mains.**—Messrs. Callender's Cable and Construction Co., whose mains in the gas company's area we described last week, are laying a heavy trunk main from the Neptune Bank station to the Newcastle area. This trunk main runs viâ Walker-road, through Walker, to the sub-station at the end of Byker Bank. It proceeds thence to the sub-station at Manors (Fig. 24), where it terminates. It is intended to act as a trunk for the supply of current required in Newcastle city, and, except at the various sub-stations, it is not intended to be tapped or interfered with. Along a great part of the road a system of three low-tension mains has also been laid, and it is eventually intended to connect up any portions of this network which at present are not placed in position. This low-pressure network consists of single-conductor cables of the Callender Company's standard make, insulated by vulcanised bitumen and laid solid in Trinidad bitumen precisely as used in the Wallsend district, with the exception that instead of adopting three single troughs, one for each cable, a special form of three-chase troughing has been used with the view of economising space.

The contract provides also for the construction of a conduit having nine ways, each 4in. in diameter, consisting of specially made stoneware pipes set in a solid block of concrete into which three-phase cables will eventually be drawn. These cables will be in many respects the same as the three-phase mains laid in the Walker district, but the sectional area of conductor in each branch will be considerably larger, being 0·25 sq. in., whilst over the lead cover there will be a sheathing of steel wires so as to comply with the new requirements of the Board of Trade, who ask for special precautions of this kind to be taken wherever three-phase high-pressure current is dealt with.

Throughout the work on both contracts great care has been taken in regard to the manholes and drawpits. On the Wallsend and Willington line, owing to the difficulties met with and the nature of the subsoil, and the fact that the mains are in the roadways, these are practically small underground chambers. The mains forming the Newcastle trunk line are all laid under the footpath, and consequently the manholes, although larger in superficial area, are not quite so deep. They have been constructed with the view of making it possible to handle the heavy trunk main cables and connect them up as readily as is possible, and although they form an item of considerable expense in the total work, they are probably the best examples of manholes on a heavy drawing-in system which have ever been constructed in this country. The boxes joining the factory lengths of high-tension mains are designed so that there shall be complete continuity of the wire sheathing. They are of a type which has been proved satisfactory in practical working at Wallsend among other places. The disconnecting boxes used on the low-pressure mains are single pole, and are so arranged as to be readily accessible, but at the same time are kept perfectly watertight through the special design of the lid. The feature in the whole of the boxes in Newcastle and its district is the interchangeability of all parts, everything being made to template, and as few types as possible being adopted.

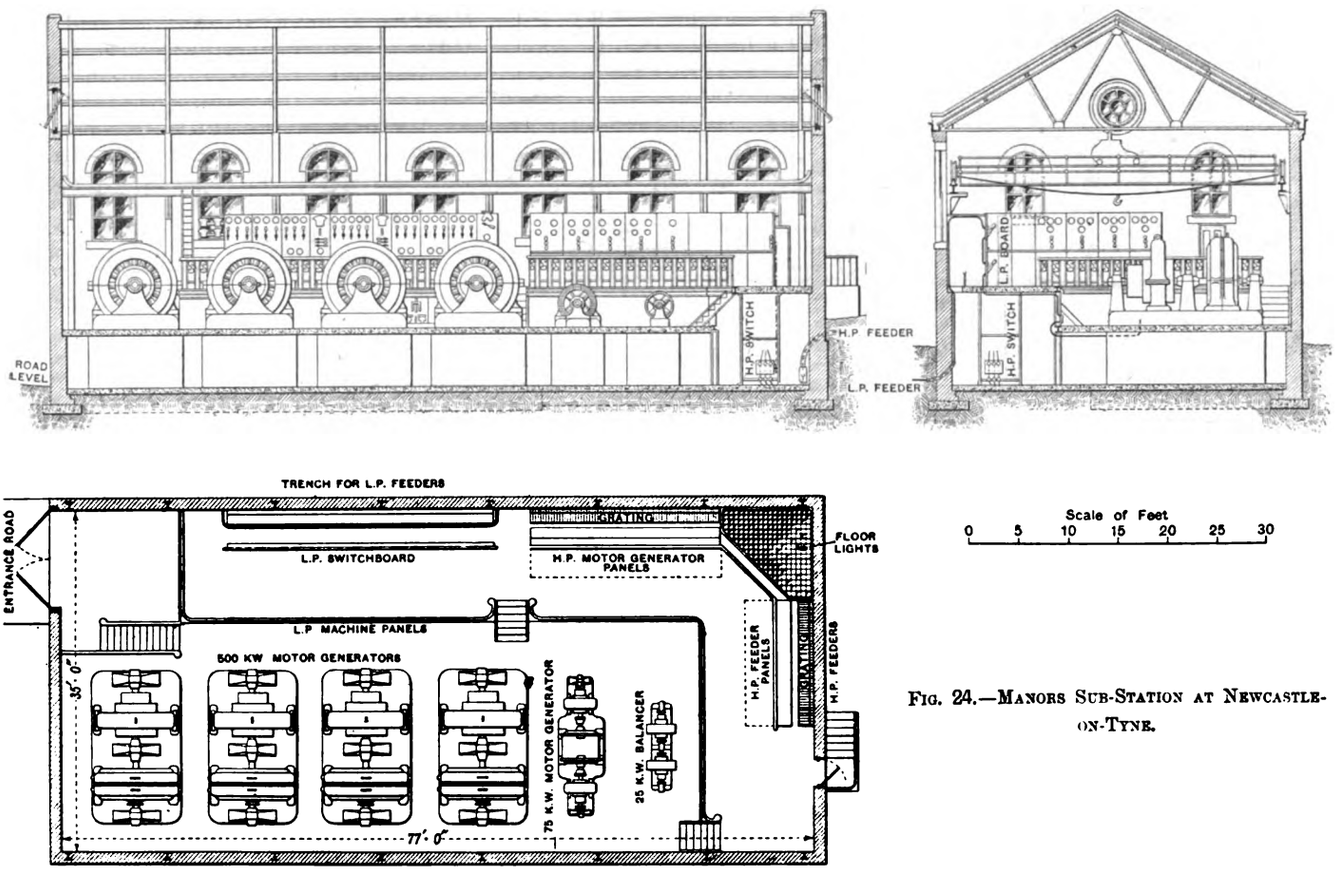


FIG. 24.—MANORS SUB-STATION AT NEWCASTLE-ON-TYNE.

Manors Sub-station.—This is an iron building with the roof supported on rolled steel columns. Plan and elevations are shown in Fig. 24. The walls are of brick, but are not intended

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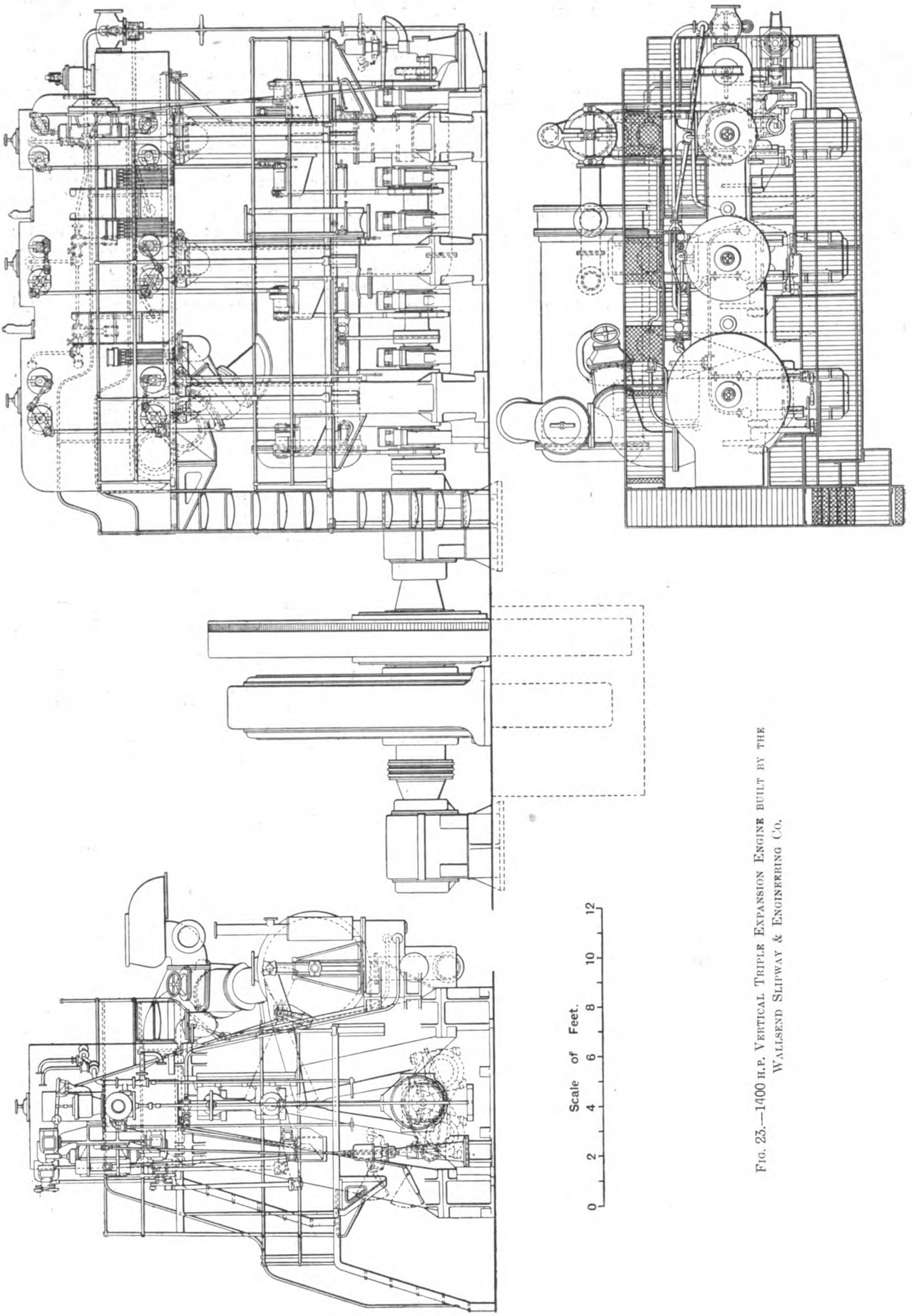


FIG. 23.—1400 H.P. VERTICAL TRIPLE EXPANSION ENGINE BUILT BY THE WALLSEND SLIPWAY & ENGINEERING CO.

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to take the weight of the structure. The basement is at road level, and the machines rest on concrete foundations which rise to a height of 6ft. above the basement. The switchboard gallery is 4ft. above the machine floor. A well is provided at the entrance door where the machinery is brought in, and a "traveller" runs the whole length of the building, whereby material can be carried to any part of the sub-station on either the machine floor or the switchboard gallery. This arrangement of levels permits of great simplicity in running the leads both from the machines and from outside. The initial equipment consists of two 500kw. synchronous motor generators, one 75kw. asynchronous balancing and starting set, one 25kw. continuous-current balancer, a high-tension switchboard, and a low-tension switchboard, and one 7½-ton travelling crane.

Inasmuch as the same types of construction and equipment are preserved in all the Newcastle sub-stations, we shall further describe the equipment without special reference to any one sub-station.

Large Motor Generators in Sub-station.—The large motor generators for the sub-stations in Newcastle are being supplied by Messrs. Richardsons, Westgarth & Co., and manufactured by Brown, Boveri & Co.; but two—the first instalment for one of the sub-stations—are by the British Thomson-Houston Co. Each set will consist of one three-phase synchronous motor, wound for the full pressure of 5,500 volts, coupled to a single continuous current generator. The two machines of each set are mounted on one bedplate. The motor has a fixed armature and revolving field, and the armature winding is star connected. The full load output of each continuous-current set is 280 amperes at 510 volts, and the three-phase motor is so designed that by means of a field rheostat the power-factor at full load can be varied from 1 to 0·8, the wattless current being a leading current. No part of the apparatus except the commutators in continuous running at the full load will rise in temperature more than 40°C. as measured by thermometer, and no part of the commutators will rise in temperature more than 45°C. The motor generators will be capable of running for one hour at an overload of 25 per cent. without excessive rise of temperature in any part or injurious sparking, the position of the brushes being fixed for all loads. The efficiency is guaranteed not to be less than 89 per cent. at full load, 87 per cent. at two-thirds load, and 78 per cent. at one-third load.

Sub-station High-tension Switchboards.—The high-tension switchboards are being supplied by Messrs. Richardsons, Westgarth & Co. Each switchboard consists of a feeder-board and a motor generator board, which are placed at right angles, and which are connected through a panel which will contain wattmeters and power-factor indicators dealing with the total power being taken by the motor generators. Each board is constructed of angle iron and marble slabs, and consists of two parts, a lower and an upper frame. The lower frame is located beneath the floor of the switchboard gallery, and contains the high-tension 'bus bars, switches, fuses, and instrument transformers. The upper frame contains the rheostats, indicating instruments, and handles for operating the main switches. The main switches are of the oil type, and are geared to the operating handles by means of a chain and sprocket wheels. All the instruments, both voltmeters and ammeters, are operated through transformers. The whole of the high-tension parts are thus kept below the floor, and safety in ordinary working is secured since all high-tension parts are inaccessible to the operator on the gallery.

Sub-stations Low-tension Switchboards.—The low-tension switchboards are being supplied by Messrs. A. Reyrolle & Co. Each board is divided into three portions—viz., positive, negative and neutral portions, which are separated by two voltmeter panels. There are three sets of horizontal 'bus bars, and any generator, balancer, or feeder can be connected to any of the three sets of 'bus bars by means of the usual arrangement of vertical bars and screw plugs. The board is designed for ultimately dealing with four 500kw. motor generators, two balancers, and nine feeders, some of which will be interconnectors between sub-stations. For starting the synchronous motor generators an arrangement of switches is provided by which any motor generator can be connected with a special starting panel, which is fitted with starting resistances and an automatic cutout, and is located at one end of the low-tension switchboard. The backs of the voltmeter switches are covered in with neat brass cases, and all voltmeter wires are run in metal tubing, thereby securing a neat and safe arrangement on the back of the board. The dynamo fuses and field switches are located on panels fixed on the wall supporting the switchboard gallery.

Sub-station Cables.—The arrangement of cables in the sub-stations is exceedingly simple, and crossings are avoided as much as possible, by running all the high tension leads from the machines to the board along the basement floor direct into the dividing boxes of the high-tension switchboard also placed on this floor. The low tension machine cables, on the other hand, are fastened by means of porcelain insulators to the underside of the machine floor, and are connected to the fuses provided on auxiliary machine panels placed on the low wall directly below the low-tension switchboard. These panels have also field breaking switches mounted on them. The leads which connect the auxiliary panels with the main board run on the underside of the switchboard gallery floor and are taken direct to the corresponding lugs on the machine switches.

Both high and low-tension feeders drop down into iron bands and thence pass out of the sub-station. All interconnecting cables are treated in the same way as the feeders, the only difference being that in the case of the low tension the ammeters are centre-reading so as to secure both incoming and outgoing current.

All the sub-stations are in direct telephonic communication with one another and with the power station, and should a breakdown occur in any one of the former its load may be taken by another by means of the above-mentioned interconnectors.

Starting.—A sub-station is started up in the first instance on the high-tension side by means of the asynchronous motor generator, which makes the continuous-current 'bus bars alive; the synchronous motor generators are run up to synchronism by motoring the continuous-current side. When these have attained their speed and have been duly synchronised with the high-tension feeders, the asynchronous motor is shut down, and the direct-current machines may run as balancers. The sub-stations are also equipped with an air compressor as in the power house; the lighting is done by means of Angold "enclosed" arc lamps, which are trimmed from the crane. Gas and water are also laid on, and lavatory accommodation is also provided.

Conclusion.—In bringing these articles to a close we may, in consideration of the unusual importance and peculiar character of the undertaking, give the names of the officials and contractors connected with it. These are tabulated below, and, in conclusion, we have only to repeat the thanks we offered at the commencement to all who have assisted us in the preparation of this series of articles:—

List of Officials.

Consulting Engineer for both Schemes: Mr. Charles H. Merz, 1, Mosley-street, Newcastle-on-Tyne, and 28, Victoria-street, Westminster, London, S.W.

*The Newcastle-on-Tyne Electric Supply Co. (Ltd.).*

General Manager: Mr. J. S. Watson.
Secretary: Mr. M. Short.
Resident Engineer for Construction of Neptune Bank Power Station: Mr. H. L. Riseley.
Architects for Power Station Buildings: Messrs. Sandeman and Moncrieff.

*The Walker and Wallsend Union Gas Co.*

General Manager and Engineer: Mr. A. B. Walker.
Secretary: Mr. C. H. Armstrong.

List of Contractors.

*I.—Neptune Bank Power Station.*

| | |
|---|---|
| Steel work of buildings | Darlington Wagon & Eng. Co. |
| Traveller | Jos. Booth and Bros. |
| Engines for continuous-current sets | Belliss and Morcom. |
| Main engines { One by | Wallsend Slipway & Engineering Co. |
| Main engines { Three by | Wigham, Richardson & Co. |
| Boilers, steam and feed piping, stokers, self-supporting chimney | Babcock and Wilcox. |
| Circulating and spray pipes, exhaust piping | Körting Bros. |
| Continuous-current generators and exciters, three-phase alternators | British Thomson-Houston Co. |

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| | |
|---|---|
| Motor generator | Richardsons, Westgarth & Co. (Brown, Boveri & Co.) |
| Motor equipment of generating station | D. Bruce, Peebles & Co. |
| Low-tension switchboards | A. Reyrolle & Co. |
| High-tension switchboard | S. Z. de Ferranti (Ltd.). |
| *II.—Newcastle Outside System.* | |
| High-tension cables | Callender's Cable & Construction Co.<br>British Insulated Wire Co. |
| Low-tension cables | Callender's Cable & Construction Co. |
| *III.—Newcastle Sub-stations.* | |
| Motor generators | Richardsons, Westgarth & Co. (Brown, Boveri & Co.)<br>British Thomson-Houston Co. |
| Low-tension switchboard | A. Reyrolle & Co. |
| High-tension switchboard | Richardsons, Westgarth & Co. (Brown, Boveri & Co.) |
| Iron work of buildings | Clyde Structural Iron Co.<br>W. T. Wier. |
| Cranes | Jos. Booth and Bros. |
| *IV.—Walker and Wallsend Union Gas Co.'s System.* | |
| Motor generators for different works | British Thomson-Houston Co.<br>Richardsons, Westgarth & Co. |
| High-tension switchboards for different works. | S. Z. de Ferranti (Ltd.).<br>Richardsons, Westgarth & Co.<br>British Thomson-Houston Co. |
| Low-tension switchboards for different works. | British Thomson-Houston Co.<br>A. Reyrolle & Co. |
| Complete equipment of works | British Thomson-Houston Co. |
| Motor equipment in different works | British Thomson-Houston Co.<br>British Westinghouse Co.<br>Richardsons, Westgarth & Co. |
| High-tension cables | Callender's Cable & Construction Co. |
| Low-tension cables | Callender's Cable & Construction Co. |

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 366.*)

In addition to the visits previously mentioned, on Tuesday, June 25th, some members inspected one of the Berlin telephone exchanges. The telephone service in Germany is provided by the Government, and the exchange visited contained a 14,000 subscriber flat switchboard, similar to that shown by the makers at the Paris Exhibition, and described in *The Electrician*, Vol. XLVI., p. 168, and Vol. XLVII., p. 134. A few of the visitors who had been specially invited also visited the Aron meter factory, and were subsequently entertained at dinner by Prof. Aron, Col. Crompton and Mr. Hirst, directors of the Aron Meter Company. The guests included several of the prominent members of the Institution party, who spent a quiet and enjoyable evening.

On Wednesday, June 26th, a series of visits to the three principal manufacturing works of the Allgemeine Elektricitäts Gesellschaft had been arranged. The cable works, which were first on the list, were reached by steamer, as in the case of Messrs. Siemens and Halske's cable works on the previous day, but this time the trip was up instead of down the river. Although several of the members could have had no special interest in the details of cable manufacture, and had visited a factory of a similar class on the previous day, very few failed to put in an appearance. A description of these works will be reserved for a future article, but it may be mentioned that here, as at the Siemens and Halske cable works, the feature exciting most interest was the extreme cleanliness and tidiness of everything. During the passage of the party through the works, as well as through the other workshops included in the programme, practically every machine was in operation, and the staffs of the company were indefatigable in answering questions put by the less well-informed, and good-humouredly hurrying on the experts whose desire to inspect each machine minutely threatened frequently to upset the time table arranged for us. There are almost as many cable manufacturers as dynamo manufacturers in the party, and the braking action exerted by the various specialists throughout was alone a proof of excellence and novelty in the works. Our guides were most indulgent, and I trust this indulgence has not been abused. Further description of the dynamo works, all the machines in which are independently driven by three-phase motors, and the excellently organised apparatus factory in the Ackerstrasse, must also be postponed for the present.

An excellent lunch was served in the workmen's canteen at the cable works, and the elegance and cleanliness of this hall excited everyone's surprise and admiration. During the meal Herr Eric Rathenau, son of the managing director of the Allgemeine Elektricitäts Gesellschaft, proposed the health of the Institution in a clever speech, delivered in English, in the course of which he reminded us that just 50 years ago the first cable had been laid between Germany and England. He raised a hearty laugh by expressing the hope that the sympathy between the two countries would remain as strong as the cables we had just inspected, and instantly corrected himself to the converse proposition—viz., that the cables might continue as fast as our bonds of sympathy and friendship

On the way back to the steamer an inspection was made of the Oberspree generating station which adjoins the works. This one is the most important and the latest of the electricity works supplying the town of Berlin, and contains large three-phase 6,000 volt generators. The steamer took us to Treptow, where the A.E.G., the abbreviated name by which the Allgemeine Elektricitäts Gesellschaft is recognised in Germany, has built a tunnel for an electric tramway for passenger traffic under the River Spree to Stralau. The total length of this tunnel is 454 metres, 105 metres being actually beneath the river, which it crosses at right angles. It had to be cut through sand on the air-shield system, and its depth is such that there is a minimum of 4 metres below the top of the tunnel and the bed of the river. The tunnel itself is tubular, of circular section, the internal diameter being 3·75 metres; the iron tube, however, is of somewhat greater diameter as there is a 12cm. lining of cement. There is also an external layer of cement 8cm. thick, for the joint purpose of preventing rust and noise. The rails are of ordinary Vignoles section at standard gauge, and current is led to the car by a trolley, the trolley wire being carried on the roof of the tunnel.

In the evening of the same day the most important and brilliant of the social functions took place—a dinner being given by Messrs. Siemens and Halske and the A.E.G. in the great banqueting hall of the Zoological Gardens. All the more important members of the staff of the two companies were present with their wives, and, in addition, there were several distinguished guests from the Berlin scientific and political circles. The first speech was the proposal of the health of the Emperor of Germany and the King of England by Herr Moeller, Minister of Commerce, who, in his eulogy of the Kaiser, recalled the fact that William II. of Germany had taken a greater interest in science than any monarch had done before him, and this interest was particularly directed to electrical science. Referring to the industrial supremacy of England, as it was a few decades ago when Germany had nothing to compare with it, Herr Moeller said that the Germans "went over there and learnt." Now, in the electrical engineering industry Germany was at least the equal of England, and the latter country might in its turn be able to acquire fresh creative energy from Germany; too prolonged a period of success was as bad for an industry as it was for an individual. The motto of both countries should be "Gemeinsame Arbeit, gemeinsames Streben, und gemeinsame Liebe." "God Save the King" and "Heil dir in Siegerkranz" were then sung to the same melody. Mr. Graham, secretary at the British Legation, followed, and hoped that his compatriots would go home with a feeling of greater sympathy with and a fuller comprehension of our neighbour. Other speeches were delivered in the same strain. Herr Wilhelm von Siemens, head of the firm of Siemens and Halske, said that Germany, when it followed England's lead, had been so eminently successful on account of the more suitable political conditions, and Mr. Alexander Siemens, in responding to the toast of the Institution proposed by his cousin, expressed his opinion that the two countries had become much more dependent on one another than any others. The English

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guests, he said, were surprised and rejoiced to see the great progress Germany had made. He concluded by thanking the German ladies' committee for the hospitality and attention they had extended to their English guests. Herr Rathenau then read amid cheers the telegram sent by the Kaiser to the Institution of Electrical Engineers (referred to in the last issue of *The Electrician*). It may be mentioned that considerable satisfaction is being felt, both on the part of the English and German electrical engineers, that an autograph telegram should have been addressed directly to the Institution by the Emperor himself, as this practice is not followed in the case of telegrams of an ordinary nature.

On Thursday, June 27th, the morning was devoted to a most interesting visit to a new electric railway, which is being constructed by Messrs. Siemens and Halske. The line will afford an important link of communication between the central and outlying parts of the capital, and it is partly underground and partly elevated. As in the case of the other more important works, it is proposed to devote a special article to it. In the afternoon the Institution party divided, some going on to Dresden and others remaining in Berlin to visit the works of Messrs. Ludwig Loewe & Co. and the Union Elektricitäts Gesellschaft. A few also were shown over the Charlottenburg technical college by Prof. Slaby. An opportunity was also afforded to some to visit the works of the German Niles Tool Co.'s works before leaving Berlin.

Arrived at Dresden, the Institution joined forces with the Verband Deutscher Elektrotechniker, the members of which institution were welcomed in the evening, at a more or less informal gathering, by Herr Buschkiel, president of the Reception committee of the Dresden Electrical Society. Herr Buschkiel alluded in delicate terms to the unfortunate incidents which had occurred during the last few days (the closing of two industrial banks, in Leipsic and Dresden respectively, and the regrettable failure of Messrs. Kummer & Co.). He trusted that the Verband meeting would prove a success, in spite of the gloom which these events had naturally cast over industry and commerce generally, and upon the electrical industry around Dresden in particular.

The Verband meeting proper began on Friday morning, and was opened by the address of the president, Prof. Eugen Hartmann, of the firm of Hartmann and Braun, who, in the course of his speech, spoke a few words of welcome in English to the members of the Institution of Electrical Engineers. A number of our Austrian brethren were also present, and to them a cordial welcome was extended as well. The most important part of the meeting was the discussion of business matters, such as the reports of the various sub-committees, and this was interesting, not only on account of the subject-matter, but also by the comparison which could be made with the methods of our own Institution.

Very few of our own members attended the meeting, however, chiefly on account of the difficulty in understanding a foreign tongue. The proceedings consisted in each case of a short commentary and explanation of the report by one of the committee in question, and the questions and discussions were short and to the point, the representative of the committee replying to each speaker at once, so that the answers were as direct as they could be. Although many professors were present, the proceedings were not marked by a single interruption or any tendency to extend the discussion to personal matters or pedantic questions of minor interest to the general body of members. Another point of interest was that those joining in the discussion spoke with fluency and precision, the only tendency to verbosity being in the Papers themselves. Whether this ease and accuracy of expression may be traced back to the habit and phraseology of the language itself, or whether it may merely have been that the speakers all knew exactly what they were talking about and had made up their minds definitely what to say before they ventured on their feet, is impossible to tell. It is observable, at our Institution at any rate, that those who speak with a true knowledge of a subject seldom err on the side of diffuseness and platitude, but, if possible, speak too tersely. There is another and most important matter in which the procedure of the Verband differs from that of the Institution of Electrical Engineers—viz., in the formation of the committees and the acceptance of their reports. Instead of the committees being appointed merely by the council, and their report being adopted by that body without being put before the members for discussion, the committee are elected at the general meeting of the Verband and their report is only accepted by the association after it has been carried by a majority of members.

Mr. Gisbert Kapp, the general secretary, having read his report upon the year's work, the first committee report to come up for consideration was the revised code of safety regulations for electric railways and tramways. A set of regulations had been adopted provisionally at last year's Verband meeting at Kiel, and these were now definitely adopted with certain slight alterations, which had appeared advisable to the committee. Then some alterations in another set of safety regulations, previously announced in the *Elektrotechnische Zeitschrift*, were proposed by Prof. Budde, and, after a few questions had been answered, were also adopted without dissent. Next, the proposed standard specification for the testing of dynamos and other electrical machinery was dealt with. From the translation of these, published in *The Electrician* of June 21st, it will be remembered that these proposed standards were of considerable interest and are likely to be of great utility. The committee which had framed them proposed that they should be adopted tentatively for one year, and that the committee should be re-appointed, and by next annual general meeting determine what modifications (if any) were required before adopting the specification finally as a standard. Considerable care had been devoted to the preparation of the specification, and 23 firms had responded to the committee's invitation to send in suggestions. At the meeting exception was taken by one or two members to the description of the manner of testing machines in other than their own bearings, it being stated that the method given might in certain instances give rise to errors in the order of 30 per cent. A proposition was, therefore, put forward that the word "can" should be substituted for "are to be" in the corresponding regulation. The amendment was out-voted, however. This was not the fate of another amendment referring to the remarkable definition of a dynamo in the introductory part of the specification which made this word embrace the whole class of electrodynamic and dynamo-electric machinery (the distinction between these two terms, it may be mentioned, was pointed out by Mr. Alexander Siemens in the discussion). On being put to the vote the resolution to amend this definition was carried, and the word "dynamo" or "generator" is to be confined in the specification to its usual accepted meaning, while when a wider term embracing generators, motors, rotatory converters and motor generators is required, a word such as electrical machine is to be employed.

Next a series of standards for rubber wires and cables, proposed by a joint committee of the Verband and the German Cable Makers' Association, was passed without opposition; but a proposed standard specification for the testing of dynamo and transformer core iron gave rise to an energetic discussion. The rules for the test are that a wattmeter is to be employed to determine the loss in an iron circuit made up in a prescribed manner by four sets of strips about 2ft. long and about 1in. square, with an insulating piece of presspahn at each joint of the square. The actual dimensions and manner of preparation will be published separately by the Verband. The sample is to weigh at least 10kg. and the result of the test is to be given in watts per kilogramme when tested at a maximum B = 10,000 and at 50 ~ per sec. The standard thicknesses of sheet are 0·3mm. and 0·5mm., and in no case is the thickness to vary from this by more than ± 10 per cent. The specific gravity of iron is to be taken as 7·7. In cases of disagreement a test by the Physikalisch-Technische Reichsanstalt is to be decisive.

Prof. Epstein proposed these regulations, and Dr. Benischke was their chief opponent. In the first place, Dr. Benischke objected to a definite method being fixed, and then the Physikalisch-Technische Reichsanstalt, who would probably carry out the test by an entirely different method, being appointed arbitrator. Then no curve-form was prescribed,

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and Dr. Benischke had experimental proof that wave-form was a most important factor. Lastly, no allowance was made for eddy currents. Manufacturers might thus pick out the thinnest pieces for testing, and employ a dynamo with a flat E.M.F. curve, and thus get out a loss much less than the average, although they would still be following the standard rules for testing. He finally suggested a set of different regulations for testing, similar to some that he himself had published recently in the *Elektrotechnische Zeitschrift*, and he also laid stress on the point that other sizes of sheet than 0·3mm. and 0·5mm. should be specified. Dr. Epstein replied that the uncertainty introduced by differences in wave form and in eddy current losses did not amount to more than 5 per cent., and that hence the method given was quite accurate enough for practical purposes. As it was only proposed that the specification should be adopted as standard tentatively for a year, and as it had already been the object of considerable thought and experiment on the part of the committee, he deprecated any modifications at present. In a year's time it might be possible to put the whole matter on a more satisfactory basis. Prof. Du Bois having called attention to the influence of the corners in the test sample, the closure was moved and carried, after which the specification as a whole was put to the vote and passed, with the proviso that it should be accepted only for one year tentatively as a standard.

A set of rules for protection against lightning (published in the *Elektrotechnische Zeitschrift* of May 2) was next passed, and then a number of committees were appointed or reappointed. Among the new committees is a particularly strong one to consider the question of earth currents for electric railways and tramways—taking over this work from the Berlin Elektrotechnische Verein. A committee on patents and patent law was also appointed.

Space will not allow of an abstract being given here of all the Papers read at the meeting. The general feeling with regard to them was that they were too much on special subjects, and not of sufficiently broad a nature; in fact, more the class of Papers that should be submitted to the local societies than to the Verband itself. Herr Schiemann read the first Paper—on "Fast Speed and Heavy Electric Railways." It consisted of a summary of what had been done and was now being done in this direction, followed by a brief comparison of the technical features of the various systems and an exhibition of lantern slides. Herr Meng, the Dresden electrical engineer, then described the new tramways power house he had recently erected, making the electricity works in Dresden the second largest of any in Germany—Berlin, of course, takes the first place.

The Paper on Saturday which evoked most interest was on the "Ungleichformigkeitsgrad" of steam engines, and the method of determining it. This compendious word implies in this case the irregularity of turning moment during each revolution of the engine—a literal translation of it will not be attempted. Dr. Franke, of Hanover, the author of this Paper, described the various methods that had been employed for the measurement of this factor. The first method had been to fix a pencil to a tuning fork and allow it to trace a curve on the rim of the flywheel of the engine, any deviations from the standard sinuous line showing the irregularities during the revolution. Another method was to gear a toothed wheel to the engine, let a spring bear on it, and observe the variations in the note emitted by the latter. The variations in angular velocity could also be noted by comparison with a constant angular velocity about equal to the mean of the velocity to be observed. Thus two shafts, one at the constant and the other at the variable speed might be connected through differential bevel gear and the motion of the intermediate wheel observed—as in an Aron meter, with the difference that the actual motion of this wheel is observed or recorded instead of its revolutions being merely counted. A modification of this, due to Messrs. Schaefer and Budenberg was to connect the two shafts by a cord passing over pulleys, the motion of one of which is registered by a pointer. Stroboscopic methods are also available, but although they show the period they do not necessarily show the amplitude of the variations. Electrical methods of recording the difference between the two velocities were also described. In conclusion, the author expressed his opinion that it was a technical impossibility to detect variations smaller than $\frac{1}{100}$th of the normal speed, as other effects disturb the accuracy, and further, that, as a rule, the actual variations in the mean angular velocity were greater than the variations during a revolution. Both these conclusions were criticised in the discussion.

The chief social function of the Verband was the annual dinner on Friday night, at which over 500 ladies and gentlemen were present, including the majority of the English party who were at Dresden. The speech-list was long, as were also the speeches themselves, and as these were interpolated between the courses, according to the usual German custom, the dinner lasted until the small hours of the morning. Prof. Hartmann, the chairman, in proposing the health of the Emperor of Germany and the King of Saxony, referred to the Kaiser as a German engineer and German electrician, a remark which elicited much applause. The most interesting speech of the evening was that of Mr. Gisbert Kapp. He spoke as an old member of the Institution of Electrical Engineers, recalling that in the early days what was noticeable in the Institution was the helping hand held out by the older members of the profession to the younger and the excellence of the discussions at the meetings. These things he hoped would continue. On Saturday night the entertainment was a garden party, and, on Sunday, an excursion to "Saxon Switzerland" was made by several of the members of both institutions.

(*To be continued.*)

## STORAGE BATTERIES IN ELECTRIC POWER STATIONS, CONTROLLED BY REVERSIBLE BOOSTERS.*

BY J. S. HIGHFIELD.

(*Continued from page 339.*)

The essential connections are shown diagrammatically in Fig. 9, and the machine itself in Fig. 10; this shows the booster driven by a motor, it might, however, be driven from the main engine. The booster B (Figs. 9 and 10) has laminated field magnets, excited by a fine wire coil C (the exciter coil), consisting of such a number of turns of such resistance that the pressure given by the armature when run at constant speed is the same as the pressure across the ends of the exciter coil. The exciter E is a small generator, giving 500 volts, and the necessary exciting current. This generator has a very small drop from no load to full load, which drop is corrected for by a series winding, its armature leads are coupled, one to the battery negative terminal, the other (the positive) to the positive battery terminal, by way of the exciter coil C. So long as the exciter and battery pressures are equal, no current will flow in the exciter coil, and hence the booster will give no pressure; but should the battery volts rise a current will move in C proportional to the difference of the pressures of the battery and of the exciter (which will be motored). The booster armature will then give a pressure equal to the rise of the battery pressure. Similarly, should the battery pressure fall, the booster will give a pressure equal to the fall, but will have its poles reversed, the exciter running as a generator and giving current to the battery. The booster, therefore, follows the variations of the battery pressure from the line pressure, and corrects for the variations, so as to maintain the line pressure constant whether the battery be charging or discharging. Generally, as will be readily seen, the exciter runs as a motor when charging and as a generator when discharging, but since only 240 cells are used, occasionally, when the cells are low, charge begins at a less pressure than the 520 volts on the line, the booster then runs as a motor, and the motor as a generator, returning energy to the line. Also, when the battery is fully charged the pressure is generally greater than the line pressure. Should the battery in this condition be called on to discharge, the booster opposes the discharge, and is motored; the motor then runs as a generator, and again returns energy to the line. The current variations in the motor amount to about 7 per cent. of the maximum line variation. The booster fields being laminated, and being designed to work at a low induction so that the field strength is as nearly as possible proportional to the magnetising force, the change of polarity is rapidly made, and the booster pressure varies very closely as the difference between the battery and exciter pressures. Such a booster connected in series with the battery will serve to

* Paper read before the Institution of Electrical Engineers May 9.

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maintain nearly constant the load on the generator, as it will nearly correct for all changes in the battery pressure. There will be times, however, when the current through the booster armature is large and the field very small; the armature reaction will then be an important factor in the working of such a machine. To overcome this a coil connected in series with the armature is used, so that it opposes the reaction of the armature in whichever direction the current flows; this coil consists of a few turns only. In order to increase the pressure as the load on the line increases a part of the feeder current is

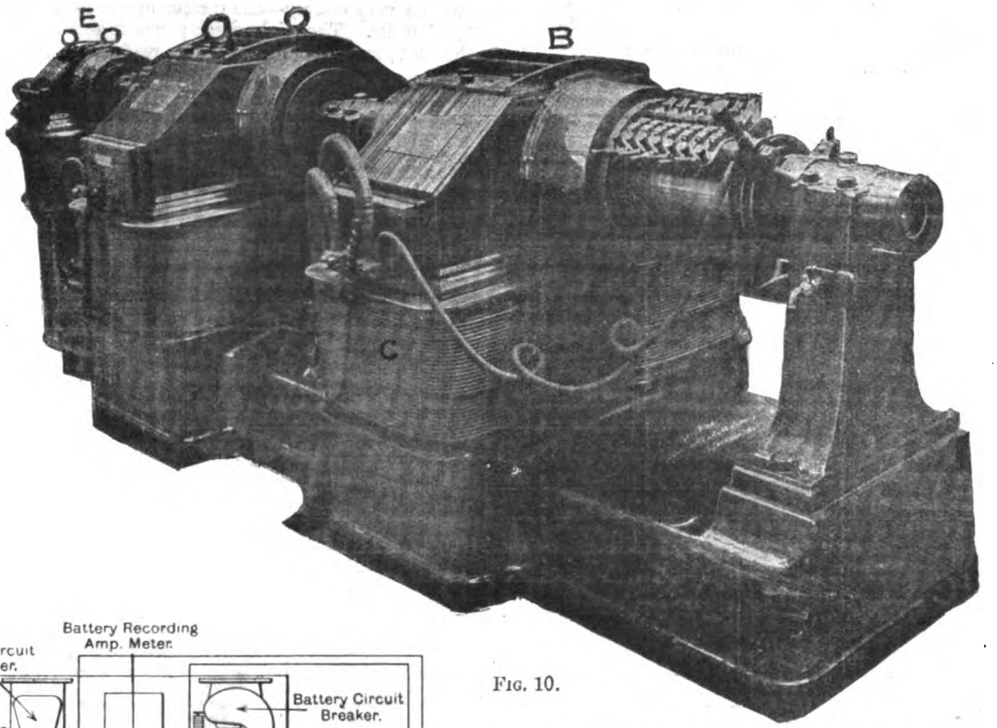


Fig. 10.

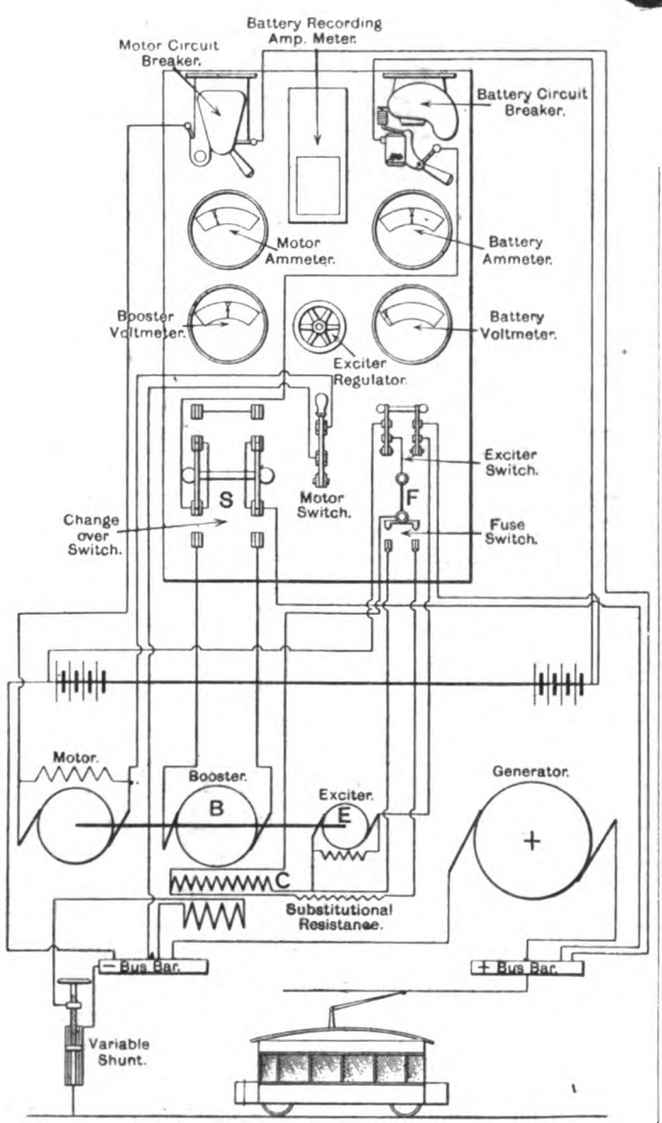


Fig. 9.—Arrangement of Reversible Booster operating Traction Load.

shunted round a coil on the booster fields in such a direction as to help the discharge or to oppose the charge, or a part of the feeder current may be taken round the exciter fields so as to raise the exciter pressure, or a part of the feeder may be taken round the motor fields so that the greater the load becomes the greater is the motor speed and hence also, the exciter and booster pressure in the discharging direction. In working with shunt-wound generators there is a tendency for the motor to hunt, so that as the line load increases the battery does more than its share; the pressure, therefore, rises and the motor runs faster; the booster pressure increases and the exciter pressure, and hence the tendency is to take still more load; a similar action occurs as the line load falls off. I have overcome this trouble by designing the motor so that an increase in pressure at its terminals strengthens the field in a greater proportion than usual by designing the motor field on the same lines as the booster field; the result is entirely to check the hunting. The switch gear used with the booster is shown in Fig. 9. The switch S connects as shown on the diagram; in its upper position the battery is directly on the line, in the lower position the battery is connected through the booster armature; F is a shunt-breaking switch and fuse in the exciter circuit.

This booster is used in series with the battery at all times when the plant is running, or when regulation is necessary when the battery alone is driving the load. The curves (Figs. 11, 12, 13) show the results obtained. The curves shown are for a Friday and Saturday load, and hence indicate the working when the variations of the load are most violent. The curves have been plotted from readings taken on Elliott's Weston instruments, one observer reading each instrument. After operating the line from 11 p.m. on Thursday night, the night load consisting of late cars up to 1 a.m., and about 50 H.P. of motors at a colliery, and the early cars from 4.30 a.m. to 6.30 a.m. on Friday morning, a 125kw. shunt-wound unit was connected, and run at full load till 2 p.m., the battery during the time, from 6.30 to 8 a.m., gaining a certain amount of charge; from 2 p.m. a 215kw. shunt-wound unit took the load, running with from 300 to 350 amperes, the battery gaining in charge till shutting down time at 11 p.m., when it ended fully charged. The figures relating to the day's work are as follows;—

| | |
|---|---|
| Units generated amounted to | 2,119 |
| Do. to line do. | 2,045 |
| Battery charge do. | 272 |
| Do. discharge do. | 318 |
| Used by booster motor | 66 |
| Maximum load on line | 382kw. |
| Minimum do. | 20kw. |

There is some difficulty in accurately metering the battery units owing to the violent changes in the strength and direction of the current. The above figures were obtained from two Thomson-Houston watt-hour meters in series, provided with pawls to admit of revolution in one direction only; the generator units were measured on an Aron meter, and the booster and line units on Hook-



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ham meters. From March 2 to March 31 the figures obtained were as follows :—

| | |
|---|---|
| Units generated | 65,615 |
| Do. sent to line | 61,665 |
| Do. used by booster | 2,034 |
| Do. charge | 10,517 |
| Do. discharge | 8,560 |

The difference between units generated and units metered to line is, of course, due to the units used by the booster motor and the units lost in the battery ; the figures, it will be noted, check one another very closely—the former figure is 3,950 units and the latter 3,991 units. The slight discrepancy is accounted for by the fact that the units metered to the line are read on an ampere-hour meter, and

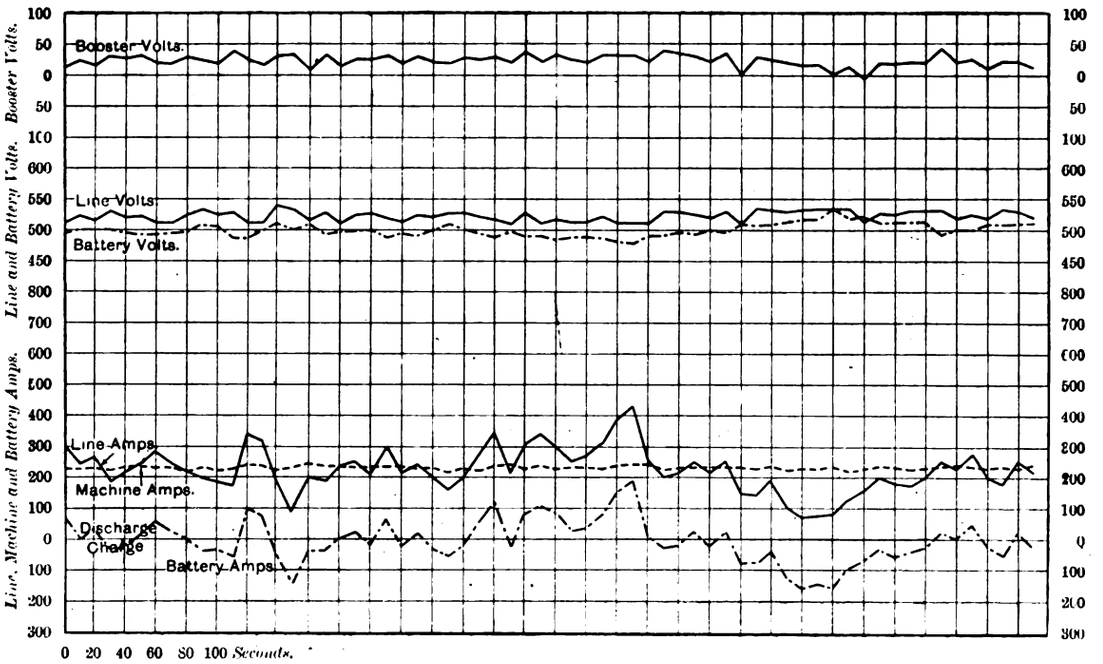


FIG. 11.—CURVES SHOWING LOAD ON GENERATOR, LINE AND BATTERY, OPERATING TRACTION LOAD WITH REVERSIBLE BOOSTER.

Generator—125kw. shunt wound.
Battery—240 cells, 450 amps. per hour.
Booster—25kw. capacity.

Cars on Line—1 with 2·25 H.P. motors for 52 passengers.
,, ,, 19 with 2·35 H.P. motors for 79 passengers.
(Readings taken Friday, March 1st, 1901, morning.)

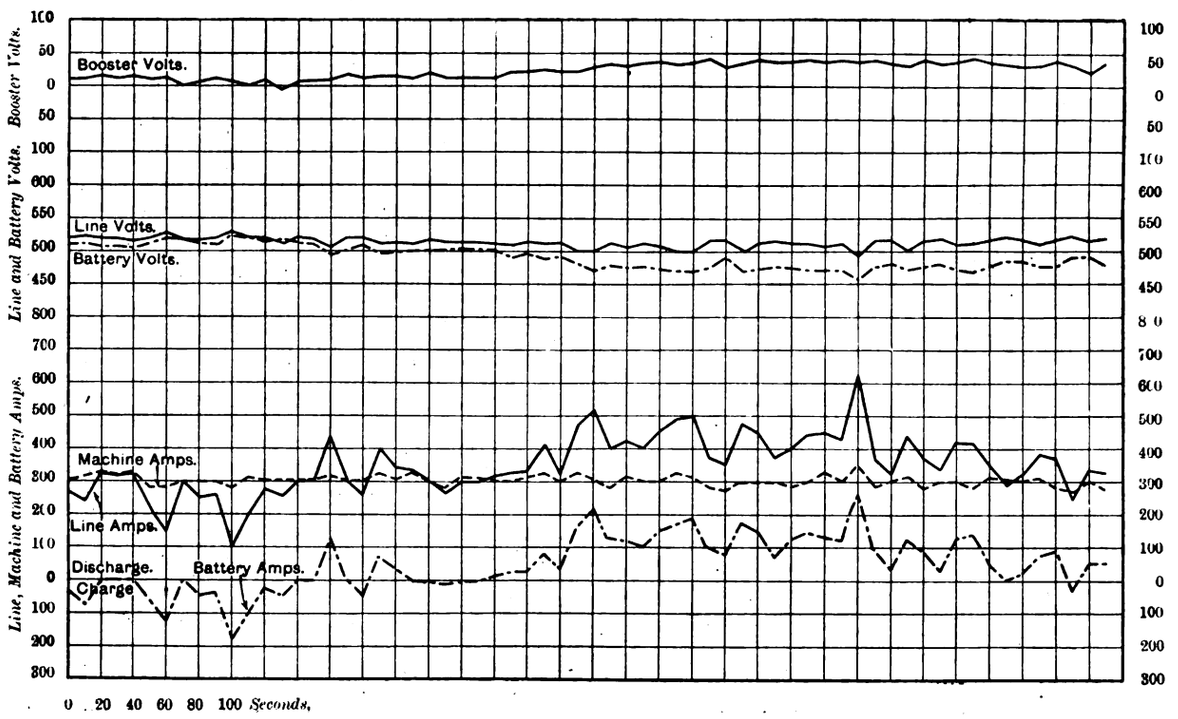


FIG. 12.—CURVES SHOWING LOAD ON GENERATOR, LINE AND BATTERY, OPERATING TRACTION LOAD WITH REVERSIBLE BOOSTER.

Generator—210kw. shunt wound.
Battery—240 cells, 450 amps. per hour
Booster—25kw. capacity.

Cars on Line—2 with 2·25 H.P. motors for 52 passengers.
,, ,, 23 with 2·35 H.P. motors for 79 passengers.
(Readings taken Saturday, March 2nd, 1901, afternoon.)

Giving the following percentages :—

| Units sold. Generated. Per cent. | Booster. Generated. Per cent. | Charge. Generated. Per cent. | Discharge. Sold. Per cent. | Discharge. Charge. Per cent. |
|---|---|---|---|---|
| 94 | 3·1 | 16 | 13·9 | 81·4 |

an error in the line pressure would affect the figure ; all the other readings are taken on watt-hour meters. The battery efficiency is really rather higher than 81·4 per cent. At the beginning of the month the average specific gravity was 1·205 when the cells were fully charged ; at the end of the month the specific gravity had risen

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to 1·210, showing that more charging was given than would have been necessary if sufficient charge had been given during the previous month. The small percentage of energy taken by the booster motor is confirmed over a long period, as shown by the additional figures in the appendix. The percentage of the whole number of units generated which passed through the battery is also rather surprising, considering that the battery takes more than one-half of the maximum line load. Referring to the appendix figures, I should say that the booster described in the Paper was put to work in the middle of August. Before that time a small booster of the same type was used with a battery giving 100 amperes at the one-hour rate; this battery frequently gave discharges of 170 amperes.

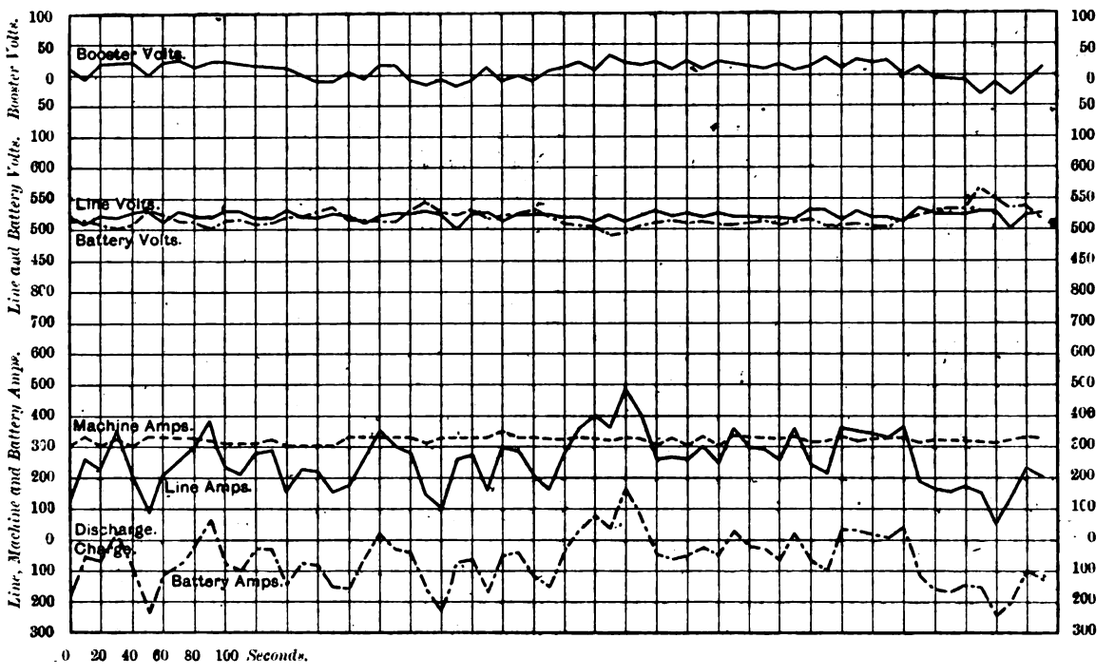


FIG. 13.—CURVES SHOWING LOAD ON GENERATOR, LINE AND BATTERY, OPERATING TRACTION LOAD WITH REVERSIBLE BOOSTER.

Generator—210kw. shunt wound.
Battery—240 cells, 450 amps per hour.
Booster—25kw. capacity.

Cars on Line—1 with 2·25 H.P. motors for 52 passengers.
" " 21 with 2·35 H.P. motors for 79 passengers.
(Readings taken Friday, March 1st, 1901, afternoon.)

This was the first booster made of the type described, and was of an experimental nature. Unfortunately, I had not arranged for the metering of all the units at that time, and therefore no figures relating to its operation are available.

*(To be continued.)*

## PHYSICAL SOCIETY.

At an ordinary meeting held by invitation of Prof. W. G. Adams in the Wheatstone Laboratory, King's College, on June 28, 1901, Prof. J. D. EVERETT, F.R.S., vice-president, in the chair, a Paper on

### "The Effect of a High-frequency Oscillatory Field on Electrical Resistance"

was read by Mr. S. A. F. WHITE. The object of this Paper is to discover if the action of light upon the electrical resistance of selenium can be imitated by using high-frequency electrical oscillations. It is found that such oscillations permanently increase the resistance of selenium. The effect of a rise of temperature is to increase the resistance of a piece of low resistance and decrease the resistance of a piece of high resistance. The effects of the field in a piece of high resistance can be reversed by exposure to light or by reheating and subsequent cooling. In the case of tellurium a high frequency field temporarily decreases the resistance, as also does a rise in temperature. Repeated heating and cooling of a piece of tellurium permanently increases its resistance. It seems probable that all of the effects are due to rise of temperature caused by minute sparks within the mass. The rise in resistance by alternate heating and cooling may be due to the formation of tellurides with the metal of the electrodes. The large negative temperature effect of tellurium suggests that it might be usefully employed in the detection of heat radiation.

The CHAIRMAN expressed his interest in the Paper, and drew attention to the very rapid action of light upon selenium.

Prof. W. G. ADAMS said that, as the effects here noticed were not so rapid as in the case of light, they were probably due to change in temperature.

Prof. J. C. BOSE said he had tried the effect of Hertzian radiation upon thin layers of various metals, and found an increase of resistance in the case of selenium and a decrease in the case of tellurium. The effect of radiation is confined to a few layers on the surface of the conductor, but it appears that it is of the same nature in continuous solids as in coherers.

A Paper by Mr. E. C. C. BALY and Dr. H. W. SYERS, on

### "The Spectrum of Cyanogen,"

was read by Mr. BALY. The authors have been able to obtain the spectrum of cyanogen by allowing the pure gas to flow through a vacuum tube and observing from the end of the tube. This is necessary on account of the brown deposit of paracyanogen which renders observation in the ordinary way impossible. The spectrum obtained differs from the flame spectrum, and consists of a series of equidistant flutings through the whole of the red and yellow, somewhat recalling those of the positive band spectrum of nitrogen. The experiments prove that:—(1) The swan spectrum is not produced by a carbon compound which does not contain oxygen; (2) the Swan spectrum is that of an oxide of carbon, as it is only produced by carbon monoxide; and as this spectrum is changed at once into the carbon oxide spectrum by admission of oxygen or by intense electric discharge, and, further, as the carbon oxide spectrum is invariably given by carbon dioxide, there can be no doubt that (3) the swan spectrum is that of carbon monoxide and the carbon oxide spectrum that of carbon dioxide.

Mr. GASTER said that this Paper might throw light on the discussion of the arc where cyanogen, carbon monoxide and carbon dioxide are present. The presence of cyanogen might be able to explain the hissing of the arc.

The Society then adjourned until next October.

## BOOKS RECEIVED.

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"Elektromotoren für Wechselstrom und Drehstrom," by G. Roessler. (Berlin: Julius Springer.) 7 marks.

"Proceedings of the Royal Society." No. 446. Vol. LXVIII. (London: Harrison & Sons). 2s.

"Transactions of the Institution of Junior Engineers." 1899-1900. Vol. X. Edited by W. T. Dunn. (London: The Institution.) 10s. 6d.

"Science Abstracts." June, 1901. Part 6, Vol. IV. (London: E. and F. N. Spon.) 2s.

"Production et Emploi des Courants Alternatifs." By L. Barbillion. (Paris: G. Naud.) 2fr.

"La Série de Taylor et son Prolongement Analytique." By Jacques Hadamard. (Paris: G. Naud.) 2fr.

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## TECHNICAL EDUCATION REFORM.

The leading article in our issue of May 10 last commented upon the then newly-introduced Education Bill of the Government and explained its twofold purpose—viz. (1) to afford relief from the immediate consequences of the Cockerton judgment, and (2) to provide a new and fairly comprehensive educational programme for the future. The relief was imperative—so much so, indeed, that many advocates of the measure insisted that it must unfailingly be passed on that account. But at the time we pointed out that the educational system of the future should not be endangered by mere considerations of local and temporary expediency, and we suggested that all necessary relief could be afforded by the passage of a short relieving bill embodying only the Cockerton clause. The Education Bill has not been passed—it has passed out of existence, abandoned by the Government, who doubtless perceive in it the inadequacy which we suggested in our earlier comments. And there is a short relieving measure now before Parliament which, doubtless, will supply all the relief that is urgently needed.

With the new measure, however, we are not now concerned; it is our purpose to bring forward some considerations on the general question involved in the original bill. Many of its supporters, while admitting that it did not offer a complete solution of the difficult and intricate problem of national secondary and technical education, were disposed to regard it as the half loaf which proverbially is better than no bread. We ourselves have described it as "an important step in the right direction, but a step that did not go far enough." Among those similarly-minded is Mr. J. B. C. KERSHAW, who contributes a thoughtful article on the subject in the current number of the *Monthly Review*. But this writer believes that "a comprehensive measure at the moment is evidently impossible," an opinion in which we do not concur. The case, however, assumes a different aspect if by a comprehensive measure is meant all that Mr. KERSHAW desires to see put into effect; that, indeed, is well-nigh impossible, though much of it is highly desirable. Mr. KERSHAW's main contention is that in matters of secondary and technical education we have begun at the wrong end; instead of commencing with the operatives and the masses, we should have first endeavoured to inculcate technical knowledge and the scientific spirit in the leaders and masters of industry. He quotes a number of writers in support of this view; apart from these, however—for they do not greatly strengthen his argument—he succeeds, we consider, in establishing his case. "It is the leaders that count," Dr. OLIVER LODGE once

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declared; and until masters are prepared to introduce technically into their industries the results of modern scientific research, it is futile to scatter elementary scientific information throughout the land in weekly evening classes. Not that this has not a value, of quite another sort; we agree with Mr. KERSHAW where he says:—

> As a system for providing interesting studies and occupations during the winter months, for the youths and maidens in dull provincial towns and country districts it may certainly be entitled to approval. As a means for awakening the intellectual faculties of the average working man it may also claim support. But when it is seriously asserted by the leaders of this movement, and as seriously believed by great numbers of our population, that this elementary instruction in science is going to restore to British trade its earlier prosperity, it is certainly necessary to prepare our legislators and the general public for a rude awakening.

But it is doubtful if the nation can afford to pay even for these luxuries, while the pressing question remains unheeded as to the improvement of national industry by the proper dissemination of technical knowledge. Already our secondary and technical education is costing us one-and-a-half millions sterling annually. More concentration of effort in promising fields is needed, and less broadcast scattering of resources throughout the entire length and breadth of the land. It is not our contention that the nation should expend its public money upon the free education of every industrial master or head of an industrial department who presents himself for such a gratuity. Men of that class can generally well afford to pay for the instruction they may receive. But there are two directions in which the Government might foster the desired growth of trained technical leaders without laying themselves open to a charge of superfluous philanthropy. In the first place, the money expended upon technical training institutions might advantageously be concentrated more upon those few large institutions which offer facilities for continued and advanced studies instead of being scattered among the multitudes of popular institutions where elementary teaching in a host of subjects is all there is to offer. It cannot be contended that these larger colleges and schools are already so well equipped that they are in no need of steady financial support; the reverse is the case, and a few thousands a year granted to each would go far indeed towards increasing their efficiency and range of utility.

The second direction in which aid might usefully be given is in a further increase in the number and value of the scholarships providing exclusively for advanced continuation studies in definite lines of work. These would offer a powerful inducement to the potential heads of industrial departments to pursue their studies to a further and more practically useful point than, in the majority of cases, they do at present. The influence of this upon the industry of the future would certainly well repay the nation for the money thus expended.

## POWER MEASUREMENT IN THE CASE OF POLYPHASE CIRCUITS.*

BY PROF. J. A. FLEMING, D.SC., F.R.S.

In polyphase circuits there are some cases in which the measurement of the mean electric power taken up in them offers no greater difficulties than in the case of single-phase alternating-current circuits, although it may involve a multiplication of instrumental readings. The theoretical treatment of the problem is rather more complicated by reason of the phase relations of the various currents involved. In the very simple case of two-phase alternating currents the power taken up in the inductive or inductionless circuit supplied can be estimated by the employment of two wattmeters, one placed in each circuit. Thus, for instance, whether the outgoing line consists of three or four conductors, we can measure the power supplied to a two-phase transformer in motor by the employment of two wattmeters connected into the circuits, as shown in Fig. 1.

Let $M_1$, M and $M_2$ be the two-phase leads, and ABC the power-absorbing circuit—whether motor or transformer. Then, if two wattmeters constructed with all the precautions already described for use with alternating currents are inserted in the two sides of the two-phase circuit, the sum of their readings will be the total power given to the circuit ABC.

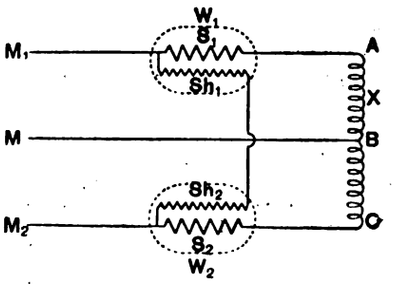


FIG. 1.

A similar arrangement can be applied in the case of three-phase circuits when connected on the *star pattern* with a common return. For if OA, OB, OC, Fig. 2, are the three-phase power-absorbing circuits, and $M_1$, $M_2$, $M_3$ the leads, and M the common return, then three wattmeters $W_1$, $W_2$, $W_3$ may be employed to measure simultaneously the power given to the circuits OA, OB, OC. The sum of these wattmeter readings is the power taken up by the three-phase circuit.

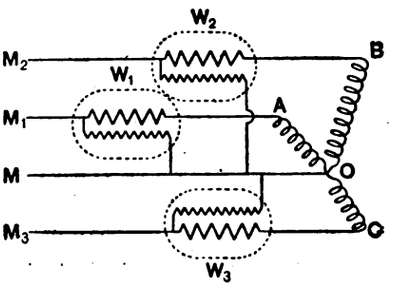


FIG. 2.

The case of a three-phase circuit arranged on the delta pattern is, however, of particular interest, because then two wattmeters, arranged as in Fig. 1 will give the power absorption whether the circuit be inductive or inductionless. The problem may, however, be considered on first principles.

Let ABC (Fig. 3) be a three-phase circuit arranged delta fashion, and let $M_1$, $M_2$, $M_3$ be the leads through which current is supplied to it. We may consider, then, in the first place, the following problem: Given the currents in $M_1$, $M_2$ and $M_3$

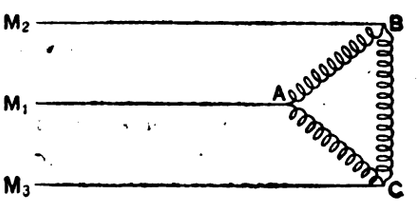


FIG. 3.

and the potential differences of the ends of AB, BC, CA, find the currents in the delta branches and the mean electrical power taken up in the circuit ABC.

Let us consider the general relation between the currents in $M_1$, $M_2$, $M_3$, AB, BC and CA. Represent the three-phase system by a network of conductors arranged as in Fig. 4. Let the instantaneous current values in the lines $M_1$, $M_2$, $M_3$ be represented by $a$, $b$, $c$, and those in AB, BC, CA by $x$, $y$

* Copyright. From a work to be published by "The Electrician" Company in a few weeks.

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and $z$, and let the outer circle represent the armature circuit of the three-phase dynamo or other source of electromotive force. Then we may represent the relations between the instantaneous values of the currents by the equations

$$x - y = a, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(i.)}$$
$$y - z = b, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(ii.)}$$
$$z - x = c. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(iii.)}$$

Hence, if we take large letters to represent the maximum values of these currents, and assume a simple periodic mode of variation, it is clear that on a vector diagram of currents the line currents A, B, C will be represented by the sides of a triangle, and the delta currents X, Y and Z by lines drawn to the angular points of this triangle from some point in the interior.

To find the currents X, Y and Z in terms of the line currents—A, B and C—we may proceed algebraically, as follows:—Square each of the equations (i), (ii) and (iii) above, multiply each by $dt$, integrate throughout a complete period and divide by T, the periodic time. Thus

$$\frac{1}{T}\int_0^T x^2 dt + \frac{1}{T}\int_0^T y^2 dt - \frac{2}{T}\int_0^T xy dt = \frac{1}{T}\int_0^T a^2 dt \quad . \quad \text{(iv.)}$$

In other words, equate the mean-square values.

In the next place, make certain assumptions for the sake of dealing with the simpler problem first, and therefore elucidating more difficult ones later on. Let us assume the circuits AB, BC, CA, are inductionless and that the currents and

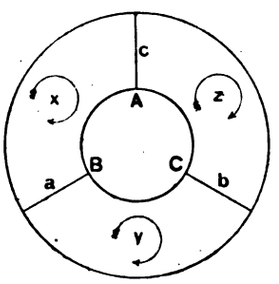


Fig. 4.

electromotive forces vary in a simple harmonic manner. Then the currents $x$, $y$ and $z$ may be expressed thus

$$x = X \sin pt, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(v.)}$$
$$y = Y \sin (pt - 120°), \quad . \quad . \quad . \quad . \quad \text{(vi.)}$$
$$z = Z \sin (pt - 240°), \quad . \quad . \quad . \quad . \quad \text{(vii.)}$$

when $p = 2\pi n$ as usual, $n$ being the frequency.

If we substitute the values for $x$, $y$ and $z$ given in the last equation in (iv.), we arrive at equations of the form,

$$X^2 + XY + Y^2 = A^2, \quad . \quad . \quad . \quad . \quad \text{(viii.)}$$
$$Y^2 + YZ + Z^2 = B^2, \quad . \quad . \quad . \quad . \quad \text{(ix.)}$$
$$Z^2 + ZX + X^2 = C^2. \quad . \quad . \quad . \quad . \quad \text{(x.)}$$

If these equations are solved for X, Y and Z in terms of A, B and C they will give us the expression for the R.M.S. values of the currents in the delta circuits, which for shortness we will call the delta currents in terms of the line currents. Now, unfortunately, the above equations are very intractable. They *can* be solved algebraically, and those who are fond of algebra can amuse themselves by finding the solutions, which are not very simple. But where algebra fails common sense steps in, and a graphical solution sufficient for practical purposes can easily be obtained.

It is clear from an inspection of the equations (viii.), (ix.) and (x.) that they are equivalent to the following geometrical problem: Given a triangle whose sides are A, B, C in length, find a point, P, within that triangle such that lines drawn from P to the angular points of the triangle are all at 120deg. angular distance from each other, and determine the lengths X, Y and Z of these lines in terms of the sides of the triangle.

It may be possible to solve this geometrical problem by purely Euclidean methods, but it is a waste of labour to attempt it. From an electrical engineering point of view the following graphical method gives a solution quite accurate enough for all practical purposes. Procure a celluloid circular protractor and cut out a sector subtending an angle of 120deg. Make a scratch on the protractor forming an angle of 120deg. with both the edges of the sector. The protractor will then look as in Fig. 5. Observe with an ammeter or with three ammeters the currents in the main leads $M_1$, $M_2$, $M_3$. These are the currents, A, B, C. On paper set off to scale a triangle whose sides represent these currents. Put two pins at two of the corners of this triangle, $l$ and $m$ (Fig. 6). Then apply the protractor with the sector edges to these pins, and move it about until the scratch lies over the other corner of the

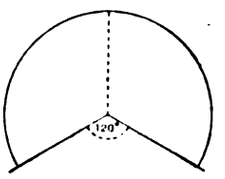


Fig. 5.

triangle $n$. Then measure off the lengths P$l$, P$m$, P$n$, where P is the centre of the protractor. These lengths will be the delta currents X, Y and Z on the same scale on which the sides of the triangle are the line currents A, B, C.

Otherwise, in default of a protractor we may draw on paper three lines making angles of 120deg., and draw on tracing paper the triangle of line currents A, B, C. Place this tracing paper over the other and trace off the lengths of the lines from the centre P, where the three radial lines intersect to the angular points of the triangle—viz., measure the lengths P$l$, P$m$, P$n$. (See Fig. 7.)

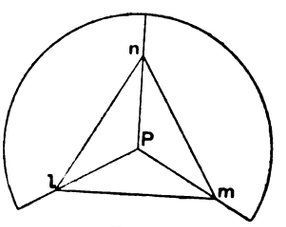


Fig. 6.

By this simple graphical construction we can find the ammeter or R.M.S. values of the currents in the delta branches when we are given those in the lines. Hence, multiplying the ampere-value of these delta currents by the observed potential differences of the delta corners, and adding the three products, we have the total power in watts taken up in the inductionless delta circuit.

It is obvious if the resistances of the delta branches are all non-inductive and equal, that the three line currents (R.M.S. value) are equal, and also the three delta currents.

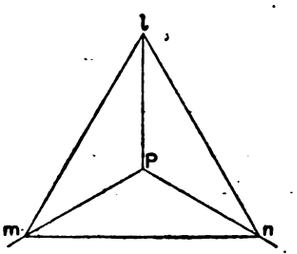


Fig. 7.

Also each delta current is equal to the quotient of each line current by $\sqrt{3}$. Accordingly, in the very simple case of a symmetrical inductionless delta circuit, the power taken up in the whole delta is equal to the product of $\sqrt{3}$ times either line current and the potential difference of the ends of either delta branch.

We have next to consider the case when the delta branches are not inductionless, which is an important case, as it involves the testing of three-phase motors and transformers worked or

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constructed on the delta pattern. Let us consider, first, the limited case when the three branches of the delta circuit have equal inductance and resistance. This is always the case with three-phase motors or transformers. A little consideration will then show that the same rule given above for finding the currents in the inductionless delta circuits will give also, in the case of equi-inductive delta circuits, the value of the delta currents. On the other hand, when the delta branches are inductive the current in each branch lags in phase behind the potential difference of the ends or delta corners. Hence we cannot find the power taken up in the whole delta circuit until we have discovered the value of this phase difference.

This may be achieved in the following manner:—Draw as before the triangle representing the line currents and the radial lines P*l*, P*m*, P*n* at angles of 120deg., representing the delta currents. Let the dotted lines on the diagram (see Fig. 8), P*e*, P*f*, P*g*, represent the phase positions of the potential differences of the ends of the delta circuits. That is, let the line P*e* represent the potential difference of the ends of the delta branch in which the current P*l* exists. Then the angle $\theta$ is the angle of lag of the current P*l* behind the impressed electromotive force P*e* acting on that circuit. The angle $\theta$ is equal to the angle $\phi$ *minus* the angle $\alpha$. (See Fig. 8.)

Now the angle $\phi$ is the phase difference between the line current represented by the side *ml* and the potential difference between the adjacent corners of the delta circuit. The angle $\alpha$ can be measured by a protractor on the triangle of currents.

Accordingly, we may find all that we require in the following manner:—Introduce into one of the lines a series coil, and put across the terminals of one of the delta branches another

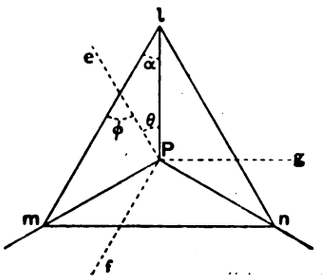


FIG. 8.

high-resistance shunt coil. Employ these two coils in conjunction with a soft-iron needle to determine, as already described, the phase difference between any one of the line currents and the potential difference between any two line circuits. This phase difference is the angle $\phi$. Find from the triangle of currents the angle $\alpha$, and then the required phase difference $\theta = \phi - \alpha$.

Hence we can find, assuming sinoidal currents and electromotive forces the phase difference between any delta current and the potential difference creating it. The power taken up in the whole delta is then easily found, for it is three times that in any one branch of the delta, and this last is XV cos $\theta$, where X is any delta current (R.M.S. value), and V the potential difference of the ends of that delta branch.

In place of a soft-iron needle and series and shunt coil a phasemeter of the type devised by Dolivo von Dobrowolsky may be employed. If the delta branches have unequal inductance and resistance then the above measurements must be repeated on each line, and for the complete calculation of the power taken up in the delta we require then to know the value of each line current, the potential difference between each corner of the delta, and the phase difference of the above currents and potential differences. The cases of most practical interest are, however, those in which each delta branch has the same inductance and resistance, as this involves the testing of three-phase transformers and motors, and the case when each branch is inductionless, but not of equal resistance, as with this we are concerned in a three-phase distribution of current for lighting purposes when unequal numbers of lamps are on each phase.

## ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Bath (Municipal) | April 20, 1900 | Leith (Municipal) | May 17, 1901 |
| Bedford (Municipal) | Aug. 3, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Belfast (Municipal) | July 6, 1900 | Liverpool (Municipal) | Mar. 22, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | London (Company) | June 8, 1900 |
| Blackburn (Municipal) | Jan. 19, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bournemouth (Company) | May 3, 1901 | Morley (Municipal) | June 14, 1901 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 10, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | May 3, 1901 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | April 19, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 26, 1901 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | South London (Company) | May 31, 1901 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | Southport (Municipal) | July 7, 1899 |
| Folkestone (Company) | April 26, 1901 | Stafford (Municipal) | Aug. 17, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Guildford (Company) | Oct. 19, 1900 | Taunton (Municipal) | June 16, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Hammersmith (Vestry) | June 29, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hanley (Municipal) | July 27, 1900 | Wandsworth (Company) | April 10, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Winchester (Company) | May 17, 1901 |
| Hove (Company) | May 10, 1901 | Windsor (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woking (Company) | Dec. 22, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Kens'gton & Knightsbr'(Co.) | Mar. 16, 1900 | Woolwich (Company) | May 31, 1901 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-on-Thames (Mun.) | July 20, 1900 | Great Yarmouth (Mun.) | Dec. 28, 1900 |
| Lancaster (Municipal) | Feb. 15, 1901 | | |

### St. Pancras Municipal Electric Supply Works.

Following on the reduced tariff in force, the revenue secured per unit sold during 1900 showed a considerable reduction compared with the receipts of 1899. The figure of 3·9d. is, however, still above the average obtained in municipal stations of similar magnitude in 1899. Unfortunately, the increased prices paid for coal increased the generating and works costs, and almost wholly neutralised the economy effected in the management charges. There appears still room for further improvement in the several items of generating costs, especially in the repairs item.

With the reduced revenue the working profit and the financial results generally have fallen off. It is necessary to explain that the capital expenditure shown does not include the whole expenditure on the public street lamps and columns. Since the decision of the County Council that loans for street lamps and columns must be borrowed under the metropolis management acts, and not the electric lighting acts, the capital account has been adjusted to exclude the expenditure on this score. In 1899 £1,600 was written off the capital expenditure on accumulators, meters, and switches; last year the reserve fund was debited with £2,917 spent in alterations in connection with the change of pressure to 220 volts.

The lamp connections at the end of the year showed an increase of 22·3 per cent. above the corresponding number at the end of 1899. The output marks an advance of 21·4 per cent., and the load factor was 15·1 per cent.

### Oldham, Ashton and Hyde Electric Tramway.

It is unfortunate that the results of the working of this line last year should have been marred by the strike of motormen and conductors. In the circumstances, although the figures cannot be considered representative of the normal working of the undertaking, yet the total costs at 5·9d. per car-mile constitute an excellent result, which compares very well with the costs on other lines, the accounts of which we have already dealt with. The costs on the Blackpool municipal tramways for the year to March 31, 1900, were 10·84d.

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per car-mile, but the revenue at 17·02d. per car-mile was almost double that which accrued to the Oldham and Hyde line. The nearest figures are those of the Glasgow tramways for the period from October 13, 1898, to May 31, 1899, the total costs being 5·9d. and the total revenue 13·9d. per car-mile. A greater proportion of the total costs at Glasgow was apparently spent on maintenance than on the Oldham line. Unfortunately for the purposes of comparison, the details of expenditure on the latter line, as appearing in the official accounts available, are very scanty.

After placing £1,000 to the depreciation fund, paying out of revenue £1,483 "strike expenses," and £1,480 interest on the 4 per cent. mortgage debentures, there remained a total of £4,578 available for distribution. A preference dividend of 5 per cent. (absorbing £2,000) was paid, and an ordinary dividend of 6 per cent., absorbing £2,400.

## OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY.

| | |
|---|---|
| *Worked by* | Oldham, Ashton & Hyde Electric Tramway [Co. (Ltd). |
| *Date of Commencement of Working* | June 12, 1899. |
| *System* | Overhead trolley at 550 volts. |
| *Tramway Manager* | M. Rathborne. |
| *Engineer* | J. A. Fraser. |

| Period | June 12 to Dec. 31, '99. | | Year ended Dec. 31, '00 | |
|---|---|---|---|---|
| **QUANTITIES.** | | | | |
| *Car mileage* | *293,884* | | *619,963* | |
| **Passengers Carried** | 2,021,871 | | 4,131,589 | |
| **Length of Route Worked** | 8·14 miles | | 8·14 miles | |
| Length of single line worked | 5·84 miles | | 5·84 miles | |
| ,, double line worked | 2·30 miles | | 2·30 miles | |
| Total equivalent length of single track worked | 10·44 miles | | 10·44 miles | |
| Length of line projected | 4·50 miles | | 4·50 miles | |
| Rolling stock, No. of motor cars | 18 | | 30 | |
| ,, No. of trailers | 12 | | 8 | |
| **CAPITAL.** | Total. | Per unit length of single track | Total. | Per unit length of single track |
| **Authorised (Total)** | £120,000 | £11,500 | £120,000 | £11,500 |
| Authorised (share) | 80,000 | 7,660 | 80,000 | 7,660 |
| Authorised (loan) | 40,000 | 3,830 | 40,000 | 3,830 |
| **Received (Total)** | 109,900 | 10,530 | 120,000 | 11,500 |
| Received (share) | 80,000 | 7,660 | 80,000 | 7,660 |
| Received (loan) | 29,900 | 2,860 | 40,000 | 3,830 |
| **Expended (Total)** | 121,462 | 11,630 | 127,681 | 12,220 |
| Depot and buildings | 6,978 | 668 | — | — |
| Electrical equipment and rolling stock | 46,279 | 4,430 | — | — |
| Permanent way | 54,024 | 5,170 | — | — |
| **Balance of Capital Account** | −1,462[b] | −140 | −7,681[b] | −736 |
| **Reserve Fund** | 322[a] | 30·8 | 322[a] | 30·8 |
| **Depreciation Fund** | 500 | 47·9 | 1,500 | 144 |
| **REVENUE.** | Total. | Per car mile. | Total. | Per car mile. |
| **Total** | £12,606 | 10·29d. | £23,156 | 8·975d. |
| Traffic receipts | 12,598 | 10·12d. | 22,845 | 8·850d. |
| Advertisements | 110 | 0·09d. | 200 | 0·078d. |
| Miscellaneous sources | 98 | 0·08d. | 111 | 0·043d. |
| **EXPENDITURE.** | | | | |
| **Total** | £7,358 | 6·009d. | £15,234 | 5·900d. |
| *Repairs and maintenance* | *464* | *0·379d.* | *1,010* | *0·391d.* |
| Power and running expenses | 5,836 | 4·765d. | 11,706 | 4·534d. |
| Administration and general expenses | 1,058 | 0·864d. | 2,518 | 0·975d. |
| **FINANCIAL RESULTS.** | Total. | Per cent. to capital expended.[c] | Total. | Per cent. to mean capital expended. |
| **Working Profit for Period** | £5,248 | 4·32% | £6,439[d] | 5·17% |
| Sum carried to depreciation fund | 500 | 0·41% | 1,000 | 0·80% |
| Net interest on loans | 829[d] | 0·68% | 1,480 | 1·19% |
| Balance from last account | — | — | 618 | 0·50% |
| **Balance Available for Distrib't'n** | 3,919 | 3·23% | 4,578 | 3·68% |
| **Ordinary Dividend paid** | nil | — | 6% | — |
| Percentage of total expenditure to revenue | 58·3% | — | 65·8% | — |
| Revenue per mile of single track | £1,207 | — | £2,217 | — |
| ,, ,, route | £1,548 | — | £2,844 | — |
| Expenditure per mile of single track | £704 | — | £1,459 | — |
| **Expenditure per Mile of Route** | £903 | — | £1,870 | — |
| **Revenue per Passenger** | 1·5d. | — | 1·35d. | — |

OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY.—REMARKS—*a* Being premiums received. *b* Over-expended. *c* Capital expended up to end of period. *d* After deducting £1,483 "strike expenses."

## ST. PANCRAS (LONDON).

| | |
|---|---|
| *Undertaking Worked by* | St. Pancras Borough Council. |
| *Date of Commencement of Supply* | November, 1891. |
| *System of Supply* | 3-wire continuous, with batteries. |
| *Chief Engineer* | S. W. Baynes. |

| YEAR ENDED | DEC. 31, 1899. | | DEC. 31, 1900. | |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 3,069,477 | | 3,637,309 | |
| ,, **SOLD (TOTAL)** | 2,477,508 | | 3,008,481 | |
| ,, sold to consumers | 2,017,722 | | 2,296,386 | |
| ,, sold for public lighting, &c. | 459,786 | | 712,095 | |
| ,, used on works | 162,023 | | 218,014 | |
| **UNITS SOLD per 8 c.p. LAMP CAPACITY** | 30·6 | | 26·1 | |
| Maximum supply demanded | 1,789 kilowatts | | 2,275 kilowatts | |
| Number of public lamps | 228 | | 416 arc, 2 (50 c.p.) glow | |
| Number of consumers | 1,286 | | 1,489 | |
| Connections to mains in 8-c.p. lamps | 110,462 | | 135,064 | |
| **CAPACITY OF PLANT IN 8-c.p. LAMPS** | 81,000 | | 115,300 | |
| **CAPACITY OF PLANT IN KILOWATTS** | 2,590 | | 3,690 | |
| **CAPITAL—** | Total. | Per kw. capacity. | Total. | Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £236,780 | £91·4 | £261,100 | £70·8 |
| Share | — | — | — | — |
| Loan (including Debenture charges) | 236,780 | 91·4 | 261,100 | 70·8 |
| **RECEIVED (TOTAL)** | 236,780 | 91·4 | 261,100 | 70·8 |
| Share | — | — | — | — |
| Loan (including Debenture charges) | 236,780 | 91·4 | 261,100 | 70·8 |
| **AUTHORISED, NOT RECEIVED (TOTAL)** | nil | — | nil | — |
| Share (unissued) | — | — | — | — |
| Share (uncalled) | — | — | — | — |
| Loan (including Debentures) | nil | — | nil | — |
| **REPAID (TOTAL)** | 17,247 | 6·66 | 21,187 | 5·75 |
| **RESERVE OR SINKING FUND** | — | — | −658[k] | −0·178 |
| **DEPRECIATION FUND** | 8,000 | 3·09 | 9,083 | 2·46 |
| **EXPENDED (TOTAL)** | 288,147 | 111 | 336,795 | 91·3 |
| Lands and buildings | 59,548 | 23·0 | 72,751 | 19·7 |
| Plant | 102,355[a] | 39·5 | 114,958[a] | 31·1 |
| Mains | 125,745 | 48·5 | 148,534 | 40·3 |
| Miscellaneous | 498 | 0·192 | 552 | 0·150d. |
| **BALANCE OF CAPITAL ACCOUNT** | −51,367[b] | −19·8 | −75,695[b] | −20·5 |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. |
| **TOTAL** | £44,768 | 4·338d. | £49,065 | 3·912d. |
| Revenue from supply | 37,560 | 3·640d. | 38,364 | 3·058d. |
| ,, meters, &c. | 97 | 0·009d. | 134 | 0·011d. |
| ,, public lighting | 6,640[c] | 0·643d. | 9,847 | 0·786d. |
| ,, sale of lamps, &c. | 115 | 0·011d. | 592 | 0·047d. |
| ,, miscellaneous sources | 336 | 0·033d. | 128 | 0·010d. |
| **EXPENDITURE—** | | | | |
| **TOTAL COSTS** | £27,231 | 2·638d. | £32,845 | 2·620d. |
| **WORKS COSTS** | 22,933 | 2·220d. | 28,373 | 2·263d. |
| *Generation of Electricity* | *16,567* | *1·604d.* | *21,854* | *1·743d.* |
| Fuel (including cartage, &c.) | 9,499 | 0·920d. | 13,343 | 1·064d. |
| Oil, waste, water, stores | 977 | 0·095d. | 1,268 | 0·101d. |
| Wages at station | 3,386 | 0·328d. | 3,958 | 0·316d. |
| Repairs & maintenance at Station | 2,610 | 0·253d. | 3,113 | 0·248d. |
| *Distribution of Electricity* | *5,250[d]* | *0·509d.* | *4,678* | *0·373d.* |
| Wages, &c. | 1,171 | 0·113d. | 1,172 | 0·093d. |
| Repairs, renewals of mains, &c. | 4,079[d] | 0·395d. | 3,506 | 0·280d. |
| *Public Lighting* | *1,116* | *0·108d.* | *1,841* | *0·147d.* |
| Attendance | 546 | 0·053d. | 852 | 0·068d. |
| Renewals | 570[e] | 0·055d. | 989[l] | 0·079d. |
| **MANAGEMENT CHARGES, &c.** | 4,299 | 0·416d. | 4,472 | 0·357d. |
| *Royalties* | *29* | *0·003d.* | *24* | *0·002d.* |
| *Rent, rates, taxes* | *1,164* | *0·113d.* | *1,572* | *0·125d.* |
| *Management* | *3,106* | *0·301d.* | *2,876* | *0·229d.* |
| Salaries | 1,721 | 0·167d. | 1,808 | 0·144d. |
| Stationery, &c. | 238 | 0·023d. | 285 | 0·023d. |
| Establishment charges | 261 | 0·025d. | 158 | 0·013d. |
| Law charges, &c. | 886[f] | 0·086d. | 625[m] | 0·050d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'd. | Total. | % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £17,537 | 6·62% | £16,220 | 5·19% |
| Carried to Depreciation Fund | 1,600[o] | 0·604% | 710[n] | 0·227% |
| Carried to Res. or Sinking Fund | 3,374 | 1·27% | 3,940 | 1·26% |
| Net int. on loans (incl. Deb. charges) | 7,321 | 2·76% | 8,648 | 2·77% |
| **BALANCE FROM LAST ACCOUNT** | 1,892 | 0·714% | 1,134 | 0·363% |
| **Do. AVAILABLE for DISTRIBUTION, &c** | 7,134 | 2·69% | 4,056 | 1·30% |
| *Deficit* | — | — | — | — |
| **ORDINARY DIVIDEND PAID** | — | — | — | — |
| **% of TOTAL COSTS to GROSS REVENUE** | 60·8% | | 67% | |
| Expenditure per kilowatt capacity | £10. 10s. 0d. | | £8. 18s. 0d. | |
| **REVENUE PER KILOWATT CAPACITY** | £17. 5s. 7d. | | £13. 6s. 0d. | |
| Expenditure per 8-c.p. lamp capacity | 6s. 8½d. | | 5s. 8½d. | |
| **REVENUE PER 8-C.P. CAPACITY** | 11s. 0½d. | | 8s. 6d. | |
| **REVENUE PER 8-C.P. CONNECTED** | 8s. 1d. | | 7s. 3d. | |
| Price charged for lighting, per unit | 6d. (3 hrs.) to 3d.[g] | | 6d. (1 hr.) to 2d.[h] | |
| ,, for power, per unit | 3d. | | 2d.[i] | |
| ,, for public lighting | £29. 2s. 0d.[c] | | 3d. per unit.[j] | |

ST. PANCRAS (LONDON).—REMARKS—*a* Includes £4,311, part of total expenditure on public lamps. *b* Over-expended. *c* For current and all maintenance and capital charges. *d* Includes £746 to re-arranging public arc lighting mains and £1,348 alterations in connection with change of pressure to 220 volts. *e* Carbons £254. *f* Insurances £247, loans expenses £115, compensation £91, hire and erection of temporary plant £126, and to L.C.C. items disallowed on capital account £220. *g* On maximum demand system during first six months and 1½-hour scale during latter six months of year. *h* Or 5d. per unit all round. During first six months of 1900 the charge was 6d. for 1½ hours, 3d. afterwards. *i* During first six months 3d. per unit and 2d. for storage batteries. *j* Inclusive of repairs, maintenance and carbons. *k* At debit of suspense account on account of explosion. *l* Carbons £544. *m* Includes insurances £276, alterations to engine room, dismounting and re-erecting plant £235, compensation £67. *n* £710 written off boilers transferred from Regent's Park Station to the King's Road Station. *o* Written off capital expenditure on meters and accumulators.

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## NOTES ON STREET LIGHTING.*

BY BAILIE W. MACLAY

(Convener of the Glasgow Corporation Electricity Committee).

At the present time, when the incandescent gas light is being so prominently forced upon the public notice, it may not be out of place to offer this Paper upon street electric lighting. One reads of statements being made by gas engineers and others interested in gas undertakings which might lead the innocent public to suppose that the days of electric lighting, at any rate for street purposes, are numbered. Perhaps, however, the public have by this time learned sufficient of the "gassy" nature of the statements which are apt to come from those who seem now at any rate to consider us serious competitors, not to place implicit trust in their statements. Whatever else electricity may have accomplished, there can be no doubt that since its advent in 1880 there has been a steady and even rapid improvement in the standard demanded for street illumination. Until electric light was first introduced experimentally into the City of London the public were contented with ordinary gas burners consuming 2 to 4 cubic ft. per hour. Some of the lamps at important places contained groups of burners which showed evidence of an attempt to give a better standard of illumination. It may be taken that these gas lights gave an average of from 8 c.p. to 16 c.p. each. When the contract for the experimental electric lighting of some of the main thoroughfares of the City of London terminated, and the street lighting again reverted to gas, the amount of illumination which had sufficed in previous years was found to be absolutely unbearable in comparison with the electric light to which the public had now grown accustomed, and larger gas burners, and increased numbers of them, had to be fitted along the routes which had been electrically lighted. Even this improvement, however, was not considered satisfactory, and in due time electric arc lighting was reinstated along all the principal routes of the City of London. It is doubtless true that at the time these operations were carried out the incandescent gas mantle had not reached it present stage of perfection, but until electricity had forced the pace, there seemed to be no serious demand for a higher standard of illumination at all. To-day, however, the public perpetually cry for more light in their streets, and the statement has appeared in one of our Glasgow evening newspapers that, if there is one thing over and above pure water and effective sanitation which is absolutely necessary in a large city, it is efficient public lighting, and to offer bad lighting in order to save money is to waste both.

Even supposing electricity had done nothing more than prove the immense advantage of properly lighted streets, it must be admitted on all hands that in that point alone it has served an extremely useful purpose. Although electricity has been content up to the present to smile good-naturedly upon the laboured enthusiasm which it sees its elder sister displaying with regard to the incandescent gas mantle, in her attempt to get somewhere near her younger rival in the matter of efficient street lighting, it may be well not to remain too long silent lest it should be thought that in reality the end of the street electric lighting was already in view. Everyone will admit the enormous improvement which is made by substituting incandescent gas mantles for the ordinary flat, plain burner, at any rate, while the mantles are new, and during the prevalence of calm, fair weather; and it is to be hoped that the extra expense, which will doubtless fall to be borne by the ratepayers, in regard to the renewal and up-keep of mantles and other accessories of the improved system, together with the extra time required to light lamps not fitted with by-passes as compared with the older arrangement, will be cheerfully borne without a murmur in consideration of the improved illumination. There is nothing, however, in all this to show that for main thoroughfares, where a really brilliant illumination is desired, incandescent gas can in any way equal, far less surpass, electric light. A great deal has been made of the argument that electric lighting is "patchy," giving a brilliant illumination within a certain radius from the lamp and a comparatively poor illumination at points midway between; and great efforts have been made to show that by converting the ordinary flat-flame gas lamps into incandescent mantle lights, the illumination is much more evenly distributed, although it may not be so intense at points near the lamps. This, however, has been investigated by electrical engineers and it has been found that an equal standard of lighting, measuring the light at points midway between the lamp columns, cannot be obtained in this manner, except by using such a number of incandescent gas mantles that the cost will be more than that of electric lighting to give the same result. Apart from this, however, it is interesting to note that the gas people themselves are devoting their greatest energies to developing incandescent mantles, which they hope will give as large, concentrated and brilliant a light as can be obtained from the electric arc. It would seem, therefore, that their anxiety in this direction goes entirely to disprove their own arguments. On a recent occasion the question of lighting the Great Western Road, which may be styled the most fashionable promenade in Glasgow, was very prominently before the public, and was discussed very fully by the Town Council as well as by the sub-committee dealing with the matter. The question in this case was to some extent mixed up with that of lighting the tramway poles which had been fixed along the centre of the road at distances of about 40yd. apart. There was a very strong feeling amongst the public in favour of electric lighting, although incandescent gas lighting had been proceeded with along a considerable portion of the route and was showing a great improvement over the previous state of affairs. It was ultimately decided to do the lighting by means of electric lamps placed at a height of 27ft. from the road level to the centre of the arc, each lamp being constructed to take 7 or 7½ amperes and to give about 700 c.p. Counter proposals were made that gas mantles should be placed upon the tramway poles, but even supposing that the vibration of the poles did not have disastrous effects upon the mantles, it was found impossible to produce an equal standard of illumination at any reasonable cost in this manner, except by introducing side lamps at intermediate points, and even then it was found that the cost for the same amount of illumination at the darkest points would be greater with gas than with electric light. In every case full benefit was given to the incandescent gas mantle, as it was credited with 50 c.p. per mantle, this being a figure which doubtless may be obtained at the first start, but which public experience goes to prove is not maintained for very long. Of course, no variations occur with electric arc lights due to the deterioration of the illuminants, and, provided the supply of current remains the same, the light is the same, year in, year out.

Probably a point which has to some extent escaped notice is the fact that lights placed high up give a much more pleasing effect than when fixed low down, even though the illumination may be uneven. It is possible that a very even illumination might be gained with a large number of closely spaced lamps of low candle power placed low down, but the effect would also be depressing in the same way that the lighting of a large hall is depressing unless the illumination extends to some extent upwards as well as downwards, or more correctly unless the whole cubic contents of the hall are illuminated. In this way, when walking along a large street or thoroughfare lighted with electric lamps at a considerable height, one feels a sense of airiness and magnitude which is missing if the lights are fixed low down.

It is not the object of this Paper to discuss in any way the question of comparative costs, but it may be well to state that the 7 ampere lamps before referred to will be charged for at the rate of £12 per lamp per annum, every lamp burning the whole night through. This charge includes the maintenance of the lamps, supply of carbons, trimming, cleaning, and the supply of current, but the capital expenditure, except so far as the mains are concerned, is borne by the Police Department, and is not provided for in these charges. Gas has been taken at the present price of 2s. 6d. per 1,000 cubic ft., and what is known as the ordinary 50 c.p. mantle has been allwed its fullest efficiency, which, in the author's opinion, is considerably more than it is entitled to. The prices which will prevail in Glasgow next year for 10 ampere arc lamps under similar conditions to the above will be £14 per lamp per annum. So far, it would seem that incandescent gas lighting in streets is not unlikely to have the same result as it has had in house lighting. It has been observed by those in a position to know best that the ordinary consumer of electric light goes through three stages:—1st, ordinary gas; 2nd, incandescent gas; and, 3rd, electric light; and for this reason electricity supply authorities cannot but welcome the improvement over ordinary gas which the gas mantle promises. No one who has used incandescent gas is satisfied to go back to ordinary gas, and when thoroughly sick of incandescent gas the final plunge is taken into electric light, from which no one ever goes back. We may, therefore, take it that street lighting is now entering upon the second stage, from which the only possible development must be an upward one, *i.e.*, into electric light. In other words, the incandescent gas mantle is now acting in a similar manner towards electricity to that in which electricity itself acted towards gas in 1880.

### DISCUSSION.

Bailie MACKENZIE (Edinburgh) said he agreed with all that Bailie Maclay had said, except in regard to his criticism of their gas friends. In Glasgow they had had a large experience of electric light, and he understood they were going ahead pretty fast. It was entirely a question of money. If the community wished electric light and was prepared to pay three times the price of gas for it, they would get it. He thought he interpreted the feelings of municipal men in general when he said that the Corporation were prepared to pay and were entitled to pay for the additional expense of having electric light in main roads, but for side streets and for unimportant streets he would not be prepared, as a municipal representative, to advocate electric light. Reference had been made to Great Western Road. He understood that electric lighting was being installed there with 7 ampere lamps, costing £12 per annum, exclusive of capital charges, at about 40yd. apart. That amounted to over £500 a mile. That will be necessary in the Great Western Road, but it could not be said that £500 a mile was a reasonable charge

* Paper read before the Incorporated Municipal Electrical Association at Glasgow.



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for small streets. Bailie Maclay had not advocated small streets. Before the Corporation of Edinburgh took up lighting a company composed of local people wanted to do that job for them. The Corporation, however, decided to keep electric lighting in their own hands. Lamps were put up in Prince's-street about 45yd. apart, and these so illuminated the streets that going into a shop was like going into a coal pit, and the shopkeepers were compelled in self-defence to put in electric lighting. The consequence was that there was not a shop in Prince's-street, not a hotel or a club, that had not got electric lighting.

Alderman PEARSON (Bristol) said that in Bristol the gas company had been obliged to make an offer to reduce their price very materially and to give a much better illuminant by means of incandescent gas. They had had a serious competition, and the Electric committee had been obliged to allow the gas company to have their own way, because they undertook to do it at a price considerably less than they were lighting the city for at the present time. So long as the company were prepared to do this he was obliged, as representing the electrical undertaking, to say that they could not undertake to give a supply at less than cost price. The public had undoubtedly been educated to demand a better light than before. The public would find that mantles had an exceedingly short life. A certain amount of vibration seriously affected the life of a mantle, and the public would come to know that this system was not a success.

Mr. WORDINGHAM said it was most refreshing to listen to such a militant Paper as that of Bailie Maclay. Most of them must feel that what he called "our elder sister" had been admiring herself in her new mantle a great deal too much. There could be no doubt that incandescent street lighting was a formidable rival to electricity. If the eye caught a number of bright points one thought the street was well lighted, but if one walked in a thoughtful mood with one's eyes on the ground, it would be seen that the illumination on the street was very poor indeed, unless an altogether inordinate number of mantles were employed. He also referred to the efforts which the gas interest was making to produce individual burners of very great intensity.

Dr. ALLFREY (Hastings) said he represented the Electricity committee of Hastings, where plain burners were being superseded by incandescent burners, and in the generality of streets they found this was a great advantage. There could be no doubt whatever that electricity where it could be afforded was infinitely preferable. In Hastings they had decided to charge the public lighting department at the same rate as private consumers.

Bailie MACLAY said he had to attend a meeting of the Town Council, and was obliged to leave the convention. The subject had not lent itself to a great amount of opposition, and it had been suggested to him on account of the fact that at this particular time there was a keen competition between the incandescent gas mantle and the electric light. He had no desire to say anything harsh about the gas undertaking, for the simple reason that he was a member of the Gas committee. While there was some little rivalry and competition he believed that there was room for both.

Ald. RADFORD (Plymouth) said that in the town which he represented the street lighting was entirely under the Electricity department, and they had to buy their gas from a company. They paid for the gas at the current rate, less 5 per cent. Last year they made an arrangement to replace the whole of the ordinary plain burners by incandescent burners, and to put up about 70 arc lights in the principal streets, and they had been able to convert the whole system in a very few months. It was in its experimental stage, however, and he was not able to give figures as to the exact life of the mantles and of the upkeep.

Mr. ROBB (Tunbridge Wells) said he had begun to think that he had come to a gas meeting instead of a convention of the Municipal Electrical Association. Electric light was superior to incandescent light. In Tunbridge Wells they had experienced the keen competition of the gas company, who had offered to light the streets with incandescent lamps. It was the duty of the corporation to contract the whole of its public lighting to the electricity department, and that was what they hoped to do at Tunbridge Wells. It had been found over and over again that in a high wind incandescent lighting was absolutely unreliable. Although the lamps might have a nominal candle-power of 50 at the start, it was very soon reduced to 40 or 30, and in some cases very much less.

Ald. BRUCE (Sunderland) said that in Sunderland the Corporation had the electric lighting in their own hands, but not the gas. They contracted with the gas company to supply them with so much per lamp, usually for a term of three years. Four years ago they introduced a system of arc street lighting on a moderate scale in the main arteries in the centre of the town. They tried some experiments with the electric incandescent light in the side streets, but educated the people to expect a better light from the arc lamp, so that they did not think it worth while to have the other. They got gas exceptionally cheap owing to the fact that they were in the centre of coal fields, and they considered it better not to introduce electric light into the side streets until they could extend the arc lamps. In the meantime they would have to be beholden to gas.

Mr. Alderman POTTER (Taunton) said the municipality had lighted up the courts with electricity, and wherever they could dispense with gas in the side streets they had done so. In many cases the mere fact that the cables were laid in the streets, and gas done away with, led shopkeepers and others to ask for a supply.

Bailie FINLAY (Glasgow) said he had no doubt that when people came to realise the advantages of electricity in their houses this light would hold the field. The first line of electric tramways had been laid on a route extending from Mitchell-street to Springburn, a distance of about 2½ miles. As a magistrate he found that the trouble caused by corner boys had diminished, and crime had fallen very considerably. In Glasgow the municipality did not apply the profits of public undertakings to the reduction of rates. They held that the large consumer of electricity ought to get it at the lowest possible price.

Councillor DEACON (Shrewsbury) said that Bailie Mackenzie's argument was based on the assumption that all local authorities held both electric light and gas undertakings. He wished that was so. He represented an old corporation that perhaps in days gone by missed a great opportunity in not securing the gas undertaking, and now they were in this peculiar position that sometimes the interest of the gas undertaking clashed with that of the public. Not very long ago they had to do a considerable amount of sewage work, and the result was a very large claim from a gas company and a loss of thousands of pounds to the corporation he represented. Bailie Mackenzie had also pointed out that we could not afford to put electric light into side streets. He disagreed with that. Feeling some responsibility in connection with the electric undertaking, and anxious to make it a financial success, he got the Council of his town to approve of the principle that wherever the electric mains were run through the streets the lighting should be taken over either by arc lamps or glow lamps, as might be most suitable in the locality.

Mr. E. TREMLETT CARTER said that, as engineers, they had to face the problem of catering for the human eye. The eye was not a scientific instrument. In face of a very bright light the eye contracted and let in very little light. In face of the same or even a less amount of light uniformly distributed the eye expanded and let in a greater amount of light, even though the actual amount of illumination might be smaller. Consequently, although there was a less intense source of light, there was a more satisfactory sense of illumination. Their friends, the gas people, were making the mistake formerly made with bare arcs. It was desirable, therefore, to have the source of light placed high up, and to distribute the light so that it would be uniform over the area. It was a physiological fact that a bare arc lamp gave a less satisfactory sense of illumination than when it was covered by an opal screen even though the screen absorbed from 30 to 40 per cent. of the light.

Mr. COLEMAN (Worcester) said the fact was acknowledged that for lighting a main street there was nothing like an arc lamp, but it was not so fully acknowledged that lighting side streets, courts and alleys with incandescent light was so satisfactory. Up to the present there were 60 incandescent street lights in Worcester.

Mr. NEWINGTON (Edinburgh) gave some statistics as to the relative cost of gas and arc lamps. They had replaced 3,000 gas lamps, putting in their place 850 arc lamps. The cost of these gas lamps was £3,200 a year, while the cost of the arc lamps was about £11,000. That was about three times the cost, but the light was increased from 25 to 30 times. He saw that in Glasgow £14 per lamp was charged, while in Edinburgh the charge was £13 per lamp per annum, and half of them were turned out at midnight.

## SOME NOTES ON DIELECTRIC LOSSES.*

BY CHARLES PROTEUS STEINMETZ.

In the following are given the results of some determinations of the loss of power in electrostatic condensers on an alternating-current circuit, and at various frequencies and voltages. The condensers consisted of tinfoil and paraffined paper, filled with paraffin by the application of heat and vacuum, so as to exclude the air as far as possible.†

Anticipating a loss of power of a fraction of 1 per cent. of the volt-amperes apparent input, I did not consider it feasible to measure directly the power by wattmeter, for the following reasons :—(1) Even with a voltage and a current greatly overloading the wattmeter, the reading of the instrument is at or below the lower end of the scale, being only about ½ per cent. of the volt-amperes impressed upon the instrument. (2) The inductance of the potential coil and the capacity of its series resistance cannot be determined with such accuracy as to derive the phase angle of the potential circuit of the instrument with sufficient closeness to avoid an excessive instrument error when testing a circuit of about 89·7° per cent. phase displacement. Therefore, I devised the following method, which proved very satisfactory :—1. An inductance coil of extremely low power-factor (from ⅓ to ¾ per cent., according to the frequency), and of a reactance equal to the capacity reactance of the condensers, was shunted thereon, so that the lagging current of the inductance and the leading current of the condensers compensated, and a small resultant current of practically no-phase displacement remained. Then the wattmeter could be used to read very accurately the total power consumed in the condensers and inductance coil. The power consumed in the inductance coil was determined by measuring volts and amperes with direct-current passing therein, and subtracting from the wattmeter readings. 2. The test was repeated with the inductance coil in series with the condensers. In this case the wattless leading voltage of the inductance and the lagging voltage of the condensers compensated, and the small resultant voltage is practically in phase with the current. In either case a non-inductive resistance, very large compared with the capacity reactance of the condenser, was inserted in series, to elimi-

* Reprinted from the *Electrical World* of New York.

† The condensers were standard 500 volt General Electric condensers, taken from stock, and after each set of tests returned thereto, so that the tests with different frequencies are not directly comparable.

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nate higher harmonics of current,* and a smooth core armature alternator was used, giving practically a sine wave.

Since the correctness of this method depends upon the absence of other losses in the inductance coil than ohmic losses, the coil was built without iron to exclude hysteresis losses, was of very large diameter, and of well stranded cable to exclude eddy currents in the conductors—the absence of eddy currents being checked by tests.† From seven to 35 blocks of condenser were used, and the tests extended over a range of voltage from 220 to 980, for parallel as well as series connection of condenser and inductance coil. The average results of tests are given in the accompanying table per block of condenser. They are essentially: (1) With a sine wave of impressed E.M.F. the current in the condenser is directly proportional to the impressed E.M.F. and to the frequency; that is, the capacity of the condenser on an alternating current circuit is constant, within the range of tests. (2) The loss of power in the condenser is, within the range of tests, proportional to the square of the impressed E.M.F.; that is, the power factor of the condenser, at constant frequency, is constant and independent of the impressed voltage. (If anything the loss rather appears proportional to a little higher power of the E.M.F. than the second.) (3) The power factor of the condenser does not seem to vary with the frequency: that is, the efficiency of the condenser appears to be independent of the frequency: or in other words, the loss of energy per cycle is proportional to the square of the electrostatic field strength, but independent of the frequency, as far as can be seen, considering that different lots of condensers were used in the different tests and the loss of power varied considerably in different sets of condensers. (4) The power-factor of well-made condensers is extremely low, averaging about 0·005, or the efficiency is about 99·5. Let $n$ = frequency, I = current, and W = loss of power per block of condensers at difference of potential E. We then have

$$I = anE10^{-6},$$

$$W = hnE^{2}10^{-9}.$$

Power factor $$f = 10^{-3}h/a.$$

| | | | | | | |
|---|---|---|---|---|---|---|
| $n$ ..... | 57·0 | 77·3 | 93·9 | 114·0 | 133·0 | Avg. |
| $a$ ..... | 15·61 | 15·59 | 15·55 | 15·57 | 15·60 | 15·59 |
| $k$ ..... | 58·5 | 86·0 | 105·0 | 102·5 | 67·5 | 83·9 |
| $f$ (per cent.)..... | 0·375 | 0·551 | 0·675 | 0·659 | 0·433 | 0·539 |

The efficiency, therefore, varied between 99·625 per cent. and 99·325 per cent., and the condenser is thus one of the most efficient pieces of apparatus known.

As regard the existence of a true dielectric hysteresis, while I believe such a phenomenon exists, I am under the impression that at least a very large part of the observed loss is not due to hyteresis, but is due to traces of air which are still occluded in the dielectric of the condenser; and caused by mechanical motion of the air molecules under the influence of the alternating electrostatic stress.

# CORRESPONDENCE.

## TEST-ROOM METHODS OF ALTERNATE-CURRENT MEASUREMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest Dr. Treichlinger's letter describing his beautifully delicate arrangements of hot strip and thermopile for measuring small alternating currents. The sensitivity which he obtains is very remarkable for a square-law instrument. It should be noticed, however, that this gain in sensitivity is to some extent counter-balanced by the high resistance (1,200 ohms) of the heated strip. [The length of the strip should read 1·5 metres., and not 1·5mm., I think.]

With regard to displacements of the zero-point, it is easy, as Dr. Treichlinger remarks, to avoid these by keeping the instrument out of circuit except when taking readings; but for many purposes it is desirable to have the indications continuous, and here displacement of zero may become troublesome.

Again, there is an interesting question suggested by Dr. Treichlinger's letter—namely, What is the best metal or alloy to use in conjunction with iron for such thermopiles? German silver, nickel and constantan are, each of them, more or less suitable. Up to 160°C. or 170°C. all three give, with iron, E.M.F.s practically proportional to the temperature difference of the junctions. Their thermo-electric powers have relative proportions roughly as follows:—

| | |
|---|---|
| Iron-German silver ..... | 100 |
| Iron-nickel ..... | 120 |
| Iron-constantan..... | 190 |

From these numbers it would seem, at first sight, that constantan is the best of the three; and, in fact, it has been used for thermopiles for quite a number of years in Germany. There is, however, another factor upon which the sensitivity of the method also depends—viz., the *resistance of the thermopile*. Except where the E.M.F. is measured by a potentiometer method, the resistance of the pile should be kept as low as possible. Nickel has here the advantage, as its conductivity is about seven times as great as that of constantan; but the negligible temperature coefficient of the latter might again turn the scale in its favour. I think I have said enough to show that the final choice would depend on the number of junctions used, the resistance of the available galvanometer, &c.

As has been seen, constantan is of great value from the thermo-electric point of view; in spite of its strong thermo-electric power with copper it is also highly valuable as a resistance material, and as such it has been very largely used in Germany. Why do we not meet it in England? I think we *do* meet it, but in disguise, for I have found that the material which bears the unscientific fancy name of "Eureka wire" has the same resistivity and thermo-electric position as constantan, and, if not the genuine article, is a remarkably good imitation.—Yours, &c.,

ALBERT CAMPBELL.

# PARLIAMENTARY INTELLIGENCE.

## METROPOLITAN DISTRICT RAILWAY BILL.

Sir John Kennaway's Committee resumed the consideration of this bill on June 28. The adjournment on June 27 was arranged to enable the parties to discuss the adoption of the following preamble and clause brought up by the promoters:—

"Whereas it is desirable to provide for the continuous working of the Inner Circle Railway by the Metropolitan Company and the Metropolitan District Company in accordance with the provisions of the Metropolitan and District Railways (City Lines and Extensions) Act, 1879, and also to secure that the Inner Circle Railway as well as the city lines and extentions of the two companies shall, when worked by electrical power, be worked upon a uniform system. Be it therefore enacted that, notwithstanding anything contained in the above-mentioned act, or in the Act of 1897, or in the Act of 1900, or in the Metropolitan Railway Act, 1898, unless within month after the passing of this act the District Company and the Metropolitan Company shall have agreed to adopt the same system for the working by electrical power of the portions of their respective railways forming part of the Inner Circle Railway and also for the working by electrical power of the city lines and extensions railways, either company may refer the question to the Board of Trade, who shall forthwith hear the parties and determine what system of electrical working shall be applied on the portions of each company's railways forming part of the Inner Circle Railway and also on the city lines and extensions railways, and each of the two companies are hereby required forthwith to apply such system to such portions of their respective railways as form part of the Inner Circle Railway, and the two companies are hereby required forthwith to apply such system to the city lines and extensions railways.

Mr. PEMBER, K.C., said the parties had met, and there were found to be two points on which an agreement could not be arrived at. First, the Metropolitan Company objected to arriving at a conclusion as to the system to be adopted within a month of the passing of the bill; and, secondly, they proposed that the special tribunal to consider what system of traction should be adopted should consist of two electrical engineers, one to be appointed by each party, and Lord Shand or some other person to be appointed by the Lord Chancellor. The Metropolitan Company proposed that the period for consideration should be four months. That

* With no resistance in series to the condenser, even with an almost perfect sine wave of E.M.F., it is quite common to find the condenser current several times larger than corresponds to the capacity, since very high harmonics, which are too small to be detected in the E.M.F. wave, may produce excessive currents in the condenser. For instance, a 19th harmonic of E.M.F. of 2 per cent. with a transformer of 4 per cent. inductance, gives in the condenser a 19th harmonic of current of over one-half the amplitude of the fundamental.

† For this purpose two stranded conductors were wound in multiple, connected in series for the condenser tests and in opposition for the check tests. In the latter case the eddy currents in the conductor obviously are the same, but since, due to the absence of an external field, the coil is practically non-inductive, the loss could be measured with alternating current by wattmeter, and checked with the ohmic loss determined by direct current.

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was too long a period looking at the fact that the District Company were losing £800 a week by the competition of the Central London Railway and the Metropolitan Company were losing £1,000 a week. As a compromise, however, he would agree to two months. As to the objection to the arbitration of the Board of Trade, he submitted that that tribunal would be eminently fitted to consider the question at issue.

Mr. FREEMAN, K.C. (for the Metropolitan Company), submitted that the clause brought up by the District Company was a one-sided proposal. According to the scheme of the suggested clause, in one month, or at the outside two months, if they had failed to agree with the District Railway as to the method of traction they were then to go to the Board of Trade, who were to decide the matter. Now, they knew from a letter of the Board of Trade that the Board would not be prepared to accept the Ganz system—which they (the Metropolitan Company) believed to be infinitely the best—until it had been experimentally tried on the railways on which it was proposed to adopt it. That could not be done within so short a period as a month. Therefore the Metropolitan Company would have to go to the Board to ask them to sanction a system which they knew they would not sanction—and could not be in a position to sanction for some time. The Metropolitan Company wished to proceed with the electrical equipment of the railway as quickly as possible, as they were losing more money than the District Railway. They were willing to go before a tribunal that would sit and decide as quickly as the Board of Trade. There could be no harm in going to an independent tribunal, and they wanted the matter referred to the highest expert authorities. Each of them would select the expert they considered best fitted to act, and there should be a third person with a mind trained in the receipt of evidence. Then clause 13 would be incompatible with the suggested arrangement of the clause. The clause said that when the railway had been converted and adapted to electric traction, and was being worked, the District Company might, by notice in writing, require all companies using the railway, or any part of it, to use electric traction instead of steam traction. The meaning of that was, they were told, the District Company were working and experimenting and ready to adopt electricity on their part of the line, and directly they started the Metropolitan Company would be unable to work by steam at all. That would mean an absolute break down of the whole of the Metropolitan system. Obviously the Committee could not intend that that should occur. Mr. Forbes said it was not meant to apply that to the Inner Circle Railway, but they must take the words of the clause which would refer to that railway.

Colonel MELLOR, Deputy Chairman of the Metropolitan Railway Co., recalled, said they could not accept the arbitration of the Board of Trade.

Counsel for the promoters took exception to this attitude of the directors of the Metropolitan Company, and insisted that the Board of Trade could be relied upon to act fairly as between the parties.

The CHAIRMAN said, as to the question of the Board of Trade accepting the position of arbitrators in the matter, he was in a position to say the Board were prepared to accept that responsibility.

WITNESS (continuing) pointed out that the District Railway Co. had said that they would not work under the Ganz system.

The CHAIRMAN: You would like a referee to be appointed to make a report and leave it to the Board of Trade to decide?

WITNESS: Yes, Lord James of Hereford or Lord Shand.

By the Committee: We should like to have a report as to what is being done on the Leco-Colito line in Italy on the Ganz system.

Mr. FREEMAN said it had been stated that that railway would not be working until August or September.

The CHAIRMAN said the Committee had now had the matter fully before them, and they would propose that the Board of Trade should be invested with jurisdiction to appoint a referee to hear the parties and make a report to them, and that they should then decide the question as to the system to be adopted on the undertaking belonging to the two railway companies.

Mr. FREEMAN said that would open the way to an arrangement no doubt, but the gentleman to hold the inquiry must not be an electrical expert, because all the experts had made up their minds. They must have a man with an open mind.

The CHAIRMAN: You want Lord Shand?

Mr. FREEMAN: Yes, some one not committed to a scientific opinion.

The CHAIRMAN said the Board of Trade would no doubt be willing to appoint some person "not being an electrical expert."

The CHAIRMAN then said the Committee had found the preamble proved, subject to the insertion of a clause which he would specify. First, however, he desired to express the gratification with which the Committee had learnt of the steps being taken to bring about the use of electricity on these railways and the adoption of a uniform system. They felt the great debt which London owed to the underground locomotion which had prevailed up to this point, and sympathised with the companies in the severe competition to which they were being subjected both under and above ground. They were satisfied that great benefit would continue to be given to the public by these railways, and they hoped that what had been done in that room would tend to bring the two systems under one control and management. The clause to be inserted was identical with that proposed by the promoters down to "either company may refer the question to the Board of Trade" [line 15 of the clause set out above]. After those words the clause would read:—

> "Whereupon the companies shall declare and submit the system which each desires to adopt, and the Board of Trade shall appoint a special tribunal consisting of an arbitrator (not an electrical engineer) and two engineers, one appointed by each company, to hear evidence and report to the Board, which will determine what system of electrical working shall be applied."

Then the rest of the promoters' clause would follow, and words would be added apportioning the cost of the inquiry equally between the two parties.

## CLEVELAND AND DURHAM COUNTY ELECTRIC POWER BILL.

On June 28 this bill came before a Committee of the House of Lords, presided over by Lord Brougham and Vaux. The proceedings before the House of Commons Committee presided over by Sir W. Houldsworth were fully reported in our issues for May 3 and May 10 last.

Mr. BALFOUR BROWNE, K.C., said this bill raised a very important question. The object of the company was to supply electricity over a wide area, mainly for power purposes, and in that they had the support of nearly everybody in the district. The Corporations who were opposing were really not antagonistic to the principle of the bill, but they wanted special protection as to competition, which he held they ought not to have. Fourteen urban and 10 rural councils in the county of Durham, and eight urban and three rural councils in the county of York were all favourable to the measure. There was no opposition from either of the counties of Durham or York. The bill was promoted entirely by gentlemen carrying on large industrial businesses in the district. There were no outside promoters at all. The promoters themselves represented in the district a capital of £14,834,000. To many of these works in the district the company would be able to convey electricity by means of wayleaves along the North Eastern Railway and the sidings into the works, the North Eastern railway—the only railway in the district—being exceedingly favourable to the scheme. The capital was to be £1,000,000, with the usual borrowing powers of £333,000. The sites of the generating stations had all been chosen having regard to the importance of water and coal being cheaply obtained. Lord Cross's Committee said such schemes ought not to be hampered by the power of purchase or by the power of veto of local authorities. The company was not to supply in the area of any authorised distributor without the consent of the distributor, but the consent must not be unreasonably withheld, and in case of dispute there was power to refer the matter to the Board of Trade for arbitration. If Darlington, for instance, did not supply energy, even though the people of Darlington wanted it for power purposes, the company were not to supply in their district unless they could show that they were withholding their consent unreasonably, and the judge of whether the consent was unreasonably withheld or not was to be the Board of Trade. Therefore, he urged, the opposing corporations were amply protected, and any further protection—though he admitted it had been introduced in other bills—would be seriously inimical to the interests of the public. Darlington, Stockton and Middlesbrough wished for power to say the company should not come in at all, whether those corporations were carrying out their undertakings to the public advantage or not, or whatever they were charging for supply, and no matter whether the company were able to supply or not. He objected to traders and manufacturers being bound to take supply from a corporation if the power company could give it more cheaply.

The CHAIRMAN: You practically enter into competition with the local authorities, not as regards illumination, but as regards power?

Mr. BALFOUR BROWNE: Yes, subject to the consent of the Board of Trade. It was not really competition at all, as at present every manufacturer had a perfect right to make his own electricity and light his own works. Further, the "brand" of electricity the company would supply was a power form of electricity; it could be transformed, but it was not very suitable for lighting. The clause which the corporations desired inserted was similar to that in the South Wales case, to the effect that: "Notwithstanding any of the provisions of this act, if the corporation shall agree with the company for a supply of electricity in bulk sufficient for all the reasonable requirements of the district and the corporation, the company shall not be entitled to supply electricity either directly or indirectly to any consumer in such district." That clause would be seriously inimical to the interests of the consumer of electricity. It meant that if the company and the corporation made a bargain, say, that the company was to supply energy at 3d. a unit, and the corporation bound themselves to take their energy from them at 3d. a unit, then the company would not compete, and the result would be that the traders in the town would have to pay any price the corporation chose to charge. In the South Wales bill a further clause was inserted that the company should not lay mains through a number of specified districts to other districts except with the consent of those districts. So that although they give wayleaves those districts refused to allow them to supply without their consent, and the promoters conceded to them an absolute veto. It was that absolute veto that Stockton, Middlesbrough, Hartlepool and Darlington wanted in the present case, and that was what he (counsel) would resist as strongly as he could because it would be contrary to sound policy. Corporations should not be interfered with in their legitimate work, but the supply of power was not the legitimate work of a corporation. The company were seeking to supply over an area of 820 square miles, only five miles of which had electrical facilities. The company hoped to be able to produce energy at a much cheaper rate than any of the corporations, and to supply it at about ½d. per unit, the price in America.

Evidence was called in support of the bill.

Mr. HUGH BELL (Bell Bros., Ltd.), repeated his evidence before the House of Commons Committee, adding that this bill would render the adoption of electricity in the district more speedy. He was already using electricity in mining to actuate drilling machines, after having tried water and compressed air. Those had been gradually abandoned in favour of electricity, which had the great convenience of portability. In the bill there was a clause providing that the company should not supply energy directly or indirectly in the district of Heston without the written consent of Bolckow, Vaughan & Co. and of the Heston Council. That was the result of an agreement with Bolckow, Vaughan & Co., who were erecting a great electric station on the river opposite their works in Heston. They were the only large consumers of electricity in that district.

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Mr. EDWARD LLOYD PEASE (Messrs. Pease & Co., coalowners), and Sir THOS. WRIGHTSON, M.P. (Messrs. Head, Wrightson & Co. and the North-Eastern Steel Co.), also gave evidence confirmatory of that given to the House of Commons Committee.

Mr. T. CALLENDER (Callender's Cable and Construction Co.) said the proposed area of the company was most suitable for the application of such a scheme. The generating stations were all in the vicinity of the coal-field, and, with one exception, were well situated for obtaining a good supply of water for condensing purposes; they were all close to a railway, and no portion of the district was beyond easy reach. With a pressure of from 10,000 to 12,000 volts, which was what the company proposed to use, there would be no difficulty in economically distributing electricity for 10 or 15 miles. The longest main would be about 11 miles, and the average length 7 or 8 miles. The three-phase system would be adopted. At present the Board of Trade required the trunk mains to be limited to a capacity of 1 000kw., but had intimated, in connection with some other large power distribution schemes, that they would probably shortly allow double that power for each main. Therefore, in estimating he had assumed as a standard 1,500kw., which was half-way between the existing and the probable new standard. The area was also a good field for the supply of electricity in regard to the number and diversity of the industries to be supplied, and he thought they would obtain therefrom an excellent load-factor of more than 25 per cent.

It has been suggested that when you get to a generating station producing 10,000 H.P. you have reached the limit of economic production. Is that your view?—I think when you get somewhere about 10,000 H.P. there is not much more saving to be made as regard the cost of generation.

But when you pass from the actual cost of generating to cheapness of supply, have you to regard not only the quantity of produce at your station, but the variety of the needs—the requirements you are called upon to meet?—Yes; the charges also are the same. About 117 miles of trunk main would be required to ensure proper communication between the stations, the cost of which would be about £2,200 per mile, which would give £257,400; to duplicate mains, 67 miles more would be needed, which would cost, at £1,700 per mile, £113,900; and, further, 42 miles of branch mains would be wanted, which, at £1,350 per mile, would cost £56,700—total, £428,000. For transformers and sub-stations (beginning with 40,000 H.P.) another £100,000 would be needed.

Mr. INGHAM, M.I.E.E., consulting electrical engineer for many years in the Cleveland district, said the convenience of manufacturers would be served by having electricity on tap rather than by having to produce it themselves. In Middlesbrough and the adjoining district and in Stockton the great bulk of the horse-power used was used by promoters of the bill.

Mr. GIBB, general manager of the North-Eastern Railway Co., said he regarded the scheme of the bill as one that would promote the interests of all the industries of the district which required power. The North-Eastern Company was very largely interested in the district, as they were the sole railway company serving it, their lines within the area of the company, exclusive of sidings, being about 350 miles in length.

Do you consider that electric power as supplied to railways and docks has become, or is becoming, a real necessity to the efficient conduct of the business?—Railways are directing attention to it more and more, hoping great things of it. There are many ways in which it would be useful for railways.

The CHAIRMAN: If this bill were passed would your company become a customer of the company?—I have no doubt we should. We have not yet considered any practical application of the facilities that would be available.

Examination continued: Supposing your company determines to adopt electric power for purposes of their business, would it be an advantage for them to deal with one company rather than with a number of authorities?—A very great advantage. I consider that most important.

Mr. WALTER JOHNSON (Messrs. Bell Bros., Ltd.), chairman of the Middlesbrough Chamber of Commerce, said the capital of firms in his district supporting the bill was about £17,500,000. If the corporations could supply electrical power as cheaply and efficiently as the company they would suffer no injury by the passing of the bill.

Mr. GRIGG (manager of the Salt Union, Ltd., and managing director of the North-Eastern Salt Co., Ltd.) said the particular usefulness of electricity to a salt mining company was the ease with which it could be used at scattered and distant points. The expense of coal cartage and of conveying steam to the artesian wells, by which the brine was obtained, and which were often three-quarters of a mile apart, made the use of steam extremely costly, as there was always considerable loss in transit from condensation. Therefore, he believed the use of electric power would be very much cheaper than steam. Before this bill was brought forward his firms had contemplated laying down electric installations, but before proceeding further they had decided to see if they could use the facilities, which the company, if the bill passed, would be able to give.

Mr. A. H. SILL, clerk to the Ormsby and Redcar Urban District Council, said the Council had obtained an electric lighting order, but had done nothing with it, owing to the cost of generating stations. They were anxious to obtain energy from some power-producing company such as this bill would establish.

Mr. HOBBS, secretary to the Cleveland Miners' and Quarrymen's Association, said the 22 lodges of this body in the district covered by the bill had held meetings and passed resolutions in favour of the bill. The men regarded the use of electricity as likely to be beneficial in the quarries and mines of the district.

Mr. H. GRAHAM HARRIS (Messrs. Bramwell and Harris), supplementing his evidence before the previous Committee, said the area of the district proposed to be supplied was 820 square miles, of which 120 square miles were being already supplied by companies or local authorities. At Niagara electric current could be taken 22 miles, but in the present scheme it was only proposed to carry it 20 miles at the outside. Having regard to the irregularity of the district and the geographical position of the businesses, it was thought desirable that the company should have a generating station in each of the centres. The total power installed at the existing authorised electrical generating stations was about 4,200 H.P., and at present about 2,100 H.P. was being supplied. The capital authorised by the bill would be sufficient to provide an installation of 40,000 H.P. It seemed to him the corporations were nervous without cause. With the current in their mains, unless transformed, it would be absolutely impossible at present, by any means we know, for the company to supply current for lighting. So that the fear that the company might take away the electric lighting business of the municipalities was entirely baseless.

In order to meet any substantial demand for power very great changes would have to be made in the present installations of these municipalities?—Yes, they are under their acts and orders governed by the limits of pressure imposed by the Board of Trade. But in the case of these bills, whose primary object is to supply power, we have no limitations at all, except when we are supplying authorised distributors. The company would supply a rough current which could not be used for lighting except by special appliances, which would involve large extra cost. The original opposition to these bills by the corporations was that there would be duplication of the mains in the streets, and that they objected to the breaking up of the streets. Now, however, they did not mind the streets, but they did not wish their existing supplies interfered with.

Supposing they had to supply power to any large extent in addition to lighting, could they avoid some duplication of the mains?—No, and a considerably increased duplication beyond that which will take place as between ourselves and them. Our mains are large in the sense that they convey large quantities of power. We shall cater for the large works. I contend that our business will be a business which the corporations cannot undertake, and which it would be wrong for them to attempt.

The promoters are not seeking at all by this bill to obtain exclusive power?—No, their course will be in the other direction entirely—to encourage local authorities and other companies to obtain their own provisional orders, the company supplying them in bulk. Of the total capital of £1,333,000, £520,000 was set apart for expenses on combined engines and dynamos, with foundations and exhaust pipes, of a total indicated horse power of 40,000, boilers with stand-by feed apparatus for water, coal-handling apparatus, condensers with feed and air pumps, and standpipes, &c. For land, including laying and sidings, &c., £26,000 was allowed; for buildings, including coal stores, foundations, boiler seatings, chimneys, &c., £54,000; for mains, transformers, and sub-stations, £530,000; for contingencies, engineering, legal, and preliminary expenses, &c., say, 10 per cent. on the above amounts, £113,000—a total of £1,243,000, leaving about £90,000 for working capital.

By Mr. BAGGALLAY: There would not be the slightest difficulty in using electricity supplied on the three-phase system for lighting, except the cost of transforming in accordance with the Board of Trade regulations. Although there was a particular "brand" of electricity especially suitable for electric power, he agreed there was nothing in the bill to say that the company should use it. Another brand might be discovered which would be more suitable for power and at the same time suitable for illuminating purposes.

This closed the evidence for the promoters.

Mr. BAGGALLAY (for Stockton and Middlesbrough) admitted all the advantages of electrical power. The corporations, he said, wished it to be open to them to allow the company to supply, but, at the same time, they wished to have an absolute veto in the matter without reference to the Board of Trade. They desired power to say, "You shall not come in and compete with us if we are doing our work well, and practically gain the undertaking which has been established at the cost of the rates."

The CHAIRMAN: Who is to be the judge of whether you are doing your work well?

Mr. BAGGALLAY: Ourselves, as in the South Wales case. If the company were given power to compete, the local authorities must stay their hands. It would not do for them to embark their money in plant to compete with the company, because if for any cause they failed in the competition they would have the plant left on their hands, and the rates heavily burdened. The only way to overcome that difficulty would be to give some such protection as he now sought. With regard to the recommendations of Lord Cross's Committee, there was not a word recommending that these companies should be authorised to compete with an authorised distributor in that distributor's authorised district.

On Tuesday Mr. ROBERT HAMMOND gave evidence against the bill. Asked by Mr. Acworth if, in his view, the scheme fulfilled the conditions laid down by Lord Cross's Committee, that where sufficient public advantage is shown power may be given for the supply of electric energy over an area including the districts of several local authorities, and demanding plant of exceptional dimensions and high voltage, witness said he did not consider the public advantages were such as should override the corporations' rights. It was admitted by the promoters that the current they proposed to generate was unsuitable for lighting and could only be so used by transformation involving heavy expense. The maximum charges mentioned in the bill (from 2d. to 3d. per unit) would be increased to 5d. to the consumer of current for light, owing to the cost of transforming, &c.

The CHAIRMAN: If the cost of using it for illuminating purposes is so great surely people will not use it for that purpose?—Yes; but it is one of the public advantages urged in favour of the bill, that they can supply to authorised distributors in bulk for lighting. I am here to show that that is chimerical.

Mr. ACWORTH: Whatever may be the advantage of generating at Haverton Hill for the supply of Middlesbrough or Stockton, is there any advantage there over generating in Middlesbrough or Stockton?—No. In Middlesbrough itself at the present time they are generating current which is used for lighting and which can also be used for power.



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Therefore, you say, that to Middlesbrough at least there can be no special advantage offered?—That is so. Electric undertakings had been successful in the hands of municipalities, and it was quite wrong to say that they had failed. As to the cost of generating it was highly satisfactory if it could be done at 2d. per unit. Out of 120 concerns in the country only 29 had reached that low cost, and of those 25 were local authorities. Experience showed that municipal authorities produced and distributed more cheaply than other undertakers.

Is there evidence that there is no case that has passed Parliament of a great town being included in a great scheme of this kind against its will?—I do not know of any. It was a misuse of Lord Cross's report to quote it in support of schemes of this kind, because throughout Lord Cross's Committee dealt with the supply of electricity in bulk, whereas here they proposed to supply to individuals. Under the statutory obligations of municipalities they cannot charge preferential rates, and cannot enter into agreements with particular customers to give special rates. Legislation from the very beginning has recognised the principle that everyone should be served alike, and the clause in this bill which permits these agreements to be made seems to me to set that aside.

Would that, in your view, leave on the Corporation the obligation to deal with the small and unprofitable consumer on fixed terms, and leave the company to make advantageous bargains with the big consumers?—Certainly.

Is there any ground for the charge that big cities are confining themselves to lighting and neglecting the power side of the business?—No. In Bradford last year, out of an output of over 3,500,000 units, 1,500,000 were for lighting, 1,000,000 for motive power, 76,000 for public lighting, and 1,000,000 for tramways. Middlesbrough and Stockton, if allowed to go on, would develop in the same direction. In Leeds they were laying down special mains for power. They had not done that at Middlesbrough yet because there had not been sufficient demand. Stockton was practically in the same position as Middlesbrough.

The CHAIRMAN: Would you say electrical energy can be generated by the local authorities more cheaply than by this company?—I would rather say that the aggregation of output would not outweigh the cost of distribution.

Would you be surprised if the company supplied cheaper than the local authorities?—Yes, distinctly. Up to 10,000 H.P., in our area, we will generate current and distribute it more cheaply than they can make it at a distance and deliver it.

In that case, what have you to fear from the company?—We have nothing to fear, as far as competition is concerned; but as a local authority we have to see our way ahead before we spend money. They are prepared to put down plant for 10,000 H.P. at once and wait for business. We, a local authority, feel that would not be prudent. They might take us to the Board of Trade on an arbitration, and say: "We are prepared to give this current to-morrow; these people want six months."

Mr. TALBOT (in cross-examination): But while your local authority is waiting before it can embark on the undertaking, the industries that want electric power will be at a standstill?—If they want it they will say so.

But I understand your answer is that the local authority cannot supply at once, because it has to wait before it gets the demand to put down the necessary plant?—Yes.

While it is doing that the industry which wants it has to go without?—Precisely. If they want it to-morrow they cannot get it. He, however, knew of no industry where it would be necessary to have electricity at once. With reference to preferential rates, under the general law promoters could not give these, but under the present bill the promoters could enter into agreements as to price. The Corporation, therefore, desired the promoters should not come into Middlesbrough with a free hand whilst the Corporation were bound as to price.

Mr. GRAHAM HARRIS, recalled as to the arrangement with Messrs. Bolckow, Vaughan & Co. and the Heston District Council, said Messrs. Bolckow, Vaughan & Co. were erecting works at Heston, and under the bill the company could not supply these, and, therefore, the company rendered them safe by making this agreement.

The CHAIRMAN: Then the company can never go to Heston?

WITNESS: Not without the consent of Messrs. Bolckow, Vaughan & Co.

By Mr. FORBES LANKESTER: I put it to you that that is proper and reasonable protection to give to other bodies who are in a position to supply electricity?—The conditions are entirely different. It was almost certain that Messrs. Bolckow, Vaughan & Co. would not invest more money in their electric installation, that they would want 7,000 H.P. or 8,000 H.P. more, and that they would take it from the promoting company.

Mr. HINE, mayor of Stockton, said the Corporation obtained a provisional order in 1890, but electricity was not supplied until last year. Ten years ago they thought great developments were yet to come, and were afraid, therefore, to invest capital. They had no great demand, and consequently delayed establishing the installation practically until someone else had done the experimental work for them. Now they had the latest development and best and most novel form of installation, and their idea was to supply for power as well as for lighting. The works were of about 500 H.P. The Corporation did not object to the company's mains passing through the district, but held that they should not be allowed to supply in the Corporation area without their consent. They did not wish to be altogether excluded from the bill, because at some future time they might desire to take electricity from the company rather than extend their own works.

Prof. A. B. W. KENNEDY, examined by Mr. FITZGERALD (for Darlington), said the existing works at Darlington were opened in December last, since which time the demand had so largely increased that the Corporation had decided to double the installation. When that had been done the works would be equal to 800 H.P. or 900 H.P. Works could be conveniently extended to 10,000 H.P., and there would be no difficulty in giving a supply for both lighting and power through the same mains. In Edinburgh power supply was given through the same mains as were used for lighting, and that applied also in varying degrees to Manchester and other places. It was proposed by the Corporation to work the tramways in Darlington by electricity. Last year, when there was a proposal that the trams should be worked by a company, the Corporation offered to supply electricity up to 400,000 units per annum at 1½d. and above that quantity at 1d. per unit. Another offer of the Corporation was to Messrs. Stevenson, and it was to supply at 1½d. per unit (plus an extra charge of about ⅛d. per unit) up to 500,000 units; above that rate the extra charge would cease. The charge which it was stated in the House of Commons that the company would make was 2d. up to 500,000 units, 1⅜d. from 500,000 to 750,000, and 1½d. from 750,000 up to 1,000,000. He should not expect to find, with any given load factor, any saving in cost of generation after the first 5,000 H.P., except, perhaps, as to management. On the other hand, there were economies which could be carried out at small stations which it was disappointing to find could not be carried out at big ones. It would hardly be economical, as was suggested in connection with Darlington, to give a supply from works 19 miles away.

By Dr. WILLIAMS (for West Hartlepool): Witness said that Corporation opened their electric works in January last, when the horse-power was 650. Since then it had been increased to 1,000 H.P. On the site of the present works plant of 40,000 H.P. could be erected. The system of supply was the same as in Darlington (continuous three-wire), which was equally suitable for power as for light. The Corporation had never refused an application for supply. The Corporation had offered to supply at 1½d. and 1d. per unit for power. He was sure the company could not supply more cheaply than the Corporation in West Hartlepool.

By Mr. TALBOT: Great works, as a rule, were not supplied from lighting mains. They usually owned their installations. A company might undertake to supply at a loss in order to get into a town in the expectation of being bought out afterwards.

Ald. BARRON, chairman of the Gas and Electric Lighting committee of Darlington Corporation, said the Darlington electricity department had sent round circulars offering supply for motive power up to 50,000 units for 2d. per unit, beyond that at an agreed price. They had offered 50,000 units at 1½d. per unit. In addition, they had approached the North Eastern Railway Co., offering them a supply. The Corporation had negotiated with the Darlington Forge Co., and other large works, and if they did not put down their own plant the Corporation hoped to supply them.

Mr. FITZGERALD addressed the Committee for Darlington, contending that there was no necessity for the promoting company to touch Darlington, the works they desired to supply being outside. The generating station it was proposed to construct at Witton Park was 19 miles away, and it was difficult, therefore, to see why the promoters were fighting the Corporation. If the petitioning boroughs were all left out of the bill the promoters would still have a district of supply 800 sq. miles in extent. Really, what he was contending for was what the promoters had themselves conceded in Heston, at the instance of one of their own promoters, Messrs. Bolckow, Vaughan & Co. The arrangement with Messrs. Bolckow, Vaughan & Co. was not disclosed to the Committee of the House of Commons when they were considering the bill, although no one doubted that the arrangement had been then made. If that disclosure had been made he thought the Committee would have extended the protection to the other corporations. He therefore asked the Committee not to pass the bill, except with a provision that the company should not supply within the borough of Darlington without the consent of that borough.

Dr. WILLIAMS (for West Hartlepool), said it had been argued that little had been done by corporations in regard to the supply of electricity for power. That was true, but the same also was true of the companies, the reason being that its applicability to power purposes had only recently been fully recognised.

Mr. HARKER C. CRUMMOCK, borough engineer, Hartlepool, said the Corporation obtained a provisional order 18 months ago, and a complete scheme had been prepared for the supply of energy for power and lighting. That scheme had been unanimously adopted by the Electric Lighting committee, and would have been before the Corporation that night for confirmation but for his absence in London. There were various large works in Hartlepool which used electrical power equal to about 2,700 H.P. There were no works requiring more than 50 H.P. which had not already supplied themselves with electricity. He anticipated that the demand the Corporation would have to meet at first would not be more than 200kw.; if it increased the Corporation could easily lay down more plant for the supply of current for power or lighting. The Corporation had power to purchase the local tramways, and if they effected the purchase they would be able to improve the load-factor by working them by electricity. If a large works were established in Hartlepool requiring 1,000 H.P. an expenditure of, perhaps, £35,000 would be required. If that firm failed or went away the rates would be burdened with that outlay. But the Corporation would require some security before they undertook such a supply.

Mr. BALFOUR BROWNE, in reply to a question from the chairman, said he did not agree that the Board of Trade would have no alternative as to the decision they might give under the directions contained in the bill, in the event of an appeal to the Board on an allegation that the consent of a corporation to allow the company to supply in their area had been unreasonably withheld. Nor did he agree that the Board of Trade having once given a decision letting the company in, the corporation would be saddled with the company in competition for all purposes and all time. He held that every application made to the Board of Trade to supply an individual manufacturer would have to be heard on its merits; and, further, that if the company got into a district to supply manufacturer A, and then wanted to supply manufacturer B, the corporation in that district could still withhold their consent if they were then in a position to supply energy cheaper than the

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company. That was the meaning of the clause, and if the Committee had any doubt about it he was quite ready to make it perfectly clear.

The CHAIRMAN: We do not call upon you to address us. In the opinion of the Committee the preamble of the bill is proved, but we are going to strike out the two provisos which relate to Heston and Messrs. Bolckow, Vaughan & Co.

Mr. BALFOUR BROWNE: I think your lordship has done right.

Yesterday the clauses were adjusted and the bill ordered to be reported.

## TYNESIDE TRAMWAYS AND TRAMROADS BILL.

The Select Committee of the House of Commons, presided over by Mr. W. H. Holland, on June 27, considered this bill. The proceedings before the House of Lords Committee were briefly reported in *The Electrician* for May 10, p. 102.

Mr. BALFOUR BROWNE, K.C., for the bill, said its object was to authorise the construction of tramways in the districts of Walker, Wallsend, Willington Quay and Gosforth, the borough of Tynemouth and the parishes of Willington and Longbeaton. The tramways would run from Newcastle to Tynemouth, and from Wallsend and Longbeaton to a point in Gosforth from whence people could be carried to the north-east of Newcastle by already authorised tramways. The main tramway under the bill would be nearly 6 miles in length, and those to Gosforth about 2 miles. All the local authorities were favourable, with the exception of the Walker District Council. The populations to be served by the scheme numbered upwards of 114,000. The only petitions against the bill were the Walker Council, the Corporation of Newcastle, the North-Eastern Railway Co., and the National Telephone Co. Newcastle Corporation said they were the owners of an extensive system of tramways, which they had power to work by electricity, and were also empowered to agree with the owners of tramways outside for the purchase of lines adjacent to their own. They urged that as the freeholders of nearly the whole of Walker, they were desirous to themselves construct the lines, and that the scheme before the Committee would not meet the requirements of the district. But the promoters were prepared to carry out every proposal that the Corporation had made to meet these wants, and had given a pledge in the Upper House that, so far as Walker was concerned, they would come next session to Parliament and ask for powers to make all the tramways which Newcastle had said were wanted. They would give exactly the same accommodation as Newcastle was willing to give. It was also objected that the tramways would run through streets where it was not possible to leave 9ft. 6in. on either side of the line. But nearly 9 miles of their own tramways in Newcastle were nearer to the pavement than 9ft. 6in., and yet they were there opposing on that ground. It was also urged that unless these tramways were in the hands of the Newcastle Corporation through communication would be impossible. If one went to Scotland by railway one travelled over many companies' lines, which showed the stupidity of that contention. If when these tramways were made some arrangement were not come to to allow the cars to run from one system to the other, it would be the fault of the Corporation. The North-Eastern Railway Co.'s opposition was chiefly on the ground of competition, and he did not think that mere competition ought to be allowed to stand in the way of tramway construction.

Mr. HOBART ARMSTRONG, one of the promoters, and Mr. CHARLES MERZ, consulting electrical engineer, having given evidence in support, a large of amount of local evidence was next given in support of the scheme, followed by that of

Mr. STEPHEN SELLON, C.E., who said it would be unjust to the promoters, who were the first in the field, if they were not allowed to run through Walker and if that district were handed over to Newcastle. If the proposals of the bill were carried out there would be no difficulty in running the company's cars in connection with the Newcastle cars, as all the electric tramways of the country were being standardised like the railways, and it was becoming a common thing for one tramway company to be granted running powers over another company's lines.

On Tuesday evidence was taken on behalf of the opposition of the Newcastle Corporation, and Alderman CAIL, Chairman of the Tramways Committee, said Newcastle had already spent £395,000 in fitting their tramways for electric traction, and expected to have the system completed by the end of the present year.

Mr. ALFRED E. ROSSIGNOL, electrical engineer to the Corporation of Newcastle, gave further evidence, and counsel having replied,

The Committee decided to pass the preamble of the Bill, except so far as it related to Walker. They felt there were special circumstances in regard to that district, both local and owing to its proximity to Newcastle. In arriving at their decision they had (as had also the House of Lords Committee) been greatly influenced by the pledge given on behalf of the Newcastle Corporation to promote a bill next session for the construction of tramways in Walker, and to proceed forthwith with the work if the bill passed.

On the consideration of the clauses,

Mr. BALFOUR BROWNE asked that a clause should be inserted giving the company powers over a piece of line in Walker and Wallsend, and connecting those places.

Mr. PEMBROKE STEPHENS, K.C. (for Walker) objected.

The CHAIRMAN said the Committeee thought Walker should meet the promoters in a generous spirit, and afford them reasonable facilities to work their tramways successfully, and pointed out to Mr. Acworth, representing Newcastle, that the idea was to bring about a through traffic and service. The Tyneside Company had rendered a service to the public in bringing forward the Wallsend section of the bill, as they had caused the authorities opposing to take immediate steps towards providing tramways in Walker.

Mr. E. MOON (for the North Eastern Railway Co.) said the terms of one of the clauses went beyond the carriage of parcels under 56lb. weight, and of minerals and materials for the use of the tramway company which had been agreed to, and would include the carriage of coal for the use of the two generating stations supplying current for operating the lines. The North Eastern Railway Co. objected to that because the power was to come from the Newcastle Electric Supply Co.'s works, which would be supplying not only the tramway, but also a great part of Newcastle. They had no objection to sufficient coal being carried to produce the power necessary for the supply of the tramways.

The Committee decided that, as it would be difficult to earmark the precise quantity of coal used for tramway power at the generating stations, the whole of the coal used should be permitted to be carried over the tramway.

Mr. FORBES LANKESTER, on behalf of the National Telephone Co., said the circumstances in regard to the telephone wires and the trolley wire of the tramway were precisely similar, and the arguments the same as in the case of South Lancashire Tramways Bill, and he asked to be given in this bill the same clause as he had been given by the Committee in that.

Mr. BALFOUR BROWNE thought what had been done in the last bill was a very serious departure from general principles and the ordinary law. He did not know what would be the result of the insertion of the clause in the South Lancashire Bill, but he understood it had been objected to by the Chairman of Committees in the House of Lords, and that in the opinion of counsel to Earl Morley any damage or injury proved to be caused by the escape of electric current from the tramway wires would seem to be a damage for which the company would be *prima facie* liable, but that if it were due to default or negligence on the part of the telephone company, that company would be liable, and that there seemed to be no need for a variation of the liabilities at common law. Telephone wires, counsel said, were put across the street under no powers of an Act of Parliament, but merely by agreement with the two householders on either side; but the tramway company would be in the street under an Act of Parliament, which was different. The matter had been considered a great number of times in connection with the great generating stations to be erected in London for the supply of energy, and it had come before the Joint Committee presided over by Lord Cross, who said that, if the wires were not put up under the powers of an Act of Parliament, those placing them there should be liable for a nuisance, and they quoted two judgments of Lord Blackburn, in the House of Lords, which showed the difference of position of agreement and of statutory powers. Under the clause the present Committee had put into the South Lancashire Bill, both parties had been treated exactly on the same basis, and he ventured to think the Committee had gone out of common law. The case put before the Committee in the South Lancashire Bill was, suppose both were negligent, should not both be liable? He said no; because one was the creature of a statute and was only liable for negligence. On the other hand, if they were there without an Act of Parliament, they would be equally liable with the telephone company. That was why he thought the Committee had altered the common law, and he asked them not to do that. It was a most important point for all people having electrical wires for carrying on tramway enterprise in this country. There was another matter—the Committee were rather at variance with the Court of Referees. The telephone company the other day had asked for a *locus* on the United Tramways Co.'s bill on this very point, and had been refused. In the Liverpool case the whole damage arose because the Corporation had not taken the proper precautions to prevent the trolley wire doing injury. If the wire had been guarded, as they were bound to protect theirs, it would have been protected electrically as well as physically. He asked the Committee to put them—if they placed that guard wire there—in the same position as any other statutory company.

Mr. J. D. FITZGERALD, K.C. (for the Birmingham Tramways Co., whose bill was also before the Committee), said he adopted Mr. Balfour Browne's argument. He could not conceive why the general law of the land should be altered in favour of the telephone company.

In giving their decision the Committee said the tramway company, which was a statutory one, must have neglected something or the accident would not have occurred, and they did not see why a statutory company should be relieved of the consequences of their negligence. It was true that in the case of the Liverpool accident both parties were contributory, but, in the opinion of the Committee, not in the same degree. The tramway current was a strong and dangerous one, whereas the current of the telephone company was a harmless one, so that the decision they had arrived at in the previous case they were disposed to confirm in the other cases, seeing no reason to change it.

## CITY OF BIRMINGHAM TRAMWAYS.

The Select Committee of the House of Commons, presided over by Mr. W. H. Holland, on Wednesday considered this bill.

Mr. J. D. FITZGERALD, K.C., for the bill, said it was promoted by the City of Birmingham Tramways Co. (Ltd.) to authorise them to construct additional tramways, &c., especially certain small additional lines for the more convenient working of the system. So far as the new tramways were concerned no question arose before the Committee. The company's different routes commenced in the centre of Birmingham, radiating out into the suburbs. There was no company in existence like the Birmingham company, which had its lines worked on four different systems—horse, cable, steam, and electricity. The peculiarity of the position was that the tramways inside the city of Birmingham were all the property of the Corporation, and were leased to the company, the several leases expiring in 1907 and 1911. But once they got outside the city the lines were the property of the company, subject to the right of the several local authorities to purchase them under the Tramways Act, 1870. Those rights of purchase accrued at different dates, commencing with 1903, and it was obvious that unless something was done before the expiration of the leases of the city lines which the



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company held from the Corporation the extraordinary state of things would arise that the tramways inside the city, which formed the main part of each route, would be worked by the company, and the pieces outside the city would possibly be under a separate working and ownership. If some arrangement was not then made for through working the inconvenience to the public would be serious, and the efficient working of the tramways destroyed. The solution of this difficulty was that the tramway company should be allowed running powers over the portions of the routes which passed into the hands of the local authorities until the expiration of the Corporation's leases of the other portions. Such running powers had been given last year and this year in the case of Bournemouth town. The present case was immensely stronger than that of Bournemouth, because it was sought to preserve the continuity of these important lines to and from the centre of Birmingham. Unless these tramways were worked as the promoters suggested they could not be conveniently worked at all. In regard to the clause asked for by the National Telephone Co., similar to that which the Committee had placed in the South Lancashire Tramways Bill, he wished it to be distinctly understood that the promoters objected as strongly as they could to such a clause.

The CHAIRMAN intimated that, if the circumstances were the same, the clause must be inserted.

Yesterday (Thursday) Mr. HUGO YOUNG (for the Aston and Handsworth District Councils) said certain clauses had been arranged between the petitioners and the promoters, by which the necessity for further opposition was obviated.

It was understood that the basis of the agreement was that Aston and Handsworth would, when the time arrived for their sections of the tramways to accrue to their respective Councils, grant to the tramway company leases to expire on the same dates as the leases from the Birmingham Corporation.

The preamble of the bill was then proved, and the bill ordered for report.

## PONTYPRIDD TRAMWAYS BILL.

A House of Lords Select Committee, presided over by Lord Clonbrook, considered this bill on Monday and Tuesday. The general manager of the Taff Vale Railway Co. gave evidence in support of the company's petition against the bill, and said an obligation was put upon petitioners to convert a mineral line into a line for passenger traffic at a cost of £16,000, and at the time that obligation was enforced there was not sufficient passenger traffic to justify the outlay. The effect of the conversion had been most disastrous. They, therefore, objected to this bill as setting up competition. The bill was, in fact, laying the basis of competition with the whole of the Taff Vale system except in respect of minerals.

The Committee declared the preamble of the bill proved, and ordered it to be reported for third reading.

## MANCHESTER AND LIVERPOOL ELECTRIC EXPRESS RAILWAY.

The Select Committee of the House of Commons appointed to consider the merits of the bill for the construction of an electric express railway on the monorail system between Manchester and Liverpool commenced their inquiry yesterday, Sir Lewis M'Iver presiding. The proceedings before the House of Lords Committee, where the bill was very exhaustively considered, have been fully reported in *The Electrician* for May 17 and 24. The bill is again very much opposed, a great array of counsel being engaged.

Mr. BALFOUR BROWNE, K.C., for the promoters, said it was before the House of Commons last year for 11 days, 45 witnesses giving evidence. That Committee threw out the bill, but in their decision the opposing railways were not recognised, the only points mentioned being that the promoters had not sufficiently considered the interests of Salford and the Mersey Docks and Harbour Board, and that the Committee were not satisfied with the brake power of the proposed railway. To-day he had no one against him but the railways. The Mersey Docks and Harbour Board were satisfied, and although in the House of Lords this session the bill was opposed by the Corporation of Salford, he believed that terms had been arranged and that the Committee would not be troubled with any opposition of that sort. The question now was that of competition of the new line with the existing railway companies, and he did not think that vested interests would be allowed to stand in the way of this new development. If the proposed new railway were successful it would undoubtedly take traffic from the existing railway companies, and if, as the petitioners declared, the proposed railway would not work, it would not do the existing companies any harm. The proposed line would do the journey between Liverpool and Manchester in 20 minutes. There was a mono-railway on the Continent (between Berlin and Zossen) running at the rate of 170 miles an hour, but the promoters in the present case were more moderate, and did not propose to run at more than 110 miles an hour. The motive power of the new railway would be electricity, which was being adopted by all the underground railways in London and tramways which were to run round the metropolis. The local authorities did not like to experiment with the ratepayers' money, therefore the carrying out of the scheme had been left to private enterprise. Manchester and Liverpool were selected for the undertaking, not for historic reasons—although the first railway was run between these towns—but for commercial reasons. In order to make this a successful commercial enterprise they must have two great centres of population, one at each end of the railway. It was not proposed to pick up traffic en route, but simply to link Liverpool and Manchester together and their popula- aggregating 1,561,000. As to the opposition of the railway companies, he showed that it was obstructive, just as was the opposition offered by the canal companies to the London and North-Western Railway Co. when it proposed to run between Manchester and Liverpool in 1825. If such arguments were allowed to prevail where should we be 50 years hence? Referring to speed and safety, he declared that the line would have no points or crossings, no ballast, no slow trains to pass, no shunting, and at the termini the speed of the trains would be slackened by gravitation, and, beyond that, the Westinghouse brake would be used, that brake being capable of stopping a train going at 110 miles an hour in 37 sec. within a distance of 1,000yd. More than this, the motors could be reversed and a magnetic brake could be applied. There was no difficulty in stopping the train even in 500yd., but the question was as to quick stoppage without inconvenience to the passengers. These were details, however, as the Board of Trade would not allow the cars to run unless they were absolutely safe. The last word of science had not been said yet in regard to the construction of cars and so forth. The present cars were an improvement on those originally experimented with, and no doubt they would be still more improved in the future. As showing the extent to which electric traction was availed of, the Central London Railway, which was at first regarded as a toy, began by carrying 80,000 passengers a day, and now, day by day and week by week, was carrying from 104,000 to 114,000 passengers daily.

Mr. FRITZ BERNARD BEHR, C.E., one of the engineers to the company and designer of the system, gave evidence of a character similar to that tendered in the House of Lords. There were, he urged, not two towns in the whole world as fitted as Liverpool and Manchester for the laying down of the first mono railway in England. They were two big towns, having many things in common, and lying within a short distance of each other, and the cost of a first railway of this kind would not be exorbitantly high. The reasons which, no doubt, had operated with Stephenson in adopting this part of the country for his great experiment had weighed with witness and inspired him to follow in the footsteps of that great inventor. He had no faith in emergency brakes, therefore he had removed from his railway all complications of traffic and had adopted a perfect system of signalling. Brakes were relied on as a secondary and not as the primary consideration. The signals would operate automaticaliy, blocking the line when necessary, and giving a clear intimation to the driver of the car when anything was amiss ahead. There would never be more than one car on each section of 7 miles of the route. Cars could be constructed to carry 50 passengers, and 102 of these could be run in each direction every day. In this way 10,000 passengers a day could be carried. A smaller car to carry 35 people could be worked more economically, and by its means 7,000 people a day could be carried.

The Committee at this stage adjourned.

## LONDON UNDERGROUND RAILWAYS.

This special inquiry by a Joint Parliamentary Committee was concluded on Tuesday, when the subject of possible damage to property by the construction of these lines was considered.

Mr. PEMBER, K.C., for the Gordon Hotels Co., argued that owners who were likely to be affected by the lines ought to have a *locus standi* against the preambles of the various bills. He contended there should be deviation of route where valuable property was at stake, and that owners ought not to be expected to take legal proceedings to recover damages from companies which might be impecunious.

Mr. POLLOCK, K.C., representing the Phillimore estate and a number of insurance and other companies interested in City properties, emphasised this contention.

Mr. FITZGERALD, K.C., for the London County Council and landowners in the City, said the London County Council were amongst the largest landowners in London, their ground rents and surplus land alone amounting in value to something like £8,000,000 sterling. The Council were owners of soil under a number of streets which they had constructed, having purchased the property in these streets at full value, as well as the soil. And yet it was proposed that underground railway companies should be allowed to run tubes through this soil without paying any compensation to the Council or other owners of property. He argued that provision should be inserted in the bills for the protection of owners, lessees, and occupiers of property in proximity to the underground railways from possible damage and annoyance. If an easement were taken it ought to be coupled with a provision that, as regarded damage by the user, the landowner should be in the same position as if a portion of his land were taken.

Mr. FREEMAN, K.C., for other petitioners, including the committee of the Stock Exchange, said the point they felt anxious about was that there should be some compensation given for damage suffered by the working of the lines. Having regard to the improved knowledge as to the actual working of these lines since the City and South London scheme was introduced, the time had arrived for prouisions to be inserted in future acts for the protection of owners of property. If his house were cracked from top to the bottom by the sinking of a shaft for a railway, he was entitled to compensation; but if similarly cracked by the working of the railway he would be entitled to no compensation. That was most unreasonable, and he contended that compensation should be paid in both cases.

Lord KNUTSFORD: That is a substantial alteration of the law.

Mr. FREEMAN: Yes, under the changed circumstances.

Mr. RIGG, for the Corporation of London, mentioned the case of St. Paul's Cathedral, the trustees of which would have no *locus standi* if the railway went underneath any of the streets south of the building, although enormous damage to the cathedral might result.

Other counsel having urged the same point, the Committee closed the inquiry.

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## DERBY CORPORATION BILL

A House of Commons Committee has been occupied for 20 days with this omnibus bill. Evidence as to the tramway section, which only forms a small portion of the measure, was given. Mr. G. Hopkins, C.E., said the new tramways were necessary, as the existing lines had been down for more than 20 years, and were totally inadequate for present requirements. Horse traction was now used, and as the lines were practically worn out they must be reconstructed in a very short time. It was proposed to employ the overhead electric system. Eventually the Committee found the preamble of the bill proved, recommending the dropping of the tramway up Duffield-road to Darley Abbey.

## NOTTING HILL ELECTRIC LIGHTING BILL.

A House of Lords Committee on Monday passed the bill promoted by the Notting Hill Lighting Co. (Ltd.) for power to acquire land near Addison-road for storing and distributing electrical energy. The bill, as amended by the Commons, expressly prohibits the company from generating electricity on the land to be acquired. No additional capital powers are given under the bill.

## BLACKPOOL IMPROVEMENT BILL.

This bill came yesterday before a House of Commons Committee, presided over by Lord Hatherton. It will be remembered that a majority of the House of Lords Committee, before whom the bill was taken in May (*The Electrician*, May 17, p. 151), passed the whole of the tramway portion of the bill. The House of Commons Committee yesterday declared the preamble proved, excepting as to the construction of one of the proposed additional tramways for which the Corporation of Blackpool seek powers, and to which opposition was offered by the Blackpool, St. Anne's and Lytham Tramways Co., who are lessees from the Corporation of certain parts of the tramways in Blackpool. The company alleged that one of the proposed new lines would lead to unfair competition. In the course of the proceedings it was stated that the tramcars used by the Blackpool Corporation were the largest in the kingdom—each accommodating 95 passengers. The number of persons using the tramways is, however, so large that even with these huge cars the traffic cannot be conveniently carried.

## ELECTRIC TRAMWAY ACCIDENTS AT GLASGOW.

In reply to a question by Mr. G. WEIR, Mr. GERALD BALFOUR stated in the House of Commons on Thursday last that the Board of Trade had received a report concerning the breakdown of the overhead wires in connection with the electric tramway system at Glasgow on June 14, and had referred the matter to the Board's expert adviser to consider whether any steps could be taken to lessen the risks of such accidents.

# ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 383.*)

Corresponding to a critical value of the potential difference, the air insulation between the balls breaks down, and it becomes highly conductive. Then the whole radiator becomes one conductor for the moment, and the potential difference begins to equalise itself—that is to say, a current flows from one side to the other, creating in the space around a magnetic flux, the direction of which is everywhere normal to the direction of the electric displacement. The electrostatic energy is, so to speak, melted down into electrokinetic energy. The flux then persists, and re-creates in an opposite direction electric displacement. The condition of the plates just prior to the passage of the air into the conductive condition is represented by the diagram in Fig. 3 (p. 116), where the U-tube drawn over the air-gap is intended to afford a diagrammatic illustration of the production of oscillations by the sudden release of a strained material body. We may consider an illustration of the process as follows:—Let a flat stretched steel spring represent the oscillator, and on it let a heavy disc be keyed like a wheel. Let the ends of the spring be fixed and the disc turned round, the spring thus being twisted. If then the wheel is released it begins to move under the action of the torsional force. It acquires kinetic energy, and when the twist of the spring has disappeared, the wheel is possessed of all the energy as rotational energy. This then expends itself in reproducing the twist of the spring in the opposite direction. If the electric oscillation in the oscillator is started sufficiently suddenly, some of the energy is thrown off in the form of a displacement wave, and as a consequence the oscillations of the radiator, as Bjerknes has shown, are quickly damped out. Accordingly, when the induction coil is kept going we have groups of intermittent oscillations, and therefore trains of electric waves thrown off which travel off or spread out through the dielectric.

* Cantor Lecture delivered before the Society of Arts, Dec. 17, 1900.

Hertz furthermore devised a resonator, a most simple and marvellously effective device for detecting these electric waves at any point in space. This in its simplest form consists merely of a nearly closed ring of wire, the ends being provided with metallic balls placed very close together. The ring may be a rectangle, and it may have a condenser inserted in its circuit, as in the arrangement due to Blondlot. In order that we may secure the sharpness of breakdown in the air insulation which is necessary to obtain the oscillations, three things seem necessary: First, the spark ball surface must be bright and clean; secondly, no ultra-violet light rays must fall on the balls, especially on the negative terminal; and, thirdly, the balls must be at a certain distance apart, best determined by experience.

In describing experiments with the Hertz oscillator, we shall call the *axis of the radiator* the direction of the line joining the centres of the spark balls, and the line through the spark perpendicular to this axis will be called the base line. Also, the line joining the spark balls of the resonator will be called the spark axis of the resonator. If the resonator is set in front of the oscillator, with its centre on the base line, then there are three principal position which the resonators may occupy. First, its plane may be parallel to the axis of the radiator and perpendicular to the base line: we shall call this the first position. Secondly, the resonator may have its plane in the plane containing the radiator axis and the base line: we shall call this the second position. Thirdly, the resonator may have its centre on the base line, and its plane perpendicular to the plane containing the radiator axis and the base line, and placed so that its plane passes through the spark-gap: this will be called the third position.

Hertz found that when the resonator is placed in each of these three positions respectively, but not too close to the radiator; and if at the same time the resonator is turned round in its own plane, so as to bring the spark axis of the resonator into various positions, different phenomena present themselves.

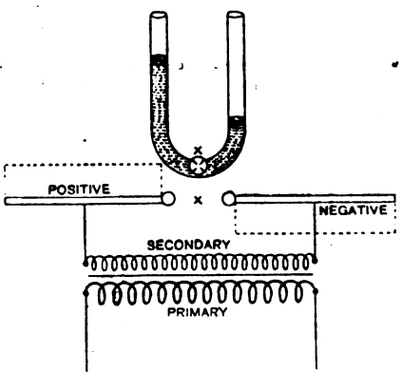


FIG. 3.—Diagram representing the Electrical Operations proceeding in a Hertz Oscillator when in action.

In the first place, if the resonator is placed in the first position, and with the spark axis of the resonator parallel to that of the radiator, then, when the radiator is sparking, small sparks also occur between the spark balls of the resonator; but if the resonator is turned round in its own plane, so that the spark axis of the resonator is perpendicular to that of the radiator, then no sparks occur at the resonator.

In the next place, if the resonator is placed in the third position, with its plane perpendicular to the axis of the oscillator, then no sparks are seen, whatever the position of the air-gap of the resonator.

When the resonator is placed in the second position, with its plane parallel to and passing through the axis of the radiator, then sparks are seen in the resonator air-gap when that gap is turned towards the oscillator; but they become less and less bright as the resonator is turned round in its own plane, until, when the air-gap is turned away as far as possible from the oscillator, they cease altogether.

In order to explain this spark production in the resonator it is necessary to make reference to an early fact discovered by Hertz. If the resonator is attached by a wire to one terminal of the induction coil, then when the coil is in action vigorous sparking is seen at the spark balls of the resonator unless the connecting wire is attached to the resonator at a point symmetrical with respect to the spark balls (see Figs. 4 and 5). This is due to the inductance of the resonator circuit. If the lengths of path measured along the resonator from the point of attachment of the wire to the spark-gap are unequal, then, owing to their unequal inductance, the rise or fall of potential produced by the coil terminal takes effect first at the spark ball attached to the branch of smaller inductance.

One might at first be inclined to suppose that no difference of potential could be created between two balls connected by a short loop of wire, but although this is the case when low frequency oscil-

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lations are used, it is not so when the frequency is very high. The same thing holds good when the resonator is not connected with the induction coil by a wire, but placed at a distance from the oscillator. In this case electric displacement produced by the radiator travels to the resonator through the dielectric. If the spark-gap of the resonator is held parallel to the spark-gap of the radiator, then the displacement or electric force arriving at the resonator fills the spark-gap of the resonator, and creates there an alternating displacement and an alternating potential difference between the balls. When this reaches a certain amplitude the air insulation breaks down, and a small spark is produced between the ball terminals of the resonator. Even although the resonator and the spark balls are connected by the resonator wire, this does not hinder the creation of the spark, as the inductance of that wire makes it a practically perfect insulator to very suddenly applied potential differences.

If, however, the resonator is held in a position so that the line joining the spark balls is in a direction at right angles to the spark axis of the oscillator, then no spark will occur in the resonator, because the electric force arriving there is not in a direction to create potential difference between the balls. If, however, the plane of the resonator is in the plane containing the base line and the spark axis of the radiator, and if the spark-gap of the resonator is so placed that its direction is perpendicular to the axis of the vibrator, then feeble sparking is seen in the resonator. This, however, is because the electric force distribution is disturbed by the metallic circuit of the resonator. The direction of the electric force, and, therefore, the displacement travelling through space, is then in the neighbourhood of the spark balls of the resonator no longer parallel to the spark axis of the radiator, but is slewed round so as to be inclined in a direction to the spark axis of the resonator. Hence the effect is to cause a displacement across the air-gap of the resonator, and, therefore, to create a spark.

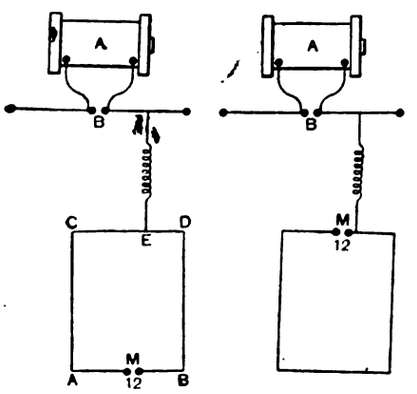


FIG. 4. FIG. 5.

FIGS. 4 and 5.—Hertz Resonator attached at an Unsymmetrical Point by a Wire to a Hertz Oscillator and having Sparks produced at its Spark-gap M.

We may ask then, what are the functions of the wire of the resonator if the spark formation is due to the action of electric force propagated from the oscillator? To answer this we must analyse a little more closely what takes place in the resonator when the spark passes. The resonator is a circuit possessing capacity and inductance, the spark balls forming, so to speak, the condenser portion of the circuit, hence it has a natural free period of electrical vibration. If in the space between the balls alternating electric displacement is produced, being propagated to that point through the dielectric, this displacement may or may not synchronise in period with the free period of vibration of the resonator. If it does time in with it, then the amplitude of the displacement oscillations is increased, and a point is reached at which the air insulation breaks down and a spark then passes. Owing to the fact that the resonator is a nearly-closed circuit, it is a very bad radiator, and as Bjerknes has shown (*Wied. Ann.*, Vol. XLIV., p. 74, 1891), such a resonator has a very small coefficient of damping. If it is a circular resonator 35cm. in diameter, as used by Hertz, it may make 1,000 vibrations before the oscillations are damped out.

It is obvious, therefore, that oscillations can be most easily set up in the resonator circuit when the vibrations of electric displacement, which give rise to these oscillations propagated to the spark-gap, are in a direction parallel to the spark axis of the resonator. In the case in which the resonator is placed with its plane lying in the plane containing the axis of the radiator and the base line, the distribution of electric displacement is disturbed, as already explained, by the metallic circuit of the resonator, and the advancing wave surface of displacement is distorted so that in crossing the spark-gap of the resonator the displacement has a component parallel to the spark axis of the resonator, and therefore the conditions are such as to be favourable to the production of at least feeble sparking.

Hertz's most famous discovery with the above-described simple resonator was the proof he was able to give of the existence of stationary electric waves set up in a dielectric bounded by a sheet of metal. He attached to his induction coil terminals a radiator composed of two square sheets of metal 40cm. in size, each having a wire 39cm. long attached to it ending in a brass ball. These plates were arranged with the rods in one line and the balls about 1cm. apart, the direction of the rods being vertical. As a resonator he used a circular wire 35cm. in diameter, with the ends nearly meeting and furnished with spark balls. A large sheet of metal was set up at the end of the room, and the radiator, with axis vertical, placed at the opposite end. The resonator was then held with its plane parallel to the metal sheet, and its spark-gap parallel to the spark-gap of the radiator. Under these conditions, if held near the metal sheet, no sparking occurred, but if moved away from it sparks were seen, and at a certain distance these sparks had a maximum brilliancy, but if the resonator was removed still farther from the metal sheet a position could be found in which the sparks again ceased. All along the base line, therefore, perpendicular to the metal sheet, it was found that there were positions of maximum and minimum sparking indicating a periodicity in the distribution of electric force in that space.

(*To be continued.*)

# LEGAL INTELLIGENCE.

## Macnaghten v. Traill.

At Dublin, on Tuesday, before the Vice-Chancellor, a motion was made to stay all proceedings in this action upon agreed terms.

The SOLICITOR-GENERAL said the action was brought by the plaintiff for an injunction to restrain the Giant's Causeway Electric Railway Co. from interfering with plaintiff's rights in his fishery in the river Bush by the erection of turbines for driving electric generating plant and the cutting of water trenches and cuts, whereby there was caused alternate stagnation and rapid rushing of water in the river, and to compel them not to intefere with the natural flow of the water in the bed of the stream, and for damages for trespass. Consent had been arrived at that the injunction, as sought, should go, the defendants to retain the use of the water trenches, cuttings, and turbines below the water-mill, and to be entitled to a reasonably large amount of water for their works.

The VICE-CHANCELLOR said that under such a vague arrangement (to which he, however was no party) he was sure the parties would be back in court again within the year, but he would make an order that the consent between the parties should be made a rule of Court, but it would not be incorporated in his order.

## Ridley v. Windermere District Electricity Co. (Ltd.).

In the Chancery Division on Friday last, before Mr. Justice Kekewich, plaintiff sought to restrain by injunction a nuisance by smoke and vibration. Counsel on his behalf (Mr. Warrington, K.C.) asked for a speedy trial. For the defendants it was contended that there might be a defence in law. Defendants' works had been going on for a very long period.

Mr. Justice KEKEWICH said when the parties were ready he would give leave to apply to fix a day for the trial.

## Graham v. National Telephone Co.

At Brompton (London) County Court on Friday last, Judge Stonor, and a jury, heard an action brought by Mr. J. C. Graham, barrister-at-law, against the National Telephone Co. for £6. 15s. damages for alleged breach of contract. Plaintiff said he had paid the company at the rate of £12 per annum for the use of a telephone, the working of which, however, had proved so unsatisfactory that he claimed damages. In February, 1899, the company put up a telephone at his chambers in the Temple, and at his residence at Kensington. From the first he had the greatest trouble in obtaining connection. Mrs. Annie Graham, plaintiff's wife, corroborated plaintiff's evidence.

For the defence Mr. J. FEARON, switch-room manager at the Kensington telephone exchange during 1900, explained that when the plaintiff desired to speak from his private house at Kensington to a clerk at his chambers, the message would have to go first to the Kensington exchange, then to the Holborn exchange, and from thence to the Temple. If the operator at either exchange neglected her duty the supervisors and manager were able to see that some one was ringing up. A "black book" was kept in which records of neglect and misbehaviour were noted. There was 1,100 subscribers connected with the Kensington exchange, but few complaints had been made.

Mr. J. CHURCHMAN, another switch-room manager, gave similar evidence.

Several lady operators at the Kensington exchange during 1900 gave evidence that the best attention was given to every call received from plaintiff's number—238.

Other evidence having been given,

The jury found for plaintiff for £5, and judgment was given accordingly, with costs on the scale above £10.

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The committee of the Croydon County Polytechnic require an assistant lecturer and demonstrator in electrical engineering. An advertisement contains further particulars. Applications to the clerk (Mr. S. W. Beckell) by July 10.

Swansea Corporation require a resident electrical engineer. An advertisement contains further particulars. Applications to the town clerk (Mr. John Thomas), Guildhall, Swansea, by July 11.

Wellington (N.Z.) Municipal Council require an electric tramway engineer. Particulars may be obtained from Messrs. John Duthie & Co., 23, Lime-street, London, E.C., to whom applications must be delivered before noon of July 20. An advertisement contains further particulars.

An assistant demonstrator in physical laboratory classes for the session 1901-1902 is required at the West Ham Municipal Technical Institute. Further particulars can be obtained from the Principal (Mr. Albert E. Briscoe, B.Sc.). See advertisement.

Stepney (London) Borough Council require an engineer-in-charge, a meter superintendent, and a meter-room assistant. Applications to Mr. Wm. C. P. Tapper, 27, Osborn-street, E., by July 8.

Middlesex County Council require an assistant engineer for electric traction work. Salary £600 per annum. Applications to Guildhall, Westminster, S.W., by 10th inst.

Kearsley District Council require a clerk of works to superintend the construction of tramways. Applications by 10th inst.

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Dr. E. W. Marchant has been appointed lecturer in electrotechnics at University College, Liverpool, in succession to Dr. A. Hay. For some time Dr. Marchant has been first assistant in the electrical engineering department at Finsbury Technical College.

In consequence of the increase in the number of students attending the senior day classes in the engineering departments of Merchant Venturers' Technical College, Mr. W. Keith Beard, B.Sc., has been appointed an additional assistant lecturer. Mr. Beard was educated at the Macclesfield Grammar School, and proceeded to Owens College, Manchester, gaining a Gilchrist scholarship of £50 a year for three years, and at the final examination for the B.Sc. degree gained an additional University scholarship of £50 a year. Since the completion of his University course he has had five years' experience in the locomotive works of the Great Central Railway Co., Gorton.

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**Alfreton.**—Having been unsuccessful in obtaining a provisional order the Council are now negotiating with the Derbyshire and Notts Electric Power Distribution Co.

**Baldwin Locomotive Works, U.S.A.**—Out of a total of 1,217 locomotives built during 1900 at the world-famed Baldwin Works, 48 were electric.

**Barnsley.**—The Council have received sanction to a loan of £19,800 for extensions of their electricity undertaking.

**Bedford.**—The accounts of the electricity department for the year ended March state that the total capital expenditure was £77,769, the total receipts for 1900 £10,780, the works costs £7,242, and that after paying interest and sinking fund there was a deficit of £912. The extra cost of coal was £982. After a lengthy discussion an amendment, moved by Mr. Carruthers, that the committee be requested to suggest how the undertaking could be turned into a profitable one, was carried, and the further consideration of the accounts was, therefore, postponed.

**Bermondsey (London).**—It is anticipated that electric current will be available by October. The price has been fixed at 6d. per unit for the first hour's maximum demand, and 3d. after, and for places of worship a uniform charge of 3d. is to be made.

**Bideford.**—Pending consideration by a committee of an offer by Messrs Southern & Co. to establish electricity supply works, the District Council have deferred the question of renewing their contract with the local gas company.

**Birkenhead.**—The Electricity committee recommend the Corporation to obtain power to borrow £40,000 for additional generating plant, distributing and service mains, &c.

**Bulgaria.**—A provisional concession has been granted for lighting the town of Varna by electricity, the estimated requirements being 50 10-ampere arcs and 1,500 16 c.p. incandescents. The concession will be for 40 years. The generating station will be steam driven as no water power is available.

**Carnarvon.**—Mr. W. Peterson intends to renew his application for a provisional order. The Council also propose to apply for an order, and it has been decided to oppose Mr. Peterson's application.

**Doncaster.**—Preliminary notice has been given of intention to apply for Parliamentary powers to construct an electric tramway between Doncaster and Barnsley.

**Dudley.**—Arc lighting is to be adopted in a number of additional thoroughfares, and application is to be made for a loan of £20,000 for additional generating plant, extensions of mains, &c.

**Dunstable.**—The Council will apply for a provisional electric lighting order for Dunstable, Houghton Regis, Caddington, Kensworth, and Totternhoe.

**Electric Railway in Canada.**—According to the *Monetary Times* of Toronto, it is proposed to construct an electric railway from Buckingham to the Original Rapids, 100 miles distant, current being generated at the waterfalls en route. The object of the line is to develop the large phosphate deposits throughout the district.

**Electrical Progress in Spain.**—There is a scheme on foot for the construction and equipment of an electric tramway to run between Almeria and Berja.

A company has been formed to supply electric light and power to Carthagena and the surrounding mining district. The company has offices at Bilbao, but a large part of its shares were offered locally at Carthagena and were promptly taken up. The company's main object is to substitute electric for steam power for working the mines. It is anticipated that the generating station will be in working order about the end of the current year.

**Electricity in North London.**—Representatives of Wood Green, Tottenham, Edmonton, Southgate and Enfield (the five districts which recently abandoned a proposed application to Parliament for a joint scheme of electricity supply) met in conference on Friday last to further consider the question. A resolution was carried to the effect that it is desirable that the joint committee of the Councils of the five districts should be reconstituted to take into further consideration the subject of establishing electricity supply in the respective areas of the councils.

**Electricity in Paper Making.**—A company has been formed at Ponte de Peilles, near Nice, to utilise the waters of the Var region to generate electric power to the extent of 100 H.P. for the driving of paper-making machinery. The factory, which at present only turns out paper of common quality to the extent of about 1¾ tons per day of 24 hours, will, when the installation is completed, increase its output three-fold, and will manufacture higher grades of paper.

**Elland.**—The Council resolved, on Wednesday, to adopt the electric lighting scheme prepared by Mr. W. Emmott. The Halifax Council are being urged to extend their electric tramway system to Elland.

**Exhibition.**—There is to be an automobile exhibition in the Crystal Palace, Leipzig, in October. It is said that machines driven by electricity or gas have a good future in the German market.

**Frome.**—The Electric Lighting committee is to visit several towns where electricity works are in operation in order to obtain information as to electric lighting.

**Grays (Essex).**—The charge for electric current has been fixed at 7d. per unit for the first two hours' maximum demand and 3½d. after.

**Gwelo (Rhodesia).**—The Sanitary Board have entered into a provisional agreement with Mr. J. L. Golding, of Bulawayo, for the electric lighting of the town.

**Halifax.**—The charges for electric current have been revised: For lighting, from 4d. to 3d. per unit, according to number of units consumed, and for power a uniform 2d. per unit will be charged.

**Hampstead (London).**—It was reported to the Council last week that the profit on the electricity works for the year ended March 31 was £2,017. The price of electric current for power has been fixed at 2d. per unit, with a minimum charge of 13s. 4d. per quarter.

**Hereford.**—The Council on Tuesday authorised application for sanction to a further loan of £5,000 for electric lighting.

**Hornsey (London).**—At Monday's meeting the District Council discussed the Middlesex County Council scheme of light railways and decided to oppose it. A deputation from Muswell Hill waited on the Hornsey Council on the subject, fortified by a memorial with 415 signatures attached, opposing the construction of the County Council lines, and urging, in the alternative, that the Hornsey Council should construct the lines if they must be put down. Mr. R. K. BURT, a member of the County Council and of the Hornsey Council, told the deputation that the people of Muswell Hill wanted a better train service, but they would never get it. The proposed tramways to the West End would give them the means of getting from north to west in 25 minutes, and would be of advantage to the Alexandra Palace. The district would get a large share of the profits of the proposed lines. Mr. SMITH would rather see the Alexandra Palace perish than that those lines should run through Muswell Hill. The motion to oppose the County Council's scheme was ultimately carried by 13 to 6.

**Hull.**—The question of extending the lighting mains to Hessle has been referred to the borough electrical engineer (Mr. A. S. Barnard) for report.

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**Johannesburg.**—The new Municipal Council has decided to undertake the electric lighting of the town, which has hitherto been in the hands of a company.

**Kensington (London).**—Mr. P. Monson, lighting engineer to the Kensington Borough Council, has been in communication with the companies supplying electric current in the district with regard to the lighting of a number of the main thoroughfares by arc lamps. Some difficulty arose in connection with the obtaining of a supply in certain parts of the area, but an agreement with the companies has been come to.

**Launceston (Tasmania).**—We have received a copy of the statement of accounts for 1900 of this municipality, which is one of the most enterprising and progressive in Australasia. It owns electricity supply and water works, museums and art gallery, public baths, &c., and will, doubtless, add electric tramways, municipal telephones, &c. There was a surplus of £525 on the working of the electricity department, compared with a deficit of £656 in the previous year. The gross revenue from the sale of current increased by £1,856. The energetic electrical engineer of the Council (Mr. W. Corin) anticipates a net profit of £1,250 for the current year, so that the accumulated deficit on the undertaking will be practically wiped out. There is a steady increase in the demand for current for lighting and power, and it is anticipated that by the end of the year the motor connections will be equivalent to 200 H.P. The Council supply motors and fittings on hire. The average lamp connections have increased from 65 per week last year to 75 per week for the first 11 months of this year. There was a small demand for heating and cooking apparatus, and some expansion in that direction may be looked for. The laundry electric flat-iron is growing in popular favour, and the revenue from that source is satisfactory. The streets of the suburb of Invermay have been lighted during the year, and some headway has been made with private lighting there. The increasing use of electricity for both lighting and power carries with it a corresponding demand on the part of the station, and the increase of generating plant is a matter for the early consideration of the Council.

**Leeds.**—The Lighting committee recommend the reduction in the maximum charge for electric current to 4d. per unit for lighting; for motive power the scale to range from 2d. to 1½d. per unit, and for cooking and heating a uniform charge of 2d.

**Leith.**—The burgh electrical engineer (Mr. J. Gray Scott) submitted a report to the Council on Wednesday on the position of the electricity undertaking at May 15. The total receipts for the year amounted to £3,172. 13s., and the expenses to £1,416. 5s. 4d. The capital expenditure to date is £59,776. 19s. 4d. It has been decided to borrow £35,000 additional.

**Lewes.**—Electricity supply is now available, the works of the County of Sussex Electrical Power Distribution Co. having been opened last week.

The Town Hall and Corn Exchange are being wired for the electric light.

**Light Railways.**—The Halesowen Light Railways order has been submitted to the Board of Trade for confirmation. Objections by July 20.

An inquiry will be held on 26th inst., at Hounslow, into the applications of the Middlesex County Council, and the London United Tramways (Ltd.) for orders to construct light (electric) railways in the district.

An inquiry will be held at Wood Green, on 10th inst., into the application of the Middlesex County Council for power to construct an extension of their authorised light (electric) railways in this district.

The permanent way of the Cheltenham-Cleeve light (electric) railway was officially inspected on Wednesday.

**Limerick.**—The Board of Trade have informed the Council that they cannot entertain the suggestion that the provisional order should remain in operation for five years further, but to give the undertakers full opportunity of exercising their powers, the Board consent to defer consideration of the revocation of the order for one year from November 9 next.

**Liverpool.**—The Tramways committee, who have been experimenting with a new life-guard for their electric tramcars, propose to fix 100 to the cars, at a cost of about £6 each.

**Luton.**—The electricity works were opened on 24th ult.

**Manchester.**—On Wednesday, in reply to a question as to why the contract for electrical machinery for the Stuart-street generating station had been given to a foreign firm, the chairman of the Electricity committee (Dr. Bishop) said it might be supposed from what had appeared in the Press that a great many English firms had offered to make the machinery, but of the 18 firms which offered to supply the motor generators, 15 stipulated that they should be made abroad. Only one of the two firms which would have made the motors in England could supply the committee with the machinery they wanted, and this firm's tender was £26,000 higher than that of the successful firm.

Sanction has been obtained for borrowing £810,000 for electric lighting.

For some time past the differences which have arisen between the corporations of Manchester and Salford as to the working of the through service of tramcars have formed a topic of discussion in local circles. The subject was referred to at considerable length at the meetings of both corporations on Wednesday when the respective tramway committees submitted reports giving their version of the cause of the rupture. An amicable arrangement is, however, likely to be speedily arrived at. Meanwhile the public, who were fairly well served by the Manchester Carriage and Tramways Co., are being put to considerable inconvenience owing to the interruption of the through service.

**Municipal Telephony.**—Liverpool City Council have resolved to establish a municipal telephone exchange, and the Finance committee has been instructed to apply to the Postmaster-General for a licence.

The town clerk of Swansea has been instructed to communicate with the adjacent local authorities to seek their co-operation with the Corporation in obtaining a licence to establish municipal telephony; and whether, in the event of the Corporation establishing a telephone service, they would become subscribers.

**Nantwich.**—Electricity supply and refuse destructor works, estimated to cost £14,000, are to be erected by the Council. The consulting engineers are Messrs. W. H. Trentham and G. R. Peers.

**Nelson.**—The Electricity department propose altering their system of supply by adopting the three-wire system with a voltage of 460 between the outers.

The Council, on Wedneday, decided to apply for a loan of £25,000 for erecting a new electricity station on the refuse destructor site.

**Pekin.**—Reuter announces that the contract for the electric lighting of this city has been given to a German firm.

**Radcliffe.**—An inquiry was held here last week into the Council's application to borrow £21,000 for electricity supply. It was announced that the Council would also construct electric tramways.

**St. Anne's-on-the-Sea.**—Extensions of the electricity works, estimated to cost about £7,000, have been authorised.

**St. Helens.**—The charge for electric current for power has been fixed at 2d. per unit for the first two hours' maximum demand and 1d. after.

**South Shields.**—From Oct. 1 the charge for electric current will be 7d. for the first hour's maximum demand and 3d. after; 7d. and 2d. are the present figures.

**Southport.**—The Duke-street-Churchtown electric tramway route was inspected on behalf of the Board of Trade on Tuesday.

**Stockport.**—A section of the electric tramways will be ready for opening next month.

**Stoke on-Trent.**—The Council have decided to proceed with the proposed municipal electricity scheme. Messrs. W. H. Trentham and G. R. Peers are the consulting engineers.

**Stretford.**—Mr. C. H. Wordingham's preliminary report on electric lighting has been adopted by the Council, and on Tuesday it was decided to instruct Mr. Wordingham to prepare a complete scheme.

**Swansea.**—A special meeting of the Electric Lighting committee has been called for this (Friday) afternoon to consider a report from the electrical engineer (Mr. J. H. Cawthra) as to extensions of the plant and mains. During the past month there had been 129 applications (equal to 15,111 8 c.p. lamps) for electric current, and the question of extensions has become urgent.

**Teignmouth.**—Notice of intention to apply for a provisional order has been given by the Provincial Electric Supply and Traction Co.

**Telegraph Clerks' Pay.**—A reply has been sent by the Postmaster-General to the application of the London branch of the Postal Telegraph Clerks' Association for an interview. He expresses himself as unable to depart from the views expressed in the letter addressed some time ago to Sir Albert Rollit, M.P., but agrees to grant the interview now sought. With regard to the regulation issued by the Civil Service Commissioners from 1881 to 1889 holding out a prospect of telegraph clerks attaining a salary of £190 per annum, the Postmaster-General states that this regulation was withdrawn after the examination in 1889. He denies that the regulation constitutes a contract or promise; it was intended to indicate only the salary which it was possible for a candidate to attain. The letter concedes that out of 530 persons who entered the telegraph service between 1881 and 1889 only four have yet succeeded in reaching the maximum scale. The letter finally points to the statement in the report of the Tweedmouth Committee that £160 was to be regarded as sufficient maximum for the general body of telegraphists, although it was recognised "that this class do not form part of the general body, but discharge duties of a superior character."

**The Electrophone.**—Notification is made by the Electrophone Limited that telephone subscribers (if a sufficient number can be obtained can be placed in connection with the company's system at an annual charge of £5, to cover performance at theatres, music halls and concert halls in London.

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**Theft.**—At West Riding Quarter Sessions, on Tuesday, two men (a labourer and a glassblower) were sentenced to 12 months' imprisonment each for stealing, on June 12, 108lbs. of bronze and copper, value £5. 8s., from the English Electro-Metallurgical Co. Another labourer was sentenced to three months' imprisonment in connection with the same offence.

**Torquay.**—The Council have postponed the question of the construction of electric tramways. The following estimate of the cost was prepared by the borough electrical engineer, Mr. P. Storey :—

Erection of new power house and shaft and providing water for condensing, &c., £10,500; removal of present generating plant and re-erection, £1,500; providing and laying new high-tension feeders to connect present lighting system, £4,755; contingencies, £837; total, £17,593. The equipment of eight lengths of tramway, with £1,870 for contingencies, was estimated at £54,233. 3s. Double-decked cars, to carry 45 passengers each, are put at £6,000 (or £600 each).

In moving the adoption of the report Ald. Kerswill stated that the electricity supply undertaking was growing at such a pace that at no distant date they would have to look out for another site for a generating station. When the present additions to the plant were completed they would be able to supply something like 22,000 8 c.p. lamps, and by the time they had their new machinery working it would be necessary to prepare for another station. The tramway scheme had been carefully thought out. If they did not deal with the tramway question soon their hands would be forced by private companies. The matter was, however, referred back for further consideration.

**University College, Liverpool.**—The annual meeting terminating the session of the department of engineering was held on the 27th ult. The total number of day engineering students is now 107, of whom 45 per cent. are reading for Victoria University degrees.

**Wigan.**—The negotiations for the purchase of the Wigan and District Tramway Co.'s undertaking have been broken off. The success of the new electric tramway to Boar's Head has been remarkable, the receipts averaging £110 per week.

**Wilful Damage.**—At Brentford (Middlesex) yesterday two young men, named Randall and Jackson, were charged with throwing stones at telegraph insulators and causing damage. A foreman of the electrical department of the Metropolitan District Railway stated that during this year 90 telegraph insulators had been broken along the particular piece of railway where the present damage had been caused. One of the prisoners stated that he had been in the employ of the National Telephone Co. and knew all about these insulators. He had no intention of damaging them, and was only playing. The magistrate (Mr. Sharpe) thought this defence an aggravation of the offence, and fined the prisoners twice the usual amount—£3 and costs.

**Woodbridge.**—The Council have referred a communication from the Suffolk Electricity Supply Co. relative to the erection of electricity works to a committee.

**Worthing.**—The proposal to apply for powers to construct electric tramways has been referred back.

**York.**—A healthy report has been issued by the city electrical engineer (Mr. C. A. Midgley) on the first year's working of the electricity department. After meeting the annual expenditure, paying interest and sinking fund, and discharging a debt of £310. 19s. 6d. incurred in preliminary expenses, there was a net profit of £98. 15s. 9d. The year had (the report states) been a phenomenal one, and had created a record which had never been equalled by any provincial station in its first year. They commenced with plant of 320 H.P., so that they were in a position to supply current to the equivalent of 6,000 8 c.p. lamps. So great was the demand, however, that a 400 H.P. steam dynamo, capable of supplying 7,000 8 c.p. lamps, was installed for the past winter, but even with this set they have not been able to have one of the others laid off, and at the end of the year (March 31) had a total lamp connection of 16,400 8 c.p. lamps connected to the mains, and over 5,000 lamps applied for, the majority of which would be connected by the end of July inst. They had had practically no trouble with the mains during the year, but those laid to Prof. Kennedy's specification were overloaded in all the streets, and would be quite unable to cope with the coming winter's demand. Prof. Kennedy in his original scheme based his figures on a total connection of 6,000 8 c.p. lamps, which he estimated would take about two years to reach; that figure had been reached by the time they were ready to supply current, and by the end of their first year they connected and were supplying current to 16,400 lamps. To meet the demand for the coming winter various extensions of the mains, estimated to cost (exclusive of excavating, jointing, and materials) about £8,600, it would also be necessary to considerably increase the capacity of the storage battery. The estimated cost of the battery and buildings extension is £2,250, making a total expenditure on mains and extensions for the coming winter of £10,850. Mr. Midgley concludes by stating that all the works are absolutely essential if the present rate of progress is to be maintained. Applications for current are already so extensive that the expenditure cannot but be remunerative. The Electric Light committee propose to carry out the extensions recommended, and it is also proposed to apply for sanction to borrow £10,850.

**Outings.**—Over 250 of the employés of the Incandescent Electric Lamp Co. had their annual excursion to Eastbourne on Saturday last.

The annual outing of the Simplex Steel Conduit Co.'s staff took place at Tewkesbury on June 29.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

As announced in an advertisement, the Visiting committee of the *Brecon and Radnor* Joint Asylum, now building at Talgarth, are prepared to receive schemes, specifications and tenders for the electric lighting of the asylum. Further information can be obtained of the architects (Messrs. Giles, Gough and Trollope), 28, Craven-street, Strand, W.C., and schemes, &c., must be addressed to the clerk to the Visiting committee, County Hall, Brecon, by August 5.

*Extension of Time.*—The *Cleckheaton* District Council have extended the time until July 13 for sending in tenders for the supply and erection of electricity generating plant advertised in our last issue.

*Shoreditch* (London) Borough Council invite tenders for the supply and erection of high and low tension continuous current switchboards and instruments. Specifications after July 1 from the electrical engineer (Mr. E. Newton Russell), Coronet-street, N. The specifications may be also inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders to Dr. H. Mansfield Robinson, town clerk and solicitor, Town Hall, Old-street, E.C., by noon July 10. An advertisement contains further particulars.

The Asylums committee of the *London County Council* invite tenders for steam boilers, pumps and fittings, cooking apparatus and fittings, and an installation of electric lighting (including generating plant) at the Epileptic Colony, Horton Estate, Epsom. Further particulars are given in an advertisement. Tenders to the committee, 6, Waterloo-place, London, S.W., by 10 a.m. July 23.

*Ilkeston* Corporation invite tenders for the construction of the permanent way and the electrical equipment of their tramways. Further particulars are given in an advertisement. Specifications, &c., from the consulting engineer (Mr. V. B. D. Cooper), Broadway House, Westminster. Tenders to the town clerk (Mr. Wright Lissett) by July 16.

*St. Pancras* (London) Borough Council invite tenders for three-phase high-pressure motors coupled to continuous-current low-pressure generators with switchboards and accessories, and for three-core lead-covered high-pressure cables. Specifications, &c., of the Electricity department, 57, Pratt-street, N.W., and tenders to the town clerk (Mr. C. H. F. Barrett) by noon of July 11. An advertisement contains additional particulars.

*Plymouth* Corporation invite tenders for tramcars, trucks, motors, trolley arms, &c. Specifications from the borough electrical engineer (Mr. E. G. Okell), Prince Rock, Plymouth, to whom tenders by noon, July 19. An advertisement contains further particulars.

*Kirkcaldy* Corporation invite tenders for feeders, mains and roadwork and arc lamps. Specifications from the town clerk (Mr. Wm. L. Macindoe), to whom tenders by 10 a.m. July 20. Specifications can also be seen, but not obtained, at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W.

*Mansfield* Corporation require boiler and engine house plant, condensers and electric pumps, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains and arc lamps, posts and accessories for public lighting, mains and workshop equipment. Tenders to town clerk by 4 p.m. July 12.

*Southwark* (London) Electric Light committee require two additional panels to the main switchboard at their electricity station. Tenders to town clerk, Town Hall, Walworth-road, London, S.E., by noon, July 10.

The Electrical Committee of the *Stepney* (London) Borough Council invite tenders for steam and other pipework, paper insulated cables, earthenware conduits, &c. Tenders to chairman by noon, July 18.

*Wallasey* District Council require machinery and tools for their electric tramways department. Tenders to Mr. H. W. Cook, Public Offices, Egremont, Cheshire, by July 18.

*Birkenhead* Corporation require 15 electric tramcar bodies and electrical equipments and trucks and trolleys for 15 cars. Tenders by July 16.

*Pontypridd* Guardians invite tenders for electric lighting of union workhouse, infirmary and other buildings. Tenders to clerk by July 23.

*Darlington* Gas and Electric Lighting committee invite proposals until July 16 for "free" or "assisted" wiring.

*Glasgow* Corporation invite tenders for concentric and single main cables. Tenders to town clerk by 10 a.m., July 9.

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*Manchester* Electricity committee require tenders for steel work, &c., for the Stuart-street generating station. Tenders by 11th inst.

*Erith* District Council require tenders for the erection of electricity station buildings. Tenders by noon 15th inst.

*Amsterdam* Municipal Council require tenders for about 140 tramcars for the overhead trolley system. Tenders by Sept. 2.

*Netherlands* Ministry for the Colonies requires galvanised iron wire, galvanised beams, poles and hangers for the Government telegraph service in Netherlands India. Tenders by July 31.

*French Post and Telegraph Department*, 103, Rue de Grenelle, Paris, invite tenders until 18th inst. for 280 tons of copper wire.

Tenders are invited by the *Spanish* Ministry of Public Works until 26th inst. for the concession for constructing and working an electric tramway between the railway station at Baeza and El Santuario de la Yedra (Jaen).

## TENDERS RECEIVED AND ACCEPTED.

The following is a complete list of tenders for electric tramway machinery at West Ham, which have been referred to the borough electrical engineer (Mr. J. K. Bock) for report :—

| | | | |
|---|---|---|---|
| Victor Coates & Co. | £22,000 | S. Z. de Ferranti (Ltd.) | £12,700 |
| Cole, Marchent and Morley | 20,577 | General Electric Co. | 12,700 |
| J. & H. McLaren | 18,002 | Mather and Platt | 12,530 |
| Dick, Kerr & Co. | 17,750 | British Schuckert Co. | 12,349 |
| E. Scott and Mountain | 14,598 | Brush Co. | 12,270 |
| British Westinghouse Co. | 14,433 | Frank Suter & Co. | 12,180 |
| Lancashire Motor and Dynamo Co. | | Johnson-Lundell Electric Traction Co. | 12,084 |
| £13,407, £13,425, and | 14,318 | C. A. Parsons & Co. | 11,829 |
| Veritys Limited | 13,998 | Witting Bros. | 11,790 |
| Bergtheil and Young | 13,597 | International Electric Co. | 11,710 |
| Thames Ironworks Co. | 13,200 | Allgemeine Elektricitäts-Gesellschaft (Berlin) | |
| John Fowler & Co. (Leeds). | 12,885 | £8,926 and | 10,840 |
| Siemens Bros. & Co. | 12,774 | | |

The following tenders for 11 water-tube boilers and fittings have been referred to the Lighting and Tramways committee for report :—

| | | | |
|---|---|---|---|
| B. R. Rowland & Co. | £17,520 | Babcock and Wilcox | £14,720 |
| J. Thompson | 16,250 | Richard Hornsby & Sons | 13,791 |
| Stirling Boiler Co. | 15,214 | | |

Dundee Corporation have accepted the tender of Messrs. Aiton & Co. for the supply of steel steam piping, valves and accessories at £1,048. The Corporation have also accepted the tender of the International Electric Co. (Liège and London) for the supply of a 700 H.P. triple expansion steam engine and dynamo at £4,283.

Belfast Gas and Electric committee have accepted the tender of Mr. George Y. Murray for well-boring and pumping machinery at the electricity works.

Llandudno District Council have accepted the tender of Messrs. Johnson and Phillips for the supply of 1,673 yds. of 0·25 triple concentric feeder cable (paper insulation) at £858. 7s.

Bermondsey (London) Borough Council have accepted the tender of the National Electric Wiring Co. for wiring the electricity generating station and stables, Neckinger, at £406. 15s. and £225. 10s. respectively.

Worthing Town Council have accepted the tender of Messrs. W. M. Smith and Son for wiring the electricity station buildings at £135.

Aberdeen Town Council have accepted the tender of Messrs. McKinnon & Co. for the iron and steel work at the Dee Village electricity station at £3,781.

Elland District Council have accepted the tender of Messrs. Meldrum Bros. for a refuse destructor.

Messrs. J. A. Newton & Co., Melbourne, have obtained an order from the Commonwealth Postal Department for the supply of 20 miles of underground telephone cable, for the Melbourne district, where the overhead system has become so congested that no further additions are practicable. The contract price is £4,992.

The Belgian State Railway Authorities, Brussels, received 14 tenders for two 30kw. shunt-wound dynamos—viz., from one French, two German, and 11 Belgian firms. Prices ranged from 12,468fr. (about £495), down to 6,837½fr. (about £250), the latter figure being the quotation of the Compagnie Belge d'Electricité, Brussels.

## BUSINESS NOTICES.

Mr. A. H. Hunt, 59, Gresham-street, London, E.C., has been appointed agent for the Walsall Electrical Co., and samples of the company's goods will be kept. The Walsall Company have been appointed agents for the "G. I." enclosed arc lamps and incandescent lamps. "Paragon" power motors, sewing machine motors, &c., and Mr. Hunt has on show a number of electrical specialites of interest in the way of traction switches, push switches, iron-cased fuses, switchboards, &c.

The Improved Electric Glow Lamp Co. (Ltd.) have removed to 7, Great Newport-street, St. Martin's-lane, W.C.

The proprietors of the *Architect and Contract Reporter*, an old-established and valuable medium for contractors and manufacturers, have formed their business into a limited liability company under the title of Gilbert Wood & Co. (Ltd.).

## BANKRUPTCIES, LIQUIDATIONS, &c.

Messrs. G. W. Warner and F. C. Shirley (trading as Warner and Shirley), electrical engineers, &c., 12, Holbein-place, Sloane-square, London, S.W., have dissolved partnership. Debts by Mr. Warner.

Messrs. W. H. Palmer and D. Watson (trading as Palmer and Watson), electrical engineers, 100, Charing Cross-road, London, W.C., have dissolved partnership.

Mr. Luis Alwyn and the Hon. R. C. Craven (trading as Alwyn and Craven), electrical engineers, 9 to 13, Cowcross-street, London, E.C., have dissolved partnership. Debts by Mr. Alwyn.

Messrs. J. McDonald and W. G. Titherington (trading as J. McDonald & Co.), electrical engineers, 23, Canning-place, Liverpool, have dissolved partnership.

The Kalgoorlie Power Syndicate (Ltd.) is being wound up voluntarily with Mr. H. J. Dixon, 257, Winchester House, and Mr. W. A. Smith, 28 and 29, St. Swithin's-lane, London, E.C., as liquidators.

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**Sale by Auction.**—Messrs. Wheatley Kirk, Price & Co. have received instructions from the Edison and Swan United Electric Light Co. (Ltd.) to sell by public auction, on Tuesday and Wednesday, July 9 and 10, at the Broadheath Engineering Works, Broadheath, near Manchester (on account of removal to Ponder's End, London), some plant and machinery, finished and unfinished stock. Further information is given in an advertisement, and full particulars can be obtained from the auctioneers, Albert Chambers, Albert-square, Manchester, and 46, Watling-street, London, E.C.

**Royal Agricultural Show.**—The 62nd annual exhibition of the Royal Agricultural Society was held at Cardiff from June 26 to July 1. Amongst the exhibitors were Messrs. Crossley Bros., John Fowler and Co. (Leeds), Gilbert Gilkes and Co., Ransomes, Sims and Jefferies, Robey and Co., Ruston, Proctor and Co., and W. H. Willcox and Co. The exhibit of Messrs. Crossley Bros. included a new pattern high-speed combined electric lighting gas engine and Crompton dynamo of 12½ B.H.P., and a number of the latest types of Crossley oil engine. These latter engines are all of the horizontal form, the vertical form of this machine having, apparently, been abandoned. Messrs. Gilbert Gilkes & Co. made a fine display of "Vortex," "Trent," and other types of turbines, water wheels and force pumps. The Robey exhibit included portable and stationary engines, including an open-type vertical high-speed engine with a working pressure of 80lbs., a 8 B.H.P. gas engine with tube ignition, and a stationary 6 H.P. oil engine. At Messrs. Ruston, Proctor & Co.'s stand several examples of "Ruston" oil engines were shown. A 5 B.H.P. machine, specially built for electric lighting work, was shown in motion driving a dynamo. Messrs. W. H. Willcox & Co. had a large exhibit of special engineers' stores, pumps, hose, engine packings, lubricators, oil purifiers, &c., which are a notable feature of this company's displays at the leading exhibitions.

**Expansion and Contraction Joints, &c.**—A useful illustrated catalogue of joints for expansion and contraction in steam pipes, &c., is issued by Messrs. Shipham & Co., Trinity Brass and Copper Works, Hull, who manufacture these goods, and whose London representatives are Messrs. John Wilson & Co., Lime-street, E.C. The increasing use of high steam pressures has necessitated the introduction of suitable pipe joints for reducing strains and preventing leakage in steam mains, and Messrs. Shipham & Co. claim to have special experience of the practical difficulties in connection with this subject, which they have met by introducing a varied assortment of joints in wrought copper, mild steel and other metals. Recent extensions at the Hull works, and the introduction of modern plant, places the company in a favourable position for the manufacture and supply of these goods.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from June 26 to July 2, with the ports of destination :—

*Africa*—Cape Town, £6 ; Durban, £341 ; East London, £74 ; Port Elizabeth, £48. *Argentina*—Buenos Ayres £150 (telegraph material). *Australasia*—Adelaide, £362 ; Brisbane, £41 ; Fremantle, £20 ; Melbourne, £855 ; Perth, £104 ; Sydney, £1,456 (including £220 telegraph material). *Canada*—Halifax, £44. *Ceylon*—Colombo, £81. *China*—Shanghai, £41. *Denmark*—Copenhagen, £2,300. *Dutch Borneo*—Banjarmasin, £165. *Germany*—Hamburgh, £245 (including £200 telegraph material). *Gibraltar*—£12,000 (telegraph cable). *Holland*—Amsterdam, £35 ; Flushing, £21 ; Rotterdam, £70 (telegraph wire). *India*—Bombay, £213 (including £114 telegraph material) ; Calcutta, £996 (including £601 telegraph material). *Japan*—Hiogo, £406 ; Nagasaki, £208 ; Yokohama, £1,089 (telegraph cable). *Norway*—Christiania, £68. *Spain*—Malaga—£60. *Straits Settlements*—Singapore, £47,175 (including £47,000 telegraph cable). *Sweden*—Stockholm, £256 (including £143 telegraph wire). Total, £68,930, against £10,485 in the corresponding week last year (June 27 to July 3).

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# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 14, 1901.

5,402. R. H. BEST. London. Improvements relating to electric pendant lamps.
5,411. G. EARL-ADAMS. London. Generator for the intensification of gravitational or electric stress.
5,421. A. NODON. London. Improvements relating to electrical reformers. (Date applied for under Patents, &c., Act, 1883, sec. 103, August 17, 1900, being date of application in France.)
5,427. H. W. DOVER. London. Improvements in the manufacture of electric cables and apparatus therefor.
5,449. G. WILKINSON. London. Improvements in underground conduits and accessories therefor for use with electrically propelled tramcars and like vehicles.

March 15, 1901.

5,452. W. H. MILNES. London. Electrically heated radiators.
5,460. J. FINLAYSON and W. SCOTT. Glasgow. Improvements in and relating to pre-payment meters for the supply of electricity.
5,464. H. H. HALL and G. SMITH. Manchester. Improvements in or connected with overhead conductors for electrical tramways and the like.
5,477. J. E. HILL. Halifax. New or improved means for diverting or cutting off electric currents in overhead electric trolley or like wires or cables, and guard wires, and disconnecting broken cables or line wires.
5,487. F. W. SCHINDLER. London. Improvements in electric-heating and cooking apparatus.
5,488. J. S. ROSS. Glasgow. Improvements in electric bell pushes.
5,489. F. G. SEALY. London. Improvements in or relating to electric tramways.
5,496. E. BATAULT. London. Improvements in electric meters. (Date applied for under Patents, &c., Act, 1883, sec. 103, August 17, 1900, being date of application in France.)
5,501. A. DURANT and O. BUCQUET. London. Improvements in diaphragms for phonographs.
5,510. R. LUNDELL. London. Improvements in commutator brushes and brush holders for electric motors or dynamo electric machines.*
5,528. J. R. MILNES. London. Improvements in wireless telegraphy.

March 16, 1901.

5,542. J. T. PEARSON. Burnley. Improvements in and relating trolley-wire guards or "protectors" of overhead-driven electric tramways.
5,547. J. MILNES. Liverpool. Improvements in electric railways and tramways on the sectional conductor system.
5,560. C. M. DORMAN and R. A. SMITH. Manchester. Improvements in electrical switches.*
5,562. J. W. DONALDSON. Manchester. Improvements in and relating to devices for cutting out broken or short-circuited sections of trolley-wires used in connection with electric traction systems.
5,570. C. A. LEE. London. Improvements in electric arc lamps and electrodes therefor.
5,589. A. MUIRHEAD. London. Improvements in electric telegraphy.
5,592. W. L. VOELKER. London. An improved method of manufacturing filaments for incandescing electric lamps.
5,589. M. KATSER. London. Improvements relating to portable electric lamps.

March 18, 1901.

5,628. J. W. SHEPERDSON. Leeds. Self-fastening rail bond for electrical connection of rail.
5,662. A. R. LEASK and P. M. BELLIS. London. Improvements in electric heaters.
5,700. J. POSCHL and J. M. GAUTSCH. Improvements in or relating to electric clocks.*

March 19, 1901.

5,713. H. LOMAX, R. LOMAX, and J. TOMLINSON, Manchester. Improvements in electrical switches.
5,714. G. SMITH and H. H. HALL. Manchester. Improvements in hand-fed arc lamps.
5,719. T. B. BIRKBY and F. E. BIRKBY. Liversedge, Yorks. Self-lubrication (without oil) of the swivelling spindles or forks connected with "trolley heads" used on the overhead trolley system of electric tramway cars.
5,728. P. MUSHET and C. P. EGGAR. Glasgow. Improvements in apparatus for changing illuminated advertisements and for other purposes, the switch connected therewith being also applicable for electric lighting generally.
5,754. E. DE PASS. London. Improvements in mounting incandescence electric lamps. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)
5,764. L. MOND. London. Improvements in obtaining zinc by electrolysis and apparatus for that purpose.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

146. MCGURTY and MCEWAN. Starting or controlling apparatus for electric motors.
2,219. ARNO. Measurement of electric power energy. (Date applied for under International Convention, July 5, 1899.
4,934. J. W. EHLERS and L. WEITZ. Current feeding devices for electric motor tramcars or the like.
5,050. THOMPSON (Helios Electricitäts Actiengesellschaft). Asynchronous rotary converters and other dynamo electric machines.
5,567. ANDREAS. Electric contacts or couplings.
5,569. THOMSON (Sperry). Electric storage batteries.
5,593. WRIGHT and REASON MANUFACTURING CO. (LTD.). Electricity meters.
5,649. S. G. BROWN and J. A. L. DEARLOVE. Telegraphic apparatus.
5,751. SPERRY. Storage batteries.
6,237. SCHWAZENBACH. Electrical gas igniting apparatus.
6,244. DAVID. Plates for secondary electric batteries and electrodes for electrolytic purposes.
6,564. GAERTNER. Reflectors for electric incandescence lamps.
6,794. ECKSTEIN and KRAUSE. Electrical combined switch and cut-out.
6,866. SPENCE. Electricity distribution on the multiple voltage system.
6,936. MOY and E. F. MOY (LTD.). Switches for electrical circuits.
6,947. LAMME. Dynamo electric machines. (Date applied for under International Convention, Feb. 26, 1900.)
6,948. LAMME. Polyphase induction motors. (Date applied for under International Convention, September 14, 1899.)
7,082. CERBOTANI and MORADELLI. Printing telegraphs.
7,287. HENNE and SCHÖNFELDER. Electric railways with underground conductors.
7,372. LANGDON-DAVIES and SOAMES. Formation of drum-windings for dynamo-electric machines.

# COMPANIES' MEETINGS AND REPORTS.

## British Electric Traction Co. (Ltd.).

The fifth ordinary general meeting of this company was held yesterday, under the presidency of Sir CHARLES RIVERS WILSON, G.C.M.G., C.B.

The SECRETARY (Mr. Chas. H. Dade) read the notice calling the meeting and the auditors' certificate.

The CHAIRMAN said: The year to March 31 has been a period of great activity for our company, with the result that we have largely developed and extended our business, that the financial position of the company has been greatly improved and strengthened, and that an increased dividend is available for distribution. The present accounts cover 12 months, whereas the statement previously submitted covered 15 months. The gross profits for the past year are £157,382, including £43,783 brought forward, but not including premiums on new issues. After paying all expenses and interest on debenture stock there remains £116,947 available for distribution. The dividend on the preference shares requires £34,256 and the dividend of 9 per cent. on the ordinary shares amounts to £55,866. The dividend already paid in respect of the six months to September 30, was at the rate of 6 per cent. per annum, and the distribution now to be made is at the rate of 12 per cent. per annum, making 9 per cent. for the 12 months. We propose that the goodwill account and the amount for cost of licences and testing of new systems should both be reduced by £2,500. After debiting profits with these and other items, there remains £21,457, which we propose to carry forward. In addition to the profits on trading we have received a net sum of £128,855 in respect of premiums on new issues of capital; this has been carried direct to reserve, which now stands at £338,520. During the year a very large amount of capital has been employed on the construction of new tramways and light railways, which lines have only quite recently been opened for traffic and so have produced no revenue. Upwards of 45 miles of new lines have been opened for traffic since the interim report in November last, and the capital outlay on these lines is on an average not less than £12,000 a mile. The amount of engineering work which has been executed during the year has been considerable. Since our last annual general meeting our various associated companies have opened for traffic nearly 60 miles of new or reconstructed tramways and light railways, and several electric lighting stations have commenced the supply of current. The Swansea tramways have been converted to electric traction, representing 5½ miles; Tynemouth tramways and light railways, 3¾ miles; Kinver light railway, 4¼ miles; Merthyr light railways, 3½ miles; Poole light railway, 3¾ miles; Gateshead tramways and light railways, 9½ miles; Bideford and Westward Ho railway, 5½ miles; Devonport tramways, 5 miles; Dudley, Stourbridge and District, various extensions, 11 miles; and Potteries light railway, 7 miles, making 58 miles opened during the year. We have obtained during the year acts of Parliament and orders, which have been confirmed, for the South Staffordshire light railways, 7 miles; Wellingborough tramroads, 19 miles; Peterborough light railways, 5½ miles; Christchurch tramways, 4½ miles; Gateshead light railways, 2½ miles; Weston-super-Mare tramways, 3½ miles; Morley and District light railways, 8¾ miles; Spen Valley light railways and extensions, about 19 miles; Sheerness and District light railways, 2½ miles; Worcester and District light railways, 4¾ miles, and Barnsley and district light railway extensions, 3 miles. These do not altogether cover the sphere of our action, because we have also obtained light railway orders, which have been granted subject to the approval of the Board of Trade, for Durham and District

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light railway, 2§ miles; Jarrow and South Shields light railways, 3¼ miles; Kidderminster and Bewdley light railways, 3§ miles; Potteries light railway extensions, 5§ miles; Rhondda Valley light railways, 2¼ miles; Wigan light railways about 4 miles; and Worcester light railways extensions 4 miles—altogether between 26 and 27 miles. I have troubled you with these particulars because they will bring home to you the very large amount of work which we are doing and which we have in prospect. We have at the present time 238 miles of lines in operation, of which about 118 miles are worked by electricity, 56 by steam, and 64 by horses. Many of these horse and steam lines are in course of conversion to electric traction. Altogether this company and its various associated companies have in operation, in course of construction or promotion upwards of 440 miles of tramways and light railways, and this does not include about 75 miles of omnibus routes. The aggregate traffic receipts which last year were at the rate of about £400,000 per annum, are in the present year amounting to about £600,000 per annum, made up mainly of 1d. and 2d. fares. The number of passengers carried is about 100,000,000.

With regard to our capital account, the subscribed share and debenture capital is £2,120,740; and as Messrs. J. S. Morgan & Co. and the Electric and General Investment Co. will forthwith exercise the option which we have given them to take up the unissued share capital, the total present subscribed capital may be put at £2,000,000 in shares and £600,000 in debenture stock, leaving the directors power to issue £400,000 debenture stock to bring the issued capital up to £3,000,000. The unissued capital is £379,260, and Messrs. Morgan and the Electric and General Company will make an issue of this capital almost immediately. I may here say a few words on the arrangement we have made with the Brush Electrical Engineering Co. We have for some time felt the necessity of having some central establishment where we could obtain with economy and facility all the necessary appliances for our business. Of course, it would be quite out of the question for each of our associated companies to have its own stores and its own establishment of that description. We had at one time contemplated the creation of a central store under our own management from which the necessities of our associated companies could be provided, but there were objections to that course. In the first place the outlay would be very considerable, and the delay in establishing a business of that kind would also be very great. We then remembered the very excellent and friendly relations we had with the Brush Electrical Engineering Co., with whom in the past we have had many large transactions of a most satisfactory character. When we approached the Brush Company with the view to some combination which should be profitable for both, we were met in a very cordial and friendly spirit, and the result was we acquired a substantial holding in the shares of that company—15,555 ordinary shares. We have also a substantial holding of their preference shares, acquired under other circumstances. The arrangement will be a great convenience and economy for the working of both companies. With regard to the item of contracts and undertakings appearing in the balance-sheet at £626,333, this is larger by £82,887 than it was last year, which is explained by the increased work that we have carried out. Of the items making up this large amount £54,314 represents good realisable assets in the various acts and orders which we have obtained and not yet financed, but which are included in this item at the actual cost only. The powers included in this item include the Barnsley light railways, Durham light railways, North Metropolitan scheme, Morley light railway, Peterborough light railway, Birkdale electric lighting and tramways, Sheerness light railway, Spen Valley light railways, Weston-super-Mare tramways, Wellingborough and district tramroads, Jarrow light railway, Leamington and Warwick electric lighting and tramways, and a few others. As to our investments, which stand at a cost of £1,349,130, this item is made up of consols £102,901, loans and advances to associated companies and others, £73,105; mortgages, debentures, and shares of associated and other companies, £1,173,123. It is necessary that a company carrying on the extensive and varied operations which we undertake should have a good and strong reserve, and I think you will support us in the view that the fact of our having £100,000 in consols very much strengthens our position. With regard to other investments, amounting to about £1,250,000, we have on this occasion for the first time published a list of them at the end of the year. The list shows that our investments extend over about 70 different undertakings, and that in the aggregate they appear in the books at less than their par value. As to the remaining items on the assets side of the balance-sheet, there is an amount of £422,279 due to us by sundry creditors. This includes £357,399 due from other companies in respect of sales of undertakings—that is, for companies formed but not developed, or in respect of issues not completed. Some of these accounts have already been liquidated, and others will be received in the course of the current year, but, of course, other items will take their place. The reserve fund stands at £338,520. The sundry creditors amount to £159,021. This includes £25,000 still owing to the pioneer company, and, as I have frequently explained, this is merely a book entry. The pioneer company will be wound up in the course of this year, and this item of £25,000 on the liability side and the *per contra* item of £24,940 included in investments will disappear. The balance on profit and loss account is £63,376, of which £21,457 will be carried forward. These items together equal the total sum of assets, and I think you will agree that the position of the company, as shown by the balance-sheet, is extremely strong. The profit and loss account includes a new item—namely, the amount of contributions to the superannuation fund, which is £1,117. 14s. 10d. You will remember that I explained last year the scheme for the creation of an officers' superannuation fund, and it met with your approval. It has been received with great goodwill and approval by the officers, for although it has only been in operation since January 1 last, 23 of the companies have already given their adhesion to it, and some 60 officers have already joined it.

I now come to a matter of very considerable importance, which bears upon the stability of our various associated companies, and also upon the credit and reputation of the parent company—that is, the British Electric Traction Co. You are most of you aware that the tenure of the concessions obtained for working tramways and light railways in this country is only of a temporary description, and that after a certain period it is open to local authorities to purchase these undertakings. Under the Tramways Act of 1870 very considerable loss was entailed upon the earlier companies worked by steam or horses by the acquisition at the expiration of the concession of their undertakings by the local authorities upon terms which did not admit of a repayment of the capital, and which, consequently, inflicted very great loss on those companies. These were somewhat amended by the light railway legislation, and also by the Acts of Parliament which were occasionally obtained for certain undertakings, and no doubt better terms are now obtainable. The tenure was generally longer than it was under the Tramways Act, and the conditions under which the undertakings are eventually purchased by the local authorities are also more favourable. There is also the fact that the profits from electric traction are more favourable than by the old method of traction. But even after allowing for all these better circumstances the fact still remains that these concessions are terminable, and that is a contingency we must look forward to. Even, however, if that were not so, we have to consider the necessity of constant renewals of our permanent way, and of our electric equipment, our cars, &c. Under these circumstances we considered whether it was not advisable to make some comprehensive scheme by which this contingency should be provided for by the establishment of sinking funds. We thought we might take advantage of the very strong position we occupy to interest our various associated companies in the establishment of a mutual fund. After taking proper actuarial and legal advice we arrived at this conclusion—that, if the shareholders approved, we propose that a fund should be established, to be under the control of trustees to be nominated by this company, and to issue to subscribing companies certificates or policies guaranteeing by the British Electric Traction Co. the payment of fixed sums at given dates in return for the payment to the fund by the associated companies of such a smaller sum as will, with compound interest not exceeding 3¼ per cent., amount to the guaranteed sum at the given date. As security for this guarantee it is proposed that the British Electric Traction Co. should deposit with the trustees interest-bearing securities. The working out of this scheme, while very beneficial to all the companies concerned, will result also in some small profit to this company, which we can legitimately take for the trouble and responsibility we have undertaken. If any of the associated companies desire additional security they can make arrangements with the insurance companies to obtain such additional security. We think that the adoption of the scheme will be an answer to some of the critics who have expressed apprehensions in regard to what thty consider the wasting character of tramway securities.

I have only one further remark to make—namely, that in view of the very heavy increase of executive work at headquarters, we have felt it necessary to appoint one of our directors, Mr. Raworth, under the special power reserved to us, to the post of an additional managing director, with the title of "technical director." In that capacity he will undertake the responsibility, with Mr. Sellon as chief engineer, of the management of the engineering branch of our business. I now move the adoption of the report and accounts and the payment of the dividends set out therein.

The Hon. Sir CHARLES W. FREMANTLE, K.C.B., seconded the motion.

A discussion followed, in the course of which satisfaction was expressed generally at the position of the company, but Mr. SMART criticised the action of the directors in giving Messrs. J. S. Morgan & Co. and The Electric and General Investment Co. (Ltd.) the option to take up the company's unissued share capital in consideration of their guarantee in connection with the issue of 30,000 preference shares. By this option he stated that an enormous profit had been made by the two firms, and he contended that any advantage in the issue of shares should be given to the shareholders.

The CHAIRMAN, in reply, said that the directors were most desirous of giving the shareholders every advantage they could, but they had, in connection with the large works undertaken by the company, to have large sums of money at their disposal, and in former cases, when they had offered shares to the shareholders they had not been taken up. Under these circumstances he defended the course taken by the directors and stated that they had been greatly relieved by obtaining the money guaranteed under the issue referred to.

The motion was adopted and the retiring directors and auditors were afterwards re-elected.

A hearty vote of thanks to the chairman, directors, and staff, was unanimously carried, and the proceedings terminated.

## United River Plate Telephone Co. (Ltd.).

The fifteenth annual general meeting of this Company was held on Tuesday, under the presidency of Mr. J. IRVING COURTENAY.

The SECRETARY (Mr. E. M. Reiss) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: The figures in the accounts so plainly cover the substance of what may be expected from me to-day that I only feel it necessary to comment briefly upon some of the most important items in what I think may be considered the most satisfactory statement we have ever had the pleasure of laying before you. Our business is expanding in all directions, and while trade generally in the River Plate for the last twelve months has been poor, the interests of our Company have suffered but little thereby. Compared with the previous year, our issued share capital stands at £490,000 instead of £373,195. Our debenture stock, £179,947, remains the same. The reserve fund is £40,000 against £20,000, and the depreciation fund £8,495, against £3,495. The balance of profit is within

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£250 the same as last year. The credit side of the balance sheet shows an additional capital outlay of £30,968, in the main represented by underground plant. Sundry debtors are considerably increased, chiefly on account of advances to manufacturers for materials, a large part of which have now been shipped. Real estate in the River Plate, £85,087, represents our five principal central office properties in Buenos Ayres and La Plata, which are not only intrinsically worth the amount at which they stand, but much more, as they constitute permanent centres not subject to exorbitant increase of rents or inconvenient eviction. Securities at cost, £120,682, is another tower of strength to us. The actual value of these securities at Stock Exchange prices is about what was paid for them. It is expected that this large sum will be rapidly reduced by the expenditure on the underground plant. Expenses of preference share issue, £5,840, is an item which, through proposed appropriation of profit, will wholly disappear in our next balance-sheet. Bills receivable, £22,000, and cash at bankers, in hand, and at call, £29,544, show a favourable difference over last year of £17,000. Profit and loss account, on the debtor side, shows an increase of £6,330 in expenses in the River Plate, the great part of which is attributable to a general and necessary increase of wages in Buenos Ayres and to the numerous changes of lines and routes rendered necessary by the improvements and rebuilding now very largely in progress in that city. On the credit side it will be noticed that the receipts from subscriptions and other sources have increased £8,370, and from dividends and interest £1,673, a total increase in receipts of over £10,000. The result is that in the proposed appropriation of profit we write off the whole of the expenses connected with our late issue of preference shares, place £15,000 to reserve, and, after providing for the final dividend on the ordinary shares, making 7 per cent. for the year, carry forward £6,058. The Board consider it most desirable that the reserve fund, already a strong feature in our balance-sheet (which will now amount to £55,000), should be substantially increased, and they have confidence that the earnings of the business will regularly permit this to be done. I now move the adoption of the report and accounts.

Mr. F. W. JONES seconded, and, in fully endorsing the statement of the Chairman that the accounts were the most satisfactory that have ever been presented to the shareholders, said: The strength of the financial position of the Company is shown by the fact that after providing for debenture interest and preference share dividend there remained at the end of the year, in securities at a fair valuation and cash, over £160,000. This large sum has since been reduced by capital expenditure, and what we have in hand will rapidly be required for underground plant, for further purchase of real estate for central and sub-offices, and for extensions of the business that are looked forward to. Further and strongly emphasising our financial strength is the real estate, all freehold, of which we are the proprietors, the cost of which is well within its actual value, which is constantly increasing. The value to us of this real estate could, as the Chairman has indicated, hardly be over-estimated. It forms permanent anchorage grounds from which our telephone lines radiate in all directions, and the freedom from liability to removal and to the payment of unreasonable rentals is of incalculable value to us. I would also particularly instance as a new element of strength our subway work, which has become and is likely to continue to be one of the principal features of our capital expenditure. It is from this necessarily very expensive work that we expect to be relieved from the heavy outlay on removals and repairs of aerial lines to which we are now constantly subject; and at the same time it will enable us to more rapidly and with an improved service, attend to the increased demand for telephones which is confidently anticipated.

Mr. LEA-SMITH was pleased to hear that the Directors intended to put by a large sum to reserve, as he was sure that was a right policy to follow. In regard to the question of having their own exchanges, were that not the case they would, in the event of a lease falling in, be practically in the hands of the landlords, and it was, therefore, good policy for the Company's exchanges to be their own property. What surprised him in connection with the Company was the market price of the shares—especially the preference shares.

Mr. MOUNTCASTLE inquired the nature of the securities, and if as much as £120,000 would be required to complete the whole of the underground plant.

Mr. JONES, in reply, expressed the hope that the Company would spend not only the £120,000, but double that amount eventually. The underground plant was to be in the case of their Company, as it was in the case of London, their absolute strength. The underground plant would never be completed practically, because it would go on extending as the city extended, but when it was completed, in so far as that could be done, he believed that they would find that the list of subscribers would mount up very greatly indeed. They had now about 10,000 subscribers, but it would not surprise him in the least if, within a reasonable time—five or 10 years—that number were more than doubled.

The CHAIRMAN said the securities held by the Company were very good, and consisted of railway and other first-class Stock Exchange investments, exchequer bills, and some of the national securities.

The motion was then carried unanimously.

The retiring Directors, Mr. J. I. Courtenay and Mr. F. Green were re-elected, as were the auditors, Messrs. Welton, Jones & Co.

Alterations in the Articles of Association having been approved, a cordial vote of thanks to the Chairman and Directors terminated the proceedings.

## Electric Construction Co. (Ltd.).

The directors' report states that the profit for the year ended May 31, including £4,777. 1s. 9d. brought forward, is £30,018. 18s. 2d., which it is recommended should be appropriated as follows:—Dividends of 7 per cent. on the preference shares (payable July 31), £3,713, and 6 per cent. on the ordinary shares (one-half payable July 31 and one-half Jan. 31, 1902), £13,452, adding to reserve £4,792. 10s. (the premium on preference shares) and £5,207. 10s. from surplus profits, a total of £10,000, and leaving £2,853. 18s. 2d. This makes the reserve £30,000.

The buildings and plant have been thoroughly maintained, and £5,000, as usual, has been credited to depreciation account, which now amounts to £38,000. The new factory is equipped with the best labour-saving tools and appliances, capable of turning out economically and with despatch the largest electrical machinery that may be required, but the full benefit of the expenditure has accrued only during the latter part of the year.

The electrical equipment of the extension of the City and South London Railway, completed last year, has given full satisfaction, and another contract for further extension has been entered into with the railway company. The works are well supplied with orders, and a great demand for electrical plant is anticipated in the near future. The relations with all classes of the employés continue satisfactory, and the directors have pleasure in awarding the usual bonus in recognition of good service. The compensation paid under the Workmen's Compensation (1897) Act is £295. 15s. 7d. for the year.

The Madras electric tramways have yielded a moderate return on their cost to the company, and the traffic is steadily increasing.

The directors recommend that Mr. James Gray, who has been for eight years secretary, be elected to a seat on the board.

## Electrical Power Storage Co. (Ltd.).

The directors of this company, in their report for the year to May 31, state that the profit for the year is £5,665. 9s. 5d., and the balance forward £258. 7s. 8d., making £5,923. 17s. 1d. £1,000 has been carried to contingent fund, and a dividend is recommended of 5 per cent. on the ordinary shares, absorbing £4,491. 8s., leaving £432. 9s. 1d. to be carried forward.

The buildings, plant, tools, &c., have been maintained in thorough repair and condition at a cost of £2,698. 12s. 11d. out of revenue. A gold medal was awarded to the company at the Paris Exhibition in recognition of the general excellence of its manufactures. The area of the works at Millwall has been increased and firepoof stores erected.

The output during the year has been in excess of any previous year, although increased cost of raw materials has obliged the company to charge higher prices for its manufacture. Numerous important contracts for power and lighting stations have been completed, and a number of similar contracts are in course of execution.

The company's staff has given much attention to the improvement of the traction type of cell for use in electrically-propelled vehicles, and the company is doing a considerable and increasing business in this class of work.

**ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)**—The directors report for the year to May 31, states that the accounts show a gross profit of £18,574. 2s. 10d., and after deducting all general charges and the interim dividend on the ordinary shares, there is a net balance of £10,409. 0s. 2d. The directors propose to carry £409. 0s. 2d. to contingencies fund and to divide the remaining £10,000 as follows:—Dividend of 5s. per share on the ordinary shares for the year (2s. of this was paid in December) requiring £3,000; bonus of 2s. per share, £2,000. Dividend of £50 per founders' share for the year, £5,000, in each case less income tax. No distribution is proposed for the past year in respect of the founders' or of the ordinary shares reserve funds. Warrants for the dividend, payable July 1, on the 6 per cent. cumulative preference shares have been posted.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**CHEPSTOW ELECTRIC LIGHTING AND POWER CO. (LTD.)**—Reg. June 27, capital £2,000 in £1 shares, to carry on at Chepstow and elsewhere the business of an electric light and power company in all branches, electricians, engineers, &c. The subscribers are C. O. Liddell, S. W. Yockney, civil engineer, T. V. Ellis, J. Rowe, civil engineer, G. C. Francis, W. S. Jones (each with 50 shares), and Dr. W. A. Shoolbred (25 shares). The first directors are C. O. Liddell, S. W. Yockney, T. V. Ellis, G. C. Francis and W. S. Jones.

**L'AUTO-REGULATEUR MOTEUR HYDRAULIQUE "CASSEL" (LTD.)**—Reg. June 20, capital £15,000 in £1 shares, to adopt an agreement with Mr. E. F. Cassel, and to carry on the business of electrical, mechanical, civil and consulting engineers, founders, machinists, &c. The first directors are E. F. Cassel, E. W. Serrel, jun., O. Servan, and E. C. de Segundo.

**LEATHERHEAD AND DISTRICT ELECTRICITY CO. (LTD.)**—Reg. June 26, capital £10,000 in £1 shares, to acquire the Leatherhead Electric Lighting Order (1898), to carry out the works authorised, or to acquire and carry out any similar or extended order, to carry on the business of an electric lighting company and to produce and supply electricity, &c.

**LODGE-MUIRHEAD WIRELESS AND GENERAL TELEGRAPHY SYNDICATE (LTD.)**—Reg. June 29, capital £50,000 in £1 shares, to acquire from Principal O. J. Lodge, F.R.S., and Dr. A. Muirhead, the benefit of certain existing inventions relating to telegraphy and telephony, to acquire other patents, licences, concessions or inventions relating to telegraphy, telephony and the like, and to carry on business as telegraph, mechanical and electrical engineers and contractors, manufacturers of dynamos, telegraphic apparatus and instruments, wires, cables, insulators and electrical fittings, launch and ship builders, wire drawers, tube makers, &c. The subscribers are Principal O. J. Lodge, F.R.S., A. Muirhead, D.Sc., electrical engineer, H. J. Muirhead, F. L. Muirhead, electrical engineer, G. J. B. Porter, W. Russel, and C. S. Goule. The first directors are Dr. A. Muirhead, H. J. Muirhead and F. L. Muirhead.

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**METALS CORPORATION (LTD.)**—Reg. June 21, capital £25,000 in £1 shares, to adopt a agreement with the Electrical Corporation (Ltd.) for the acquisition of certain inventions relating to the electro-deposition of metals, the manufacture of tubes or sheets of copper or other metals, and of copper wire or strip, and to carry on the business of metal workers and merchants generally.

**MOTOR TRUST (LTD.)**—Reg. June 13, capital £3,000 in £1 shares, to adopt an agreement with Messrs. G. F. Milnes & Co. (Ltd.), and to carry on the business of manufacturers of and dealers in motor and other carriages, electricians, mechanical engineers, machinists, makers of electrical apparatus, &c.

**NEW PRINCIPLE AUTOCAR (LTD.)**—Reg. June 25, capital £100 in £1 shares, to carry on business as motor carriage, &c., makers, engineers, makers of engines, motors and dynamos, &c.

**R. AND A. PARKER (LTD.)**—Reg. June 25, capital £25,000 in £1 shares, to acquire the business of R. and A. Parker, at Chorley, electrical engineers, machinists, founders, &c.

**WEST RIDING TRAMWAYS AND ELECTRICITY SUPPLY CO. (LTD.)**—Reg. June 28, capital £275,000 in £1 shares (125,000 preference), to adopt an agreement with the United Kingdom Tramway, Light Railway and Electrical Syndicate (Ltd.), to acquire or construct tramways or light railways within the districts of Castleford, Featherstone, Normanton, Whitwood, Knottingley, Pontefract and Tadcaster, in the West Riding of Yorkshire, or elsewhere in England, to apply for powers to equip, maintain and work by electricity or other power, tramways and light railways, and to carry on the business of tramway, railway, and light railway proprietors, makers of accumulators, dynamos and electrical apparatus, suppliers of electricity, electrical and general engineers, metallurgists, carriage builders, &c. The subscribers are R. L. York, engineer; R. J. Longley, civil engineer; H. Courtney, surveyor; W. Spinks, civil engineer; E. F. Chapman, gas engineer; L. W. Stanley, consulting chemist; and S. H. Cook.

**BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)**—In the annual return to May 3 the capital is given as £850,000 in 100,000 ordinary, 40,000 "A" preference and 30,000 "B" preference shares of £5 each, of which 100,000 ordinary, 40,000 "A" preference and 27,500 "B" preference have been taken up. £5 per share has been called up on 40,000 "A" preference, and £200,000 has been received. £637,500 is considered as paid on 100,000 ordinary and 27,500 "B" preference shares. Mortgages and charges, £440,000.

**DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION CO. (LTD.)**—The annual return to May 1 gives the capital as £200,000 in 20,000 ordinary and 20,000 preference shares of £5 each, all of which have been taken up and paid for in full. No mortgages or charges.

**ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)**—The annual return to May 10 gives the capital as £200,000 in £1 shares, 171,594 of which have been taken up. £1 per share has been called up and paid on seven, and the remaining 171,497 are considered as fully paid. No mortgages or charges.

**OXFORD ELECTRIC CO. (LTD.)**—According to the annual return to March 22 the capital is £100,000 in £5 shares, 10,000 of which have been taken up. £5 per share has been called up on 3,510, and £17,550 has been received. £34,000 is considered as paid on 6,800 shares, including £1,550 credited as paid on 310 forfeited shares. Mortgages and charges, £49,450.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27d. per oz. (July 4). Consols (2¾ per cent.) 93⅝—93½ for money, 93 15/16—93 17/32 for account; 2½ per cent. 93¼—94¼ (July 4). Consols Pay Day, Aug. 31; Stocks and Shares Continuation Days, July 15 and 29; Ticket Days, July 16 and 30; Pay Days, July 17 and 31; Mining Share Carry-over Days, July 12 and 26.

**AKTIENGESELLSCHAFT ELECTRIZITATSWERKE VORMALS O. L. KUMMER & CO.**—A meeting of the shareholders of this company, which has got into financial difficulties, was held on the 29th ult. It was stated that the company was interested in several undertakings (including the Murnau-Oberammergau electric railway) which had not realised expectations. The meeting was adjourned, and in the meantime it is probable that an attempt at re-constructing the company will be made.

**BRITISH CONTINENTAL ELECTRICITY CO. (LTD.).**—The directors' report states that during 1900 80 applications had been received for electric light. 2,462 8 c.p. lamps have been added during the year, and the sale of current had increased 20 per cent. The full dividend is declared on the 5½ per cent. cumulative preference shares and 2 per cent. on the ordinary shares. £2,589. 16s. 11d. has been spent on capital account during the year, including the purchase of an 80kw. alternator.

**DOULTON & CO. (LTD.)**—The directors recommend a dividend of 7 per cent.

**EASTERN TELEGRAPH CO. (LTD.)**—Subject to final audit, the accounts of this company show, after payment of interest on 4 per cent. mortgage debenture stock, dividend on the 3½ preference stock to March 31, and the interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31 last, a balance sufficient to pay a final dividend of £1. 5s. per cent., and a bonus of £2 per cent., both tax free, on the ordinary stock, both payable on 17th inst., making, with previous payments on account, a total distribution of 7 per cent. on that stock for the year ended March 31. The transfer books will be closed from July 10 to 17 inclusive.

**ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.)**—Subscriptions have this week been invited to an issue at par of 10,000 6 per cent. cumulative preference shares of £5 each and of £75,000 5 per cent. debenture stock. The lists closed yesterday (Thursday).

**ELECTRICAL LUMINISCRIPTOR CO. (LTD.)**—The first statement of accounts has been issued. The capital is £43,550, of which £42,000 has been expended in the purchase of patents.

**GREENWOOD AND BATLEY (LTD.)**—Mr. Arthur Greenwood presided at the annual meeting on Saturday. He congratulated the shareholders on the healthy nature of the report. Trade had been good in all branches except the textile department. They had recently commenced operations in the De Laval patent turbine, and were looking forward with confidence to this branch of their business. In reply to questions, the chairman said they were getting light railway orders, so that they might obtain the contract for equipping them electrically. The report was adopted.

**NEW GENERAL TRACTION CO. (LTD.)**—Subscriptions have been invited to an issue of £200,000 5 per cent. mortgage debentures of £100 each at par in this company, which was formed in March, 1896, and has a controlling interest in the Douglas Southern, the Isle of Man, and the Coventry Electric Tramways. The company also owns the electric tramways at Norwich, which were opened for traffic in August last year, and are now successfully working. Included in the assets is a large interest in a system of tramways working in the suburbs of Philadelphia, U.S.A. The progress of the company has been continuous, the profits earned being set out in tabular form in the prospectus. The list closes to-day (Friday).

**SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.)**—Interest warrants to June 30 on the 4½ per cent. first mortgage debenture stock have been posted.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed July 10 as a special settling day in 3,000 £1 shares (2s. 6d. paid, Nos. 7,001 to 10,000) of the *Pearson Fire Alarm Syndicate (Railways, Docks and Shipping) Ltd.*, and has ordered the further issue of £103,919 3½ per cent. preference stock of the *Eastern Telegraph Co. (Ltd.)* to be quoted in the official list.

**THOMAS PARKER (LTD.).**—The directors' report for the year ended April 30 states that after allowing for depreciation the balance standing to credit of profit and loss is £11,021. 17s. 6d., out of which the directors propose to pay a dividend at the rate of 10 per cent. per annum, less tax, and to place £2,500 to reserve (making it £17,500).

**URBAN ELECTRIC SUPPLY CO. (LTD.)**—Letters of allotment in the recent issue of shares in this company have been posted.

**WELSBACH INCANDESCENT GAS LIGHT CO.**—At a meeting of this company last week the chairman (Sir H. C. Burdett) referred to the Von Auer electric lamp, commonly called the "Osmium" lamp. He stated that they would gather from the report of the Austrian company that half the German and half the French patents had been sold for a sum of £10C,000. He (the chairman) understood that Dr. Von Auer had now got the lamp into an excellent condition, and was only waiting for a supply of osmium, "for which diligent search had been made."

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways. | June 29 | 4,727 | + 274 | 25 | 109,026 | + 2,434 |
| *Blackburn Corporation.. | „ 28 | 473 | + 14 | 26 | 12,056 | + 1,056 |
| Blackpool Corporation... | „ 27 | 911 | + 182 | †13 | 9,389 | + 2,072 |
| Blackpool and Fleetwood | „ 30 | 920 | + 196 | 26 | 9,937 | − 189 |
| Bolton Corporation ..... | „ 30 | 1 575 | + 212 | 13 | 19,583 | + 2,926 |
| Bradford Corporation... | „ 30 | 1.047 | + 581 | 13 | 13.337 | + 6,918 |
| Brisbane Trams ..... | May 15 | 2,008 | + 204 | 19 | 38,519 | + 3,994 |
| *Bristol Trams & Carriage | June 23 | 4,743 | + 1,595 | 25 | 107.183 | + 31,965 |
| *Buenos Ayres & Belgrano | June 2 | 2,715 | + 1.041 | 22 | 41,395 | + 11,449 |
| Calcutta Trams. Co. ... | „ 29 | R19,299 | + R915 | ... | ... | ... |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | „ 29 | 6,144 | ... | 26 | 161,176 | ... |
| City & South London Ry. | „ 30 | 1,868 | + 378 | 26 | 50,839 | + 17,114 |
| Cork Elec. Trams ..... | „ 27 | 558 | + 74 | 25 | 10,950 | + 1,402 |
| Dover Corporation ..... | „ 29 | 239 | + 23 | 13 | 2,855 | + 222 |
| Dublin & Lucan Rly. ... | „ 29 | 119 | − 10 | 26 | 2,460 | + 123 |
| Dublin United ..... ‡ | „ 30 | 5,499 | + 560 | ‡26 | 80,227 | + 224 |
| Dublin Southern Dist.... ‡ | „ 30 | 1,422 | + 77 | ‡26 | 21,315 | |
| *Dundee Corporation ... | „ 26 | 709 | + 295 | ... | ... | ... |
| *Glasgow Corporation ... | „ 29 | 11,989 | + 2,657 | 4 | 46,905 | + 7,517 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 29 | 951 | + 267 | 13 | 11,562 | + 2,481 |
| Hull Corporation ..... | „ 29 | 1,645 | + 405 | 52 | 77,956 | + 36,697 |
| Liverpool Corporation... | „ 22 | 9,166 | + 918 | 25 | 212,005 | + 29,727 |
| *Liverpool Overhead Rly. | „ 30 | 1,696 | + 14 | 26 | 40,981 | + 3,479 |
| *Manchester Corporation | „ 29 | 1.053 | ... | ‡3 | 3.294 | + 171 |
| Perth (W.A.) Elec. Trams | „ 28 | 804 | + 456 | 52 | 35,668 | ... |
| Portsmouth Corporation | „ 29 | 903 | − 51 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 30 | 3,763 | + 1,377 | 26 | 83,847 | + 30,741 |
| Southampton Corporat'n | „ 27 | 794 | + 296 | ... | ... | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding week last year
* Partly electrical. † Minus 3 days. ‡ Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 26. | Price Wednesday, July 3. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending July 3. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅝ ⅝ | ⅝ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) ... | 70 75 | 95 100 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ 12½ | 12½ 13½ | 4 9 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ...xd | 103 106 | 101 104 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ 8¼ | 7⅞ 8¼ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 5/6 | Do. 7 per Cent. Preference | 8⅜ 9 | 8⅜ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7 7½ | 7⅞ 7⅞ | 2 5 2 | ... | ... | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp.... | 9 10 | 9 10 | 4 10 0 | February and August | ⅝ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 5⅝ | 5½ 5⅝ | 3 18 3 | ,, ,, | ... | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) ...xd | ... | 102 104 | ... | ... | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5⅞ 6¼ | 5⅞ 6¼ | 4 8 0 | March | 5 1/16 | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.)...xd | 109 112 | 107 110 | 4 2 0 | June and December... | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8⅛ 9⅛ | 8 9 | 4 8 11 | February and August | 8⅛ | 8⅜ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12⅛ 13⅛ | 12⅛ 13⅛ | 4 12 2 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ...xd | 122 127 | 120 125 | 4 0 0 | June and December ... | ... | ... |
| £200,000 | Stock | 45/8 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) ...xd | 102 104 | 100 102 | 4 8 3 | ... | ... | ... |
| 40,000 | 10 | 3/0 | County of London and Brush Prov. Ordinary | 8½ 9½ | 8½ 9½ | 4 4 3 | ... | 9⅜ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 13 | 12 13 | 4 13 4 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ... ...xd | 105 108 | 103 106 | 4 5 1 | ... | 105½ | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5½ 5⅝ | 5 5⅛ | 3 12 9 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅞ 8⅜ | 7⅞ 8⅜ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11⅞ 12⅞ | 11⅞ 12⅞ | 4 4 0 | ... | ... | ... |
| 10,000 | 5 | 8% | Do. 6 per Cent. 1st Pref. | 6⅞ 7 | 6⅞ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)..... [Deb. Stk. (red.) | 102 105 | 102 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 102 104 | 102 104 | 3 17 1 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1⅞ 1⅞ | 1⅞ 1⅞ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ..... | 96 100 | 96 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13½ 14½ | 13 14 | 4 5 9 | April and October..... | 13⅜ | ... |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13½ 14½ | 13 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage xd | 110 113 | 108 111 | 4 1 0 | June and December ... | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) .. xd | 96 99 | 94 97 | 3 12 0 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary ..... xd | 15½ 16½ | 15 16 | 4 7 6 | March ..... | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary ..... | 5⅞ 6⅜ | 5⅞ 6⅜ | 3 16 11 | ,, | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric ..... | 2 1/16 | 2 1/16 | 11 13 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb.... | 65 75 | 65 75 | ... | January and July ..... | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 104 | 102 104 | 4 6 2 | April and October..... | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary ..... | 15 16 | 14½ 15½ | 4 13 7 | February and August | 14⅜ | ... |
| 20,000 | 5 | 8/6 | Do. 7 per Cent. Preference ..... | 9 10 | 9 10 | 3 10 0 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) ...xd | 98 101 | 97 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 | 2 | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ..... | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2⅜ 3½ | 2⅜ 3½ | ... | ... | ... | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary ..... | 12 13 | 12 13 | 4 0 9 | March and September | 12 1/16 | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... | 4⅛ 4⅜ | 4¼ 4½ | 4 9 0 | April and October..... | 4 1/8 | 4½ |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock..... xd | 125 130 | 123 128 | 4 14 0 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary ..... | 8 10 | 8 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference ..... xd | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures ..... | 96 101 | 97 102 | 4 18 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) ..... | 92 97 | 93 98 | 4 12 0 | ... | ... | ... |
| 15,000 | 10 | 9/6 | Blackpool and Fleetwood Tramways..... | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2⅜ 3⅜ | 2⅜ 3⅜ | ... | ... | 2⅜ | 2 9/16 |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. ..... | 4¼ 4¾ | 4 4½ | ... | ... | 4⅜ | 4⅜ |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. ..... | 99 101 | 99 101 | ... | ... | 100⅜ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary ..... | 22½ 23 | 22½ 23 | 3 15 0 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) ..... | 10⅞ 11 | 10⅞ 11 | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... | 114 116 | 114 116 | 3 9 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary ..... | 6½ 7 | 6½ 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference ..... | 9½ 9⅞ | 9½ 9⅞ | 5 2 7 | May and November ... | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. ..... | 100⅞ 102⅞ | 100⅝ 102⅝ | 4 8 11 | ... | 100⅞ | ... |
| 62,074 | 10 | 6/0 | British Elec. Trac. Ord. ..... | 14½ 15⅛ | 15 16 | 5 9 8 | ... | 15⅝ | 15 |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. ..... | 12 13 | 12 13 | 4 12 4 | February and August | 12 1/16 | 12⅝ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... | 124 125 | 122 125 | 4 0 10 | ... | 125 | 123¾ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary ..... | 1⅛ 1⅜ | 1⅛ 1⅜ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. ..... | 5⅛ 5⅜ | 6⅛ 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" ..... | 5 5⅛ | 5⅛ 5⅜ | 1 13 0 | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures ..... | 102 105 | 104 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 2 0 | ... | 98⅛ | ... |
| 34,440 | 10 | 6/0 | Calcutta Trams. (Nos. 1 to 34,440) ..... | 10⅛ 11⅛ | 10⅛ 11⅛ | 2 14 2 | ... | 11⅛ | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) ..... xd | 104 106 | 102 104 | 4 6 6 | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares..... | 1⅞ 2 | 1⅞ 2 | ... | ... | 2 | ... |
| 196,980 | 10 | 2/6 | Central London Ordinary ..... | 9¼ 9⅜ | 9¼ 9⅜ | 2 16 5 | June and December... | ... | ... |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs ..... ..... | 113 118 | 113 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5⅛ 5⅜ | 5⅛ 5⅜ | 4 10 11 | ... | 5 1/16 | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. ..... | 100 103 | 100 103 | 3 17 10 | ... | ... | ... |
| £865,000 | Stock | 1½% | City and South London Railway Con. Ordinary .. | 55 57 | 54 56 | 2 4 6 | February and August | ... | ... |
| 47,500 | 10 | 2.0 9 | Do. Ordinary (Nos. 22,501 to 70,000) ..... ... | 5⅛ 5⅜ | 5⅛ 5⅜ | 2 3 6 | ,, ,, | 5⅜ | 5 1/16 |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) ... | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) ..... | 122 127 | 124 128 | 3 18 0 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... | 111 116 | 112 117 | 3 8 6 | May and November ... | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary ..... | 12 13 | 12 13 | 5 0 0 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference ..... | 15 16 | 15 16 | 3 16 0 | ... | ... | ... |
| £300,000 | 100 | 4½% | Do. 3½ per Cent. Mort. Debs. (red.) ..... | 98 102 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5½ | 5½ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4¾ 5⅛ | 4¾ 5⅛ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary..... | 22 22½ | 22 22⅝ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference..... | 14½ 15⅛ | 14½ 15⅛ | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... | 112 114 | 112 114 | 3 19 2 | January and July ..... | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. ... | ... ... | ... ... | ... | May and November ... | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary ..... | 8⅛ 8½ | 8⅛ 8½ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ..... | 13 13¼ | 13 13¼ | 3 16 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... | 102 104 | 100 102 | 3 18 3 | January and July ..... | ... | ... |
| £350,000 | Stock | 31/8 | Lond. Utd. Trams. 4½% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | xd106 108 | 104 106 | 3 15 6 | ... | 107⅞ | 104 |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) ... | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) ..... | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary ..... | 3 3⅛ | 3 3⅛ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 5/0 | Do. 6 per Cent. Cumulative Preference ..... | 4⅛ 5 | 4⅛ 5 | 6 0 0 | May ..... ..... | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord..... | ... ... | ... ... | ... | February and August | ... | ... |
| 5,000 | 10 | 5/0 | Do. 5 per Cent. Preference ..... | ... ... | ... ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary ..... | 12 13 | 12 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference..... | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £145,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... | 105 107 | 105 108 | 4 3 4 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | ... ... | ... ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) ..... | ... ... | ... ... | ... | April and October..... | ... | ... |
| 150,000 | 1 | ... | Do. 6% Preference (fully paid) ..... | ... ... | ... ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) ..... | ... ... | ... ... | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 8% | Waterloo and City Ordinary ..... | 93 96 | 92 95 | 3 3 2 | June and December ... | ... | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, June 26. | | Price Wednesday, July 3. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending July 3. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) ..xd | 100 | 103 | 98 | 101 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ | 4⅛ | 3⅜ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £80,720 | Stock | 15/0 | Anglo-American | 53 | 56 | 53 | 56 | 5 12 7 | Feb., May, Aug., Nov. | 53 | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 78 | 100 | 98 | 100 | 6 2 0 | ,, ,, | 99½ | 98⅜ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 | 10⅛ | 10 | 10⅛ | 2 7 7 | ,, ,, | 10 1/16 | ... |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock ..... xd | 175 | 185 | 175 | 195 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock..... xd | 101 | 103 | 100 | 102 | 3 18 3 | ,, ,, | 101⅛ | 100⅜ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14⅛ | 15½ | 14⅛ | 15½ | 6 9 0 | ,, ,, | ... | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £80,800 | 50 | 4½% | Do. 4½ per Cent. Debentures..... xd | 100⅞ | 104⅞ | 99⅞ | 103⅞ | 4 7 6 | January and July | ... | ... |
| 80,710 | 20 | 3/0 | Direct United States Cable | 10⅛ | 11 | 10⅜ | 11⅛ | 6 2 0 | Jan., Apr., July, Oct. | 11 1/16 | 10 15/16 |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | xd 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary ..... [to 1,200) (red.)... | 140 | 145 | 140 | 145 | 4 17 0 | Jan., Apr., July, Oct. | 144⅛ | 142 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 90 | 93 | 89 | 92 | 3 16 0 | ,, ,, | 91⅛ | 89 |
| £1,482,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 109 | 113 | 109 | 113 | 3 11 1 | May and November | ... | ... |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ | 14 | 13⅛ | 14 | 5 0 0 | Jan., Apr., July, Oct. | 13⅞ | 13⅜ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 116 | 3 9 3 | February and August | ... | ... |
| £200,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) ... | 100⅞ | 103⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November | ... | ... |
| 180,237 | 10 | 2/6 | Globe Telegraph and Trust | 9⅜ | 10⅜ | 9⅜ | 10⅜ | 5 1 5 | Jan., Apr., July, Oct. | 10 | 9⅞ |
| 180,043 | 10 | 3/0 | Do. 6 per Cent. Preference | 14⅜ | 15⅜ | 14⅜ | 15⅜ | 3 19 8 | ,, ,, | 15⅛ | 14⅞ |
| 150,000 | 10 | 5 0 | Great Northern of Copenhagen .....ex coupon 52 | 30 | 32 | 31 | 32 | 4 13 9 | January and July | ... | ... |
| £78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos. | 100 | 103 | xd 99 | 102 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European ..... [1 to 1,200) (red.) | 43 | 47 | 43 | 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 ... | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.)...xd | 100 | 103 | 99 | 102 | 3 18 6 | June and December | ... | ... |
| 11,889 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 8% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 13 10 | ,, ,, | 127½ | ... |
| 14,600 | 10/0 | ... | West African Telegraph | 2 | 3 | 2 | 3 | 4 9 2 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 7 | March and September | ... | ... |
| 20,008 | 2½ | ... | West Coast of America | ⅛ | ¼ | ⅛ | ¼ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures ..... xd | 100 | 103 | 99 | 102 | 3 18 6 | January and July | ... | ... |
| 80,231 | 10 | 6d. | West India and Panama | ¼ | ¼ | ¼ | ¼ | ... | May and November | ... | ... |
| 54,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | 10 0 0 | ,, ,, | 5½ | ... |
| 4,000 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | 12 0 0 | ,, ,, | ... | ... |
| £99,000 | 100 | 5% | * Do. 5 per Cent. Debentures ..... xd | 103 | 106 | 101 | 104 | 4 16 2 | January and July | ... | ... |
| 207,280 | 10 | 2/0 | Western Telegraph (late Brazil'n Submarine) .. xd | 13⅜ | 14⅛ | 13⅜ | 14⅛ | 4 18 3 | Mar., June, Oct., Dec. | 14 | ... |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906)...xd | 102 | 105 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £344,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) ..... xd | 102 | 105 | 100 | 103 | 3 17 8 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅜ | 4⅛ | 3⅜ | 4⅛ | 4 11 2 | August | ... | ... |
| 234,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 | 3/0 | 3/0 | 3/6 | 8 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ | ⅜ | ⅛ | ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 500,000 | 5 | 2/6 | National | 3 | 3⅛ | 3⅛ | 3⅜ | 8 9 2 | February and August | 3⅜ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference ... | 11 | 12 | 11 | 12 | 5 0 0 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference ... | 11 | 12 | 11 | 12 | 5 0 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4 | 4½ | 4⅜ | 4⅝ | 5 14 3 | ,, ,, | 4⅝ | ... |
| £1000,000 | Stock | 2½% | * Do. Debenture Stock 2½ per Cent. (red.)...x1 | 89 | 92 | 87 | 90 | 3 17 9 | June and December | 90 | 87 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) ...xd | 96 | 99 | 94 | 97 | 4 2 6 | ... | 97 | 95⅛ |
| 171,504 | 1 | 0 3⅛ | Oriental | ¾ | 1 | ¾ | 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 5 | 5⅛ | 5 | 5⅛ | 6 7 3 | July | 5⅜ | 5⅛ |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. ..... xd | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December | 5⅛ | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ... xd | 103 | 106 | 101 | 104 | 4 16 2 | June and December | 101 | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ | ⅝ | ⅜ | ⅝ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | 13/16 | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ | ⅝ | ⅜ | ⅝ | 8 0 0 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 9⅝ | 10⅝ | 10 | 11 | 6 16 4 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6 | 6⅝ | 6 | 6⅝ | 4 12 4 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 5 14 3 | ... | ... | ... |
| 90,000 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ | 1⅝ | 1⅜ | 1⅝ | 3 6 7 | September | 1⅝ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2⅜ | 2⅝ | 2⅜ | 2⅝ | 5 1 1 | ,, | 2 1/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock ... | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £135,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock ..... x1 | 101 | 104 | 99 | 102 | 4 8 3 | January and July | ... | ... |
| 80,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 | 15 | 14 | 15 | 5 0 0 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference ... xd | 5⅝ | 6 | 5⅛ | 6 | 4 3 2 | ,, ,, | 5⅞ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) x1 | 109 | 113 | 107 | 111 | 4 1 0 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 | 98 | 93 | 97 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary ..... xd | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 15 7 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅝ | 4 | 3⅝ | 4 | 5 12 7 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.)xd | 102 | 107 | 100 | 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 39,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£5 paid) .. | 1 | 1⅛ | 1 | 1⅛ | 10 12 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2 | 3 | 2 | 3 | 8 16 6 | ,, ,, | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock(red.) xd | 87 | 89 | 80 | 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5⅛ | 5⅜ | 5⅛ | 6 | 4 12 0 | Half-yearly | 5 1/16 | ... |
| 20,000 | 5 | 1/6 | Do. 6% Cumulative Preference | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 5 4 4 | ... | ... | ... |
| £130,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 5 | ... | ... | ... |
| 112,100 | 5 | 1/2½ | Electric Construction Co. (Limited) | 1⅜ | 2⅛ | 1⅜ | 2⅛ | 5 6 8 | January and July | 1 1/16 | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | ... | ... |
| 18,000 | 10 | 2 10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9¼ | 10⅛ | 9⅜ | 1 1/16 | 4 17 7 | ... | 10 1/16 | 19 |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15⅝ | 16⅛ | 15⅝ | 16⅛ | 6 1 3 | February and August | 16⅛ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock(red.) ... | 107 | 111 | 107 | 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 23 | 4 13 0 | ... | 21⅛ | 21⅛ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 36 | 40 | 36 | 40 | 5 4 11 | March and July | 37½ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1905... 2x1 | 102 | 105 | 101 | 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 6 9 1 | ... | ... | ... |
| 30,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | 6⅛ | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10⅛ | 11⅛ | 10 | 11 | 5 9 0 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6⅛ | 7 | 6⅛ | 7 | 4 5 9 | ,, ,, | 6⅞ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debent... | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refused to quote these

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,208. [No. 12. Vol. XLVII.] FRIDAY, JULY 12, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

On Saturday last the newly-created University of Birmingham celebrated its first Congregation, amidst circumstances somewhat novel and different from similar functions in older universities. Thus, for example, instead of the proceedings being conducted in dignified Latin, the popular vernacular was employed throughout—greatly, we should imagine, to the detriment of its impressiveness. However, these be practical and utilitarian times; and as it is probable that 90 per cent. of the audience at Birmingham would not have understood the Latin, this alteration was presumably an adaptation to environment. A praiseworthy feature of the arrangements was that in virtue of which students of Masons College, before the granting of the charter, were permitted to graduate; and, accordingly, no less than 60 students received their degrees. In order that he might become a graduate of the university of which he is principal, Dr. Oliver Lodge received the honorary degree of Master of Science.

The formal inauguration of the first completed section of electrically-equipped line by the London United Tramways took place on Wednesday, when nine prettily decorated cars conveyed the guests from Shepherd's Bush to Southall and back to the generating station at Chiswick, along a route gay both with bunting and inhabitants, who showed by their cheers their appreciation of the new method of conveyance. After a hurried ramble through the generating station, the visitors sat down in the principal car shed to a luncheon, at which Mr. George White, the chairman of the company, presided. "The London United Tramways Co." was proposed by Mr. A. J. Balfour and responded to by Mr. G. White. The health of Mr. J. Clifton Robinson, chief engineer and managing director, was next proposed by Prof. Silvanus Thompson, and after Mr. Robinson's reply the proceedings terminated.

It was certainly a happy thought of the London United Tramways Co. to have secured the presence of Mr. Balfour, the occasion being one of greatest importance to the metropolis, and it was most appropriate that the statesman upon whose shoulders rests that ever-growing incubus—the housing of the working classes—should be invited to speak at the opening of a metropolitan system of tramways which promises to afford the best solution of this great social problem. Mr. Balfour, in his speech, naturally dealt with this side of the undertaking, which he considered one of the greatest engines of social reform and amelioration, and it was his business, as a member of the House of Commons, to promote every form of legislation dealing with the improvement of the lot of our countrymen; but all that Parliament could do sank into insignificance compared with what could be done by great enterprises of this character. We are glad to note that a statesman of Mr. Balfour's position sees the enormous relief to congestion that the electric tramway affords. This is a point on which we have frequently insisted.

We have already given a preliminary account of the generating station and system (see *The Electrician*, Vol. XLVI page 8), and we hope in the near future to give a complete and detailed description of this important undertaking. Meanwhile, we may note that the company have completed 15 miles of line, 8 miles of which were opened to the public for the first time last Wednesday; 40 miles of line have been authorised, another 15 miles have been sanctioned by the House of Commons, and will shortly be decided for or against by the House of Lords, whilst a further 25 miles is projected. Already so many as 210,657 passengers have been carried during a single day on a 7½ miles length of line, and the company expect an annual result of no less than 150,000,000 passengers when the system has been completed. We sincerely congratulate the company on the successful accomplishment of this piece of engineering.



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On another page of this issue we give an abstract of a Paper read by Mr. Edgar A. Ashcroft before the Institute of Mining and Metallurgy on June 19th. The Paper deals with the treatment of sulphide ores, and is a description of the modified Phœnix process for extracting the silver, lead and zinc by a combination of metallurgical, chemical and electrolytic reactions. The modified process was patented in the names of Swinburne and Ashcroft in 1899 (Patent No. 14,278). Our readers may remember that in 1897 Mr. James Swinburne patented a process for treatment of these ores, the principle of which consisted in feeding the crushed but unroasted ore into a bath of molten zinc chloride, and in electrolysing the semi-molten mass thus obtained with a molten lead cathode and carbon anode. The lead was to be removed first by electrolysis, and then the zinc, while the sulphur was to be separated and recovered at the anode. A small syndicate was formed in December, 1898, to carry out experimental trials with this process, and Mr. E. A. Ashcroft was retained to take the technical charge and management of the experimental plant. These trials were conducted first at the laboratory in Victoria-street and, later, at the old Cowles Aluminium Works at Milton in Staffordshire. The original Swinburne process did not fulfil the expectations of its inventor on further trial, and the process now brought forward, as the result of two and a-half years' work, differs in many important points from its predecessor. Briefly stated these are: (1) The removal of the sulphur by substitution of chlorine; (2) the removal of lead by substitution of zinc; and (3) the removal of iron, manganese and gangue by settling. In other words, a comparatively pure fused mass of zinc chloride is submitted to electrolysis in place of the mixture of sulphides and chlorides described in the earlier patents. The criticisms passed on the earlier process were, therefore, justified.

The metallurgical and mechanical difficulties that have to be met in carrying out this modification of the original process successfully are of considerable magnitude, and though in some cases the inventors appear to have surmounted them, it is yet too early to assert that the modified Phœnix process has successfully solved the sulphide ore problem. For instance, the figures given for a trial run with 1,000kg. ore show that only one-half of the sulphur was recovered, and yet the estimates of costs and recoveries appear to have been based on a 95 per cent. recovery of all the contents of the ore. The treatment of the washings of zinc chloride is a question of considerable importance for the successful operation of the process, and this also does not appear to have been finally settled. According to recent investigations by Lorenz, the electrolysis of fused zinc chloride containing water yields $Zn(OH)_2$, and, therefore, the method described by the inventors for the removal of the last traces of water from the fused electrolyte will probably lead to contamination of the zinc chloride with the basic salt. The use of an E.M.F. of 4·4 volts with an electrolyte containing sodium chloride also must lead to some decomposition of this salt, and it is quite possible that at times the deposition of zinc at the cathode is a secondary and not a primary electrolytic action within the cell. The decomposition value of sodium chloride in the fused state is 4·21 volts. However, we hope that the further trials of this process, which have now been transferred from Milton to Weston Point, will result in final success; and we are pleased to note that the inventors show a disposition to overcome all technical and mechanical difficulties before appealing to the general public for the capital to erect a large works. There have been too many financial disasters in connection with zinc processes in the past; and we trust that the Phœnix process will not be added to their number by any undue haste on the part of those financially interested in its future.

A meeting was convened at the St. Pancras Town Hall on Monday last for the following somewhat unusual purpose, viz.:

To consider the recent requirements made by the Postmaster-General with regard to being supplied with plans on cloth to a scale of not less than 10 feet to the mile, showing the position of mains, &c., laid in the public thoroughfares; and

To approve of a representation being made to the Postmaster-General, pointing out the difficulties in complying with his request, and asking for a modification of his requirements.

Friction, it appears, has arisen between the St. Pancras electricity department and the Post Office in connection with the laying of the new telephone tubes in certain parts of the borough. For example, in the Gray's Inn-road the telephone tubes are laid between the electricity mains and the houses in such a way as to prevent service mains being run from the former to the houses. This location of the telephone tubes has been due to the house cellars preventing the tubes from being placed at their usual depth. This led to considerable trouble, with the result that 14 metropolitan borough councils and local authorities, including the St. Pancras Borough Council, were requested to supply plans as described above. There is no doubt that the Postmaster-General is within his right in demanding accurate maps or plans of such electricity mains. This will be gathered from the following abstract from the Electric Lighting Clauses Act, 1899:—

1. The undertakers shall forthwith, after commencing to supply energy under the special order, cause a map to be made of the area of supply, and shall cause to be marked thereon the line and depth below the surface of all their then existing mains, service lines, and other underground works and street boxes, and shall once in every year cause that map to be corrected so as to show the then existing lines. The undertakers shall also, if so required by the Board of Trade or the Postmaster-General, cause to be made sections showing the level of all their existing mains and underground works other than service lines. The said map or sections shall be made on such scale or scales as the Board of Trade prescribe.

2. Every map and section so made or corrected, or a copy thereof, marked with the date when it was so made or last corrected, shall be kept by the undertakers at their principal office within the area of supply, and shall at all reasonable times be open to the inspection of all applicants, and those applicants may take copies of it or any part thereof. The undertakers may demand and take from any such applicant such fee not exceeding 1s. for each inspection of the map, section or copy, and such further fee not exceeding 5s. for each copy of it, or any part thereof, taken by the applicant as they prescribe.

It is doubtful whether a scale of "not less than 10 feet to the mile" is contemplated by these regulations. We believe, however, that the Postmaster-General possesses other powers by which he can insist on being supplied with plans to any scale, even of panoramic dimensions, if he so think fit. The plans usually kept in stock by the electricity committees are, we believe, on a scale of 5ft. to the mile, and only a

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small additional accuracy would be afforded by making them on the proposed larger scale. In fact, in order to show the position of the mains to within a few inches, as appears to be required, it would be necessary to use a scale of, perhaps, 40ft. or 50ft. to the mile. Obviously, to map out the entire areas on such a scale would be prohibitive, and an unreasonable demand on the part of the POSTMASTER-GENERAL. It appears to us that the most satisfactory course would be for the POSTMASTER-GENERAL to notify the electric light authority as to the streets in which he intends to lay his telephone tubes, whereupon the electric light authority would, in its own interest and at a reasonable expense, provide the POSTMASTER-GENERAL with sufficiently large plans of those particular streets. Thus all the reasonable requirements of the Post Office would be met without the waste of time and money involved in preparing gigantic plans of entire areas.

Trunk-line Telephony.—The telephone from Châlons-sur-Marne to Frankfort and Berlin was opened on the 1st inst.

The Berliner Telephone Patent Decision.—Those interested in this case will find the full text of the decision in the *Electrical World* for June 29th.

Appointment.—The Council of University College, London, has appointed Mr. J. D. Cormack of the University of Glasgow to the chair of mechanical engineering.

| Cable Interruptions. | Date of Interruption |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Bali—Lombok | July 3, 1901 |

Erratum.—Too late for correction in our article on "Luton Electricity Works" we are informed by Messrs. Nalder Bros. and Thompson that their measuring instruments are used throughout on the switchboard at the Luton electricity works, except for two electrostatic Kelvin voltmeters.

Telegraph and Telephone Trust in the United States.—A correspondent of the *Morning Post* telegraphs that the Gould interests are reported to be forming a huge trust to control the telegraph and telephone lines in the States, and to buy up the several cable companies whose lines run from the United States to Europe.

A Movable Storage Battery Sub-station.—The *Street Railway Journal* for June describes a movable storage battery sub-station used by the Brooklyn Rapid Transit Co., who operate during the summer months a service of trams which is discontinued during the winter. The cost of furnishing a sufficient feeder system was found to be too great, so a battery of 248 cells was installed in seven old railway carriages, the battery having a discharge rate of 250 amperes for seven hours, or 1,000 amperes for one hour.

Steam Engine Specifications.—The Engine Builders' Association of the United States has submitted for the consideration of architects and engineers the following suggestions in connection with specifications for the installation of steam engines:—

(1) That contracts which provide a penalty for failure to deliver in time or for failure to meet guarantee ought also to provide equal premiums for earlier or better results than specified. (2) That bonds should not be required on installation contracts unless corresponding bonds for similar amounts are given to secure payment. An exception always being made in the case of government, state or municipal contracts. (3) That settlements or any part of them ought not to extend beyond three months from completion of contract, and that delay on the part of the owner ought not to delay payment beyond a reasonable time. (4) That a guarantee against defective material or workmanship should not be made to cover a period of more than one year from date of shipment. (5) That purchasers of engines ought not to be furnished with complete working drawings, but simply with general drawings showing the assembled engine in outline, with such principal dimensions as will answer for building foundations, the erection of engines or their care.

Wireless Telegraphy on the "Lucania."—The following interesting particulars are given by a daily contemporary:—The "Lucania" picked up the broken signals from the Marconi station at Crookhaven on the south-west coast of Ireland at 2:10 p.m. on Friday last. At 2:25 p.m. they became coherent, and the first message was sent out from the ship at 2:30 p.m., the distance at this time being about 43 knots west of Browhead. The first messages were sent from passengers to their friends in America, Germany, the United Kingdom, &c. At 3 p.m. the first service message was sent by Capt. McKay to the Cunard Company, Queenstown. Up to 5 o'clock p.m. about 30 messages were transmitted, and other messages went on until 5.30 p.m. Return messages were received from the Cunard Company to the captain, and also one message to a passenger. Communication was maintained with Crookhaven until 7.30 p.m., when Roches Point, at which a temporary station is being fitted, was picked up. Communication was established with Rosslare, on the south coast of Ireland, at 11:50 p.m., when about 44 miles distant, and signals were exchanged with the operator until the station had been left behind 40 miles. Holyhead was picked up at a distance of 40 miles, and messages continued to be sent from that station until it was left 38 miles behind. The experiment was a very distinct success, and all on board the ship were loud in their appreciation of the system and of the possibilities it opens out.

Obituary.—It was with great regret that we announced in last week's issue the death of Prof. P. G. Tait, which occurred in the house of Sir John Murray, in Edinburgh, on the 4th inst. Prof. Tait's scientific work covers a wide range of mathematics and physics, and a selection of his collected Papers are now being published by the Cambridge University Press in three volumes of 500 pages each. His chief contribution to mathematics was in the development of quaternions; in physics he will be remembered by his numerous Papers on thermodynamics and kindred subjects; whilst his well-known thermo-electric diagram, which he presented to the Royal Society of Edinburgh in 1878, forms the basis of all work that has since been done in that subject. *The Times* in an appreciative article finishes as follows:—"As a teacher he was first rate, and he excelled in what has proved a rock of offence before now to many an able Scottish professor—the management of a big class. His style of lecturing was lucid and studiously simple, his experiments chosen with a single aim to the explanation of the matter in hand. For mere sensational display by the teacher he had as much contempt as for the 'pernicious practice' of unlimited note-taking by the student. The university class-room, he said, was not a place of public amusement, with its 'pantomimic displays of red and blue fire, its tricks whether of prestigiation or of prestidigitation, and its stump oratory.' Oratory, he declared, was essentially art, and therefore could not be science. Yet, while he taught that science is essentially simple, and is best expressed in the simplest and most direct forms possible, he also warned his pupils that its study is beset with difficulties, and held, as Aristotle did of moral philosophy, that a certain maturity of mind is necessary to overcome them successfully. But, whatever may have been his theory, the efficacy of his practice is sufficiently attested by the number of distinguished men of science who are now proud to remember that they once sat at his feet."

We regret also to record the death of Mr. Howard C. Jobson, well-known to the electrical industry as one of the principal members of the firm of Buller, Jobson & Co., until the change in the style of the firm to the present title of Bullers Limited. Mr. Jobson had been in bad health for a long time, and had recently returned from a voyage round the world, which, while it benefited him physically, did not appear to have effected a cure. This, and some trifling business concerns, seemed to weigh on his mind, and, in a moment of great depression, while on a railway journey from Kidderminster to London, he attempted his life and expired from loss of blood. Mr. Jobson was well-known in cricket circles, and his sad death comes as a blow to a large number of acquaintances in Kidderminster and district, where he has resided for many years. He leaves a widow and two children.

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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Europium.*—In his beautiful researches on electric fluorescence in a vacuum in 1885, Crookes mentioned a band which he attributed to samarium and which, on account of its disappearance in presence of calcium, as well as for other reasons, he called the "anomalous ray." In 1889, he attributed this line to some meta-element, and suspected the presence of other meta-elements as well. E. Demarçay, the discoverer of radium, has now identified this line with the spectrum of a new element intermediate between gadolinium and samarium which he calls europium, with the symbol Eu and an atomic weight of about 151. The best manner of obtaining the oxide is by fractioning magnesium nitrate. It is found that the line spectra, reversals, absorptions and electric fluorescence of the sulphate in vacuo all vary together with the condensation of the element, and therefore satisfy the criterium of elementary nature. The sulphate may be obtained in such purity that the samarium spectrum is quite invisible, and only a few of the strongest gadolinium lines show up. The fluorescent spectrum, which is brightened by the presence of calcium, consists of three chief bands, with wave-lengths of about 609, 593, and 576 respectively.

[E. Demarçay, *Comptes Rendus*, June 17, 1901.]

*German Electrical Units.*—The *Reichsgesetzblatt* has published the regulations laid down by the German Federal Council with regard to the determination and nomenclature of electrical units. The ampere, ampere-hour, watt, watt-hour, farad, and henry are the units, mega-, kilo-, milli-, and micro- are prefixes used as heretofore, and the effective current intensity of an alternating current is defined as the square root of the mean value of the squares of the instantaneous intensities. The conditions under which the silver is deposited in the silver voltameter are strictly defined. As regards electric supply meters, it is enacted that the error of the meter may not exceed 0·6 per cent. of the maximum current, plus 6 per cent. of the actual current; or, if the actual consumption is only 4 per cent. of the maximum consumption, 2 per cent. of the actual consumption are added to the first figure. Provided always that in the case of light installations the consumption to be indicated does not fall below 30 watts. In the case of alternate or polyphase meters, where there is phase-difference, double the tangent of the phase-difference is to be added to the error (in percentage of actual consumption), as determined above.

[*Zeitschr. f. Instrumk.*, June, 1901.]

*Harmless X-rays.*—Röntgen rays sometimes give rise to mortification of the skin, and medical men have sometimes been prosecuted in consequence. When the tubes are driven by influence machines that does not happen, but then the activity is reduced, and the presence of moisture and the necessity of an earth connection may be awkward. R. Demerliac has found that tubes worked by alternate currents of high frequency and high tension never produce erythema, and that, on the contrary, the rays so obtained possess the curative properties recognised in electrotherapeutics since the experiments of D'Arsonval, Oudin, Doumer, and others. He, therefore, employs the Oudin resonator, which, with certain precautions, may be made to work X-ray tubes. They light up on connecting them with the upper knob of the apparatus. A broad concave cathode and a small anode or an annular anode are used. The cathode is joined to the resonator, and the anode may be left free or put to earth. The discharge is most effective when it proceeds in one direction only. A cathode valve should, indeed, be useful. The tubes may be brought quite close to the skin without risk, and thus any loss of penetrative power is effectually counteracted.

[R. Demerliac, *Comptes Rendus*, June 24, 1901.]

*Energy Absorbed by Vacuum Discharges.*—P. Cardani has recently followed up the interesting result of his previous work that the form of discharge in a gas is characteristic of its physical condition and independent of its chemical nature. He distinguishes 14 successive stages of evacuation, beginning with the ribbon-shaped spark at pressures from 650 to 320mm. This is followed by a complete brush, a spreading brush, a luminous cathode (6mm.), the beginning of the dark cathode space (0·7mm.), the extension of the dark space over 8, 20, 35, and 50mm. respectively, white brush at the anode, wandering brushes at the anode, X-rays, and disappearance of luminosity. All these successive stages are reached at the same pressures in air, hydrogen, and $CO_2$. The maximum energy in proportion to the total energy is consumed at a pressure of 180mm., just where the spark gives way to the brush discharge. The minimum is when the cathode phenomena become well marked, and the dark space is about 8mm. long. On further exhaustion the energy rises again to near the maximum, but the appearance of X-rays is not marked by any discontinuity. If cathode rays are due to a special form of ionisation, it follows that the energy required for generating the electrons is always the same.

[P. Cardani, *Phys. Zeitschr.*, June 29, 1901.]

*Globe Lightning.*—J. Violle describes a globular lightning discharge as follows:—"On Sunday, June 9, at 1:30 p.m, towards the end of a somewhat violent storm which passed over Fixin, near Gevrez-Chambertin (Côte d'Or), I observed a globe discharge under the following conditions:—I was on a balcony facing the east, and thence I watched the thunderstorm, in which lightning flashes succeeded each other at frequent intervals in the shape of fiery tracks slightly sinuous and nearly vertical, generally doubled, and about 2 miles away. Then, after an interval of several minutes, I saw a fiery ball which seemed to fall from the sky like a stone, in the same place where the straight flashes had been seen, and from the same height. After another interval the region in question was again illuminated several times by brush lightning, in the shape of diffused discharges within a limited space. I cannot attribute the phenomenon to an optical illusion, as it was seen in the same manner by a person close by, who immediately exclaimed. I also made sure that no meteorite fell in the spot, though I was already convinced of the electric nature of the phenomenon." The phenomenon squares with the accepted explanation of the globe discharge as due to local heating of the track, except as regards the falling "like a stone."

[J. Violle, *Comptes Rendus*, June 24, 1901.]

*Anti-Coherers.*—In reply to Neugschwender (see *The Electrician* last week, p. 396), E. Marx maintains that Schäfer plates do not act electrolytically, but by the evaporation and condensation of the silver bridges in the gap. In the first place the plates may be thoroughly dried without interfering with the signals. As regards Neugschwender's contention that the re-deposited silver would be in the form of oxide, the author points out that silver oxide is reduced by heating, and that any deposit must, therefore, be of metallic silver. The deposit will be confined between the silver mirror and the celluloid film, and will, therefore, be re-deposited in the gap made by the razor. But the crucial fact is that anti-coherers may be constructed by simply having a narrow bridge over the gap which is not destroyed by the impact of electric waves. In this case there can be no question of electrolytic action. What probably happens is that the bridge acts as a bolometer wire, its resistance increasing with the rise of temperature produced by the impact of the waves. This observation suggests the possibility of constructing bolometers which may fulfil all the functions of coherers, or rather anti-coherers, besides being "self-righting."

[E. Marx, *Phys. Zeitschr.*, June 29, 1901.]

**Electrical Industry in the Transvaal.**—According to *The Times*, the Johannesburg municipality is now in full working order, and amongst other schemes on foot there is one for establishing municipal electric tramways, and another for extending the gas and electric mains.

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# LUTON MUNICIPAL ELECTRICITY WORKS.

The public opening of the electricity works at St. Mary's-road, Luton, took place last Wednesday, when everything went off in the most satisfactory manner. It is well known that Luton is the chief seat in England of the straw-plait industry, which dates from the reign of James I., and which employs about 20,000 persons, so that the use of electrical power in the workshops should make the load-factor of this town remarkably good.

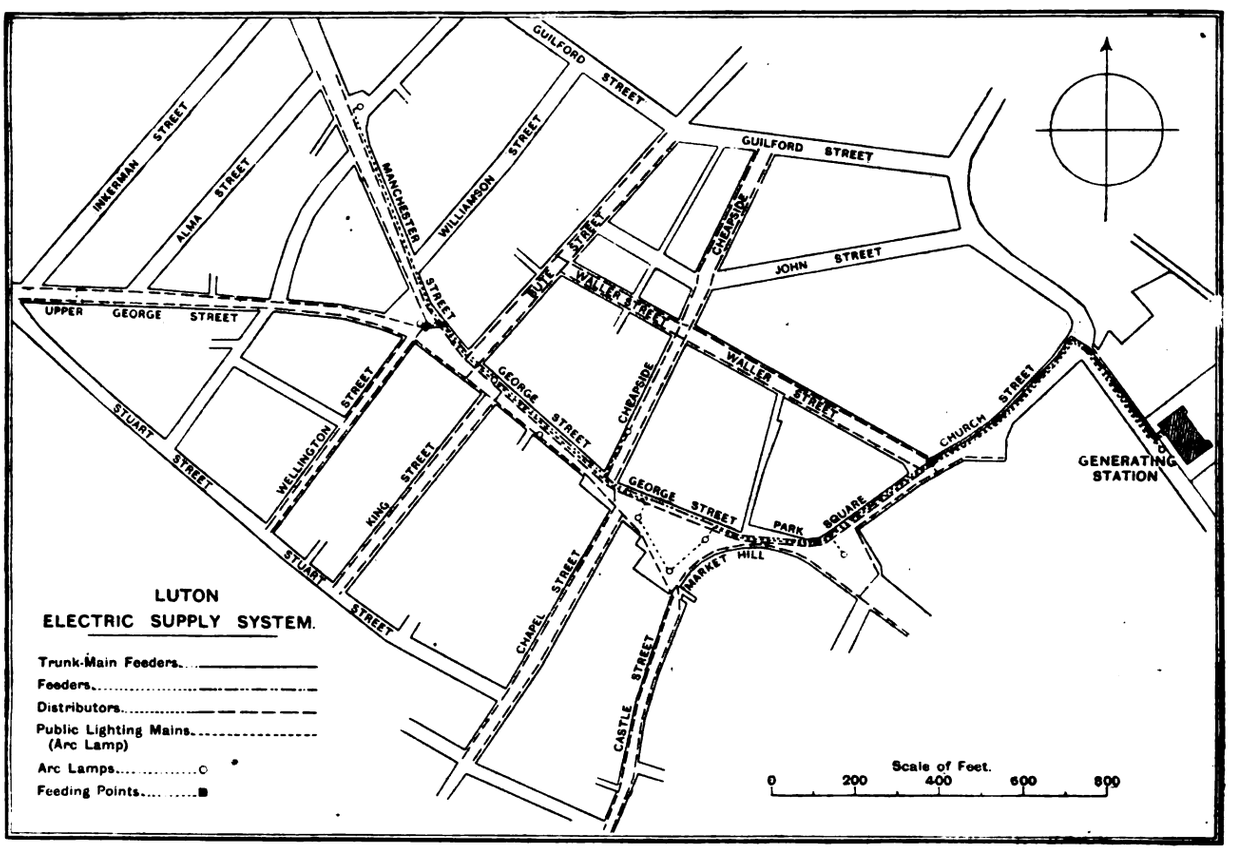
The Borough Council obtained their provisional order in 1895, and in 1896 the Electric Lighting committee conferred with Mr. Albion T. Snell, and a sub-committee was appointed, which visited a number of electricity works. Mr. Snell was requested in April, 1897, to report fully on the lighting of the town. His report was approved by the committee and confirmed by the Town Council in June, 1898, and the following month he was instructed to prepare specifications and plans. Tenders for plant and buildings amounting to £26,000 were accepted by the Corporation, and the work was commenced in the summer of 1900.

The buildings were erected under the superintendence of the borough surveyor, Mr. A. J. L. Evans, who prepared the necessary designs and acted as architect. The elevation, 122ft. long, which faces St. Mary's Church, is in Luton grey brick, with pilasters of Ibstock red facings and Bath stone string courses, neckings, and cappings. The engine and boiler rooms are parallel to each other, and permit of extension towards the river. The floor of the engine room is laid with slabs of artificial stone, and the walls are lined with glazed brick to the underneath side of the girders supporting a 6-ton traveller. Both engine room and boiler house have skylights throughout their length, with ventilators on each side. The first plant is designed so as to be practically self-contained and independent of future extensions, so that in the event of accident, from fire or otherwise, it can be separated from the larger units which will follow.

The chimney shaft is octagonal with a square base. It is 120ft. high above ground line with a minimum internal area of 60 sq. ft. The firebrick lining is carried up for about 40ft.

Two lancashire boilers have been erected by Messrs. Tinkers, fitted with Musgrave superheaters. Each boiler is 8ft. diameter by 30ft. long, and is fitted with two internal furnaces 3ft. 3in. in diameter, the flues being reduced to 2ft. 9in. at the back of the boiler. The boilers have been built for a working pressure of 160lb. per square inch, and have been tested hydraulically to a pressure of 280lb. per square inch. The steam pipes forming the main ring are 8in. in diameter with 7in. branches to the boilers in the lower run and branch pipes to the engines from the top member.

At present one Green economiser of 240 tubes, capable of raising 15,000lb. of water per hour from 60°F. to 212°F., has been fixed, but space is provided for a further 120 tubes.




LUTON: MAP SHOWING POSITION OF THE POWER STATION AND MAINS.

The scrapers are worked by an electric motor through worm gearing. The coal bunkers are in line with the boilers and open on to the firing platform. In the first instance the boilers will be hand fired, but arrangements have been made for mechanically handling the coal at a future date.

The main exhaust pipe is 12in. in diameter, and is laid in a culvert under the engine room floor. The exhaust steam is passed through a Wright surface condenser of the Berryman type, capable of condensing 10,000lb. of steam per hour with a vacuum of 25in. of mercury; or it can be taken direct to atmosphere through a Blake and Knowles automatic valve. The air pump is of the Edwards type with two cylinders coupled to a compound engine. The circulating water is supplied from a concrete-lined cooling pond adjacent to the river Lea, and it is arranged that a flow of water from the river can be passed through it. The pipes syphon through a steam driven centrifugal pump, the maximum capacity being 40,000 gallons per hour. Ultimately, it is intended to erect a cooling tower above the pond.

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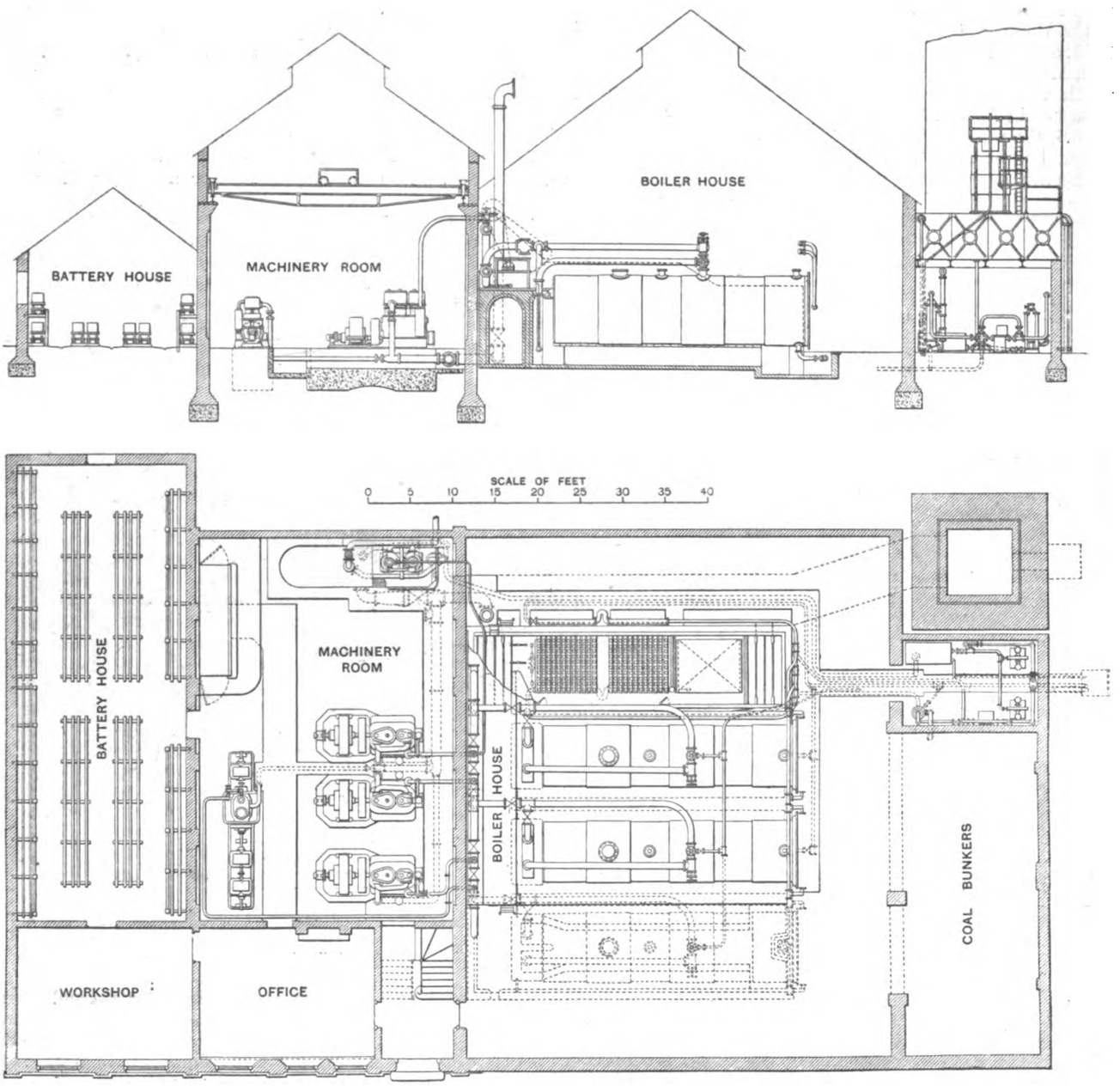
The feed water service comprises two steam Pearn flywheel pumps, and a steam injector, each capable of delivering 10,000lb. of water per hour. There is a cold storage tank of 6,000 gallons capacity, and a Tyacke water-softening plant capable of treating 250 gallons per hour. The usual duplicate services have been provided for feeding the boilers with condensed water from the hot well, from the cooling pond, or from the cold storage tank, either through the economiser or direct to the boilers through a small feed water heater. The feed water is measured by a Kennedy meter.

The main switchboard, built by Messrs. Nalder Bros. and Thompson, is made of Sicilian marble mounted on an iron frame, and consists of five dynamo panels and five feeder panels, with battery and balancer regulating panels in the centre. On the lower centre panel are mounted the ammeter, automatic cutout and resistance for connecting the middle wire to earth. At the back of the board are three horizontal 'bus bars, and in the front are vertical 'bus bars so arranged




LUTON: PLAN AND SECTIONAL ELEVATION OF GENERATING STATION.

The generating sets comprise three 85kw. steam dynamos by Messrs. W. H. Allen, Sons & Co. running at 390 revs. per min., and a 42kw. steam balancer by the same makers running at 480 revs. The two balancing dynamos are connected to the engine through a coupling, so that they can be disconnected and run as a motor balancer when desired. On the other side of the engine is permanently coupled a 16kw. dynamo, used for charging the regulating cells.

The large dynamos have four poles and carbon brushes, and are designed to give each an output of 170 amperes at 500 to 550 volts when running at normal speed, and capable of 15 per cent. overload for three hours without undue heating. They are shunt-wound, with regulating resistances in the shunts.

that any machine can be coupled to either of the horizontal 'bus bars. Each dynamo is connected through an automatic maximum and minimum cutout on one pole, and a main switch interlocking with the field switch on the other pole. Each set can be excited separately or off the 'bus bar. The instruments are either Weston, Kelvin, or Nalder Bros. and Thompson edgewise permanent magnet moving coil type.

There are two batteries each of 140 cells of the Chloride type. Each battery is capable of discharging at the rate of 160 amperes for two hours, 100 amperes for four hours, or 70 amperes for seven hours. The main batteries are charged across the terminals of the 'bus bars. The regulating cells

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are in the centre on either side of the neutral wire, and are charged by the dynamo coupled to the steam balancer already referred to.

The whole of the street cables were supplied and laid by the Callender Company. They are insulated with vulcanised bitumen laid on the solid system in wooden troughs filled with bitumen, and covered with tiles. So far two main feeders are laid, one of 0·3 by 0·8 by 0·8 sq. in. section to the nearest part of the distributing system, and the other 0·2 by 0·20 sq. in. to a point near the Town Hall. The distributing mains in the heaviest section are 0·15 by 0·1 by 0·15 sq. in., but otherwise they are 0·075 by 0·05 by 0·075 sq. in. Two pairs of twin pilot wires are brought from each of the feeding points to the station. The street boxes have been arranged with the poles in separate iron boxes, so that each main can be disconnected without risk of short circuit.

Ten public arc lamps have so far been erected, and are coupled in series off the outers, a connection being made between the fifth and sixth lamp to the middle wire through a switch, so that five lamps can be switched off without interfering with the other five. The lamps are Crompton's single carbon long type, and each post is fitted with an Edmundson's automatic cutout and compensating resistance, controlling the lamps from the station in the usual way. The posts were specially designed for Luton, and are built so that the centre of the arc is approximately 23ft. from the ground. Two 32 c.p. incandescent lamps are to be used after the arcs have been switched off at midnight.

About 2,000 lamps of 8 c.p. have been connected up; the price of gas is 2s. 4d. per 1,000 cubic ft., and the Corporation is supplying current at 6d. for the first 400 hours of maximum demand, and 3d. per unit afterwards for lighting, the price for power being 6d. and 2d. per unit, and for heating a uniform rate of 1½d. per unit. This preferential rate for heating has been decided on by the Corporation in order to encourage electric heating of the various factories. Wright's maximum demand indicators and Aron meters are being used. The following is a list of the principal contractors:—

| | |
|---|---|
| Tinkers Limited ..... | Boilers and economisers. |
| W. H. Allen, Son & Co. ..... | Engines and dynamos. |
| Babcock and Wilcox..... ..... | Pipe work, feed services and water softening plant. |
| Nalder Bros. and Thompson. ... | Main switchboard and instruments. |
| J. Wright & Co. ..... | Condensing plant. |
| Callender's Cable & Constrn.Co. | Street mains and public arc lighting. |
| General Electric Co. ..... | Meters. |
| Reason Manufacturing Co. ..... | Demand indicators. |
| Neville Bros..... ..... | Buildings. |

Mr. W. H. Cooke, who represented Mr. Snell whilst the work was in progress, has now been appointed borough electrical engineer.

## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

The exhibition which is now being held in Glasgow is well worthy of attention from the electrical engineer and all who are interested in electrical progress. Local ambition has described the exhibition as "international"; but this is scarcely a correct designation of the show in its entirety, and far from accurate when applied to the machinery section and the technical departments. In many respects, however, this is an undeniable exhibition of the shrewd Scot and his inimitable ways. The spirit of the Scot penetrates into the smallest details, about which I need not enter into particulars, irksome enough though they be to the exhibitors and attendants, who vainly look for everyday conveniences to be freely provided in a place where they must necessarily spend a good deal of time. In the preparation of this series of descriptive articles this same spirit has withstood me, as it appears to have also conflicted with all who have attempted a similar task. I have desired to take my trusty photographer with me into the exhibition in order that your readers might be promptly provided with pictures of the electrical exhibits. But no, the spirit of the canny Scot prevented me, even triumphing over the alleged hatred of the Glasgow Corporation for private monopolies. For lo, the arch-haters of such monopolies—as the National Telephone Co. would assure you—have bred a nest of monopolists in their own exhibition, for filthy lucre. There are sanitary and catering monopolies, executive monopolies of various descriptions, and—where I am hit hardest—there is an absolutely exclusive photographic monopoly (for a great sum granted they this privilege). Accordingly, not only your special correspondent but also even the exhibitors themselves are debarred from using a camera in the exhibition; a man may not even photograph his own stand. Now a photographer, even when he is a monopolist, may find the work cut out for him to be a tougher job than he can promptly get through; and it is not to be wondered at, if, when he finds all the exhibitors want him at the same time, he is unable to please everybody. Even at Paris we were allowed, on obtaining a special permit, to employ our own photographer, but of course Paris is not Glasgow. The exhibitors have other grievances besides those we have mentioned, as, for instance, the insufficient supply of steam to enable all the engines to be run when desired, and the imperfections of the foundations provided for those engines. However, I will leave this unpleasant subject now; my reason for mentioning it was by way of explanation of a defect in the exhibition arrangements that must of necessity be reflected in any descriptive article.

From an electrical point of view the Glasgow Exhibition is superior to any collection of exhibits that have hitherto been assembled in the United Kingdom. No really international electrical exhibition has ever been held here; and, coming as that at Glasgow does, soon after the inimitable show at Paris, it suffers from a comparison which it is scarcely fair to make. The electrical expert visiting Glasgow will probably find nothing new to him, but he will see a convenient collection of things that will be highly suggestive and typical; and the ordinary non-expert student will discover a rare opportunity to acquaint himself with all the latest types and patterns of machinery in the most recent developments of electrical industry. Our advice to the electrical visitor who has sufficient time to spend is that he should first study the electrical arrangements as a systematic whole before attempting to investigate detailed exhibits. Let him remember that in great part the exhibition is lighted and its moving exhibits are driven by electric power. The best course, therefore, is to go first to the steam-raising department, which can be reached by passing through the great Machinery Hall. Here the various types of land and marine boilers should be noted, together with the diversified arrangements for hand and automatic stoking, the gas firing of one of the exhibits, the superheating, fuel-economising, and feed-heating arrangements, &c. A visit should be paid to the yard outside where the gas generator for firing the boiler just mentioned is at work. Note also that there are two sets of main steam ranges, one for high and the other for lower pressure, besides the independent main from a superheater to one of the large steam engines. The high-pressure range works with saturated steam at about 160lb., and supplies all the engines for driving electric generators; the other main range works at about 120lb., and supplies a number of smaller engines and steam plants about the hall.

From the boiler room the visitor should pass to the other side of the partition which separates the boilers from the Machinery Hall. Here he will find a large and varied display of steam-driven dynamos, mostly of British manufacture, and nearly all of well-known and thoroughly tried types. These are run on occasion, taking it in turn in groups to supply current to the main switchboard, from which it is distributed for lighting and motive-power purposes throughout the exhibition. Before staying to examine in detail any of the steam-dynamo plants, the visitor should proceed to this switchboard, which is essentially the centre of the electrical system. Appropriately, therefore, I select it as the first of my illustrations (Fig. 1); and, while acknowledging my indebtedness for the photograph to the exhibitors, Messrs. Kelvin and James White, I may add that I am chiefly indebted to the various exhibitors for the illustrations that will accompany my descriptive notes on their exhibits. The switchboard is constructed to take continuous current from the main generators at 2 × 250 volts on the three-wire system. There are at present 12 of these generating sets, as enumerated

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later; five are on the outer mains and seven are used on the sections at 250 volts. There are eight feeder panels taking current from the three-wire 'bus bars. Six of the feeders run direct to sub-boards in various parts of the exhibition; the two remaining feeders supply the ring mains round the Machinery Hall. I was informed that up to the time of my recent visit, the top load on the entire switchboard was equivalent to 1,200 amperes at 500 volts, the top motor load being 800 amperes at the same voltage.

Passing from the switchboard the visitor should next investigate the manner in which motive power is distributed. He will observe that there are two main line-shafts running the entire length of the Machinery Hall; one of these is electrically driven, the other is run direct from a steam engine situated near its centre. Besides these, power is also supplied to individual stalls by means of electric motors placed on the stalls. The current for all motors is taken from ring mains laid round the hall on the three-wire system at 2 × 250 volts.

At this stage the visitor may conveniently investigate the general system of lighting. The Committee have aimed at presenting to the public examples of various systems of illumination by means of electricity, ordinary gas, high-pressure gas, acetylene gas, and high-pressure oil. The electric lighting of the exhibition buildings has been divided into three sections, viz., Industrial Hall, Grand Avenue, and Machinery Hall, and each section is still further sub-divided into several circuits, so that no serious inconvenience would be felt should any breakdown occur. The Industrial Hall is lighted by means of 845 10 ampere Brockie-Pell arc lamps, and 404 16 c.p. Zurich incandescent lamps; the Grand Avenue by means of 105 10 ampere Brockie-Pell arc lamps, 120 16 c.p. and 20 200 c.p. Ediswan incandescent lamps; and the Machinery Hall by 250 10 ampere Brockie-Pell arc lamps, 200 16 c.p. and and 30 200 c.p. Ediswan incandescent lamps. The main cables for the lighting of these buildings have been "given on hire" by the British Insulated Wire Co., and the arc light cables by Messrs. Isidor Frankenburg. The wiring installation for the Industrial Hall has been carried out by Messrs. Claud Hamilton, and the wiring for the Grand Avenue and Machinery Hall by Messrs. Lowdon Bros. & Co. In the fine art galleries the lighting has been carried out by the Glasgow Corporation electricity department, and about 4,000 incandescent lights have been installed, and 100 H.P. for motors. The concert hall is entirely lighted by means of 326 16 c.p. and 61 32 c.p. Ediswan incandescent lamps, and the No. 1 restaurant by 49 10 ampere Brockie-Pell arc lamps, the wiring contractor being Messrs. Claud Hamilton. Nos. 2, 3, 5 and 6 restaurants are fitted with 158 10 ampere Brockie-Pell arc lamps and 140 16 c.p. Zurich incandescent lamps, the wiring contractor being Messrs. Lowdon Bros. No. 7 restaurant, press room and band stand are lighted by the Bon Accord Acetylene Gas Lighting Co., of Aberdeen. The farm steading and agricultural building are lighted by the Home and Colonial Acetylene Gas Lighting Co. Messrs. Jas. Templeton & Sons' kiosk is lighted by 48 16 c.p. Zurich incandescent electric lamps, the wiring contractors being Messrs. Lowden Bros. The heating and lighting section is lighted by the Welsbach ordinary gas system. The west portion of the north and south gardens is lighted by 90 10 ampere Brockie-Pell arc lamps, the cast-iron pillars and brackets being "given on loan," by Messrs. Walter Macfarlane & Co. and Messrs. M'Dowall, Steven & Co., the overhead wiring being supplied free by Messrs. The Scottish Aluminium Co., Greenock. The centre of the north and south gardens are being lighted with the Welsbach Company's high-pressure gas system, the pressure pumps being "given on loan" by the Water Motor and Automatic Liquid Elevator Co. The east gardens are being lighted by the Kitson Heating and Lighting Syndicate with their high-pressure oil system. A small portion of the north gardens is being lighted by the Scott-Snell Gas Lighting Co. with their high-pressure system.

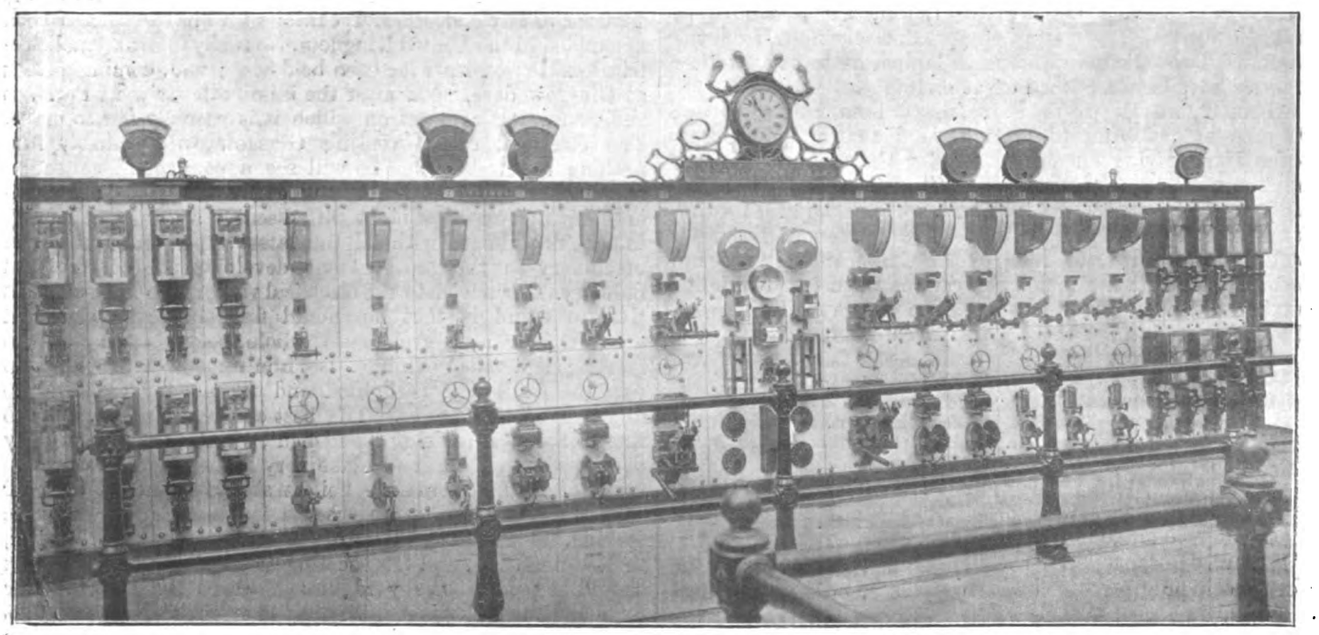

FIG. 1.—MAIN POWER AND LIGHTING SWITCHBOARD (EXHIBITED BY MESSRS. KELVIN AND JAMES WHITE).

When this preliminary survey has been made, the visitor will be in a better position to examine in detail the various electrical exhibits in the Machinery Hall and in the numerous kiosks and out-buildings in remote parts of the gardens. Accordingly, I purpose to cast my description in the same mould, giving first a summary of the boilers, generators, and the switchboard, and then proceeding to describe some of the more interesting exhibits in detail. Below will be found a list of the exhibits in the various departments:—

*Boiler Department.*

| | |
|---|---|
| One Duff's gas producer | W. F. Mason & Co. |
| Four chain-grate land type water-tube boilers. | Babcock and Wilcox. |
| One four-grate marine type water-tube boiler. | Ditto. |
| One gas fired water-tube boiler | Stirling Boiler Co. |
| One mechanically stoked (Vicar's) water-tube boiler | Ditto. |
| One "Economic" boiler | Davey, Paxman & Co. |
| Four Lancashire boilers | Penman (Ltd.). |
| One superheater | Davey, Paxman & Co |
| Two economisers | E. Green & Son. |
| One induced draught fan | Sturtevant Engineering Co. |
| Four Berryman feed heaters | J. Wright. |
| Steam piping in boiler house & Machinery Hall | A. & J. Stewart and Menzies |

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*Steam Dynamo Sets.*

| No. | Engine by | Dynamo by | Rating. |
|---|---|---|---|
| 1 | Willans & Robinson ... | Crompton & Co. ..... | 1,200 H.P. |
| 1 | Ditto ... | British Schuckert Electric Co. | 1,200 H.P. |
| 1 | Davey Paxman & Co... | Electric Construction Co. ... | 650 H.P. |
| 1 | Alley & Maclellan ..... | Mavor & Coulson ..... | 300 H.P. |
| 1 | Robey & Co. ..... | Mavor & Coulson ..... | 600 H.P. |
| 1 | Belliss & Morcom ..... | D. Bruce Peebles & Co. ..... | 250kw. |
| 1 | Ruston, Proctor & Co. | Ruston, Proctor & Co. ..... | 100 H.P. |
| 2 | Robey & Co. ..... | E. Scott & Mountain ..... | 150 H.P. |
| 1 | Sisson & Co. ..... | Clarke, Chapman & Co. ..... | 150 H.P. |
| 1 | Browett, Lindley & Co. | Edison & Swan Co. ..... | 250 H.P. |
| 1 | E. Scott & Mountain... | E. Scott & Mountain..... | 100 H.P. |

The power and lighting supply equipment also includes a balancer by Messrs. D. Bruce Peebles & Co. capable of dealing with 100 amperes out of balance. I may add that there are a number of steam dynamos on exhibit which are not included in the above list, as they are not used on the supply service. These will be described later.

*(To be continued.)*

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

*(Continued from page 402.)*

Several interesting visits to works were made in Dresden, the first being to the electricity works. There are three municipal supply stations in the town, one on the single-phase system for lighting, and two tramway power stations in which continuous current is generated directly for the tramways. The works were built in 1895, and the original system of 2,000 volts primary and 110 volts secondary single-phase current has been retained; the transformers are on the consumers' premises and there is no secondary network. Another reminiscence of old times is the employment of artificial loads for paralleling, and the resistances for these are of large dimensions, as the largest machines have capacities of 800kw. The station, which is about 1 mile from the centre of the supply area, was built by the Helios Company. Six of the alternators—four of 520kw. capacity each and two of 700kw. —are of this firm's manufacture, and the remaining two (800kw. each) were built by Messrs. Lahmeyer & Co. The latter are driven by horizontal slow-speed tandem engines, manufactured by the Dresdner Maschinenfabrik und Schiffswerft, and the others are directly coupled to engines of similar type, four made by Messrs. C. E. Rost & Co. and two by the Augsburg Company. The general lines of the Lahmeyer machines are apparent from Fig. 3. They have slotted armatures and solid pole-pieces on the magnets. The main dimensions of the engines driving them are 775—1,250mm. clynders by 1,258mm. stroke, and their valve gear is on the Collman system, the eccentric shaft for which is driven from the crank shaft through bevel gear. The flywheels of the Helios dynamos are covered in with boiler-iron, as was the large machine shown by this firm at Paris last year.

The switch gallery is curiously arranged. Instead of a regular switchboard there is an instrument pillar on the gallery for each machine, the pillars being of iron and standing side by side quite independently. The generator switches are worked by levers in front of the pillars, the actual switches being in a cellar below, together with the feeder switches. In the arrangement of this cellar there is too much wood and too many short-break switches to recommend it to English practice.

The load on the station is almost entirely lighting. On the day previous to our visit, the maximum load had been 980kw., with a power factor of 0·92, and the minimum 240kw., with a power factor of 0·80. Of course in winter the maximum load is considerably higher, there being between 1,800 and 1,900 consumers on a network consisting of nearly 100 miles of concentric cable. This cable is laid in brick ducts filled with sand. In addition to the lighting network there is a 10-wire telephone network about 10 miles in extent, connecting 27 important points on the lighting network. The price charged for current is 60pf. (7½d.) per kilowatt-hour for lighting and 25pf. (3d.) for other purposes, the former tariff being subject to discounts up to 20 per cent.

The more modern of the tramway power-houses occupies a building adjoining the electricity works. This station has only been running a year, and was designed by the municipal engineer, Herr Meng; it supplies the western sections of the tramway lines with power, the eastern sections being provided for by an older station at the other end of the town. The engine room equipment consists of five horizontal tandem engines running at 90 revs. per min., and directly coupled to continuous current flywheel dynamos generating 1,600 amperes at 560 volts. Three of the dynamos are of Messrs. Schuckert's manufacture and two by Messrs. Kummer & Co., and the engines are by various makers. The dynamos are shunt-wound instead of compound, but otherwise the station follows more or less the usual traction power-house practice, and a detailed description of it is unnecessary here.

The tramways in Dresden are company-owned, and the municipal electricity works supplies current to them through meters. There are samples of the three systems—overhead, slotted conduit and "mixed." The latter is employed on routes which include streets where the overhead wire was not permitted by the municipal authorities. From the company's point of view it has, I believe, not proved a success, owing to the cost of maintenance of the cells. Current is collected from the overhead wire by Siemens sliding bar collectors, and this system is also used in conjunction with the lines which have slotted conduits for a short distance in the central part of the town.

The second visit in Dresden was to the municipal installation for heating and lighting some 20 buildings in the neighbourhood of the royal palace, these including the galleries, the opera-house and other large buildings. The furthest point to be supplied from the station is about a kilometre distant. For heating, steam is employed which is conveyed through a main following a zig-zag course in a large conduit underground. The sinuous path of the main is to allow for expansion and contraction, copper connectors being employed at each bend. The main itself rests on brackets, being supported on ball bearings in each case so that it is free to move. In addition to the steam main, the conduit conveys bare electric light mains which are mounted on insulators and supply current to the various buildings at 2 by 110 volts pressure. The conduit is high enough for a man to pass without stooping, and special precautions are taken to prevent the intrusion of water, the conduit being near the river and at a lower level. Electric thermometers are placed every 100 metres, and are connected to the station to enable the attendant there to observe that the maximum permissible temperature is not exceeded, and there are also water-level indicators recording at the station. The lagging of the main leaves an air-gap between two layers. Steam is generated at 8 atmospheres pressures, this being reduced to 6 atmospheres for the heating surface and again reduced at each house according to the demand. To measure the pressure in any of the buildings there is a board at the station so connected to a telephone, an induction apparatus and a balancing resistance that the pressure can be determined by a null method. Absence of smoke is considered more important here than economy either in capital expenditure or works costs owing to the peculiar conditions and situation, and therefore elaborate precautions are taken to prevent smoke. The stoking arrangements may be described as hand-fed automatic coking stokers, the coal being fed by hand into hoppers whence it drops by its own weight on to a grid and thence into the furnace. There is also a flap over the door of the grate to enable a draught of air to be passed over the surface of the coal. Moreover the architecture of the building itself is handsome and has been chosen so as not to clash with its surroundings. The electrical generating station by itself presents no very unusual features. There are two vertical two-cylinder engines connected to 350kw. dynamos, and a third driving a 175kw. machine, and the

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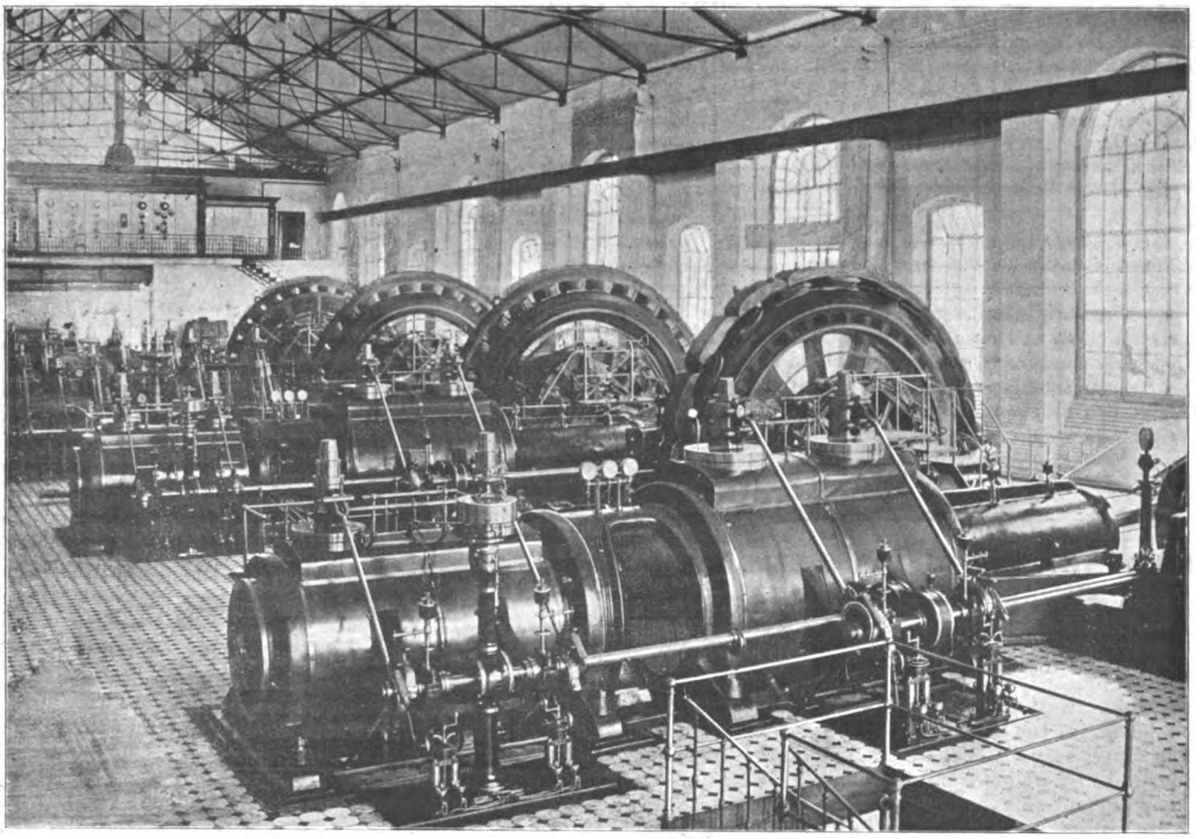

FIG. 2.—GENERAL VIEW OF ENGINE ROOM IN DRESDEN ELECTRIC LIGHTING WORKS

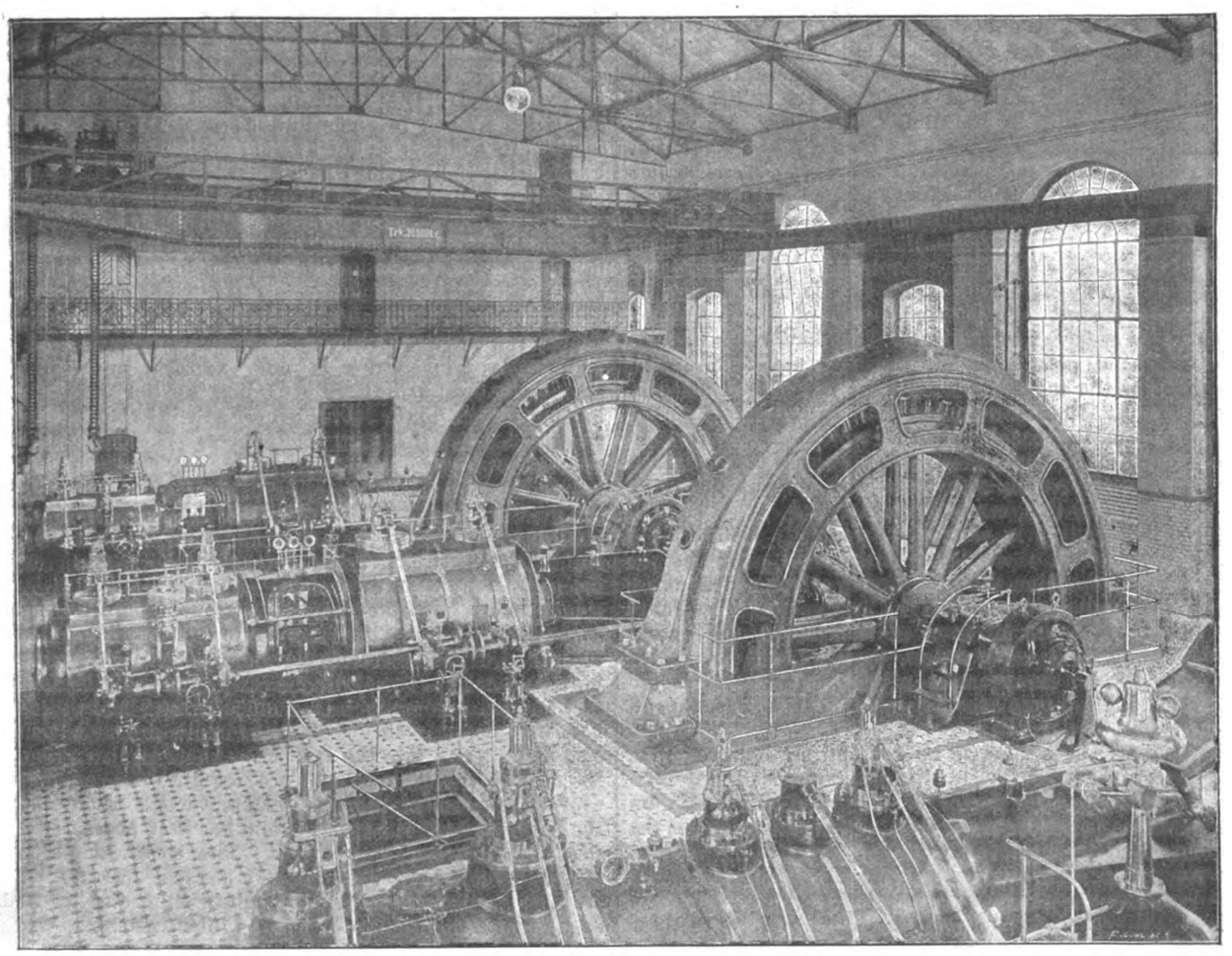

FIG. 3.—THE 800 KW. DRESDNER MASCHINENFABRIK-LAYMEYER MACHINES AT THE DRESDEN ELECTRIC LIGHTING STATION.

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accumulator is relatively large, having a capacity of 2,100 ampere-hours. Six feeders are connected to the switchboard, some of them through resistances for the purpose of reducing the pressure at the feeding points to a common standard. The Dresden telephone exchange was also visited by some of the members. The building is a fine one and is surmounted by a dome of insulators, which on nearly all German post offices takes the place of the ugly erections used in England for the reception of the wires. Several of the overhead wires have already been replaced by underground cables, however, and the whole system will in all probability be eventually on the metallic circuit underground system, twin underground wire being even employed for the individual subscribers. The overhead lines are of bronze, and the cables are in sizes up to 224 pairs, paper-insulated and lead-covered.

A secondary battery with cells of 36 ampere-hours capacity is employed for ringing and for the microphone circuits, the ringing current being passed through a pole-changer. In the switch-room itself, it was apparent that the traffic could not be dealt with at the same rate as in our big exchanges in this country, although there are 5,800 subscribers and the boards are equipped for 70,000. The boards are of the flat type, and when sitting the operator cannot reach to the further side. From the one side of the board the 5,800 jacks of the multiple can be reached sitting; but from the other side, as the unused jacks are nearest to the operator, she has to stand up in order to make some of the connections. The speaking in the exchange was much louder than is found advisable in England, the operators having breast-plate microphones, the mouthpieces of which were at a considerable distance from the girls' mouths, and after use for each conversation the microphone mouthpiece was clapped up against the operator's breast, a hinge being provided for the purpose. It struck one o'clock while I was in the switch-room, and a new shift of girls came in to replace the others. During the change there was plenty of conversation between them, and very casual attention was paid to the switchboard. However, the number of indicators dropped at the time was few, so either the subscribers have been drilled not to ring up during dinner-time or else they take a more decided mid-day rest than is usual for the English telephone subscriber. Another example of the easy-going nature of the service was that each operator had in front of her a list of the names of the subscribers on her section. The switchboards, I was told, had only been erected for about two years; but it was noticeable that neither the calling drops nor the ring-off indicators were self-restoring. I also observed that in the case of junction and trunk calls the answering operator does not see her subscriber through, but has merely to put him through to the exchange wanted or to the trunk room, where the demand has to be repeated. In the trunk office were the trunk boards proper and the trunk-junction boards. In several cases one operator had only two trunk lines to serve. The time of the conversation is controlled by sand-glasses, four being provided on every two-line trunk board.

Perhaps the most interesting of the works visited at Dresden were the railway repairing shops and the station at which current is generated for these and for lighting the yards, workshops and railway stations. A three-phase system is employed, there being 200 motors, representing 1,300 H.P., connected to the mains, but all the lighting, which includes 900 arcs of from 6½ to 20 amperes and about 7,000 incandescent lamps, is connected to one phase only of the system. Thus the network is always running unbalanced, but the engineers consider this to be of no moment, the dynamos being designed to give their full output either as single-phase or three-phase machines, and the pressure regulation being always carried out in accordance with the voltmeter connected to the lighting phase. Induction motors are employed throughout, and the power-factor is about 0·7 at full load. The size of the motors varies from ⅓ H.P. to 40 H.P., and the total connection to the station, including lamps and motors, represents some 2,400 H.P.

The station has been running since 1894, and it must, therefore, be regarded as one of the earliest works of its class. Thus of the six units (Siemens and Halske machines driven by horizontal tandem engines, with a total capacity of 1,600kw) five generate three-phase current at 230 volts, which is transformed up by stationary transformers to 8,118 volts. The sixth machine, put in last year, generates this pressure directly. From the engine room cables run to a distributing tower, from which the overhead lines start, there being 120km. of overhead high-pressure conductors, and, in all, 14·5km. of underground cable. Cable is employed for crossing the Elbe. The overhead line is protected by Siemens horn lightning conductors placed at frequent intervals. The low-pressure circuits are supplied through 119 transformers, 24 of these (aggregating 427·5kw.) are three phase, and reduce the pressure to 115 volts for the motors, and the remaining 95 (aggregating 875kw.) are single-phase transformers with a secondary pressure of only 75 volts.

A thing which attracted considerable attention was the speeding gear connected to the governors and controlled electrically from the switchboard. On the whole, however, the switchboard construction was naturally of out-of-date design, the high-pressure fuses being, for instance, placed in wooden cupboards in the step-up transformer room. Amusement was also caused by the many uses to which the cooling pond was put. Jet condensers are employed, worked from the tail-rods of the engines, and discharge into a cooling pond. The second purpose to which this pond is put is that of an oil separator, the oil being skimmed off the surface and sold. The third use of the pond is as an artificial load, but whether merely for testing purposes or for paralleling the alternators I did not ascertain.

In the repairing shops, both separate and group motor-drive is employed, there being 107 motors for the former purpose and 11 for the latter. The greatest number of machine tools in one group is eight. The largest motors are 15 H.P. ones for driving the turn-tables and the fans, and the aggregate horse power of all the motors is 417 H.P., the average power consumption being 150 H.P. and the maximum 250 H.P. Current is distributed to the transformers by a 3,000 volt ring main fed at two places, and there are seven 50kw. three-phase transformers for power supply at 115 volts, and 15 10kw. single-phase transformers supplying current at 75 volts for lighting.

*(To be continued.)*

## VISIT OF THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS TO FALCON WORKS, LOUGHBOROUGH.

Last Friday week the Brush Electrical Engineering Co. chartered a special saloon to take members of the technical press from London to Loughborough on the occasion of the visit of the Incorporated Association of Municipal and County Engineers to their Falcon works. We were accompanied by several members of the directorate, Mr. B. Broadhurst, the secretary, and Mr. E. H. Tyler, the superintending engineer. Each visitor on arrival was given a plan of the works showing the route of inspection, and all the plant in course of manufacture was clearly labelled, giving full particulars as to output, destination, &c., the arrangement doing the greatest credit to Mr. F. E. Andrews, works secretary, Mr. E. A. Leeson, works manager, and Mr. C. S. Thomson, assistant works manager. After the inspection lunch was served in one of the stores.

The first shops visited were the heavy tool shop, the erecting shop for the large engines and dynamos, and the iron foundry. The block is about 450ft. by 120ft. The work in hand included two 1,000kw. inductor alternators for Leicester, seven 400kw. steam inductors for Wandsworth and St. Luke's, one of these being under test, two 500kw. sets for Melbourne, besides a large number of smaller sets. There were also several fine sets finished, including two 1,000 H.P. Universal engines. The next block consisted of the truck shop, the car paint shop, the car wood-working shop, and the car erecting shop, and, slightly separated therefrom, the timber store. This block is about 400ft. by 350ft. Almost every description of car was in course of construction. These included 50 maxi

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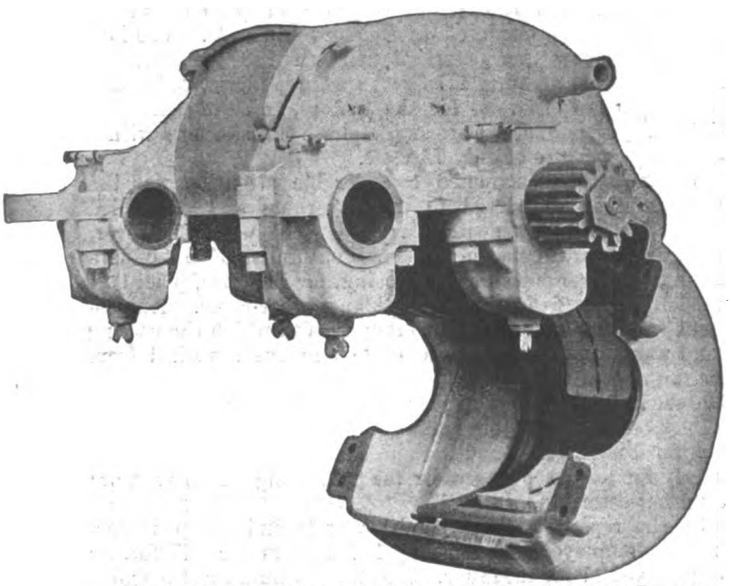
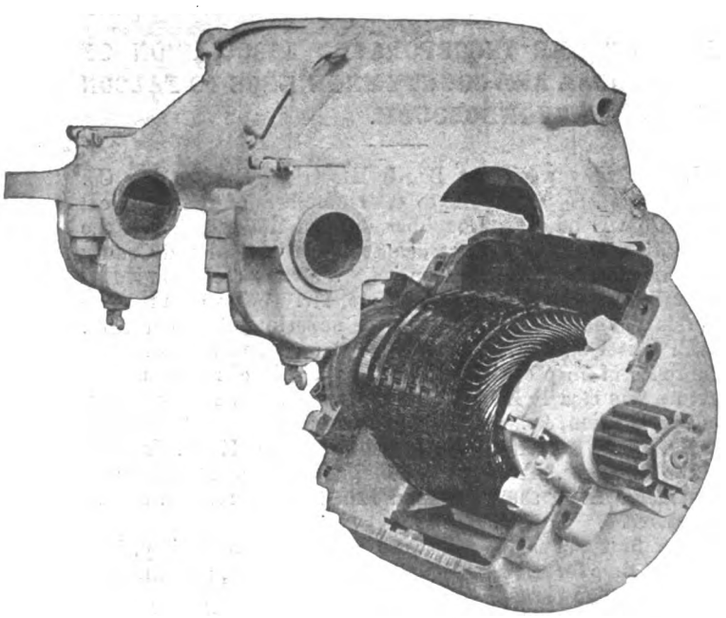
mum traction double deck type, each to carry 67 passengers, and 170 cars carried on four wheel trucks to carry 43 passengers for Manchester, 100 cars for Bradford, 20 for Southport, 80 for Glasgow and 80 for Newcastle. The remaining block, about 250ft. by 250ft., contained the traction motor shop, small engine shop, small dynamo shop, controllers and



25-H.P. TRACTION MOTOR, SHOWING METHOD OF REMOVING BOTTOM FIELD COILS.

accessories shop and winding shop. The time was insufficient for seeing the smithy, pattern shop and old buildings.

One of the principal novelties is certainly the 25 H.P. traction motor. It is of the usual ironclad type, with slotted and laminated armature. The pole-pieces are formed by laminations cast into the motor frame, and are wound symmetrically with four field coils. The bottom half is



25-H.P. TRACTION MOTOR, SHOWING METHOD OF REMOVING TOP FIELD COILS.

arranged to hinge downwards, and the armature bearings allow the armature either to be left in the top half or lowered in the bottom half with equal facility. This is achieved by a simple arrangement of bolts, which is clearly shown in the illustrations. The lubrication is carried out by means of steel rings revolving in an oil well of ample dimensions. Oil is often not employed, we believe, on American motors, owing to the severe winters in the United States. Four oblong slots are formed by omissions in the pole laminations, and reach through to the outside of the case, where the opening is protected by a hood and a raised edge. The slots are opposite to a radial slot in the armature core, which is fed with air through longitudinal air ducts parallel with the armature spindle. The result during rotation is that air is taken from the motor case and expelled through the pole slots, thus giving a positive ventilation. The brush holders are of the usual carbon block type, but are fitted with a finger, which ensures a good contact between the carbon and the body of the holder, and prevents the chattering of the carbon when the commutator becomes uneven from wear.

The power house for lighting and driving consists of three 150kw. sets and one 50kw. set, whilst there is floor space for a 300kw. set in addition. Besides the ordinary testing arrangements, there is a 800kw. water dynamometer and a water tank for weighing steam used in the engines up to 1,000kw. size.

There is thorough protection against fire, tanks of the capacity of 15,000 gallons being placed over one of the stores and arranged to automatically start sprinklers in shops in which there is inflammable material should a fire break out. The starting of the sprinklers would also automatically start pumps working to refill the tanks. A complete system of hydrants and hose is also provided.

## STORAGE BATTERIES IN ELECTRIC POWER STATIONS, CONTROLLED BY REVERSIBLE BOOSTERS.*

BY J. S. HIGHFIELD.

(*Concluded from page 405.*)

Figs. 14, 15, 16, 17 show curves photographically reproduced from charts taken from Elliott recording instruments. Fig. 14 shows the action of the battery without the reversible booster, the line pressure being kept by hand from 490 to 550 volts; without hand regulation the variation on a shunt-wound generator would be altogether too great if the battery were worked anywhere near the one-hour rate. Figs. 15, 16, 17 show the operation with the booster in the ordinary way of working. Unfortunately, the instrument on the generator was not of the latest type, fitted with a dash-pot, so that the quick changes which occur are somewhat magnified. Errors in the engine governor also account for some variations.

I should here note that the ultimate object of the booster is to correct for the varying characteristic of the battery: when in a partly charged condition, the battery characteristic is a falling one, somewhat similar to the characteristic of a shunt-wound generator. The characteristic, however, varies according to the state of charge of the battery. The reversible booster described serves to correct for the varying nature of the battery characteristic so as to make the characteristic of the battery and booster the same whatever the state of charge, and to make it either falling or flat, or rising over a wide range. By making the characteristic flat, the load on a shunt-wound generator working in parallel with the boosted battery will be nearly constant. By adjusting the booster so that the characteristic closely follows the characteristic of the generator, without shunt or compound wound, the load will be shared by the battery, as in the case of two generators in parallel.

There is one other point I should here refer to, that is the nature of the fluctuations of the current taken by the motor driving the booster. Since the number of cells used is 240, the boost on the top charge amounts to 100 volts—that is, the pressure is from 600 to 620 volts on the cells when they are fully charged. The least pressure to which the battery falls on the heaviest discharges is 440 volts—the boost on charge is, therefore, greater than on discharge; hence, with the same current the motor takes more driving on charge than on discharge; and therefore, with the steady load on the generator, the charging current is never as great as the discharging current, as will be seen from the curves. The greatest observed current taken by the motor is 70 amperes, but this is unusual, the normal maximum not exceeding 50, or about 7 per cent. of the maximum load. The battery used consists of 240 cells, giving 450 amperes at a one-hour rate of discharge. The booster is rated for 200 amperes continuously, and will carry 450 amperes momentarily; the brushes work without lead, and do not spark even when a current of 200 amperes is passing without any field.

* Paper read before the Institution of Electrical Engineers May 2.

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In considering the use of batteries in connection with large plant operating roads with upwards of 400 cars, it is necessary to take into account the above-mentioned fact, that the load will be a fairly even one, and with properly designed engines very little improvement in economy can be obtained by a further levelling of the load by a battery. There may be special cases, for instance, where a small all-night service is worked, or where a peak, due to extra cars, exists at stated hours, which a battery could carry, and so save the use of extra boilers or engines for only one or two hours. In general, however, I am inclined to consider that the central station is not the correct place for a battery to be used with plant for this size of road. Consider the case where a system of town tramways, operating upwards of 400 cars, is driven from a single station situated reasonably near to the centre of the load, several of the routes running out some

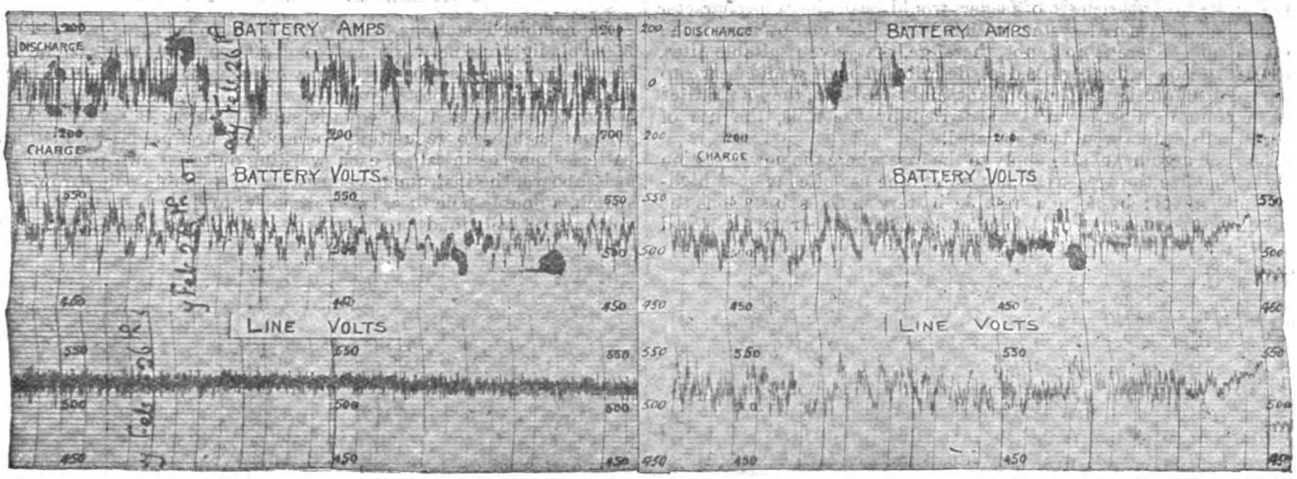
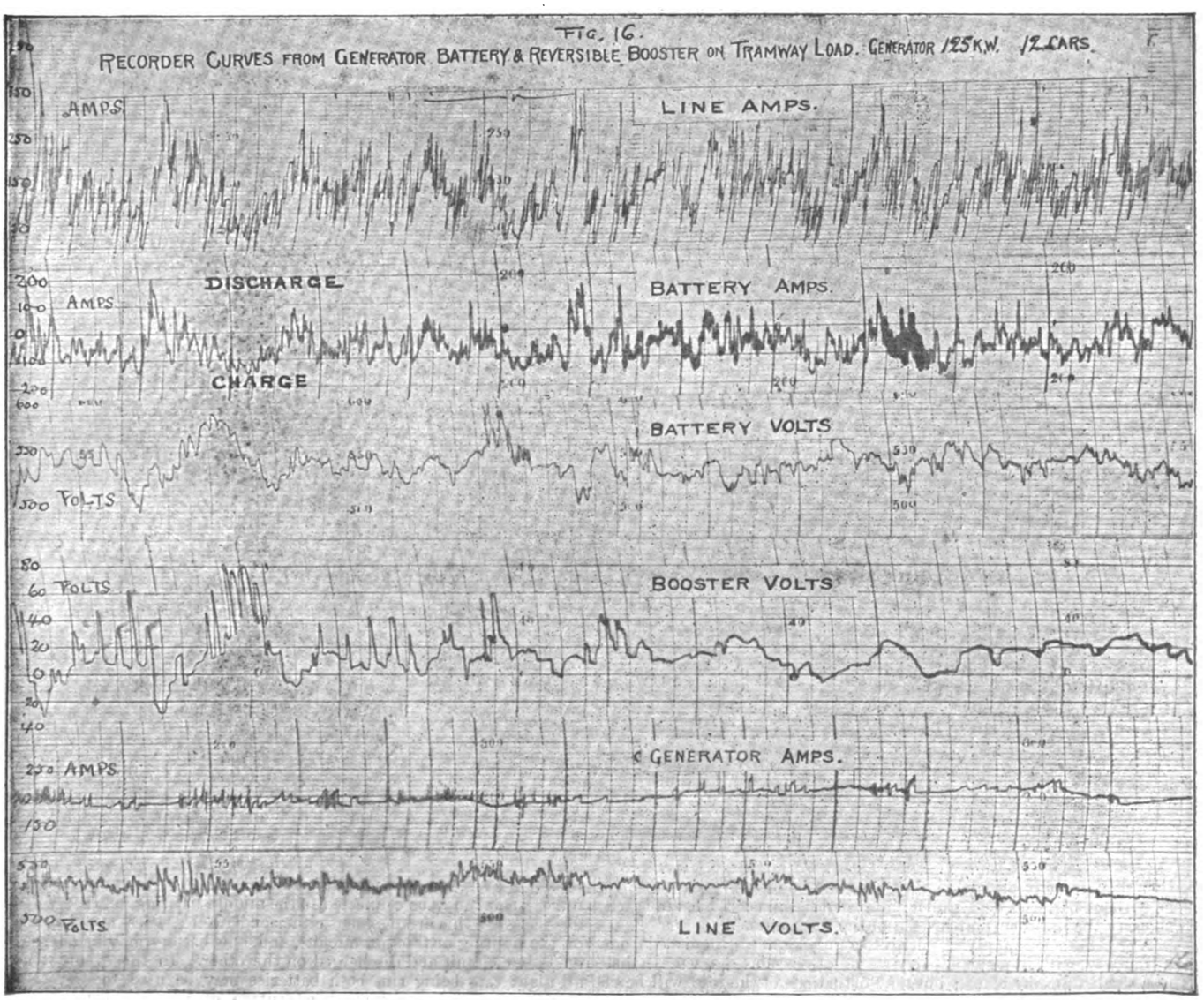



FIG. 15.—WORKING WITH BOOSTER. FIG. 14.—WORKING WITHOUT BOOSTER.

Recorder Curves for Traction Load worked with Battery and Reversible Booster.

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six or more miles in various directions from the centre. Each route should be fed by its own feeders to obviate any breakdown on one route affecting the remainder; each route might account for 30 or 40 cars; the load on each set of feeders would be of the same character as the load on a small system with a load-factor of not more than 25 per cent. There is no doubt, therefore, that given suitable sites, batteries in sub-stations worked as described above would serve to keep the load on the feeders constant, and since less than a third of the maximum current would be carried by the rails, the use of boosted rail-feeders would be obviated.

The same arguments also apply to the case where the power-station is so far outside the area as to necessitate the use of converted high-tension currents: by using a suitable battery in the sub-stations the load on the converters could be kept constant, the rotaries would however, be greater, and therefore the right place for batteries on a railway system will be in sub-stations situated near the load centres.

### Batteries in Combined Stations.

In combined stations, supplying both to a three-wire 460 to 500 volt lighting network and to a 500 volt tramway system, the boosting system can be used in a convenient way: 240 cells are sufficient with the booster just described for a tramway circuit at 500 to 550 volts, and are equally suitable for a 460 volt lighting system. Since no regulating connections are used two identical batteries may be installed, each working on to its own panel on the switchboard, the instruments consisting of a double-pole throw-over switch, a double-pole fuse, two voltmeters to show batttery and line volts respectively, and an ammeter reading both sides of zero: leads

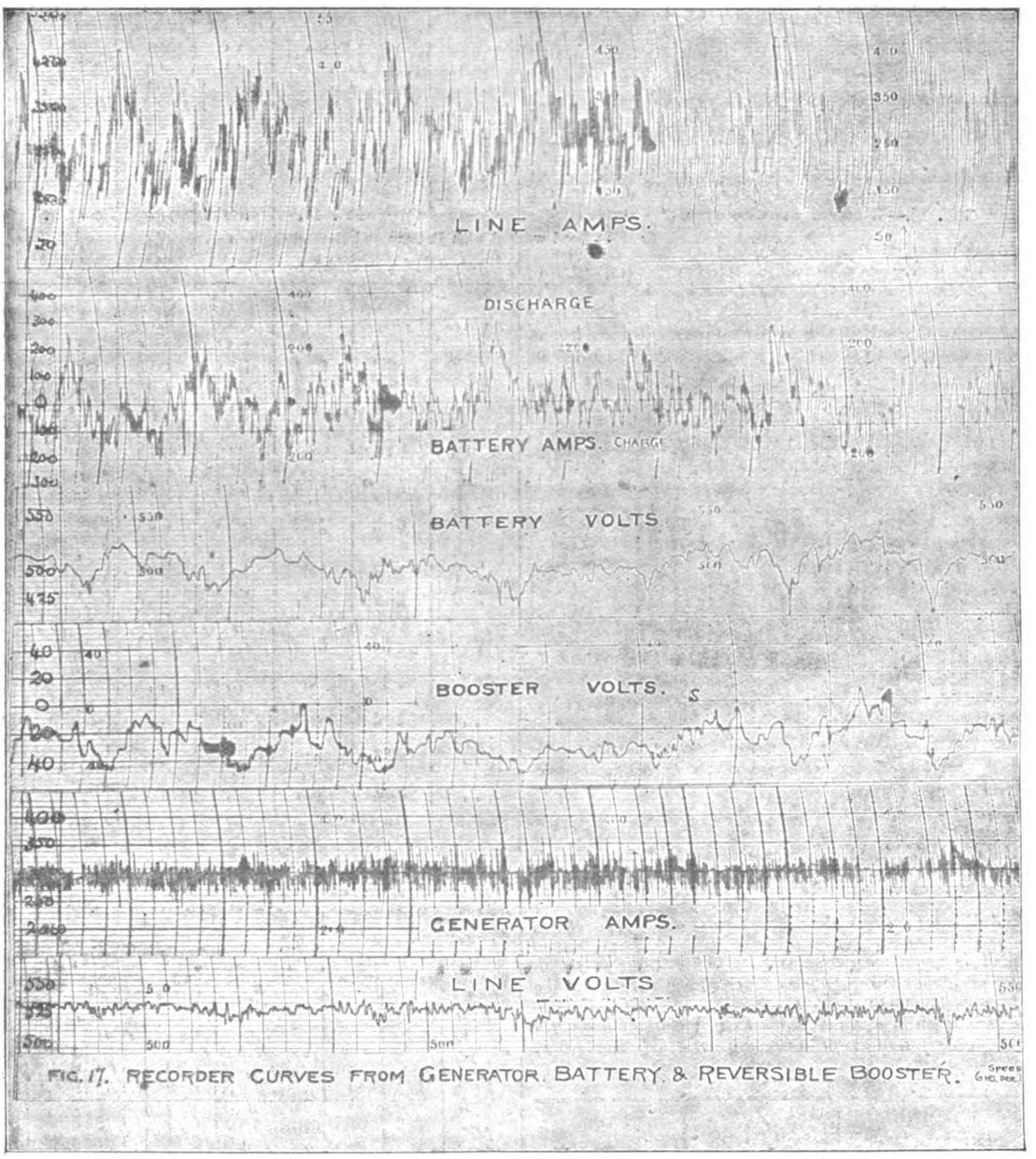


FIG. 17. RECORDER CURVES FROM GENERATOR, BATTERY, & REVERSIBLE BOOSTER.

then operate more perfectly; they need not be of such great capacity as without batteries, and the high-tension feeders could be designed to carry the mean current instead of the maximum.

A power-station supplying energy to a railway, as distinguished from a tramway, will, in general, carry a load of the same character as that of a small tramway plant; but the fluctuations of the load will be of greater amount, due to the greater energy taken in starting the heavier vehicles. At the same time, it is more easy to arrange the running schedule for a railway than for a street tramway, so that only a few cars or trains start or ascend heavy grades simultaneously; the stops generally are less frequent, and the road is flatter than that obtaining in the ordinary tramway. The distances run will probably, should also go to the middle point on each battery, so that the middle point may be connected to the middle lighting 'bus bar when desired. By this arrangement either or both batteries may be used on the lighting or traction circuits, and one battery may be charged on either circuit and discharged on the other. In the event of no all-night cars being run both batteries may be used to drive the lighting load. A very great advantage of working batteries as described on traction loads is that an ordinary shunt-wound generator driven by an engine without any great weight of flywheel may be used, thus enabling the generators to be worked without alteration on the lighting 'bus bars, and saving the cost and complication of equalising gear. It seems hardly necessary to point out how

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much easier is the work put on the running plant when batteries are used so as to give it a steady load, compared with driving the cars direct when all the fluctuations come on and have to be dealt with by the engine.

### General Considerations.

It is convenient to summarise the points referred to under the separate heads of: (1) Batteries in lighting stations, (2) batteries in traction stations, (3) batteries in combined stations. In the first case the battery should be used to serve as a regulator for the pressure, to enable the individual units to be fully loaded without the use of several graded sizes, and to enable the number of units to be decreased; that is to say, to enable a few units of greater and of uniform size to be adopted, instead of the many graded units usually installed, and to improve the plant load-factor over the whole year, especially to enable the steam raising and distributing plant to be more uniformly worked; and, in special cases, to effect a saving in feeder copper, and to enable the area of supply to be economically extended. In the second case, although the engines may be working only at one-third to one-half of their load, the boilers during working hours are economically loaded, and a battery will effect a saving of fuel, from the boiler point of view, by serving to operate the all-night load, shortening the boiler working hours, and ensuring that, when the engines are running, the boilers are working at a good load. The saving of one hour's steaming in the morning, and at night when only a few cars are out, will also effect a considerable saving in fuel. The battery, however, enables the engines to be run nearly at full load at all times; it thus makes the steam

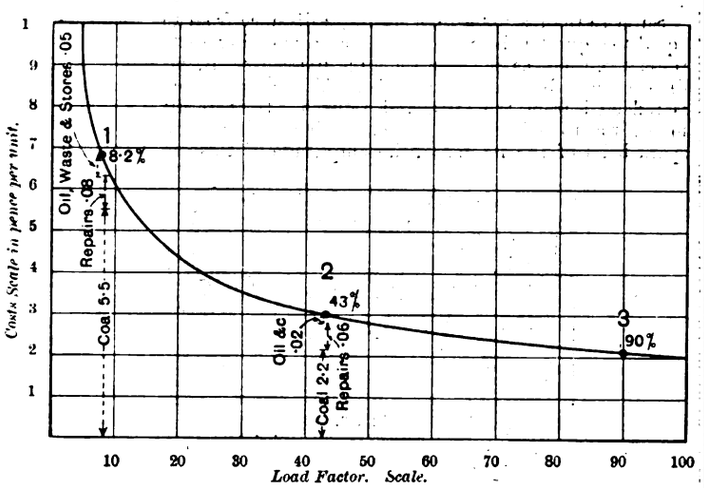


Fig. 18.—Load Factor and Costs.

Figures worked on basis of Lancashire coal at 9s. per ton. Load factor for points 1 and 2 = $\frac{\text{Units generated}}{200 \times 24}$. Point 2 is taken from a coal-test over 48 hours with a Lancashire boiler, 8ft. diameter, 30ft. long, steam at a pressure of 150lb. per square inch superheated. Compound condensing engine 300 I.H.P. Coal used, 18,700lb. Units generated, 4,225. Total coal per unit, 4·44lb. Coal used in banking fires, 560lb. Point 1 estimated from this test; point 3 from electrolytic works. The oil and stores and repairs are approximate.

used per unit less, and also saves considerable wear and tear of plant; it enables, especially in small systems, a greater number of cars to be operated by a given plant, 20 light cars being easily worked by a 125kw. unit. Used in sub-stations the battery should effect a large saving in copper both for line and rail feeders; it should frequently enable negative boosters to be dispensed with, and it permits of the working of long routes with direct supply at the standard pressure. In combined stations the use of a battery worked in conjunction with a reversible booster enables all the plant to be of the same pattern, shunt-wound generators operating quite as well as compound ones. The arrangement of two identical batteries enables an interchange of energy to be made between the traction and lighting units, a point of value especially in stations of small and moderate size.

The special points to be considered in designing the battery with a view to its economical use are: (1) The capital cost as compared with that of plant. For a lighting station this should be worked out at not less than the three-hour rate of discharge, and at this rate will be found not to differ much from that of plant of the same capacity. For power-stations the capital cost may be worked out at the one-hour rate of discharge, and will be less than the cost of corresponding plant.

The cost of battery depreciation is an exceedingly difficult figure to arrive at. I find that the cost of re-plating throughout for a battery in lead boxes, or in stout wood lead-lined boxes, amounts to about one-half the cost of the battery, when allowance is made for old material. Giving the plates a life of six years, this represents about 7 per cent. per annum on the cost of the battery. Allowing for complete re-plating every six years, the repairs on a battery are a negligible amount, and the wages account is also exceedingly small, the labour involved being for filling up the cells every week or fortnight, and for taking the specific gravities every week as before described. The chief considerations, therefore, are the saving in fuel due to working with a better load factor—especially working the steam-raising plant at a better load factor—the saving in wages through working the running plant a reduced number of hours; and, finally, whether the saving effected through these causes makes up for the cost of the lost energy in the battery itself. From results obtained over a period of one year the efficiency of working under lighting conditions may be taken as 74 per cent., and, from the few figures I have, the efficiency under traction conditions is 84 per cent.

I have found great difficulty in obtaining reliable figures as to the connection between the cost of coal, oil, water, stores, and repairs, and plant load factor. I have, through the courtesy of the engineer of an electrolytic works, obtained the figure of 0·21d. per kilowatt-hour for the above items on a load factor of close on 100 per cent. I have weighed the coal to one boiler operating a single engine driving the traction load over 16 hours, and, taking a low figure for the cost of oil and repairs at my station, I obtained the figure of 0·3d. per unit for a load factor of 43 per cent.; the engine being of 300 I.H.P., gave a fair load for a 30ft. × 8ft. Lancashire boiler using superheated steam. I obtained a third point on the curve by calculation from this test, allowing for the coal used in banking and in keeping the steam pressure at not less than 80lb., the working pressure being 160lb. The load-factor is arrived at by assuming that the engine and boiler could give 200kw. steadily. I shall be very much gratified if the discussion throws further light on this question, and enables me to correct or confirm the curve, Fig. 18, plotted from the above figures.

It appears to me to be a matter of some difficulty to properly define the term "load factor" in this connection. Taking a single engine and boiler working at or near full load for a given number of hours, hours per day might be plotted on the horizontal line in Fig. 18 instead of load factor. The ratio between time of working and costs would then depend chiefly on the length of steam pipes which it is required to keep hot when the engine is standing. But the case might be considered where the engine and boiler are working continuously but at various loads; the curve would then represent the efficiency of engine and boiler at these loads. With several engines and boilers the question becomes more complicated, and I find myself unable to come to any general conclusion, and I submit the curve for what it may be worth.

With regard to the arrangement of batteries the present tendency to connect all the cells together by burning the lugs of the plates in each cell is undoubtedly excellent practice. The shorter and stouter these lugs are made the better will be the self-regulation of the battery. Cells of stout lead, or of wood solidly put together and lined with lead, are preferable to glass boxes on light wood trays. It is of great importance that the positive and negative plates should be designed to wear equally; if one set of plates have much greater capacity than the other the weaker ones will wear out first, causing greater expense for renewals. Watt-hour meters for measuring the charge and discharge should form part of the equipment of all batteries; even daily charging and discharging are essential to the life of the plates, and if the daily input for a lighting battery is 25 per cent. more than the output weekly readings of the specific gravity will show if the charge is right.

The energy efficiency obtained of 74 per cent. on the lighting battery is certainly due, in part at least, to the great ease of operating attained by the methods described.

The increased efficiency observed when the battery is worked as I have described on an intermittent load is interesting. It appears to be due to the fact that the discharges are often of such short duration that the increased pressure due to the gas effect is utilised on these discharges. The fact that the battery alone "floating" on the line operates best when the working pressure of each cell is taken at about 2·08 volts seems to confirm this view.

In conclusion, I must apologise for the somewhat tentative way in which I have put forward my views; my excuse is, that there are so many variables in considering battery working that it is not easy to find a starting-point from which to calculate. I have to thank Messrs. Elliott Brothers and the British Thomson-Houston Co. for lending me several instruments, and my assistants, Messrs. Hollingsworth, Eccles and Carter, for helping me with the experimental work.

## APPENDIX.

The tramway system was very rapidly extended throughout the year, as is shown by the figures, the consequence is that the load factor over the whole year is lower than will be the case next year, when less new work will be done; the load factors for the quarters give a more true idea of the correct figures.

The boilers under steam at any time were two Babcock boilers fired with refuse burnt in a destructor, and two 30ft. × 8ft. Lancashire boilers, say the equivalent of three 30ft. × 8ft. Lancashire boilers.

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COMPLETE FIGURES RELATING TO AN ELECTRIC POWER STATION DRIVING A TRAMWAY AND GENERAL SUPPLY LOAD.

The figures relate to the period from March 31, 1900, to March 31, 1901.

| | | April to June. | July to Sept. | Oct. to Dec. | Jan. to March. | Year's total. |
|---|---|---|---|---|---|---|
| Units gener. | Lighting | 58,938 | 64,350 | 122,924 | 124,907 | 371,119 |
| | Traction | 120,477 | 144,562 | 182,058 | 194,662 | 641,759 |
| | Total | 179,415 | 208,912 | 304,982 | 319,569 | 1,012,878 |
| Units sold | Lighting | 47,620 | 53,845 | 102,410 | 105,382 | 309,257 |
| | Traction | 118,407 | 132,041 | 168,008 | 183,229 | 601,685 |
| | Total | 166,027 | 185,886 | 270,418 | 288,611 | 910,942 |
| Batteries (1) | Charge | 27,110 | 31,640 | 30,920 | 32,493 | 122,163 |
| | Discharge | 19,680 | 24,120 | 22,270 | 24,810 | 90,880 |
| (2) | Charge | ... | ... | Mar. 2 to 31 only 10,517 | | ... |
| | Discharge | ... | ... | | 8,560 | ... |
| Booster motor units | | From Aug. 22 only. 2,660 | | 6,194 | 5,720 | 14,574 |
| | | kw. | kw. | kw. | kw. | kw. |
| Max. load on feeders | Lighting | 180 | 216 | 278 | 250 | 278 |
| | Traction | 307 | 344 | 402 | 430 | 430 |
| | Combined | 482 | 560 | 638 | 660 | 660 |
| Max. load on plant | Lighting | 194 | 195 | 292 | 220 | 292 |
| | Traction | 206 | 302 | 212 | 255 | 302 |
| | Combined | 390 | 470 | 504 | 475 | 504 |
| Plant hours | Lighting | 670 | 614 | 1,304 | 1,391 | 3,988 |
| | Traction | 1,455 | 1,418 | 1,410 | 1,451 | 5,734 |
| | Combined | 1,455 | 1,418 | 1,410 | 1,451 | 5,734 |
| Load factors | Lighting | 12·1 | 11·8 | 17 | 19·4 | 12·7 |
| | Traction | 17·5 | 17·8 | 19·0 | 19·6 | 16·2 |
| | Combined | 15·9 | 15·1 | 19·4 | 20 | 15·8 |
| Plant load factors | Lighting | 45 | 53 | 32 | 41 | 32 |
| | Traction | 41 | 33 | 60 | 52 | 37 |
| | Combined | 31 | 31 | 43 | 46 | 35 |
| *Percentages* | *Sold* Gener. | 80·8 | 83·6 | 83·3 | 84·3 | 83·3 |
| Lighting | *Charge* Gener. | 46·0 | 49·1 | 25·1 | 26·0 | 33 |
| | *Disch.* Sold | 41·3 | 44·8 | 21·7 | 23·6 | 29·4 |
| | *Disch.* Charge | 72·6 | 76·2 | 72·0 | 76·3 | 74·4 |
| Traction | *Sold* Gener. | 98·3 | 91·3 | 92·3 | 94·1 | 93·7 |
| | *Booster* Gener. | ... | ... | 3·40 | 2·94 | 3·30 |
| | *Charge* Gener. | ... | ... | from Mar. 2 to Mar. 31 only 16·02 | | ... |
| | *Disch.* Sold | ... | ... | | 14·0 | ... |
| | *Disch.* Charge | ... | ... | | 81·4 | ... |

*Table showing capacity of battery and plant in some direct current stations.*

| | Total capacity in kw. | | Ratio of battery to steam plant in kw. | | Total capacity in kw. | | Ratio of battery to steam plant in kw. |
|---|---|---|---|---|---|---|---|
| | Plant. | Bat. at 3-hour rate. | | | Plant. | Bat. at 3-hour rate. | |
| Aberdeen ..... | 1,620 | 260 | 0·16 | Northwich .. | 194 | 66 | 0·34 |
| Sunderland ... | 1,880 | 60 | 0·03 | Leith..... | 640 | 115 | 0·18 |
| Norwich ..... | 1,664 | 120 | 0·07 | Llandudno .. | 400 | 60 | 0·15 |
| Notting Hill... | 660 | 100 | 0·15 | Hull ..... | 3,900 | 300 | 0·07 |
| Oswestry ..... | 173 | 40 | 0·23 | Bradford ... | 3,569 | 270 | 0·07 |
| Wolverh'mpt'n | 1,440 | 220 | 0·15 | Burnley ... | 822 | 120 | 0·14 |
| Manchester ... | 7,250 | 240 | 0·03 | Shrewsbury. | 540 | 60 | 0·11 |
| Lincoln ..... | 600 | 85 | 0·14 | Bury ..... | 760 | 70 | 0·09 |
| Chester ..... | 1,000 | 30 | 0·03 | Kensington.. | 1,000 | 157 | 0·157 |
| Charing Cross | 4,900 | 800 | 0·16 | Edinburgh... | 9,697 | 460 | 0·048 |
| Chelsea ..... | 3,100 | 190 | 0·06 | Dewsbury... | 485 | 85 | 0·175 |
| Stockport ..... | 460 | 250 | 0·54 | South'mpt'n | 730 | 250 | 0·34 |
| Whitehaven ... | 210 | 55 | 0·26 | Belfast ..... | 2,200 | 200 | 0·09 |
| Canterbury ... | 300 | 150 | 0·5 | Harrow..... | 350 | 70 | 0·2 |
| Leyton ..... | 1,260 | 200 | 0·15 | Stafford..... | 198 | 140 | 0·7 |
| Hove ..... | 1,200 | 90 | 0·07 | Nottingham | 2,569 | 30 | 0·01 |
| Barrow ..... | 525 | 40 | 0·07 | Blackburn... | 2,127 | 75 | 0·03 |
| Halifax ..... | 1,900 | 200 | 0·1 | Glasgow ... | 10,848 | 468 | 0·04 |
| Nelson ..... | 116 | 88 | 0·75 | Guildford ... | 200 | 66 | 0·33 |
| St. Helens..... | 950 | 230 | 0·24 | Dundee..... | 1,283 | 248 | 0·19 |

# ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 420.*)

A very important discovery in connection with this phenomenon was made by Sarasin and De la Rive (*Comptes Rendus*, March 31, 1891), who found that the distance between two non-sparking places essentially depended upon the size of the resonator and was approximately equal to four times the diameter of the circular resonator. The earliest view taken of the effect was that the radiator creates stationary dielectric waves of definite wave length, and that the resonator indicates this wave length by sparking when held as described at places of maximum electric force. But it is found that the size of the radiator very little affects the result. Another hypothesis was that the radiator sends out waves of all wave length, resembling, therefore, white light, and the resonator picks out and responds to its own particular wave length. But this hypothesis is not justified by any facts. The most probable explanation was that given by M. Poincaré in 1891, and also by Prof. J. J. Thomson ("Recent Researches on Electricity and Magnetism," p. 402). The radiator, as shown by Bjerknes, is a very strongly damped system, and at each discharge hardly makes more than a dozen oscillations, even if so many, before its electrical vibrations are damped out (see Figs. 6 and 7).

Suppose the resonator then held at a distance from the metal wall equal to a quarter the wave length corresponding to this particular resonator, then, as the electric force passes over it, it will create a displacement between spark balls. This displacement travels on, is reflected from the wall, and returns. If it returns at such a moment as to assist the displacement, then, being made between the spark balls of the resonator, the amplitude of this displacement is

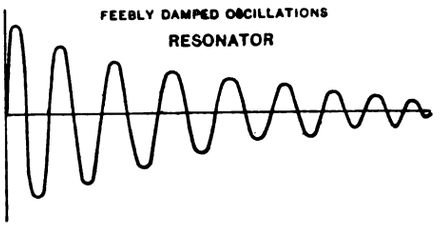


FIG. 6.

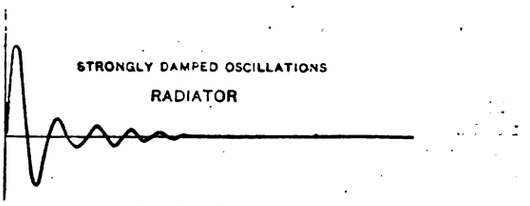


FIG. 7.

FIGS. 6 and 7.—Diagrams representing Feebly Damped (Fig. 6) and Strongly Damped (Fig. 7) Electrical Oscillations.

increased and a succession of such assistances will break down the insulation of the air and a spark will occur. It is clear, therefore, that this reinforcement of the displacement amplitude will occur when the distance of the resonator from the metallic wall is a quarter of its own wave length. Sarasin and De la Rive used resonators of various diameters (D) as shown in the table below, and measured the distance ½L between places of maximum sparking in the resonator.

**Table I.**

| D. | 4D. | Distance between two adjacent points of maximum sparking = ½L. |
|---|---|---|
| 100cm. | 400cm. | 406cm. |
| 75 | 300 | 282 |
| 50 | 200 | 222 |
| 35 | 140 | 152 |
| 25 | 100 | 120 |
| 20 | 80 | 86 |
| 10 | 40 | 38 |

Accordingly, the positions of the resonator when the maximum sparking takes place in its air-gap reveal, not the wave length of pre-existing stationary waves, but the oscillation period or wave length corresponding to the resonator itself. Nevertheless, they prove the

* Cantor Lecture delivered before the Society of Arts, Dec. 17, 1900.

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existence of stationary dielectric waves in the space between the metal sheet and the radiator. Prof. J. J. Thomson notes one point as yet unexplained. The above table shows that the wave length is eight times the diameter of the resonator. If this is really the wave length of free oscillations of the radiator system we should have expected it to be equal to $2\pi$ times the diameter of the circular radiator and not to eight times.

By making an estimate of the vibration period of the oscillator and measuring the wave length or double distance between two maximum sparking places as the resonator was moved along the base line, Hertz was able to make an approximate estimate of the velocity of propagation of these electric waves, and show that it was of the same order as that of light. Since his time more accurate work has confirmed the above estimate, and shown that there is an almost absolute identity between the experimentally-determined velocity of light through air and that of electrically-produced waves through the same medium. Hertz also showed that these waves were guided in direction by metallic wires.

Space will not permit us to enter into a full discussion of these experiments, but the reader must be referred for details to other sources of information.* The exceedingly careful experiments of Messrs. Trowbridge and Duane on the propagation of electric waves are, however, so valuable a contribution to the subject that it is desirable not to omit reference to them.† In studying the propagation of electric waves along wires experimentalists have generally employed some modification of conductor systems usually called the Lecher arrangement. In this arrangement a Hertz oscillator consisting of two plates, as already described, is attached to the secondary circuit of an induction coil, and two other insulated plates are placed parallel and opposite to these respectively, but separated by a little distance, the dielectric being air or any suitable solid. To these last plates are attached long wires which extend parallel to each other through space. When the coil is in operation and sparks passing between the primary spark balls, the rapid oscillation of potential of the plates of the Hertz oscillator creates similarly rapid changes of potential of the secondary plates, and hence produces electric oscillations in the long wires. The condition of these wires when of suitable length is then as follows:—

At certain places there are alternations of potential which may be called potential loops, and at other intermediate positions there are potential nodes or places of minimum potential variation. There is also a variation of current in different parts of the wires. In some places the current has a maximum value and in others a minimum. Accordingly, when we are dealing with the propagation of these rapid oscillations along wires, it is curious to find that the current has not always the same strength in different parts of the same wire. Strong currents may exist in some places, and yet little or no current at all in other parts of the same continuous wire.

If the ends of the wire are free or open, the current is necessarily zero at the free ends. In all these cases the places of maximum potential variation are those of minimum current or vice versa. There are many ways in which this distribution of current and potential along the wires of the Lecher apparatus can be explored. If the variations of potential are of sufficient amplitude, the position of the nodes and loops can actually be seen in a dark room by the unequal distribution of a luminous glow surrounding the wire, bright at some places, but less bright or absent at others.

Hertz studied the propagation along wires by placing his resonator with spark-gap parallel to the wire along which the waves were travelling, and moving it to different positions. If, for instance, a wire attached to a plate placed opposite to one of the plates of a Hertz radiator is stretched out parallel to the base line, and if a Hertz resonator is placed with its centre on the base line and its spark-gap parallel to this wire, then if the plane of the resonator is at the same time perpendicular to the plane containing the spark axis of the radiator and the base line, we have seen that under these conditions the direct action of the radiator produces no sparking in the resonator. If, however, the resonator is placed in this position and moved along with its spark-gap parallel and near to the stretched wire, small sparks are seen at the resonator balls at some places, but not at others, thus showing a variation in the distribution of potential at different places along the stretched wire.

Another method, due to Lecher, is to bridge over the wires with a vacuum tube, which can be slid along into different positions. The vacuum tube may have in it rarified air with a trace of turpentine vapour, or it may be made of some fluorescent glass. In any case the tube is found to become luminous in some positions and not in others. The vacuum tube may be placed across the open ends of the wires, and these may be bridged across by a metal wire which is slid along into various positions. In some positions of the bridge the vacuum tube will glow and in others it will not.

A third arrangement is to employ a bolometer. If fine insulated iron wires are twisted round a wire in which oscillations are set up, and if these iron wires form part of one arm of a Wheatstone bridge, then it is found that the oscillations of current in the wires induce others in the iron wire which heat it and change its resistance; the balance of the Wheatstone bridge is thus upset. By sliding the iron wires along the wires conducting the oscillations it is possible to discover the places of maximum and minimum current in these last conductors.

A fourth arrangement is by the use of a quadrant electrometer having a needle connected to one pair of quadrants. By the use of this idiostatic electrometer we can explore the distribution of potential along the wires. These and several other methods enable us to measure the wave length of the oscillations of potential or current along wires.

In the experiments of Messrs. Trowbridge and Duane referred to above, the Hertz oscillator consisted of a pair of sheets of tinfoil separated by a very thick sheet of ebonite. These sheets of tin thus forming a condenser, were connected to spark balls and formed a primary oscillator. Outside these sheets of tin were placed other sheets of ebonite, and then two more tinfoil plates connected by a wire laid out in a long rectangular form. At the far end of this secondary circuit was a small spark-gap with pointed cadmium terminals. When oscillations were set up in the primary condenser circuit, sympathetic oscillations were excited in the secondary circuit, and by adjusting the length of wire in the secondary circuit it was brought into resonance with the primary. It was then found that there was a current node at the central point and ventral or maximum current points at other places along the two parallel sides. The positions of these places on the wire were determined by the bolometer.

The vibration period of the secondary circuit was determined by photographing the secondary spark. Hence, observations gave the frequency and the wave length. The mean of a very large number of observations with this apparatus enabled Messrs. Trowbridge and Duane to prove that the velocity of the waves along wires was equal to $3 \times 10^{10}$cm. per sec, that is, the same as the best determination of the velocity of the light in air. The material of which the wires are made, as long as it is not magnetic, has no effect upon the result. These facts show that the effects must really be due to the propagation of dielectric waves in the space between the wires, and experiment shows that their velocity is sensibly the same as that of free electric waves in space. In other words, the wires only guide the waves. The distribution of electric force or displacement is such that it is perpendicular to the surface of the wires, and the magnetic force or flux is perpendicular to the electric displacement.

Before proceeding to discuss the special properties of electric radiation, it will be convenient to make a brief allusion to other methods of detecting electric waves. One of these, which has proved most useful in practice, is based upon the properties of aggregations or of metallic microphonic contacts of becoming changed in resistance by the impact of electric waves. The late Prof. D. E. Hughes undoubtedly proved in 1879 that a tube loosely full of metallic powder was by the action of an electric spark at a distance caused to pass from an electrically non-conductive to a conductive condition.* It was not, however, until 1891, when Prof. E. Branly described his experiments on the same subject, that the effect of electric sparks upon loose agglomerations of metallic particles was examined with sufficient care.†

The term "coherer," which was introduced by Dr. Lodge to describe a loose or microphonic contact between metal surfaces, balls or points and plates, has passed into general use to describe any form of loose collection of metallic particles in a tube which is affected as regards conductivity by electric waves. The chief property of such a loose or imperfect microphonic contact, whether between single pieces of metal or innumerable particles of metal, is that large variations of resistance can be made in a circuit containing it when the microphonic contact is exposed to the action of electric force.

It appears, however, from the experiments of Prof. Bose (see *Proc.* Roy Soc., Lond., July, 1899, Vol. LXV.) that this variation is not always a reduction in resistance. If the substances in loose contact are pieces of clean potassium immersed in paraffin oil, the action of the electric waves, according to Prof. Bose, is to produce an *increase* in resistance. This fact alone shows that we must be cautious in making theories as to the cause of the commencement of electric conductivity in these cases. Moreover, the same

* Hertz's original Papers are published under the title of "Electric Waves," and have been translated into English by Prof. D. E. Jones. For a summary of Hertz's work see "The Alternate Current Transformer," Vol. I., J. A. Fleming; also "Recent Researches in Electricity and Magnetism," Prof. J. J. Thomson; and "The Work of Hertz," by Dr. O. J. Lodge.

† *Phil. Mag.*, Aug. 1895, or *The Electrician*, Vol. XXXV., p. 712.

* For an account of Prof. Hughes' early work see Fahie's "Wireless Telegraphy," Appendix D, or *The Electrician*, Vol. XLIII, p. 40, May, 1899

† For an account of the investigations of Prof. Eduard Branly on "The Electrical Conductivity of Discontinuous Conducting Substances," see *La Lumiere Electrique*, May 16, 1891. or *The Electrician*, Vol. XXVII., p. 221. Also *Comptes Rendus*, December 6, 1897, or *The Electrician* Vol. XL., p. 333; also *Comptes Rendus*, July 25, 1898, or *The Electrician*, Vol. XLVIII., p. 87; see also Dr. Dawson Turner's Paper on "Experiments on Electrical Resistance of Powdered Metals," *Proceedings* of the British Association, Edinburgh, 1892; or *The Electrician*, Vol. XXIX. p. 432.



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investigator has found that a sensitive tube made with certain powdered metals, such as arsenic, exhibits a different behaviour to strong and weak electric radiation. A given radiator increases the resistance of powdered arsenic when the tube is within a certain critical distance, but reduces it if placed beyond that distance.*

It has been suggested that the phenomenon of the coherers of two metallic surfaces, at first lightly but not electrically in contact, under the action of an electric wave is due to the creation of a large difference of potential between them, and that they are thereby drawn together and cohere. It may be, however that a chemical action between the metal particles and the dielectric in which they are immersed, when a gaseous liquid or solid, is an essential part of this change in resistance. Metallic particles embedded in solid dielectrics like gelatine or collodion can also be made to pass from an insulating to a conducting condition by the action of an electric wave.† In the case of tubes partly full of loose metallic filings the nature and pressure of the atmosphere included in the tube undoubtedly exercises a great influence on its behaviour under electric waves. The employment by Mr. Marconi of a good vacuum is unquestionably a factor in his production of an extremely sensitive and reliable detector.

It appears, therefore, that so far from an increased conductance being invariably the result of the action of electric force on a loose contact, it may either be an increase or a decrease. It will probably be found that when the matter is more fully explored these facts fit in with and explain many previously unintelligible phenomena.

Many years ago Edison invented an instrument which he called an electromotograph, and made it the foundation of his well-known chalk cylinder telephone receiver. He discovered that the friction, and therefore the coherence, between certain surfaces, such as a metal surface and a chalk surface moistened with solutions of certain salts, was greatly reduced by passing a current through them. Neugschwender has discovered (see *Electrical Review*, Vol. XLIV., May 26, 1899) that a film of moisture caused by breathing on a scratch made in a silver coating on a glass plate was sensitive to electric waves, the result being an increase in resistance (see *Wied. Ann.*, Vol. LXVIII., p. 92). In one case the resistance of the film was raised from 50 to 90,000 ohms by the impact of electric waves, the scratch being 20mm. long and $\frac{1}{3}$mm. wide. Contrary to expectation, the property was not destroyed by evaporating the film, and this led Neugschwender to suspect that metallic salts dissolved in the moisture had something to do with the phenomenon.

It may therefore prove to be the case that increase or decrease of conductivity in heterogeneous substances by the action of electric waves is not only a more or less universal phenomenon, but is a complex effect, and not explained sufficiently by christening the conductor a coherer. In view of the fact that a marked increase in resistance is the result of the action of electric force on certain conductors, it might be better to abandon the terms coherer as somewhat inapt in many cases, and simply call these substances sensitive to electric force or electric waves *electrovariable conductors*, denoting them positive or negative according as the conductance increases or decreases.

Accordingly, most powdered metals, loose metallic contacts, loose aggregations of carbon particles, and other substances, may be called *positive electrovariable* conductors, because they increase in conductivity by the action of an electric wave; whereas aggregations of particles of the alkaline metals, films of moisture on glass, certain films of metallic salts, and other substances, may be called *negative electrovariable* conductors.‡

*(To be continued.)*

Electric Light at Lewes.—The inauguration of the electric light at Lewes took place on the 2nd inst., the opening ceremony being performed by the Mayor. The provisional order was obtained in 1898, and work was commenced about four months ago by the County of Sussex Electrical Power Distribution Co. So far, two 50kw. Universal engines coupled to Brush dynamos have been installed, whilst foundations are already prepared for a third set of 100kw. capacity. Babcock and Wilcox boilers and jet condensers are being used, and there is a small storage battery for day loads, having a capacity of 200 ampere-hours.

* See Prof. J. C. Bose on "Electric Touch and the Molecular Changes produced in Matter by Electric Waves," *The Electrician*, Vol. XLIV., p. 626, 1900.

† See Minchin on "The Action of Electromagnetic Radiation on Films containing Metallic Powders," *Proc. Phys. Soc.*, Nov. 24, 1899, or *The Electrician*, Vol. XXII., p. 123.

‡ Prof. J. C. Bose has employed the terms positive and negative in the same sense.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)

"A Pocket Book of Electrical Engineering Formulæ." By W. Geipel and M. H. Kilgour. New and enlarged edition. (London: "The Electrician" Printing and Publishing Co.) 7s. 6d.

"Journal of the Institution of Electrical Engineers." No. 151. Vol. XXX. June. (London: E. and F. N. Spon.) 4s.

"Elektromotoren und Elektrische Arbeitsübertragung." By F. Niethammer and E. Schulz. (Leipzig: S. Hirzel.) 18m.

"Die Beleuchtung von Eisenbahn-Personenwagen mit besonderer Berüchsichtigung der Electricität." By Dr. Max Büttner. (Berlin: Julius Springer.) 5m.

## ELECTRICITY WORKS ACCOUNTS.

### Bradford Municipal Electric Supply Works.

Again, in the working of its electricity supply undertaking during 1900, Bradford confirms and maintains the reputation it has gained for low costs. It was inevitable that with higher fuel prices the aggregate costs should show an increase, and, as a matter of fact, with a rise of 0·063d. in the fuel item, the total costs were 0·071d. higher in last year than in 1899. Another item, however, which has gone up is that of repairs and maintenance at the station, and in rising from 0·111d. to 0·18d. per unit it forms, in our opinion, the sole exception to a brilliant series of results. To a great extent the rise of some of the costs has been neutralised by economies in others—notably in the management and property charges.

The amount given in our table as the capital expenditure to the end of 1899 is, it will be noticed, less depreciation in respect of plant and mains, and not, as usual, the gross expenditure. The 1900 official accounts furnish particulars which enable the gross total to be given—viz., £298,812—to the end of 1900. Of this total, £44,367 represent the expenditure on tramway mains. Corresponding to the £206,239 given for 1899 the capital expenditure, less depreciation to the end of 1900, was £230,258 total. The expansion of the business was great last year, the equivalent lamp connections at the end of the year being over 30 per cent. higher than at the end of 1899. The output at 3,424,658 units sold indicates an increase of not less than 41·7 per cent. Of this total output 42·7 per cent. was for private lighting purely, 27·24 per cent. for motors, 2·23 per cent. for public lighting, and 27·84 per cent. for traction. The traction supply load factor was 23·3 per cent., that of the remaining supply 12·4 per cent.

### Hastings Municipal Electric Supply Works.

It is highly creditable to the management of this undertaking that, in the face of a largely increased fuel charge, the total costs have been reduced by nearly 0·3d. per unit. This result was achieved by the reduction of the management and property charges from the rather abnormal figure of 0·97d., at which they stood in 1899, to 0·59d. last year. With the exception of the fuel item, a great improvement is also noticeable in the generating costs, though there is certainly room for further economies in the wages, and oil, waste, &c.

The reduction in the tariff is responsible for the altered state of the net revenue account, but the fruits of a lower price are already to be discerned in the increase in the lamp connections of 23 per cent., and in the output of nearly 30 per cent. The following table shows the past progress of the undertaking. The two years covered by our analysis are the first under the municipal administration:—

| Year. | Output. | Equiv. lamp connections. | Load factor. | Rev. per unit sold. | Total costs per unit sold. | Working profit. | Dividend under company. |
|---|---|---|---|---|---|---|---|
| 1895 | 265,846 | 9,667 | ... | 5·76d. | 4·64d. | £1,246 | Nil. |
| 1896 | 283,100 | 10,064 | 12·6 | 5·92d. | 4·37d. | 1,894 | Nil. |
| 1897 | 338,705 | 13,418 | 12·5 | 6·30d. | 3·86d. | 3,426 | 6% |
| 1898 | 393,678 | 14,817 | 12·7 | 6·76d. | 4·56d. | 3,302 | 7½% |
| 1899 | 404,266 | 19,423 | 12·8 | 6·94d. | 3·96d. | 5,046 | ... |
| 1900 | 524,330 | 23,864 | 12·1 | 5·43d. | 3·65d. | 3,896 | ... |

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| | BRADFORD. | | HASTINGS & ST. LEONARDS. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Bradford Corporation. | | Hastings Corporation. | |
| *Date of Commencement of Supply* | September, 1889. | | 1893. | |
| *System of Supply* | [through motor generator. 3-wire with batts. on one side only, other side | | Alternate-current transformers. | |
| *Chief Engineer* | R. A. Chattock. | | L. Andrews. | |
| **YEAR ENDED** | DEC. 31, **1899.** | DEC. 31, **1900.** | DEC. 31, **1899.** | DEC. 31, **1900.** |
| **QUANTITIES—** | | | | |
| Units generated | 2,858,841 | 4,141,284 | 542,619 | 687,503 |
| „ **SOLD (TOTAL)** | 2,416,130 | 3,424,658 | 404,866 | 524,830 |
| „ sold to consumers | 2,357,126[a] | 3,348,213[a] | 281,866 | 401,830 |
| „ sold for public lighting, &c. | 59,004 | 76,445 | 123 000 | 123,000 |
| „ used on works | 287,794 | 414,058 | — | — |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 24·2 | 30·4 [traction | 19 8 | 22·9 |
| Maximum supply demanded | 2,010 kilowatts | 2,275 kw. light'g, 467 kw. | 360 kilowatts | 495 kilowatts |
| Number of public lamps | 51 arc, 12 incandescent | 51 (600 watt) arc | 53 (15-amp.) arc | 53 (15 amp.) arc |
| Number of consumers | 1,075 | 1,300 | 378 | 484 |
| Connections to mains in 8-c.p. lamps | 132,631 | 172,741 | 19,423 | 23,864 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 99,700 | 112,500 | 20,450 | 22,950 |
| **CAPACITY OF PLANT IN KILOWATTS** | 3,189 | 3,600 | 655 | 735 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £218,381 / £68·5 | £287,204 / £79·8 | — / — | — / — |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 218,381 / 68·5 | 287,204 / 79·8 | — / — | — / — |
| **RECEIVED (TOTAL)** | 199,787 / 62·6 | 229,537 / 63·8 | £64,871 / £99·1 | £104,789 / £143 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 199,787 / 62·6 | 229,537 / 63·8 | 64,871 / 99·1 | 104,789 / 143 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 18,594 / 5·83 | 57,667 / 16·0 | — / — | — / — |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | 18,594 / 5·83 | 57,667 / 16·0 | — / — | — / — |
| **REPAID (TOTAL)** | 21,770 / 6·83 | 25,680 / 7·14 | — / — | — / — |
| **RESERVE OR SINKING FUND** | 5,358 / 1·68 | 10,102 / 2·81 | 812 / — | 5,273 / 7·18 |
| **DEPRECIATION FUND** | — / — | nil / — | — / — | — / — |
| **EXPENDED (TOTAL)** | 206,239[b] / 64·6 | 298,812[j] / 83·1 | 78,916[a] / 120 | 102,256[a] / 139 |
| Lands and buildings | 31,040 / 9·73 | — / — | — / — | — / — |
| Plant | 69,394[c] / 21·8 | — / — | — / — | — / — |
| Mains | 85,839 / 26·9 | — / — | — / — | — / — |
| Miscellaneous | 19,967 / 6·26 | — / — | — / — | — / — |
| **BALANCE OF CAPITAL ACCOUNT** | −2,916[d] / −0·914 | −69,275[d] / −19 3 | −14,045[b] / −21·4 | −2,533[b] / −3·45 |
| **REVENUE—** | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold |
| **TOTAL** | £29,206 / 2·903d. | £36,555 / 2·561d. | £11,703 / 6·940d. | £11,883 / 5·433d. |
| Revenue from supply | 28,133 / 2·795d. | 34,953[k] / 2·450d. | 8,673 / 5·142d. | 8,667 / 3·964d. |
| „ meters, &c. | 839 / 0·083d. | 1,078 / 0·076d. | 1·0 / 0·077d. | 412 / 0·188d. |
| „ public lighting | 234 / 0 023d. | 524 / 0·037d. | 2,650 / 1·572d. | 2,650 / 1·210d. |
| „ sale of lamps, &c. | — / — | — / — | 130 / 0·077d. | 44 / 0·020d. |
| „ miscellaneous sources | — / — | — / — | 120 / 0·071d. | 109 / 0·050d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £11,666 / 1·180d. | £17,859 / 1·251d. | £6,657 / 3·945d. | £7,987 / 3 653d. |
| **WORKS COSTS** | 8,236 / 0·820d. | 13,821 / 0·968d. | 5,027 / 2 980d. | 6,700 / 3·064d. |
| *Generation of electricity* | *7,334 / 0·729d.* | *11,733 / 0·822d.* | *4,597 / 2·724d.* | *6,398 / 2·924d.* |
| Fuel (including cartage, &c.) | 3,579 / 0·356d. | 5,976 / 0·419d. | 2,662[e] / 1·578d. | 4,624 / 2·114d. |
| Oil, waste, water, stores | 640 / 0·064d. | 881 / 0·062d. | 459 / 0·272d. | 497 / 0·227d. |
| Wages at station | 2,003 / 0·199d. | 2,307 / 0·162d. | 983 / 0·583d. | 885 / 0·405d. |
| Repairs and maintenance at station | 1,112 / 0·111d. | 2,569 / 0·180d. | 492 / 0·292d. | 393 / 0·180d. |
| *Distribution of electricity* | *649 / 0·065d.* | *1,315 / 0·092d.* | *157 / 0·093d.* | *95 / 0·043d.* |
| Wages, &c. | 296 / 0·029d. | 418 / 0·029d. | 21 / 0·012d. | 10 / 0·005d. |
| Repairs, renewals of mains, &c. | 353 / 0·035d. | 897 / 0·063d. | 135 / 0·081d. | 85 / 0·039d. |
| *Public lighting* | *253 / 0·025d.* | *773 / 0·054d.* | *273 / 0·162d.* | *207 / 0·095d.* |
| Attendance, Renewals | 253 / 0·025d. | 773 / 0·054d. | 273 / 0·162d. | 207 / 0·095d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 3,619 / 0·361d. | 4,038 / 0·283d. | 1,630 / 0 967d. | 1,287 / 0·589d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *928 / 0·092d.* | *1,249 / 0 088d.* | *450 / 0·267d.* | *406 / 0·186d.* |
| *Management* | *2,701 / 0·268d.* | *2,789 / 0·195d.* | *1,180 / 0·700d.* | *881 / 0·403d.* |
| Salaries | 1,164 / 0·116d. | 1,545 / 0·108d. | 577 / 0·342d. | 569 / 0·260d. |
| Stationery, &c. | 184 / 0·018d. | 195 / 0·014d. | 64 / 0·038d. | 43 / 0·020d. |
| Establishment charges | 693 / 0·069d. | 650 / 0·046d. | 54 / 0·032d. | 88 / 0·040d. |
| Law charges, &c. | 660[c] / 0·066d. | 398[l] / 0·028d. | 485[g] / 0·288d. | 181[h] / 0·083d |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £17,339 / 9·30% | £18,696 / 7·41% | £5,046 / 6·40%[d] | £3,896 / 4·30% |
| Sum carried to Depreciation Fund | 3,816 / 2·05% | 4,181 / 1·66% | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 6,747 / 3·62% | 9,484 / 3·75% | 2,336 / 2·96%[d] | 2,306 / 2·55% |
| Net interest on loans (incl. Debenture charges) | 4,875 / 2·61% | 5,830 / 2·31% | 2,446 / 3·10%[d] | 3,331 / 3·68% |
| **BALANCE FROM LAST ACCOUNT** | 10,327 / 5·54% | 11,641 / 4·61% | −10 / 0·013%[d] | 253 / 0·28% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 11,641[m] / 6·24% | 10,191[m] / 4·04% | 253 / 0·321%[d] | — / — |
| *Deficit* | — / — | — / — | — / — | *1,488 / 1·64%* |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 40·7% | 48·8% | 56 9% | 67·2% |
| Expenditure per kilowatt capacity | £3. 14s. 5d. | £4. 19s. 2d. | £10. 3s. 2d. | £10. 17s. 5d. |
| **REVENUE PER KILOWATT CAPACITY** | £9. 3s. 2d. | £10. 3s. 0d. | £17. 17s. 2d. | £16. 3s. 2d. |
| Expenditure per 8-c.p. lamp capacity | 2s. 4½d. | 3s. 2d. | 6s. 6d. | 6s. 11½d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 5s. 10½d. | 6s. 6d. | 11s. 5½d. | 10s. 4½d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 4s. 4½d. | 4s. 2¾d. | 12s. 0½d. | 9s. 11½d. |
| Price charged for lighting, per unit | 4½d.[f] | 4½d.[h] | 1½d per unit, plus 10s. per 8 c.p. lamp demanded per annum.[e] | 6d.[f] |
| Price charged for power, per unit | 2½d. to 1d.[f] | 2d. to 1d.[i] | | [1½d. per unit. £15 per kw. demanded, plus |
| Price charged for public lighting | — | — | | |

BRADFORD.—REMARKS—*a* Includes 1,275,214 units for private lighting, 463,630 units for motive power and 618,282 units for tramways. *b* After deducting depreciation on machinery and mains to Dec. 31, 1899. *c* Includes £2,082 on public lamps. *d* Over-expended. *e* Includes £257 on lamps, £279 bank commission and £124 insurance. *f* 2½ per cent. discount within two months *g* 1,461,262 at 4½d. for lighting, 933,455 at 2d. to 1d. for motive power and 953,496 at 1d. for tramways. *h* Less 2½ per cent. for prompt payment and free supply of incandescent lamps. *i* 2d. per unit net for intermittent supplies, 1d. per unit net for continuous supplies; heating, 2d. per unit. *j* Being gross total expenditure, including depreciation and £23,312 on tramway mains and £21,055 on tramway mains suspense account. *k* Includes £3,973 from tramways *l* Includes £122 insurances, £38 stamps for debentures and £214 net on incandescent lamps. *m* After deducting income tax, £586 in 1899 and £649 in 1900.

HASTINGS AND ST. LEONARDS.—REMARKS—*a* Inclusive of £54,800 consideration money for purchase of undertaking under contract of July 23, 1897, and £6,518 amount paid to company for new machinery and plant, alterations to buildings, extension of mains, transformers, &c., by company subsequent to date of contract *b* Over-expended. *c* Includes £279 coal dues. *d* Per cent. to capital at end of year (£78,916). *e* Or 6d. per unit and 5s. meter rent per quarter. *f* Or £15 per kilowatt demanded and 1½d. per unit. *g* Insurance £185 and £274 expenses re orcep. *h* Insurance £161.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny

Editorial, Publishing and Printing Offices,

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*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

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## STANDARD RAILWAY TRACTION.

Like a farce constructed with the ponderous proportions of a five-act melodrama, the negotiations with regard to electric traction on the Inner Circle drag their slow length along. The wearying and unedifying history of this alleged project has been duly recorded, and our comments upon the successive chapters of it have uniformly condemned the dilatory policy which has taken possession of the directors. We are now brought to a stage at which the two railway companies owning the Inner Circle, each professing the most earnest desire for immediate conversion to electric traction, are playing their old game of dawdle and delay by a well-conceived disagreement as to the precise system which shall be adopted. One insists upon one system; the other is equally determined to have another system. The two systems are mutually exclusive: it is impossible to work one part of the line one way and the rest the other way. There, in a nutshell, is the situation, which could scarcely be better designed for the breeding and rearing of delays. Some day, perhaps, our grandchildren may celebrate the inauguration of electric traction on the Inner Circle. For the present we shall leave the subject; it has been introduced merely as a prelude to a question of far more widespread importance. The spectacle of the present disagreement between two companies owning the Inner Circle conjures up in the mind of the electrical engineer a hideous picture—a nightmare—of the possibilities of similar disagreements on a far larger scale, in the future, throughout the railway world. In the present example the disagreement leads to a deadlock, and probably nothing will happen until both companies agree upon the same system. With the general railway system of the United Kingdom, or of the civilised world, the case is entirely different. Let us confine our attention to this country and take a homely illustration. Suppose that the Midland Railway Co. were to equip the 50 miles described in Mr. Langdon's recent Institution Paper on the falsely so-called American third-rail continuous current system, like the pioneer Liverpool Overhead Railway; and then, induced by growing success, were gradually to extend this system over its entire network of main and branch lines. Suppose that, simultaneously, the Great Northern Railway Co. became enamoured of a high-voltage polyphase system and were to equip at first 50 miles or so and gradually its entire railway network on

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the chosen system. Further to complicate matters, still other systems, at different voltages and different frequencies of current alternation, might be adopted by other railway companies; so that in the end the railway "system" of the United Kingdom would become a chaotic patchwork. It needs no pointing for our readers to see that such a lack of co-ordination, such disconformity between interconnected lines, would essentially destroy all interchangeability of working. The rolling stock of each railway would be rigidly confined to that railway, so far, at any rate, as motor vehicles might be concerned; and running powers over other lines would be useless because unworkable.

We shall probably be told that the picture we have drawn is not likely to be realised for many years to come, for the reason that main railways will probably not be electrically equipped until much greater experience has been gained with electric traction on suburban lines. We do not agree that this objection is valid; our contention is that the adoption of a system for suburban traffic will, in most cases, actually commit a railway company to that same system—as regards the line and rolling stock—for its entire network of lines. Let us illustrate this by another example. Suppose that the Metropolitan Railway Co., having succeeded in getting a polyphase system adopted for the Inner Circle, were to decide upon extending electric traction to its other lines—*e.g.*, the line to Harrow and Aylesbury—it would in general be obliged to adopt the same system. Now, in this particular example, the Great Central Railway Co. runs its trains over a considerable portion of the Aylesbury line. Hence, if the Great Central Railway Co. had already adopted any other system for a suburban portion of its lines—say, at Manchester or Nottingham—it would ultimately clash with the Metropolitan system. Or, if it had not, it would be tied down entirely to the polyphase system, just because the Metropolitan Railway Co. had originally adopted it. Moreover, other main lines—*e.g.*, the Great Western Railway and the London and North-Western Railway—run their trains over portions of the Metropolitan and Metropolitan District Railway lines, so that these also would be committed to the same system, with the only alternative of lamentable clashing between systems in the future. We trust, therefore, we make it clear to our readers that this is not a question that can be safely shelved until a distant date, when the electrical equipment of a long main line first comes up for practical settlement. By that time the question will have settled itself. "Just as the twig is bent the tree's inclined"; and if systems in little are bent in a definite direction to-day, full grown systems at a future day will not submit to being forced out of their natural development.

And the remedy?—the remedy lies in standardisation. Compulsory standardisation would probably be necessary if it is to be effective. Parliament is the supreme authority in such matters, and the only authority strong enough for the task. This is far too serious and important a matter for the arbitrament of an executive department, such as the over-worked Board of Trade. And the sooner Parliament has drawn up and sealed a complete set of electric railway regulations, standardising construction and equipment in all essential details, the better it will be for the success of electric railway traction in the future. The Board of Trade has already been named as the arbitration authority in the event of continued disagreement between the Inner Circle companies after the passage of the bill they are now promoting in Parliament. This is a step in the right direction, inasmuch as it would subject such matters to a measure of outside authority; but it falls lamentably short of the full needs of the situation. A better solution, even as regards the particular railway in question, would be for Parliament to insist on the incorporation in the bill itself of all the essential details of the electrical equipment of the permanent way. And this mode of dealing with the problem becomes all the more imperative when we recognise that Parliament is dealing not merely with an isolated and independent railway, but with the germ of an electrical equipment that must spread far beyond its present limits, and must ultimately affect other railway systems in the manner we have described. Now is the psychological moment for dealing with the broad question on a national basis. Much more is needed than the Board of Trade has power to insist upon. Not merely is it necessary to choose between rival polyphase and continuous current systems; details need to be closely specified. The working voltage on the line, the frequency—if alternating currents are finally selected—the position of the working conductor, its height and shape and the method of protection; all these matters require to be rigidly standardised, if our railway system is to preserve its unity. We must either do this to-day or have to undo a great deal of costly work in the future. There is no other alternative.

## SULPHIDE ORE TREATMENT.*

This Paper deals with the experimental work carried out by the author, Mr. E. A. Ashcroft, in conjunction with Mr. James Swinburne, during the past two and a half years. The earlier experiments were conducted in the laboratory, the later ones at the old Cowles Aluminium Works at Milton in Staffordshire. Many tons of zinc, lead and other metals have been obtained during the trial runs at Milton, but the process has not yet been worked upon a commercial scale.

The modified Phœnix process embraces the following four operations, which are cyclic in character:—

1. The displacement of sulphur (or other elements) from combination with metals in an ore by means of chlorine gas in the dry way.
2. The substitution of one metal for another in a mixture of fused chlorides by precipitation with a metal (or alternatively the fractional electrolysis of the mixed chlorides in a fused state).
3. The separation of siliceous gangue (which is unacted upon) from the final metallic chloride by settling and decantation and washing the residues in water (or alternatively by distillation of the chloride from the residues).

Purifying the final chloride, boiling down the wash solutions, if any, and preparing the chloride for electrolysis.

4. The electrolytic decomposition of the final chloride for the recovery of its metal and chlorine.

4*a*. Pumping the chlorine gas to a suitable pressure.

The first step—the displacement of sulphur by chlorine—is claimed as an original discovery as regards metallurgy, and the inventors believe that it may have an important future—outside the limits of the particular application in their own process. Chloride of sulphur is only formed when working below a certain temperature, namely 600°C. Above this temperature the whole of the chlorine can be obtained in combination with the metals present in the ore. The method adopted for carrying out this treatment with chlorine involves decomposing the ore in a converter, using a large-sized vessel, into which is introduced, at a suitable heat, an emulsion of the sulphides under treatment, with fused zinc chloride. The chlorine gas is then injected at the bottom and ore is fed in at the top, whilst the resulting sulphur, which is vaporised at anything over 450°C., is carried away into a condensing chamber or flue, and there collected. Decomposition is rapid and complete, and the heat set free in the reaction maintains the proper temperature. The addition of ore to the converter and the blowing in of gas is continued until the apparatus is full of fused chlorides in liquid form, in which is suspended the siliceous gangue, which is quite unacted upon at the temperature of working.

The greater part of the contents of the converter is then run off for further treatment by means of a tap-hole or by tipping the converter, and that which remains holds sufficient heat to enable the process to be resumed by blowing in more gas and putting in more ore.

The operation is thus a continuous chlorinating smelting process, which has the substantial advantages of working without fluxes or fuel at a low temperature and without water jackets.

* Abstract of a Paper read before the Institute of Mining and Metallurgy on June 19.

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In a trial run lasting 12 hours, with 1,000kg. mixed sulphide ore of the following composition :—

| | | | |
|---|---|---|---|
| Pb | 29 per cent. | Fe | 5 per cent. |
| Zn | 26 „ | Mn | 2 „ |
| S | 21 „ | | 100 „ |
| Gangue (by difference). | 17 „ | | |

Ag, 19oz. per ton.

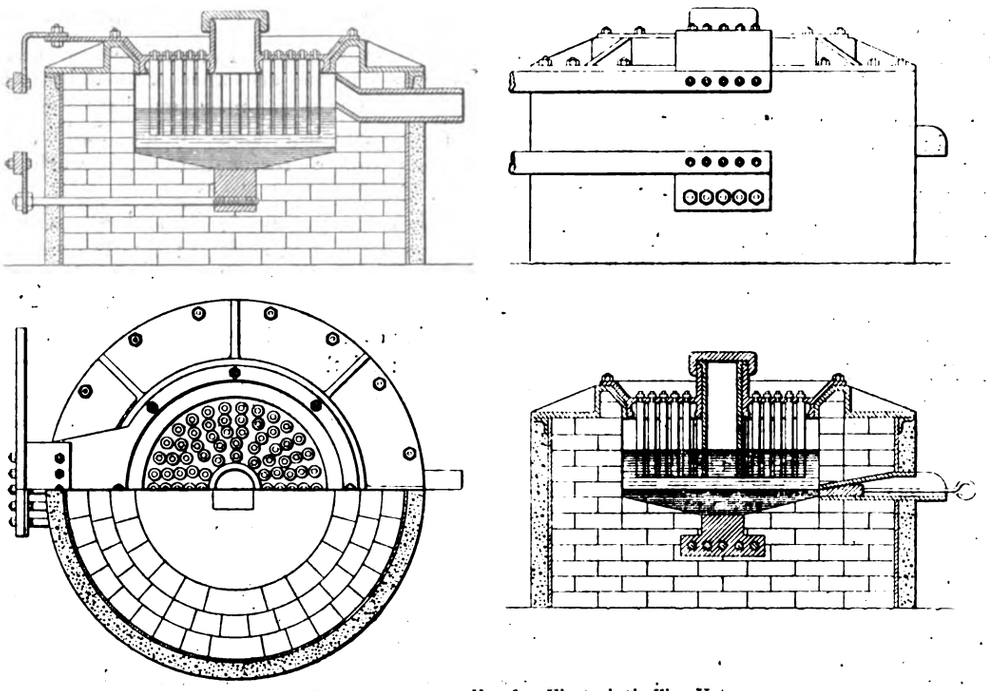

Fig. 1.—Electrolytic Zinc Vat.

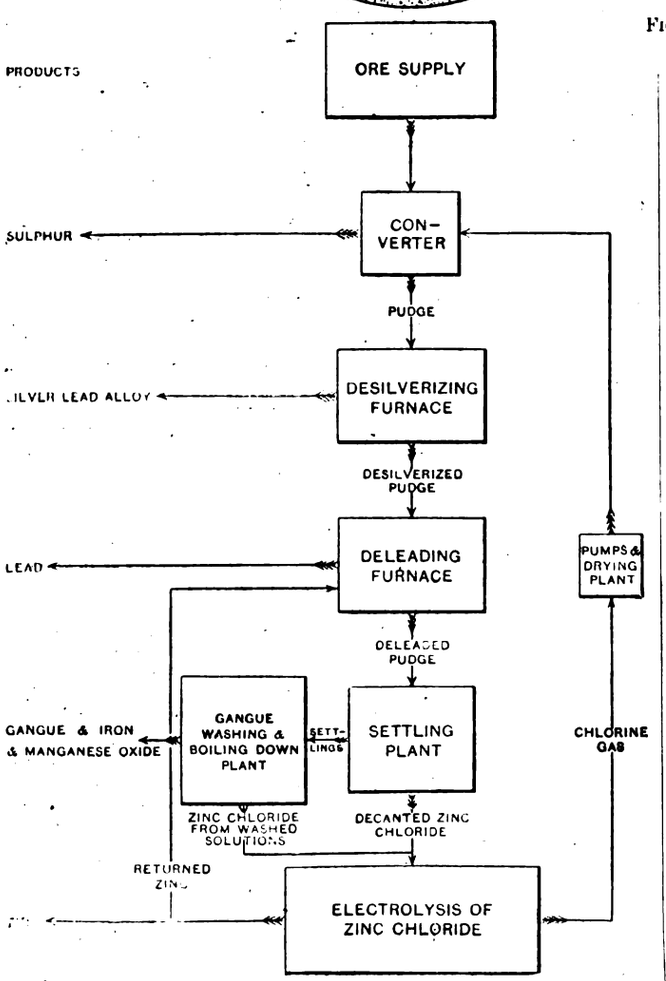


Fig. 2.—Diagrammatic Representation of Phœnix Process.

[illegible] chlorine gas were used, 100kg. sulphur were recovered, and 1.[illegible] fused chlorides were obtained, containing 23 per cent. lead, 21 per cent. zinc, and 13·5 per cent. suspended gangue, in addition to iron, manganese, and chlorine. The silver in this chloride mixture amounted to 15½oz. per ton.

The second of the four operations is the removal of the silver and lead from the mixture of chlorides by substitution. The silver (and gold also if present) is extracted by agitating the fused mixture with metallic lead. A rich bullion can be obtained in this way, containing the whole of the precious metals.

Lead is removed by substitution of zinc, large quantities of zinc being required for this operation. This is all converted into zinc chloride, and is recovered in the fourth step of the complete cycle of operations. These substitutions of lead and zinc, for silver and lead are carried out in a specially-designed muffle furnace, at a temperature of 450°C.

After the recovery of the silver and lead by metallic lead and zinc, as described above, the only foreign element which would interfere with the electrolysis of zinc chloride in this combination is iron, and this metal is readily oxidised to $Fe_2O_3$ in the converter by the simple application of a blast of air at a certain stage of the converter process. The suspended $Fe_2O_3$ is afterwards removed with the gangue matter.

The removal of the gangue, and oxides of iron and manganese, is the third operation. This is effected by allowing the fused zinc chloride to stand, and by decanting from time to time the cleared portion of the chloride. The residues may be treated in several ways. They may be heated to 720°C., and the chloride distilled over; they may be washed, and the washings concentrated under vacuum; or they may be washed, and the washings boiled down under ordinary atmospheric pressure, the concentrated solution then being added to the main bulk of fused zinc chloride. At Milton it has been the custom to adopt the latter plan, and to remove the traces of water brought in from the boiled-down wash solutions and at the same time to eliminate traces of iron, lead, and other impurities which would contaminate the zinc or silt up the electro vats with infusible alloys, by means of a short preliminary electrolysis with a cheap form of carbon anode which is destroyed by the oxygen liberated. The resultant of this preliminary treatment, which is carried out in a special form of vat arranged for easy removal of carbons and easy cleaning out of vat, is a completely neutral zinc chloride free from hydrogen, iron, or lead, which yields a full equivalent of zinc and chlorine for the current passed through it, yields the zinc quite pure, and does not destroy the carbon anodes of the main vat system. The special preliminary vats are left open to the air, as no chlorine gas is evolved until the treatment is complete. The traces of H, O, and $CO_2$ escaping into the atmosphere are negligible.

In order to make up for the small losses of zinc involved in this stage, it will be necessary to introduce from time to time additional zinc chloride into the process, and in the estimates of costs, an addition of 5 per cent. $ZnCl_2$ for each ton of ore treated is allowed for.

The fourth and final step in the complete Phœnix process, is the electrolysis of the fused zinc chloride, and recovery of the zinc and chlorine. For various reasons internal heating of the fused mass has been found the most practical, and Fig. 1 shows an apparatus which has been in use for over nine months without visible deteriora-

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tion. The size illustrated takes a current of 3,000 to 4,000 amperes with 4 to 4·5 volts at the terminals and produced nearly a ton of zinc per vat per week. The apparatus consists of an outside steel tank 6ft. diameter, lined with 18in. of ordinary Stourbridge fire-bricks, the inner layers of which are set in a special cement. The cathode is a mass of molten zinc of approximately one ton, and connection is made to it by means of a heavy steel block buried in the brickwork and provided with five screwed copper tubular rods through which the current enters from outside and through which free circulation of air can take place, to prevent overheating. The anode consists of a removable cast-iron plate, lined on the underside with special cement, from which depend 120–2¼ rods of hard carbon immersed about 6in. in the electrolyte.

The figure illustrates the construction of the vat and connections, and the position of the anode, cathode, and electrolyte. The current efficiency of this process after the preliminary electrolysis is about 95 per cent., which allows for all leakage, &c. The pressure efficiency is, however, much lower. The theoretical voltage of decomposition of zinc chloride, calculated on thermal data, and assuming the correctness of Faraday's law, is 2·2 volts. The normal working volts are about double this. The vat is maintained at a temperature of 475°C. The carbons last about six months. When the preliminary treatment of the fused zinc chloride is properly carried out the action upon the carbons is practically negligible. The zinc obtained contains traces of lead and iron, but a purity of 99 83 per cent. has been easily attained in the experimental runs, and doubtless this can be improved upon.

It is found advantageous to the electrical conductivity to have sodium chloride, calcium chloride, &c, in admixture with the zinc chloride in the electro vat, so that the regular zinc analysis of the electrolyte should not show more than 28 per cent. zinc as against 48·5 per cent. for pure $ZnCl_2$. These foreign chlorides are not decomposed in the presence of $ZnCl_2$, and, therefore, do not require renewing; but in practice, as small quantities of foreign chlorides are usually worked through with the $ZnCl_2$ from the converter department, the tendency is for these to slowly accumulate in the electro vats. This is rectified by a periodical removal (about once a month) of a portion of the electrolyte which is then worked with the ordinary converter products through the purifying department.

Fig. 2 is a diagrammatic representation of the the various steps in the Phœnix process as described above, showing that the process is truly cyclic in character.

Part II. of the Paper is devoted to a discussion of the commercial possibilities of the process, and limits of space will only permit a summary of the results arrived at.

The cost of operating the Phœnix process is estimated to amount to £2. 16s. per ton of ore treated, using steam power at Port Pirie, or £2. 3s. using water power in Europe.

Allowing for freight charges upon the raw ore, and upon concentrates, the comparison of costs and profits, with the concentration process now being used for Broken Hill ores, works out as follows :—

| — | Net recoveries. | | | Total costs. | | | Profit. | | |
|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | £ | s. | d. | £ | s. | d. |
| Concentration at Broken Hill and smelting in Europe or Port Pirie... | 2 | 15 | 0 | 1 | 15 | 0 | 1 | 0 | 0 |
| Phœnix worked in Europe..... | 8 | 10 | 0 | 5 | 5 | 6 | 3 | 4 | 6 |
| Phœnix worked at Port Pirie ..... | 8 | 10 | 0 | 4 | 16 | 6 | 3 | 13 | 6 |

(Including costs of marketing products.)

An appendix and 12 plates are given with the complete Paper. Two of the plates are reproduced with this abstract.

## BRAKING APPARATUS FOR ELECTRIC CARS.*

BY A. L. C. FELL.
(Tramway Engineer, Sheffield Corporation.)

The various methods of braking cars on electric tramways call for serious consideration owing to the comparatively high speed at which electric cars travel through crowded thoroughfares, and also that cars may be safely handled on steep gradients. On railways a fairly good rail can always be relied on, but in street tramway work the state of the rails is very unreliable. Car brakes may be classed under six different headings, viz. : (1) Hand brakes, (2) friction brakes, (3) slipper brakes, (4) pneumatic brakes, (5) electromagnetic brakes, (6) Newell electromagnetic brake.

*Hand Brakes.*—The best known of these is the link suspended type, the links being set at a slight angle so that gravity will tend to keep the shoes away from the wheels when they are not in operation. The shoe and head are usually of the well-known "Christie" pattern, the shoes being retained in the holders by means of a pin which can be easily removed when the shoes require replacing. The brake beams and equalising brake beams are placed with their surfaces against each other, the power lever being the fulcrum at their centres. In the majority of cases the brake rods are made in one piece, thus avoiding unnecessary swivel joints. The link suspension is claimed to give much freer movement as it does not become clogged with either mud or ice. In the writer's opinion there is not any particular advantage to be gained by using one particular type as compared with another. The chief point in connection with all brakes is that reliable men should be employed to fit them on to the wheels of the cars so as to ensure even pressure on the wheels. One very important matter concerning the adjustment of brake rods is not to employ locking nuts, as they cause serious delay when this work is necessary. The adjusting nut should be kept in position by a pivoted claw which can be simply thrown back when it is necessary to move the nut.

The writer has tested various types of brake shoes and finds the "Corning" brake shoe is the best. This shoe, although somewhat more expensive in first cost, has been found to last several times the life of an ordinary cast-iron shoe without materially affecting the wear and tear on the wheels. The main body of the "Corning" shoe is of tough, hard iron cast about a soft grey iron core. The body of the shoe has a chilled face. The combination of the chilled iron body and the soft iron inset makes the frictional quality almost equal to that of ordinary cast iron. The wearing qualities of this combination appear to give splendid results. A sample of one of these shoes is shown. This ran over 12,300 miles on a route where the gradients are very steep, viz., 1 in 11 and 1 in 12, and would easily have run another 1,000 miles before replacement would have been necessary. Ordinary hard cast-iron brake shoes on another car on the same route only ran for 6,000 miles before they were worn out. The difference in the diameters of the wheels under the two cars was inappreciable. Tests are now being made with various types of brake shoes on steel-tyred wheels, but at the time of writing comparative results cannot be given.

*Friction Brakes.*—On cable cars or on electric cars, where only one motor is used, or where a broad gauge is in operation, a friction brake can be operated. This consists of a spool or boom upon which a chain is wound, the chain being attached to the brake lever and the spool or boom driven by two friction plates operated by the driver through the medium of a lever a slight pressure on which applied by the hand or foot instantly applies a very effective brake. This type of brake acts very rapidly in the case of an emergency; it is simple in design, cheap to obtain and to operate, its only objection being the amount of room required to properly mount it on the axle. For this reason, on the majority of tramroads in this country, it could not be used.

*Slipper Brakes.*—This is the most useful type of brake at present in operation in England, and simply consists of wood blocks which are pressed down on to the rails by means of levers The levers are operated by means of a hand wheel connected by a chain or worm gear at either end of the car. The operating hand wheel is fixed on to a tube spindle, which is placed outside the solid hand-brake spindle. The two spindles are quite independent of one another and separate ratchets and pawls are provided for locking them independently. It has been found in practice that it is advisable to design the slipper brake operating hand wheel so that it is impossible to lift the car off the rails. The framework carrying the slipper-brake shafting, levers and slides is fixed to the sides of the truck frames. On all gradients steeper than 1 in 20 it is advisable to use the slipper brake, and the best results have been obtained when the slipper brake is worked as an auxiliary to the hand or electric brake. On single lines with steep gradients the slipper brake is especially useful, as it not only retards the descending car, but also cleans the rails for the ascending car.

*Pneumatic Brakes.*—On several systems in this country pneumatic brakes are fixed on the cars, but, in the writer's opinion, they are not satisfactory, since they are not always reliable. They require complicated and perfectly fitted mechanism to compress the air; the cost of maintenance is very high, and the conditions under which a street car has to work are unfavourable to success on account of the mud, dirt and dust under the car. The air, which is compressed, has to be drawn in under very unfavourable conditions, and the dust rapidly cuts up the cylinder of the air compresser. The difficulties in connection with driving the air compresser and keeping up a sufficient supply for frequent stoppages are problems which have not yet been satisfactorily solved.

*Electromagnetic Brakes.*—One type of this brake consists of two cast-iron discs, one of which is fixed to the motor and has a coil of wire wrapped round it, the other is keyed to the axle. The motors are used as generators and gradually short-circuited through a rheostat and the disc coil above mentioned. The discs are thus magnetised, and braking action is produced from three causes :—

(1) Retardation due to converting motors into generators by driving them from the car axles on practically short circuit.

* Paper read before the Incorporated Municipal Electrical Association at Edinburgh.

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(2) Drag due to eddy currents which are set up in brake disc as it revolves in the intense magnetic field of the brake shoe.

(3) The mechanical friction between the brake disc and shoe.

As the braking effect is so rapid, great care has to be exercised not to magnetise the discs too quickly, otherwise the wheels will at once be skidded unless a very plentiful supply of sand is used. On a good rail this type of brake can be used for taking a car down a gradient of 1 in 11, but it is always safer to use a slipper brake in conjunction with the electric brake. In practice it has been found advantageous to bring the slipper brake into operation at the top of a gradient and fix it, the speed can then be regulated by the hand or electric brake. In the writer's opinion the hand brake should never be used in conjunction with the electric brake, but, if the former is in use, it should be released before the electric brake is applied.

*The Newell Electromagnetic Brake.*—This is arranged to act as a magnetic slipper brake, the slipper being made of cast iron and having coils wound round it. The method of magnetising the slipper is similar to that employed to magnetise the disc brake described above, but in this case the slipper is drawn down on to the rail, whereby a strong braking action is set up. The writer has not had an opportunity of practically testing this brake on a roadway, but the experiments made at the Tramways Exhibition in London in 1900 were very satisfactory.

*Brake Tests.*—Tests have been made to ascertain the best methods of stopping cars under various conditions. Cars were run over a marked-off space on a practically level road. The speed was in each case carefully noted, and the brakes were applied at the same point in each case. The results are tabulated on Table A. From these results and from previous experience it appears that for all-round general purposes the hand brake worked in conjunction with the slipper brake is the best and most reliable method of regulating the speed of a car. This is especially the case if the rails are greasy, because the wood block thoroughly cleanse the rail. For emergencies the electromagnetic disc brake is the most satisfactory, but it requires to be applied very carefully as it is very liable to cause skidding. The constant use of electric brakes is not to be recommended because: (1) They are expensive items, and the wear and tear is very excessive; (2) when the gradients are very steep the life of the motors will be appreciably shortened as they will never get an opportunity to cool down.

# PARLIAMENTARY INTELLIGENCE.

## YORKSHIRE ELECTRIC POWER BILL.

On July 3 a Select Committee of the House of Lords, presided over by Lord Brougham and Vaux, considered this bill. The measure, when before the House of Commons Committee, was fully reported in *The Electrician* for May 24 and June 14.

Mr PEMBER, K.C. (for the bill), said this was a measure which resembled very much the South Wales bill of last year and the Derbyshire and Nottinghamshire bill of this year, inasmuch as it was promoted by the principal representatives of a country-side which teemed with manufacturing industries of all kinds. Some 63 gentlemen, who were all well known locally, had formed a syndicate to promote the measure. They employed 55,000 hands and machinery of 42,000 H.P., and the rateable value of their undertakings was £216,000. The area comprised 1,800 sq. miles, and embraced 27,000 factories or workshops requiring 2,000,000 H.P. As the coal of the western district, where much of this industry centred, became exhausted they would, doubtless, move to the eastward, where there were virgin coalfields. The four generating stations under the scheme were to be at Methley, Wharfe, Thornhill and Bingley. At present nearly all the electricity used in the area was for tramways or lighting—very little was used for power—11 of the larger boroughs in the district had electric works either in operation or in course of construction, and 16 more had provisional orders, but had not carried out any works. The promoters had done what they could to conciliate the authorities short of giving them an absolute veto. Many people thought municipal trading reprehensible and a doubtful advantage to society, but surely municipal trading plus monopoly was absolutely intolerable. Electricity was on the eve of very important development indeed for haulage purposes, as, for instance, on the Aire and Calder Navigation. That canal passed through Leeds. If the promoters were supplying electricity for haulage to the Aire and Calder Navigation outside Leeds, it would be a monstrous thing if that supply had to cease the moment that canal reached Leeds, and could not be given again till it left the Leeds boundary. The local authority could only contract to supply within their own small area. Amongst the petitioners against the bill, Sheffield objected strongly to the attempts to confer on the company a competing and conflicting power of supply, and submitted that they were willing and able to meet all the requirements of the city as regarded present and future demands, and that no interference with their powers should be sanctioned. That, said counsel, amounted to a request for absolute veto in the strongest and most unmistakable manner; they even declined to allow a wayleave. Leeds Corporation similarly claimed an absolute veto. They said the proposal of the bill would introduce an innovation in the law relating to the supply of electrical energy. That was not true. Bradford Corporation contended that the protection afforded by clause 49 (which was similar to that inserted by Parliament in the South Wales bill last year) was illusory. Heckmondwike, he contended, had no right to be present. He was still more surprised to find Rotherham, who asked for an absolute veto, appearing. Both the latter corporations had withdrawn their opposition on the company agreeing to insert the provisions contained in clause 49.

Mr. A. LUPTON (W. Lupton & Co.) said the collieries represented by the promoting syndicate had a total annual output of 15,000,000 tons. The industrial centres were on the coalfields, close to railways and canals, and at each there was an ample supply of water for condensing and boiler purposes. The company could not supply in areas where local authorities had orders without their consent or the authority of the Board of Trade, but with regard to places which had no orders the company took the free power to go in and supply, unless orders were hereafter obtained, when these places would be in the same position as those already having orders.

Mr. GIBB, general manager of the North-Eastern Railway Co., supported the bill. His company wanted to get a through supply of electrical energy for their railway, 140 miles of which were within the area of the company.

The CHAIRMAN: You would rather take energy from this company than from a corporation?—Yes.

By Mr. WEDDERBURN, K.C. (for Leeds): For purposes of haulage you would be compelled to pick up your energy at different points along your line?—Yes; but the application of electricity to the North-Eastern Railway for haulage purposes was not in contemplation.

Mr. GEORGE CAWLEY, consulting engineer, said he had studied the question of electric haulage, and was negotiating with the Leeds and Liverpool Canal for the adoption of a system of haulage, called the Thwaites-Cawley system, to the waterway. He then explained by means of a model the method of working, which consisted of an electric motor running along an elevated rail at the side of the canal and, by means of a rope, hauling the boat. The cost would be less than half that of horse haulage. At present no one had adopted the system.

Mr. BALFOUR BROWNE, K.C. (for Bradford), here said Bradford (and he hoped Leeds and Sheffield would take the same position) did not in the least object to the promoters having wayleaves on the outskirts of the borough to reach places beyond, but they did strongly object to the streets of Bradford, in the very centre of the town, being continually cut up to enable the company to get through to other places. He understood the promoters had drawn a circle with a radius of half-a-mile round the centre of Huddersfield in which no mains were to be laid. Bradford being a larger place desired to have a circle with a radius of 1½ miles. Outside the circle there would be no hardship in breaking up the roads. Then the company were seeking to supply railways and canals in the city of Bradford, and that, he contended, was not right. On this point he held that the consent of the Corporation should first be secured, but if the promoters would insert a clause to the effect that if the Board of Trade said the Corporation were withholding their consent unreasonably then the company should be able to come in and supply, as had been done in the Cleveland case, he would be satisfied. If the Corporation could not sell current as cheaply as the company they ought to stand aside.

Mr. GERALD FITZGERALD (for Sheffield) agreed with Mr. Balfour Browne.

Mr. PRITCHARD (for Leeds) said he had not had an opportunity of consulting his clients.

Mr. BRYDGES (for the promoters): This puts a different complexion on the opposition, and the promoters would consider the suggestion.

Mr. THOMAS MARSTON, manager of the Aire and Calder Navigation, supported the bill. The total length of the Navigation was 90 miles, all of which was within the area covered by the bill.

The directors had considered the bill, and considered it admirably adapted for the purposes of the Navigation. Electricity was already used largely for haulage on the Continent. He thought the through supply of electricity should not be broken off at any particular point. The proposal of the corporations that the Navigation should not take a supply from the company within their areas was unreasonable, inasmuch as the Navigation had power to supply themselves with electricity and carry it along their own banks. It would be better for them to deal with a company rather than with a local authority. Better terms would probably be obtained from the company.

Mr. WILLIAMS, general manager of the Leeds and Liverpool Canal Co., said the canal was 148 miles in length, 30 miles being in the area of the company, and his directors considered the adoption of electricity for haulage, working cranes, locks and other appliances would be in their interests, and they would prefer to take it from one central distributing authority.

Mr. JOHN HEPPER (Messrs. John Hepper & Son, Leeds) said he wished to see electricity introduced into the Leeds district because there were a large number of works which from time to time altered in the character of their manufactures, and had to be converted to different uses. The engine power in those works was very often unsuited to the altered character of the work. Electrical power would be most advantageous and convenient in such cases and would be largely used. He thought that for a long time to come Leeds Corporation would be unable to cope with the demand for electricity, and that it would be better to have a dual supply.

Prof. S. P. THOMPSON said he had been consulted with regard to this scheme, and was more or less responsible for it. He considered it a question of national importance, as well as of importance to this particular district, that the scheme should be sanctioned. The area, 1,800 sq. miles in extent, comprised all the principal manufacturing portions of the West Riding south of the rivers Wharfe and Ouse. It adjoined the areas of the Lancashire Power Co. and the Derbyshire and Nottinghamshire Co., and contained 27,000 workshops, manufactories and collieries, and the amount of horse-power now being used in it was over two millions.

At this stage Mr. WEDDERBURN said, in view of the probability of the parties being able to come to terms, he suggested an adjournment.

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Mr. BAGGALLAY (for the bill) said the promoters wish to be placed in a position to enter into contracts with railways and canals throughout their system for the purpose of working and handling their traffic or goods. The difficulty which the proposal of Mr. Balfour Browne involved was that they could not now enter into such a contract without the present clause in the bill. The arbitration proposed would prevent their entering into contracts, as it would not probably take place for two years, whereas the contracts with the canals would be entered into now. If at the present time the three corporations would guarantee a supply within their borders to the promoters, as their customers, of all such current as they might require for the above purposes at the same price as the promoters supplied outside, less the cost of collection, such current being transformed by the corporations to the pressure required before measurement, this might meet the promoters' case. If they failed to guarantee such supply within, say, one month after notice, then the promoters should be at liberty to supply direct. Similar power should be given the promoters to supply on any breach of guarantee, provision to be made for penalties. The explanation was that the company hoped to get contracts from the railways and canals, which would be very valuable in the starting of the undertaking, chiefly in raising capital.

After consultation Mr. PEMBER said the chairman might dismiss the question of routes for the present. So far as he understood, it was practically conceded that the company should get through the areas of the corporations somehow, and the only question was as to how. With regard to the supplies to the railways and canals, the Committee knew from Mr. Baggallay how far the promoters were prepared to go. That did not seem satisfactory to the petitioners. If the Committee considered that the matter was now ripe for decision they might not want to hear more evidence.

Mr. WEDDERBURN said the Corporations of Leeds, Bradford and Sheffield were prepared to submit to the clause which the Committee gave in the Cleveland case and the suggestion which Mr. Balfour Browne had made. [He then proposed a clause which, however, the promoters could not accept, and the consideration of the bill proceeded.]

The CHAIRMAN said that practically the preamble of the bill was proved, and suggested they should take it as proved, and go on with the clauses.

It was then understood that the Committee had passed the preamble.

Prof. S. P. THOMPSON, recalled, gave evidence with regard to the question of supply to railways and canals. Asked if it would be inconvenient if the railways and canals had to pick up their supply as suggested in these small areas of Leeds, Bradford and Sheffield rather than from one company, witness said there would certainly be some inconvenience, but how much he could not say. There would be the additional disadvantage of dealing with two persons instead of one, and the material disadvantage that whenever a railway or canal entered the boundaries of these places the electrical connections would have to be cut off and new ones made with the new sources of supply. That was a distinct engineering inconvenience.

Mr. FITZGERALD said that Sheffield asked that unless default of supply was proved the Corporation should have the first opportunity to supply.

Mr. WEDDERBURN said the Corporation had bought out the Yorkshire House-to-House Electric Supply Co. recently, and had scarcely completed the purchase when some of those who had been connected with the company came to Parliament and sought power to compete with the Corporation and take from them a portion of the business bought. That seemed hardly fair. The Committee should decide that at present there was no proof that Leeds Corporation were not doing their duty, but that if ever the company could show that they could supply better than the Leeds Corporation, then a tribunal, to be now settled by the Committee, should determine that question.

The CHAIRMAN: What objection would you have to the insertion of the Cleveland clause instead of this?

Mr. WEDDERBURN: The Cleveland clause said the company should not supply anyone unless and except upon the decision of the Board of Trade. The present bill said that under no circumstances should the company supply a large number of people, but with the exception of a certain number of canals and railways; and they asked, with regard to railways and canals, that they should have the right to supply them without reference to the Board of Trade. He urged that the principle of the Cleveland clause should apply to railways and canals, and that the company should only have the right to supply them when the Board of Trade said the corporations were incompetent.

Mr. PEMBER, in reply, said the supply of electricity by the company to railways and canals was an essential part of the company's scheme, and urged that the power should be given to the company to supply to these two classes of undertakings, even in the area of the Corporations. With regard to the case of Huddersfield, which had been specially mentioned by the chairman, the Huddersfield clause was quite the earliest that was agreed, the negotiations having been opened nearly a year ago. A number of outlying district councils in the neighbourhood of Huddersfield were known to be desirous of obtaining electricity supply, and Huddersfield was willing to do what it could to assist. But a group of these local authorities had petitioned against the bill, and insisted upon provisions which, if they had been granted, would have killed it. Mainly through the friendly offices of Huddersfield this opposition was converted into warm support, and the clause for the protection of the district councils was the result. It therefore became a matter of no great difficulty to agree with Huddersfield on certain lines.

Mr. BALFOUR BROWNE said, for Bradford, and, also, he thought he might say, for Leeds, that the promoters had to some extent met his clients upon similar lines to Huddersfield, and, therefore, that matter was settled. The only thing that now remained was the question of the supply of railways and canals in the centre of the towns. The towns of Leeds, Bradford and Sheffield were large, and no large town with an electric capacity of 10,000 H.P. had ever been included in an electric power bill. Manchester and Liverpool were distinctly and absolutely excluded in the Lancashire power bill last year, and that was rather a striking case, because while Manchester, Liverpool, Oldham and Bolton were excluded, Southport, which was a smaller town, was included. In the same way Glasgow and Nottingham had been excluded from power bills for all purposes. The point was whether the railways and canals were to be embraced in this bill.

The Committee then proceeded with the adjustment of the clauses. In clause 50, which provides protection for district councils,

Mr. WEDDERBURN asked for the insertion of a new clause, which would limit the proviso in clause 49 under which the company obtain power to supply railways and canals in the cities and boroughs.

Mr. FITZGERALD submitted that the Committee could not consider the clause in the Cleveland bill because clauses had been inserted in the present bill when in the House of Commons for the benefit of the three corporations of Leeds, Bradford and Sheffield, and those provisions the corporations preferred to anything in the Cleveland bill.

Mr. BALFOUR BROWNE said what the promoters had provided for Huddersfield was fair and proper, and he asked for the same protection in the prohibited radius, which had been agreed to, of 1½ miles from the Town Hall at Bradford.

The Committee having considered the clauses relating to the supply of railways and canals,

The CHAIRMAN said: The Committee have decided to retain clause 47 as it is in the bill, as follows:—

47. The powers of the company for the supply of energy under this act shall be subject to the following restrictions, that is to say:—

1. Energy shall be supplied by the company only
   (*a*) To authorised undertakers and
   (*b*) To persons requiring a supply for power.
2. The company shall not supply energy for lighting purposes except to authorised undertakers provided that the energy supplied to any person for power may be used by such person for lighting any premises on any part of which the power is utilised.
3. The company shall not supply energy (except to authorised undertakers or to any railway or water company or proprietors or trustees of any canal or navigation for power) in any area which at the date of the passing of this act forms part of the area of supply of any authorised distributors without the consent of those distributors. Provided that where any distributing company refuse or withhold such consent the company may appeal to the Board of Trade as to whether the consent of such distributing company is unreasonably refused or withheld and the Board of Trade may dispense with such consent if in their opinion it is unreasonably refused or withheld. The consent shall be deemed to be unreasonably refused or withheld if such distributing company are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time and in considering what are reasonable terms and what is a reasonable time the Board of Trade shall amongst other things have regard to the terms upon which and the time within which the company are willing and able to give the supply.
4. After any place shall have become the whole or part of the area of supply of a distributing authority the company shall not without the consent of such authority supply energy in any such place to any person (not being an authorised undertaker or a railway or water company or the proprietors or trustees of a canal or navigation) who was not supplied by them previously to such place so becoming the whole or part of the area of supply of such distributing authority.

Mr. FRERE (Parliamentary agent for the promoters): I take it as regards wayleaves we are all agreed.

Several counsel assented.

Mr. WEDDERBURN said as to wayleaves from Leeds, mains were not to be laid in an area covered by a radius of 1¾ miles from the junction of Briggate and Commercial-street, on the north of the river, and within a radius of 1¼ miles on the south.

Mr. WAUGH asked that Heckmondwike might be placed in the same position as other boroughs in respect to clause 49 of the bill.

The Committee refused the application, and the remainder of the clauses having been adjusted, the bill was ordered to be reported.

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The clause inserted for the protection of Sheffield provides substantially for a prohibited area within a radius of 1½ miles from the Obelisk, the restriction also extending outside that radius to certain streets, along which the company may not lay mains, but which, subject to the approval of the Board of Trade, they may cross.

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## MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

Sir L. M'Iver's Committee of the House of Commons continued their consideration of this bill on July 5.

Mr. F. B. BEHR, C.E., continuing his evidence, gave the reasons which had determined him in selecting the route as much as possible alongside the Cheshire Lines Railway, and pointed out that, although his railway would not serve intermediate stations by relieving the existing railways of their express traffic, they would give those railways an enormous inducement to develop the intermediate and goods traffic. The passenger traffic between Liverpool and Manchester to-day was about 8,500 per day. He had designed carriages to give accommodation for 10,000 passengers per day, and another series to give accommodation to 7,500 passengers. But it would be as unfair to bind him in the Committee to any design of carriage as it would have been to bind Stephenson to the Rocket type of locomotive. He proposed to run a car each way every ten minutes. There would be about 204 trains a-day, and if in each of these there were eight third-class passengers at the fares now charged by the existing railways



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the working expenses at 8d. per car mile would be covered. If they had 20 third-class passengers per car 5 per cent. could be paid on the capital.

By Mr. LITTLER, K.C. (for the Cheshire Lines Committee): Witness denied that in 1888 he suggested to the French Government that his railway should be brought into use for military purposes. Nor was it true to say that the car oscillates and rolls considerably. Or that the greatest speed obtained was 31 miles an hour. Or that on one occasion several passengers in the car at Brussels rose at once, with the result that the car was tilting over when he called out to them to sit down to prevent an accident. These were all malicious and absurd inventions.

On your system a passenger will not be able to take luggage, except what he can carry in his hand?—Oh, yes, we can take it if we wish to. I have made no special provision for excursionists, but, if necessary, I could give accommodation for 60,000 passengers a-day.

Do you know that the united capital of the five companies you are attacking is £150,000,000?—Yes.

If they were to run at half your rates, what would become of you?—We should run at half the rates also, and my shareholders are quite as well able to bear competition as are yours. I have never said we shall charge the present rates.

In reply to further questions, Witness said the driving wheel would be worked by the sprocket chain system, the chain being a new one made by Mr. Reynolds. It would be able to transmit 375 H.P. at 375 revs. per min.

By Mr. POPE, K.C. (for the Lancashire and Yorkshire and L. and N. W. Companies): Witness admitted that if there should be 300 people on his platform at one time waiting to get away it would be 40min. before some of them would be able to leave.

Mr. ERIC GERARD, engineer-in-chief and inspector-director of the State railways and chief of the Cabinet of the Ministry for Railways in Belgium, and president of the Belgian Society of Electrical Engineers, said he was formerly president of the committee appointed by Belgium to examine the Behr high-speed railway. The committee made a secret report to the Belgian Government. It was not made public and if the petitioners had obtained a copy he was at a loss to know how it had been procured.

The document was handed in.

Mr. BALFOUR BROWNE (to witness): It has been suggested that there was considerable oscillation, vibration, and noise in the working of the railway?—The absence of springs to the guide wheels and the bad ballasting of the line had a great effect, but these were small details which could be easily remedied. An offer has been made to the Belgian Government to construct a high-speed railway between Brussels and Antwerp but it has not been accepted. If, however, a high-speed railway is constructed I shall recommend the adoption of the monorail. Mr. Behr's railway at the Brussels Exhibition was badly constructed and there was considerable difficulty in obtaining for it the necessary amount of electrical power. Nevertheless it rounded curves with the utmost safety whilst running at a speed of 75 miles per hour. I should not have hesitated to travel on the railway at a higher speed if the electric energy had permitted it. The proposed line if properly equipped offers fewer chances of derailment and greater safety than an ordinary railway. The danger caused by centrifugal force and friction are capable of reduction to a minimum on the monorail system.

Cross-examined by Mr. POPE, K.C.: Are you of opinion that the Brussels experiment demonstrated the value of the new invention?—Yes, perfectly.

By Mr. BALFOUR BROWNE: He believed Mr. Behr's invention had stood as good an engineering test as any scientific invention could stand short of actual working on a commercial basis. He did not know of any other system capable of practical application for very high speed.

By Mr. LOUGH (member of the Committee): Whenever a speed of 100 miles per hour or over was required it would be necessary to have a monorail, as it was beyond human skill to design a two-rail system capable of carrying a train safely at such a speed. The danger of one line subsiding would always be present, together with the danger of derailment in rounding curves.

By Sir L. M'IVER: The Belgian Government were undecided as to whether they should enter upon the construction of high-speed railways, or leave them to private enterprise. He thought they would content themselves with constructing the platform, as it were, leaving it to private companies to occupy that platform. He could not see that any new dangers would arise from the use of the monorail system.

Can not you see a danger in carriages passing each other at this high speed when only 18in. apart?—I think that distance is sufficient.

M. DE GRAUX, engineer-in-chief and managing director of the traction and materials department of the State railways of Belgium, said he was appointed Government Commissioner to the Brussels Exhibition of 1897, and in that capacity became much interested in the monorail experiments. The machinery and apparatus for generating electric current were constructed in a great hurry, with the result that the installation was not so good as desired. The road on which the rail was constructed was not in very good condition. He, as a Government Commissioner, was charged with the duty of seeing that the public might with safety be admitted into the carriages, and in the course of the trials he never had the feeling that there was danger. His impression had always been that there was absolute safety. For the purposes of high speed the monorail system was preferable to the two-rail system.

Have you any doubt that in a properly constructed monorail a speed of 110 miles an hour might be attained with safety?—The conditions under which the trials were made were difficult, but in spite of that the cars went at a speed of 110km. an hour with perfect safety. If the conditions were better there was no doubt in his opinion that the cars might be run at 150km. an hour, and perhaps more. He did not know till now that the Belgian jury which inspected the railway had found that the system was dangerous. He knew, however, that the jury had granted Mr. Behr a gold medal.

Mr. BEHR, cross-examined by Mr. A. J. WALTER (for the Cheshire Lines Committee), said the monorail system was worked by electricity with continuous current in the way that every electric railway in this country and in America was worked at present. The working voltage would be 1,000. 110 miles an hour by electricity was an absolute novelty at present on a large commercial scale, but not as an experiment. They ran at 110 miles in Belgium.

How are you going to get electricity into the car?—By a conductor rail.

By an overhead rail?—Not so far as I know. The electricity is to be picked up by a number of shoes pressing on the conductor rail. For the present it was proposed to adopt a car of 39 tons, weighing 11 tons above the rail. The length of the car over all would be 42ft.—the body 25ft., the stern point 7ft., and the bow point 9ft. The framework of the car would be of aluminium alloy of the specific gravity of 2½, and the under frame of steel.

Is not the use of aluminium for the body of a car absolutely unknown in the construction of railway carriages?—I do not know that it is. I cannot give you the tensile or bending strength of aluminium off hand. You can vary it by making a different alloy.

What horse-power do you propose in your motors?—140.

Can you drive your car at 110 miles an hour with 140 horse power?—Yes, with a current of 1,000 volts.

Has 1,000 volts ever been used before?—I do not know a higher tension than 750 volts. The driving chain would transmit about 2¾ tons of power. The chain he intended to use would be an improved Renold chain and would transmit twice the amount of power which Mr. Renold recommended for his ordinary chains. He had not provided straps for the passengers in the car, nor was the car padded. The lateral pressure on the rail would be about 25 tons going round a curve of 30 chains at a speed of 110 miles an hour. He could not admit that the centrifugal force on a passenger standing up in the car when it was going at a rate of 110 miles and rounding a curve would mean a pressure of 80lb. When a man was sitting down that part of him touching the car would practically be a part of the car. He was not aware that in connection with tramways every form of chain driving had been abandoned on the ground of its absolute inutility, but he was aware that it had been given up to a large extent. As to slackening the speed of a car, it would be possible to retard it at 5½ft. or 6ft. per second, but it would not, except in an emergency, be necessary to stop the car at that rate. He denied that in rounding curves there would be a tendency for the cars to mount the rails. In going round curves the springs of the guiding wheels would press the wheels inwards upon the rails, and in this way the tendency to leave the rails which existed on two-rail lines was entirely obliterated. It had been suggested that the cars would break in two in the middle, but this was purely a question of the strength of the material. The breakdowns on the railway in Brussels during the experiments was due to the stoppage of the electric current. It was quite true that both the Belgian and Russian Governments had taken an interest in his railway, and that commissions had been appointed by both to report upon it. A proposal had been made in Belgium for the construction of a line on the monorail system between Antwerp and Brussels, and the matter was discussed in the Chambers. Ultimately the proposal was rejected, but not through any objection to the system.

Mr. LOUGH: When did it first occur to you to endeavour to obtain this high speed?—In 1892. It would not be possible to repair the railway in the daytime, as human nerves could not stand the strain of expecting these trains.

Mr. YERBURGH asked what kind of brake it was intended to use—The high-pressure Westinghouse brake. This would stop an ordinary train in 1,000 yds. In addition to this an electric magnetic brake could be used for emergencies. It should be observed that in the proposed railway there would be no danger from defective couplings as on ordinary railways, as there would be no couplings, the cars going singly. To carry 60,000 passengers a day on the railway it would be necessary to multiply the blocks and system of posts.

Mr. ROBERT E. COOPER said he was an engineer of 30 years' experience. He was joint engineer with Mr. Behr in the construction of the proposed railway. He was sure the proposed line would be perfectly safe. There would be no difficulty in the cars passing each other at a distance of 18in. apart. The wind pressure would not be an insurmountable difficulty. The strain would be only 1 ton per square inch, and the Board of Trade allowed 6 tons per square inch. The marginal strength in this particular was very great indeed, and that meant greater safety.

By Mr. LITTLER (for the Cheshire Lines Railway): If your express railway is a failure, there is nothing to prevent your making it a stopping railway?—No.

The CHAIRMAN: They cannot object to a clause to prevent them making it a stopping railway.

WITNESS (continuing) said there would be sufficient space on the proposed railway (on embankments and in the cuttings and tunnels) to enable the distance between passing cars to be increased from 18in. to 2ft. 6in.

Mr. LITTLER: Do you know that on the two-rail system on the Baltimore and Ohio Railway in America trains have run in 1·20min. 2·4 miles, or at a rate of 130 miles an hour?—Not on a curve.

Do you know that on the New York Central Railway trains have run at 112, 102, and 103 miles an hour?—No. I am aware that a speed of 85 miles has been attained, but that has been where there are no short curves.

Asked as to the effect of centrifugal force on the passengers, witness said: The guide rails are not to prevent the car running off the rails, but to steady it, and steady it as much on the straight as in going round a curve. The most perfect theoretical form of car would be to have it without guide rails. We had a model made on that principle, and it worked with remarkable freedom and smoothness. A passenger weighing 12 stone would have a lateral pressure of 67lbs. going round a curve, and that, resolved into effect upon the man on the seat, would be that a

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12-stone man would become a 13 stone man so far as the seat is concerned. Resolving the two forces—the horizontal force of 4¾ stone with the vertical force of 12 stone—that gives a resulting strain of 13 stone, so that the effect on the actual seat would be the same as if the man weighed 13 stone. The effect on the man himself would be that, suppose he were tilted to an angle of 30deg., he would not know, physically, that he was going round the curve at all, because he would be in the same position, though the seat would have another stone upon it. If he were standing, and were 6ft. high, and got a lurch in rounding a curve, he would have to put his leg against the swing of the carriage, a distance of 1ft. 2in. He would have the additional strain of 1 stone on his leg.

So that all this talk of tying a man down to a seat with a baby strap is rubbish?—Yes.

Mr. J. M. DOBSON, C.E. (Messrs. Hawkshaw and Dobson), said he had carefully examined the plans and sections, and approved them. There were stiff gradients at each end of the line, but these were a distinct advantage, as the fall would assist the car on leaving and the rise slacken its speed on arriving. A train going at full speed on the level could be pulled up in 40sec. in 1,100yds. With regard to the permanent way, the construction would compare very favourably with that of the two-rail system. The single rail on which the cars would run would be heavier than ordinary rails and would have to carry less. The distance between the cars when passing each other would be 1ft. 6in. On the South-Western Railway the space was 1ft. 10½in., on the Cheshire Lines 1ft. 10¾in., and on the London and North-Western 2ft. 2in. He thought perhaps it might be advisable to have the rails a greater distance apart on the proposed railway, but there would be no difficulty in doing that. In case the Cheshire Lines wanted to cross the electric railway at any point there was no engineering difficulty in the way.

Mr. SHELFORD, C.E., said it had been suggested that passengers might suffer some discomfort in going round curves. If that was so the difficulty could be met by giving a slight tilt to the trestles.

The CHAIRMAN observed that this was an entirely new point in the enquiry.

Counsel for the bill said they did not put it forward as material. They did not think such a device would be necessary, but it was merely put forward as one way in which the alleged difficulty might be met.

In answer to the Chairman, Witness said in the first instance the system was regarded as in the nature of a toy, but subsequently it was discovered that by lowering the centre of gravity they could go at high speed round curves. It was the Brussels experiments which convinced him that the idea was a good one, and that such a railway might be constructed to run at high speed and with perfect safety.

Mr. W. R. GALBRAITH, C.E., also gave evidence in support of the bill, and the inquiry was adjourned.

## SHANNON WATER AND ELECTRIC POWER BILL.

The Select Committee of the House of Lords, presided over by Lord Welby, on Tuesday considered this bill. The House of Commons proceedings are reported in *The Electrician* for May 3rd last.

Mr. BUSHE, K.C., said the scheme was one of great importance, and had excited much local interest. The only opposition remaining came from the owner of a small island at the entrance to Lough Allen, and who alleged that his property would be injured by the scheme of the bill. Unfortunately, in Ireland there was no coal supply, although Nature had been bountiful in providing a magnificent supply of water. The utilisation of water power opened up splendid possibilities for Ireland, and especially in regard to the river Shannon. The project was a simple one from an engineering standpoint. The power house would be at Cloonlara, where there was a fall of 40ft., and where the turbines would be constructed. The canal from below Killaloe to the power house would be about 2½ miles in length, and the Shannon would only be deprived of the water used for some 6 miles of the river's course. The promoters asked power to supply over an area of some 30 miles radius, of which the power house would be the centre. Limerick, situate about 4½ miles from the site of the proposed generating station, had 40,000 inhabitants, was the home of many industries, and was at the present moment greatly in need of cheap power.

The electric tramways in Limerick required a supply of electricity in bulk, and the owners of the tramways had agreed with the promoters to take current from them. The Limerick city authorities also wished to take a supply of current in bulk for electric lighting. The merchants and traders of Limerick and the county councils of Clare and Limerick supported the project. The promoters proposed to equip the power house at first for 5,000 B.H.P.

Mr. FRASER, C.E., engineer to the scheme, said the capital of the company was to be £360,000, with £180,000 borrowing powers—total, £540,000. In regard to certain lands scheduled in the bill outside the radius of the area of supply, the company would have power to place a generating station on them, not for the purposes of the scheme generally, but to supply electricity to factories that might by agreement be placed on that land.

Lord R. CECIL opposed the bill, for which, he said, there was no necessity.

Evidence was then given against the measure, and on Wednesday the Committee decided to pass the preamble.

## THE NATIONAL TELEPHONE CO. AND ELECTRIC TRAMWAYS.

On Monday the Court of Referees in the House of Commons, presided over by Mr. Parker Smith, considered a petition deposited by the National Telephone Co. praying to be heard by counsel against the bill promoted by the Worcester Tramways Co., empowering that company to re-construct and operate by electricity their system of tramways.

Mr. BALFOUR BROWNE, K.C. (for the promoters of the bill), strongly objected to a *locus standi* being granted to the petitioners, arguing that the matter sought to be raised by them should be left to the decision of general law.

Mr. FORBES LANKESTER (for the National Company) urged that facilities ought to be given that company for endeavouring to get inserted in the bill a clause defining the liability of the respective companies in case of their wires coming by accident into contact, and current from the tramways being conveyed by the harmless telephone wire and doing damage to persons or property. The clause the company desired to get inserted was similar to that which had been inserted in the South Lancashire Tramways bill, the Birmingham (City) Tramways bill, and the Tyneside Tramways and Tramroads bill.

After long discussion the Court decided not to grant the *locus* sought.

## WORCESTER TRAMWAY BILL.

The decision of the Court of Referees of the House of Commons denying to the National Telephone Co. a *locus standi* in opposition to this bill will have the result that the measure will be included in the unopposed measures to come before Earl Morley's Committee.

## CITY AND BRIXTON RAILWAY BILL.

Opposition having been withdrawn to this measure, it has been remitted to the Earl of Morley's Committee on Unopposed Bills.

## WIRELESS TELEGRAPHY BETWEEN LIGHTSHIPS AND SHORE.

In the House of Commons yesterday, Sir JOHN LENG asked the President of the Board of Trade whether it was in contemplation to adopt wireless telegraphy for communication between lighthouses and lightships and the coastguard and lifeboat stations on the shores of the United Kingdom.

Mr. G. W. BALFOUR: The question of the establishment of electrical communication, including wireless telegraphy, between lighthouses and lightships and the shore is under the consideration of the Departmental Committee appointed in 1899. I cannot say at present that wireless telegraphy will be selected as the best method of communication in any particular case.

Sir JOHN LENG then asked the Secretary to the Treasury whether any agreement had been arrived at between the Post Office and the Admiralty to facilitate the use of Marconi's wireless telegraphy by British steamships for postal telegraphs and news messages.

Mr. A. CHAMBERLAIN said no agreement had yet been come to.

Sir HOWARD VINCENT: May I ask how this matter stands, for it is of great importance. Is anything being done, or are the negotiations at an end?

Mr. A. CHAMBERLAIN: Negotiations are proceeding.

## CAPE-AUSTRALIAN CABLE.

In the House of Commons last evening, Sir EDWARD SASSOON asked the Secretary of State for the Colonies whether a contract had been signed in connection with the establishment of the Cape to Australia cable; whether he would state the nature of the landing privileges accorded to the contracting company, more especially with regard to the Cocos Islands; and whether, in view of modern precedents, and considering the appeals made by Canada, Australia and Cape Colony, he would obtain the insertion of an expropriation clause reserving to the State the right of purchase on equitable terms.

Mr. J. CHAMBERLAIN: No general contract will be signed between His Majesty's Government and the Eastern Telegraph Co. in regard to this Cape to Australia cable, but the conditions by which the company will be bound will be embodied in landing licences shortly to be issued for this cable at Mauritius, Rodrigues, and Cocos Islands on the lines indicated in my answer to the question of the hon. member on March 11 last. I have not received any appeals from Canada, Australia and the Cape that an expropriation clause should be inserted in these licences.

## UNDERGROUND TELEGRAPH CABLES.

Last evening, in the House of Commons, Sir JOHN LENG asked the Secretary to the Treasury whether an intimation recently made, that the main roads of Post Office telegraphs throughout the country had become so crowded that it was necessary to reserve the remaining space for the public wires which would be required in the immediate future had been made in view of the recent augmentation in the number of wires by the underground cable to Birmingham and the North; whether the intimation of the Postmaster-General that his inability to undertake the work would not prevent newspapers obtaining private wires through some other agency than the Post Office meant that the Post Office had finally abandoned its claim to a monopoly of the telegraph service, and that it was now open to promoters to establish a special telegraphic service for the newspaper press; and whether the statement in the "Post Office Guide" for July, that the Postmaster-General undertakes the construction and maintenance, on rental terms, of private telegraph and telephone wires for firms or private individuals was now annulled, and firms or individuals connected with the Press would be excluded from the rights or privileges common to all others.

Mr. A. CHAMBERLAIN: In the communication referred to, the Postmaster-General did take account of the fact that there is now an under-



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ground telegraph line between London and Birmingham, but the difficulty of finding routes for new wires has been only slightly lessened by this addition to the Post Office system. The Postmaster-General has never claimed any monopoly of telegraphic communication except that which was granted to him by Parliament in 1869, and the use of a private wire connecting premises belonging to the same person or firm for the transmission of telegrams relating to the business of the owner was not included in the monopoly. There is, therefore, no special reason why the Postmaster-General should provide such telegraphs. A newspaper proprietor is at liberty to erect a telegraph of this kind for himself, or to have it erected and maintained by a private contractor, but he is not allowed to establish a telegraphic system for the general distribution of telegrams to the Press. The statement in the "Post Office Guide" to the effect that the Postmaster-General undertakes the construction and maintentance on rental terms of private telegraph and telephones wires is not to be regarded as annulled. It is expressly stated in the "Guide" that the rates quoted apply to wires of short length only. What the Postmaster-General finds is, that his power to provide long wires is limited by the physical difficulty of obtaining routes; and, in view of this difficulty, he deems it expedient to reserve the available routes for the public service, rather than allow them to be absorbed for private purposes. This is of special importance in view of the requirements of the telephone service, as long telephone trunk wires must necessarily be carried above ground. The Postmaster-General still undertakes to provide short private wires. His liability to provide long wires does not apply only to wires for the Press, but to all wires of this character.

## BRITISH PATENT LAWS.

In the House of Commons on Friday last Sir J. LENG referred to the measures in preparation by the new Australian Commonwealth for placing letters patent and inventions under one uniform administration, and asked whether the President of the Board of Trade would consider the question of co-ordinating the law and regulations respecting patents and trade marks in the Australian Commonwealth, New Zealand and Canada with those of the United Kingdom, so that British patent law might run throughout the Empire.

Mr. G. BALFOUR said that letters patent, designs and trade marks were matters in which the Parliament of the new Commonwealth was empowered by its act to legislate upon, but he was unaware of any measures being taken in the direction indicated by Sir J. Leng. It would rest with the Governments of the Colonies to frame their laws and regulations, and it was open for the Colonies to adopt the terms of the International Convention for the protection of industrial property. Some of the Colonies had adopted these terms.

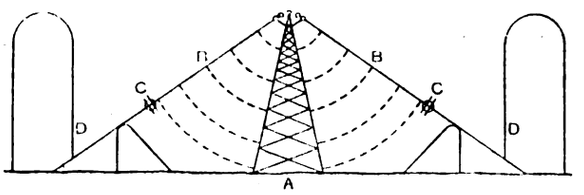
## WIRELESS TELEGRAPHY.*

BY REGINALD A. FESSENDEN.

Even an experimenter working along similar lines and finding a considerable number of devices which he had considered as peculiarly his own, described in the Paper, may be pardoned for feeling a considerable degree of pleasure in reading the admirable communication recently made by Mr. Marconi to the Society of Arts. Mr. Marconi is certainly to be congratulated not only upon the practical results which he has achieved, but also upon the beauty of the methods employed. It is most certainly apparent that his method has now passed from the original crude stage to a practical and commercial one. It may be of interest to compare the results, at least some of them (for it would be inadvisable at present to publish more than a part), obtained on this side of the water by the United States Weather Bureau. These experiments were commenced under the direction of the chief of the Weather Bureau, Prof. Moore, in January, 1900. Under his direction, and with his approbation, the subject was investigated from the beginning, with a view first to finding out definitely the nature of the phenomena, and then devising means for utilising the forces to best advantage. First will be described a number of cases in which the work of Mr. Marconi and that of the Weather Bureau has gone along parallel lines; secondly, the differences between the methods and results obtained so far as published; and, lastly, an indication of work done by the Weather Bureau which has not been, so far as is known at present, duplicated. Naturally, on account of commercial considerations, it will not be possible to go into details so much as might be desired, and for the present this deficiency must be excused. The first point in which parallel results have been obtained is that concerned with the employment of larger capacities, more especially in the form of cylinders. Mr. Marconi describes the use of concentric cylinders, the inner one connected through a self-inductance to ground, and explains very clearly that in the case of wire conductors the electrical oscillations rapidly die away, and that with greater capacity we have a more persistent vibrator.

The following quotation from one of the patent applications of the Weather Bureau experimenters will show that in this respect the same result has been reached:—"The employment of simple wires having small capacity as sending conductors is objectionable, for the reason that the radiation is so rapid that there are very few oscillations in each discharge, and hence the inductive rise in voltage at the receiving station cannot attain sufficient value to permit of the use of inductive devices for arresting the potential at such station. By the employment of conductors having large capacity at the sending station, and by properly proportioning the self-inductance and resistance, the radiation from the conductor can be so controlled that there will be a large number of oscillations; for example, 50 or more at each total discharge. In other words, the discharge is so controlled that only a small fraction of the total energy is radiated at each oscillation. By thus extending the period of radiation opportunity is afforded for the inductive voltage at the receiving end to rise to its full value. By increasing the number of oscillations for each total discharge from the sending conductor, and by adjusting the receiving system so that its natural periodicity corresponds, or approximately so, to the period of the electromagnetic waves, the distance of travel of the waves is not solely dependent upon the heights of the sending and receiving conductors as has heretofore been held." And the corresponding claim: "In a system of wireless telegraphy a conductor adapted to radiate electromagnetic waves having its capacity, inductance and resistance so proportioned that only a relatively small fraction of the energy of the large conductor is radiated during a single oscillation, thereby preventing rapid vibrating in oscillations, substantially as set forth."

As regards the details by which this is accomplished, Mr. Marconi uses two concentric cylinders, the inner one having an inductance connected with it. The object of the inductance is not fully described, but Mr. Marconi lays great stress upon it. According to the writer's experiments, the object of this inductance is three-fold. In the first place, as Mr. Marconi explains, it gives a difference in phase; secondly, it is only the outer conductor which radiates, and this radiates just as a simple cylinder of the same size would radiate if used as an ordinary vertical conductor, but for the fact that the oscillations are more persitent when the inductance is put in. For the formula for logarithmetic decrement contains the power, R L, and hence we can decrease the decrement—*i.e.*, render the oscillation more prolonged by increasing L. Also, as the two concentric cylinders act as a condenser, and this in combination with the inductance means that we really are shunting the spark-gap with a synchronous circuit of a larger capacity, as was suggested by Dr. Pupin in his discussion on wireless telegraphy before the American Institute of Electrical Engineers.




In this respect the work has not been parallel, for while the patent application and the drawings described inductances used in this manner, the same effect has been obtained, not by increasing the denominator, but by decreasing the numerator of the fraction R/L. This has been done in three different ways, which will be described at a later date. The advantage of this method is that whilst when we increase the denominator we decrease the period and also decrease the total amount of energy radiated per oscillation, if we decrease the numerator we keep the amount of energy radiated the same, and do not change the period, while at the same time we make the logarithmetic decrement just as small as can be obtained with the inductance. This means a greater sending power with a given height.

Another line in which parallel results have been obtained is in the tuning of the secondary of the receiving transformer. Mr. Marconi shows clearly the necessity of this, and we may compare this with the following statement from another of the patent applications:—

"It has heretofore been impossible to make the receivers respond solely to waves of one periodicity, as other periodicities, if above a certain power, will affect the receivers. By constructing the second conductor so that the oscillations for each total discharge are increased, and by employing at the receiving station two or more tuned circuits, a very perfect resonance or tuning between the stations can be obtained. With one tuned circuit at the receiving station, and with conductors permitting a rapid radiation at the sending station, electrostatic and hysteresis effects become very prominent, and the great self-inductance desirable for sharp resonance cannot be attained. By employing two tuned circuits, one connected to the receiving conductor and the other secondary to the first, the electrical effect in the secondary will occur only when the resonance is very sharp." And the corresponding claim, "In a system of wireless telegraphy a sending conductor in combination with a prime conductor, including the receiving conductor and one or more secondary circuits controlled by the primary circuit; a transmitting device included in the last circuit of the series, the several circuits being tuned to correspond to the period of the second conductor, substantially as set forth."

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Here, however, there is another difference. Mr. Marconi makes the secondary of his coil equal to the height of the sending conductor. The writer makes it equal to twice the height of the sending conductor. Two explanations of this are possible: First, that Mr. Marconi uses the secondary wound in such a manner that the wire really has a longer natural period than if it were straight; secondly, that he is really working with the first overtone. I have found that the overtones are very pronounced, more especially when the spark-length is slightly longer than that generally used. There may be some other cause not at present known, but all the writer's experiments seem to show that the wave-length is really four times the length of the vertical conductor and not twice. Another difference consists in the form of the radiating conductor. Mr. Marconi uses concentric cylinders, but in the Weather Bureau experiments simple cylinders were at first used. Later these were replaced by conductors of the form shown in the accompanying sketch, in which A is a tower, BB are cables insulated from the tower at its top, CC are insulated strain insulators, and DD ropes boiled in an insulating compound. The spark or other apparatus is placed at the top of the tower and the waves go out, as shown by the dotted lines. This kind was later superseded by a third form, and this kind by a fourth, which will be referred to later. Another case in which parallel work was done is that in which a Thomson high-frequency coil (commonly called a Tesla coil, but in reality first brought out in its present form by Prof. Elihu Thomson) was used. Unfortunately, however, some other modifications are used with it, which, as the patents have not been granted, it will be impossible to describe at present. The writer's experiments show plainly that Mr. Marconi's remarks on Prof. Slaby's work are justified, and that much better results can be obtained by the Marconi methods. Lastly, with respect to the general direction in which the work of the Weather Bureau has progressed: In the first place, it has been found possible in several ways to get over the old difficulty which troubled Hertz and later experimenters, *i.e.*, that when the spark-length was increased beyond a certain length the discharge became no longer oscillatory. An electrical device was invented which, on being applied directly to the sending wire, measured directly the amount of energy radiated. A curve was then plotted, showing the relation between spark-length and energy radiated, and it was found that the curve gave a sharp bend with a spark about 1in. in length, and no further increase of radiation could be obtained. Different kinds of coils with different primaries and secondaries, different methods of producing the voltage, different kinds of gases and fluid insulators in which the balls are immersed, and different kinds of arrangements of the terminals were tried, but all without success. But finally the solution was found, with the result that with the later apparatus an amount of radiation 16 times as great as that got with the ordinary 12in. coil and 1in. spark was obtained. This means, of course, greater sending distance, and it may be mentioned here that transmission without the use of transformers, inductive devices, cylinders or any other apparatus for raising the voltage, has been accomplished over a distance of 50 miles without using more than a fraction of the available energy. The same result was also accomplished in two other ways.

The question of high conductors has proved a rather serious one, because, as Mr. Marconi has pointed out, if we use large surface conductors, though they may be short, yet they are objectionable on account of the wind pressure. Means for overcoming this are described in some of the patent applications, but the method was finally abandoned because means have been found by which a conductor only 1 metre high can be made to radiate as much energy and of the same period as a conductor 100 metres high. Another difference again, has been the fact that it has been found necessary to differentiate in form between the receiving and sending conductors, *i.e*, to have the receiving conductor with more self-inductance and less capacity than the sending conductor. Other work done by the Weather Bureau has been along the line of producing a non-interfering system. The admirable and beautiful work of Mr. Marconi has resulted in a system by which, within certain limits, messages can be sent without interference. But one great objection has been found in the Weather Bureau experiments to this method, although it is described in some of the earlier patents of the Weather Bureau experimenters. That is, that while it is no doubt possible, under certain conditions, to send and receive individual messages, yet by connecting two brass semicircles to a motor revolving at several thousand revolutions per minute, it is possible to make what may be called an electrical siren, which runs up and down a scale of seven or eight octaves several thousand times a minute, and which, as at some period of the scale it gives a note corresponding to any given syntonised receiver, is consequently able to stop all communication, when used in conjunction with the apparatus for strengthening the radiation, within a radius of 500 miles or so. Consequently, this method has been superseded by several other methods which permit of selective signalling, no matter how strong the interfering radiator may be or how close it may be, even approaching the interfering radiator within a few feet producing absolutely no effect. The parallel manner in which a considerable part of this work has been done may possibly be taken as evidence of the fact that the matter has now got down to a sound scientific base. Mr. Marconi and his eminent collaborateur, Dr. Fleming, are certainly to be congratulated on the results they have so far achieved, and no one joins more heartily in wishing them the best of success than the writer. The future of wireless telegraphy in their hands is certainly assured, and it cannot be many years before Mr. Marconi will see the great system which he was the first to see the points of and to put in practical form in as universal use as our present methods of telegraphy.

# LEGAL INTELLIGENCE.

## National Company for the Distribution of Electricity by Secondary Generators v. Gibbs.

This case came before Mr. Justice Cozens-Hardy, in the Chancery Division, on Tuesday.

Mr. FLETCHER MOULTON, K.C. (for the plaintiffs), said this case had been before his lordship on a previous occasion. The plaintiff company had made an agreement with defendants, John Dixon Gibbs and Lucien Gaulard, the latter now being dead, was represented by Madame Ruelle, the agreement being dated May 25, 1883, and provided for the assignment of certain letters patent, and there was also a covenant by the vendors that the patents were valid. His lordship had come to the conclusion that the covenant was not joint and several and that it did not bind Madame Ruelle. An appeal was brought on that point, and the Court of Appeal decided that in the particular language of the document the covenant was joint and several, and therefore would bind Madame Ruelle. The case now came back to his Lordship to have the substance of the case decided on the question of the damages to which the plaintiff company was entitled. (The previous proceedings in this matter have been fully reported in *The Electrician*.)

Counsel on both sides having addressed the Court with long legal arguments as to the respective rights and liabilities of their clients,

His LORDSHIP found the plaintiffs' case succeeded, and directed an inquiry as to damages. His lordship then directed that there should be judgment for defendants on the counterclaim for £2,581. 3s., with interest at 4 per cent. from that day, and judgment for the plaintiff on the claim. There was an apportionment of the costs.

## Wayleave Rentals.

An interesting action was heard at Gateshead County Court on Tuesday by Judge Greenwell, when Mr. Meynell, barrister, on behalf of the National Telephone Co., applied for costs in an action brought against the company by Mr. R. Howe, and which action was afterwards withdrawn.

Mr. HOWE appearing on his own behalf, said he had brought the action owing to the placing of wires on his house in Whitehall-road, Gateshead, These wires had been up for 18 months before he was aware of the fact. No notice of placing them there was given, and no anterior permission obtained. The wires, whenever there was a high wind, caused considerable damage, greater than would be covered by the 10s. annual rent he had demanded from the company. He withdrew the action when he found how expensive it would be to prosecute it, and decided it would be best to submit to the loss.

Mr. MEYNELL said Mr. Howe had not represented the case properly. The house on which the telephone wire had been placed was leased by Mr. Howe to a Mr. Aitchison, who had applied for a telephone connection, and the wire attached to the roof was that required for this connection, and no other wire had been placed upon the house. The question was a very important one, as it raised the issue as to whether a tenant was entitled to put a telephone into the house without the owner's permission. The particulars of the claim were 6s. 7d. damages done to the roof in putting up the wire, and 10s. for a year's rent. The 6s. 7d. was not disputed, and had been paid into court, and he now submitted that he was entitled to judgment against Mr. Howe with costs.

The JUDGE said Mr. Howe had no right to interfere. He had handed over his house to a tenant for seven years, and a telephone was nowadays part of the ordinary condition of domestic household management. He must, therefore, award costs to the defendant company.

Mr. MEYNELL urged that, as the action was of great importance, both to the company and to the tenants of houses, he should be awarded costs on a higher scale.

The JUDGE acceded to the request of counsel, and said Mr. Howe had had a concession made in his favour by the company not claiming, as they might justly have done, costs on a still higher scale. He should have given notice of withdrawing the action immediately on receiving notice of the payment into court of the 6s. 7d. damages, instead of waiting till the company had notified him of their intention to defend the action.

## Wrigley v. Windermere District Electricity Supply Co.

In this action (for an injunction for alleged noise, smoke and vibration), before Mr. Justice Kekewich, on Friday last, it was arranged that an inspection of defendants' premises should be made by a competent person, and a report be presented to the Court whether he considers there is nuisance caused by noise, smoke and vibration, and whether, in his opinion, anything can be done by defendants to remedy it. The hearing of the action was fixed for July 30.

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### British Electric Works Co. (Ltd.).

In the High Court on Tuesday the petition of Samuel Walker (Ltd.) for the compulsory winding up of the British Electric Works Co. (Ltd.) was withdrawn. Counsel for petitioners said the company was now in voluntary liquidation, and the liquidator would pay the costs of the petition.

Mr. EVE, K.C., for the company, said they had sold their assets, and there was sufficient to pay all the creditors in full, and make a return to the shareholders.

### J. and W. Stewart v. "Irish Independent" Publishing Co.

On Wednesday in the King's Bench Division, Dublin, the defendants in this action having unreservedly withdrawn the expressions objected to by the plaintiffs, and agreed to publish an ample apology in the leading Irish papers, Mr. Justice Boyd allowed the action to be withdrawn. The allegations made against Messrs. J. and W. Stewart were in connection with the contracts given to the firm for the electric lighting works of the Dublin Corporation at Pigeon House Fort, and were to the effect that the firm do not employ trades union labour, or comply with the fair wages resolution of the House of Commons.

### Rating Appeal.

At the Clerkenwell (London) Sessions, last week, Mr. W. R. M'Connell, K.C., and the magistrates present heard an appeal of the Chelsea Electricity Supply Co. against the rating of their undertaking by the Chelsea Guardians. Counsel for the parties included Mr. Balfour Browne, K.C., Mr. Freeman, K.C., and Mr. Llewellyn Davies for appellants; and Mr. Marshall, K.C., and Mr. E. A. Jelf for respondents.

Mr. DAVIES said the appeal was taken on the question of the rating of the electricity generating stations, sub-stations, offices, &c., of the appellant company at Chelsea. The original valuation of these premises was £16,460 gross and £9,648 rateable. An appeal was made to the assessment committee of the parish, who declined to reduce the gross value, but increased the deductions, and thereby the rateable value, to £8,683. Appellants now sought (1) a reduction on the gross value, and (2) further reduction on the rateable value (£15,128 gross, £5,266 rateable). The difference between the parties as to their respective valuation was really one of figures, as they were practically agreed on the gross revenue of the appellant company (£35,000). With regard to the deductions, his clients contended they ought to be allowed more generously in this than in the majority of such cases.

Mr. W. H. ELWELL, F.S.I., said he had valued the premises on the basis of the accounts for 1899, and had arrived at the following figures:—Gross receipts (including sale of current, rental of meters, &c.), £34,977; working expenses, £13,144 (including coal as in 1899, £4,152, and provision for extra cost owing to the rise in prices, £1,096); 10 per cent. on the total cost of repairs, maintenance, and renewals of tenants' fittings and chattels (£1,326); boiler insurance, £100; rates and taxes (6s. 6d. in the £ on the assessment of £15,271), £1,713; occupiers' share (tenants' profits, interest on capital, risks, &c., 17½ per cent. on £28,500), £4,987. Deducting working expenses and other items named from gross receipts, gave the gross estimated value £15,133, and this had to be reduced by the statutable deduction £9,862, leaving the net rateable value £5,271.

For the respondents, Mr. W. EVE, F.S.I., estimated the receipts on the 1899 account at £35,003; expenses (deducting rates and rents), £12,945; repairs and renewals, £4,934 (including deduction of £3,000 to reserve, &c.); tenants' share, £2,640; rates (at 6s. 6d. in the £ on rateable value of £8,663) £2,822. This left the assessment at £11,662, to which must be added a considerable sum for development since 1899, less extra cost of coal.

Other evidence on both sides was given of a similar nature, but ultimately the appeal was dismissed, with costs.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The position of senior demonstrator in the department of electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session, in consequence of the appointment of Dr. E. W. Marchant as lecturer at Liverpool University College. An inspector in electrical engineering, with experience in polyphase and high-voltage work, is also required. Applications to Prof. S. P. Thompson, F.R.S., Technical College, Finsbury, E.C. See advertisements.

As announced in an advertisement elsewhere applications for three appointments of assistant superintendents in the Telegraph Department of the Goverment of India will be received by the Secretary, Public Works Department, India Office, Whitehall, London, S.W., until July 31.

Whitby District Council require a resident electrical engineer. Applications to Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W., by 20th inst. See advertisement.

The editorship of "Science Abstracts" is vacant, Mr. W. R. Cooper, M.A., who has been so closely identified with the progress of this useful work, having resigned. An official notification appears in our advertisement columns.

Wellington (N.Z.) Municipal Council require an electric tramway engineer. Applications to Messrs. John Duthie & Co., 23, Lime-street, London, E.C., by noon July 20.

About 120 young men (expert telegraph operators, linesmen, instrument repairers, and electric light wiremen) are required for active service in South Africa. Applications to Adjutant, Electrical Engineers R.E., Regency-street, Westminster. See advertisement.

Dundee Gas Commissioners require jointers accustomed to Callender's and B.I.W. cables. Applications to city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee. See advertisement.

An assistant engineer is required for the City-road station of the County of London and Brush Provincial Co. Applications by 18th inst. See advertisement.

A lecturer in mathematics and applied physics is required for the Royal Albert Memorial College, Exeter. Salary £250. Applications to principal by July 20.

A headmaster is required for the Swansea Intermediate and Technical Schools. Salary £600. Applications to secretary, Grammer School, Swansea, by Aug. 6.

An assistant demonstrator in physical laboratory classes for the session 1901-1902 is required at West Ham Municipal Technical Institute. Particulars from Principal.

Owing to the appointment of Mr. A. G. Bird as resident engineer and manager of the Guernsey Electric Supply Co., the Bristol Electrical committee recommend that Mr. H. H. Couzens, at present third engineer at £156 per annum, be promoted to second assistant engineer at £200 per annum; and that Mr. J. H. Bolam, B.Sc., now charge engineer at £156 per annum, be promoted to the post of third assistant engineer at £175 per annum.

The Postmaster-General has appointed Mr. E. Treman deputy-controller of the Central Telegraph Office, London, in succession to the late Mr. T. Barlow. Mr. Treman joined the service of the Post Office in 1870, on the transfer of the telegraphs, and has held the post of telegraph superintendent at both Leeds and Manchester.

Mr. Frank Hatch of Wolverhampton has been appointed traffic manager of the Southampton Corporation trumways at £350 per annum, and Mr. C. G. Simpson has been appointed deputy manager at £125.

Mr. W. Orchard has been appointed electrician-in-charge at the Southampton power station.

Mr. R. Spencer Yates has been appointed resident electrical engineer at Sleaford.

Mr. Lewis, at present second assistant, has been appointed chief assistant at the Canterbury electricity works. Mr. Callender has been appointed second assistant.

**Aberdeen.**—The electric tramway routes from Castle-street to Constitution-street and that across the links to the sea beach have been opened for traffic. The third-rail system is employed on the latter route.

**Alleged Theft.**—At Widnes Police Court on Tuesday two brothers named M'Conville were charged with stealing 37 cwt. of copper, value £132, belonging to the Electrical Copper Co. Prisoners were committed for trial at the Liverpool Assizes.

**Barrow-in-Furness.**—An inquiry was held on Tuesday into the application of the Council to borrow £12,340 for making additions to the plant at the station and extending the mains to Vickerstown and Walney Island. Supply was commenced in 1899 with 43 customers, and there are now nearly 200. There was no opposition.

**Belfast.**—The Corporation have received sanction to a loan of £90,822 for electric lighting extensions.

**Bermondsey (London).**—The Council have decided to apply for a provisional order for the whole of the borough. At present the Council's electric lighting powers are confined to the parish of Bermondsey.

**Beverley.**—The Council have decided to acquire a site for electricity works, and a canvass is to be instituted to ascertain the support likely to be accorded to the projected electric lighting scheme.

**Blackrock.**—Dublin Corporation have submitted alternative proposals to the Council for supplying electric current in the district. The proposal is to supply current in bulk from the Pigeon House station for a three hours' daily maximum demand at 1¾d. per unit, or to supply electricity in bulk at Blackrock for three hours' daily maximum demand at 2·65d. per unit, the minimum charge to be £1,000 per annum.

**Bradford.**—On Tuesday the Electricity committee recommended the Corporation to increase the salary of the city electrical engineer (Mr. R. A. Chattock) from £500 to £700 per annum. The chairman (Mr. T. Shaw) said that the salary which Mr. Chattock was now receiving was much below that paid to electrical engineers in other parts of the country, and urged the increase, lest Mr. Chattock's services should be secured by some other town, and the Bradford Corporation be thus put to the inconvenience of looking for another

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engineer. Mr. H. S. Wright moved that the proposal be referred back for further consideration. An increase of £200 a year was unduly large to be made to a man who had only been in the service of the Corporation for a short time. An amendment having been proposed and supported, Mr. Shaw decided to withdraw the motion.

**Bray**.—The Council have applied for sanction to a further loan of £4,200 for electric lighting extensions.

**Burglary**.—At Clerkenwell Police Court, Walter Matthews, called "an electrician," was charged on remand with breaking into 132, Clerkenwell-road, and stealing a number of scientific instruments, value £35, the property of Thomas Reynolds. Matthews was also charged with another prisoner, named Mitchell, with breaking into the warehouse of the British Electrical Manufacturing Co. at Putney Bridge, and stealing three cheques for £7. 14s. 3d. and 51 blank cheques. Prisoner was remanded.

**Bury (Lancs.)**.—The report of the engineer and manager of the electricity department (Mr. S. J. Watson) states that at the end of March there were 254 customers, with an equivalent of 18,559 8 c.p. lamps connected2; 61,247 units of current were sold, and the maximum load was 237·7kw. The revenue showed an increase of £675, but owing to exceptional circumstances the expenses increased £1,516, making a deficit of £657, compared with a profit of £183 for the previous year. 33 arcs are used for public lighting, and applications for current for motors show steady progress. During the year a 360 B.H.P. Belliss-Siemens set was erected at the station.

**Bury St. Edmunds**.—Sanction to a loan of £11,346 for electric lighting has been received by the Council. £120 was deducted from the amount asked for, as the Local Government Board did not consider incandescent lamps a proper subject for a loan.

**Canterbury**.—Sanction to a loan of £17,00 for electric lighting extensions has been obtained.

**Carnoustie (N.B.)**.—Messrs. Crompton & Co. are applying for a provisional electric lighting order.

**Chesterfield**.—The Council anticipate giving a supply of electric current in August.

**Cromer**.—A site for an electricity generating station has been acquired by the Council for £800.

**Croydon**.—The question of avoiding risks from falling telephone and telegraph wires on trolley lines was debated by the Corporation last week. The Tramways committee, acting on the advice of their consulting engineer (Mr. E. W. Monkhouse) recommended the adoption of the automatic cutout system, which would, in the event of telephone or telegraph wires falling across the trolley wires, or in the event of the trolley wires themselves breaking, disconnect the current. The cost of adopting this system was estimated at £3,050.

The CHAIRMAN (Ald. Sir F. Edridge) said they were making good progress with the tramway permanent way. The committee had for some time been considering whether it would be possible to find an apparatus which would obviate possible accidents by the falling of telephone wires or the actual breaking of the trolley wires. The general practice of corporations had been to employ guard wires, and, though it could not be said that this arrangement had always been successful, accidents had been very few. He did not think any undertaking, except that at Blackpool, had made arrangements for protecting the public from possible danger from the trolley cable itself, and the committee proposed to adopt the Blackpool plan. The matter had been put before the British Electric Traction Co., but at present the company hesitated at expending £180, which would represent 6 per cent. on the outlay, on what they deemed to be a luxury. The Corporation had, however, the right to refer the matter to arbitration. £3,000 would be well spent in view of the increased confidence the adoption of the automatic cutout principle would give to the public generally. The report was approved.

**Darlington**.—The Council have decided to purchase the undertaking of the Imperial Tramways Co. in the district, and to expend £12,000 in electrically equipping the lines and constructing extensions.

**Denmark**.—In 1846 the firm of Burmeister and Wein was established, and in 1872 was converted into a joint-stock undertaking with a present capital of £440,000. The company has extensive shipbuilding yards on Rafshale Island, and employs over 2,000 hands. More than 15 acres are covered by these works, and the whole of the machinery for all purposes is driven by electric power. The company also has large engineering works at Christianshaven, including engine shops, iron and steel foundries, hydraulic forge, &c., and here again the whole of the driving is electric. Triple-expansion and compound engines are a special feature of the company's output, and the electricity stations of Copenhagen and its suburbs, and also large electricity stations at St. Petersburg, Malaga, Bahai and Bangkok have been supplied with engines of this company's make. The company during 1900 established itself at Shanghai.

**Egypt**.—Of the total imports into Egypt of "miscellaneous" goods in 1895 Great Britain supplied more than half the electrical apparatus, mathematical instruments and similar articles, but, although there has been a considerable extension of late years in the installation of electric light, the construction and equipment of electric tramways, the electric transmission of power, and other electrical work, British imports have by no means kept apace with this advance, and trade in these goods is now mainly in the hands of French and other Continental makers and dealers.

**Electricity in Mining**.—An electric lighting plant has been working since August last at the mines of Humphry's Hydraulic Sluicing Co. in New Zealand to enable work at the mines to proceed by night as well as day. The plant has given great satisfaction.

**Gillingham**.—The Council have made an agreement with the Chatham, Rochester and District Electric Light Co. for the acquisition of the company's undertaking within the district at £26,659.

**Glasgow**.—The balance-sheet of the Tramways department for the year ended May 31 shows a total revenue of £489,469. 8s. 7d. and working expenses £371,705. 7s. 1d., leaving a gross profit of £117,764. 1s. 6d. The previous year's figures were £469,965. 10s. 11d., £344,721. 11s. 3d. and £125,243. 19s. 8d. respectively. This year's balance has been applied as follows:—Rent of Govan and Ibrox tramways, £5,057. 14s. 7d.; interest, £38,979; sinking fund instalment, £19,470. 13s. 4d.; depreciation, £29,758. 16s. 7d.; payment to common good, £12,500; total, £105,766. 4s. 6d., leaving £11,997. 17s. for transfer to general reserve. The decrease of £34,570. 15s. in the net balance compared with last year is due to increased interest and sinking fund charges on the capital required in the conversion of the lines to electric traction, which was, until within the last few weeks of the financial year, entirely unproductive. The traffic recipts from electric traction were £80,258. 4s. 7d., and the working expenses £36,423. 4s. 5d. Capital account on June 1, 1900, as reduced by depreciation, was £937,033. 5s. 9d. The additional capital expenditure during the year to May 31, 1901, was £886,659. 18s. 11d., and was principally in connection with the conversion of the system from horse to electric traction and for the construction of additional lines. The gross capital expenditure to date has been £1,947,730. 19s. 9d., and the amount of depreciation written off since 1894 has been £153,796. 11s. 8d., leaving the actual capital account at May 31 £1,793,934. 8s. 1d. The total amount borrowed for capital purposes is now £1,680,732. 0s. 1d., of which £846,000 has been borrowed during the past year.

**Grays (Essex)**.—Application has been made for sanction to a loan for the free wiring of consumers' premises.

**Hexham**.—The Works committee is to report upon two applications from companies seeking electric lighting powers.

**Leigh**.—An inquiry was held here on Tuesday into the application of the Corporation to borrow £11,250 for electric lighting extensions. It was stated that last year there was a profit of over £600 on the electric lighting undertaking, and that the demand for current was steadily increasing.

The first annual report of the Electricity committee for the year ended March 30 has been issued. There are over 80 customers and an equivalent of nearly 5,000 8 c.p. lamps connected. Of the 76,988 units sold 53,989 were supplied for private lighting at an average price of 4·73d. per unit, and 22,999 units for power at an average of 1·25d. The total revenue was £1,184. 4s. 5d. The expenses were £572. 8s. 8d., leaving as gross profit £614. 17s. 3d. to meet interest (£306. 7s. 5d.) and sinking fund instalment (£410), a deficit of £101. 10s. 2d. on the year. The capital expenditure to date is £10,917. 7s. 7d.

**Light Railways**.—Objections to the Bath and District Light Railway order were taken on Wednesday. The opposition of King Edward's School as to the site of the generating station was overruled, and the order was confirmed.

The Kidderminster and Bewdley Light Railway order was considered by the Board of Trade on Tuesday. Mr. F. J. S. Hopwood, Permanent Secretary, said Colonel Yorke recommended that a portion of the railway in Kidderminster should not be laid till the Bull Ring had been widened to 21ft. 6in. Mr. S. Morse, for the promoters of the order said their objection was met by their only using the Bull Ring part of the railway with the consent of Kidderminster Corporation for goods and passenger traffic. After discussion it was agreed that the consent of the Board of Trade should be superimposed on the consent of the Corporation before this part of the route could be opened for traffic. The Great Western Railway Co. asked for protection in cases where the light railway would pass over or under their line, and Mr. Hopwood agreed that the Board of Trade would draw a clause to meet this opposition and would consult with the Light Railway Commissioners as to having that clause inserted in all light railway schemes. The order as amended was then confirmed.

An inquiry was held at Wood Green on Wednesday into the application of the Middlesex County Council to construct light (electric) railways in Middlesex. Mr. Askwith, for the promoters, said the principle involved was discussed and disposed of when the Commissioners made an order in March last authorising the construction of 13 miles of tramway involving an expenditure of £347,000. Four districts were affected by the present application—Hornsey, Tottenham, Wood Green and Southgate—and nine-tenths of their

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population was of a residential character. There was no question as to the present means of locomotion being insufficient. The proposed lines would be connected with the system of the North Metropolitan Tramways Co., who had agreed to sell to the Council so much of their undertaking as was in the County of Middlesex. Hornsey Council objected to the proposed line of connection with the North Metropolitan system, because they contended that the tramways should be under their control. The Mayor of Islington (Mr. W. J. Crump), Mr. James Bigwood, M.P., Mr. H. Nield, and Mr. H. Burt supported the application. The inquiry was then adjourned until yesterday, when evidence in opposition was taken.

Nailsworth District Council have unanimously approved the scheme for the construction of light electric railways from Stroud to Nailsworth, Stonehouse, Chalford and Painswick.

"**Local London.**"—This is the title given by Messrs. P. S. King & Son, publishers, Great Smith-street, Westminster, London, to a new year book dealing with London and Greater London. For the new venture it is claimed that the information has been collated with care and with particular attention to completeness and compactness. The book should prove a handy work of reference to those interested in the municipal, political, educational and social affairs of the metropolis and its suburbs. The price is 6d. in paper covers, or bound in cloth 1s.

**London County Council.**—At Tuesday's meeting the Highways committee reported on the question of the reconstruction for electric traction of a portion of the Council's tramways on the south side of the Thames. The report stated it would take less time to reconstruct the tramways than to erect the generating station. Negotiations had taken place with the South London Electric Supply Corporation, and as a result the committee recommended, and the Council agreed,

That an agreement be entered into with the South London Electric Supply Corporation, providing that (*a*) the company shall permit the Council to erect a temporary building at the company's electricity generating-station near Loughborough Junction, and to place therein two 2,500 H.P. continuous-current sets of electricity generating plant and auxiliaries, and also to place therein temporarily two Stirling boilers; (*b*) that the generating plant referred to shall be worked by a staff in the employ of the Council, and (*c*) that the company shall be paid by the Council at the rate of 1·4d. per unit of electric current used for working the tramways.

**Lowestoft.**—Acting on the advice of the consulting engineer (Mr. W. C. C. Hawtayne) it has been decided to obtain an additional 500kw. set, including pipe work and switchboard connections, at an estimated cost of £6,000.

**Ludlow.**—An inquiry will shortly be held into the application of the Council to borrow £7,500 for electric lighting.

**Manchester.**—Under the guidance of Dr. Bishop (chairman of the committee), Mr. Hesketh (chairman of the Street Mains subcommittee), and Mr. G. F. Metzger (the chief engineer), the members of the Electricity committee made an inspection on Thursday last week of the generating stations, some of the sub-stations and street mains. Dickinson-street station, where 13,000 H.P. is installed, was first visited. At present the station is supplying current for lighting and tramways, but it is intended to utilise the Bloom-street and Stuart-street works, when completed, for supplying current for the tramways. At the end of last year the equivalent number of 8 c.p. lamps in use supplied from this station was 367,000, and since then 13,000 additional lamps have been connected and three tram routes opened. The committee claim that Dickinson-street station is larger than any other municipal electricity station in the kingdom. It is hoped that the Bloom-street station, which was next visited, will be available for the supply of current by September. This station will be equipped with four sets of 3,500 H.P. each. At Stuart-street it is proposed to erect, as a first instalment, machinery of 15,000 H.P., to be ultimately increased to 60,000 H.P. From Bloom-street the party went to the stores and workshops at the Polygon, Ardwick, which cover 7,760 sq. yds. Here offices for the department have been built, and there is also a sub-station for supplying the district with electricity. The Moss Side and Rusholme sub stations were afterwards inspected. The total mileage of mains laid up to March 31 was 159¼, at an expenditure in Manchester of £422,111, in Withington of £38,487, in Moss Side of £18,804, and in Levenshulme of £2,630. During last year 7,944,540 units of current were sold. The department has 3,786 customers, and the total maximum demand is equivalent to 386,770 8 c.p. lamps.

The City Coroner (Mr. S. Smelt) held an inquest on Wednesday into the death of a linesman named Horne, employed by the Corporation tramways department.

Horne was engaged in making some alterations to the overhead wires on the Rochdale-road route on the previous day, and was working from the top of a travelling platform, when he took hold of a live wire and suddenly fell to the ground, a distance of about 20ft. He fell on his head and sustained severe injuries, from which he died on the way to the infirmary. Horne had only been in the employ of the Corporation a fortnight and had previously worked as a linesman for several years for the National Telephone Co.

Evidence was given by a linesman that Horne was working with him as assistant when the accident occurred. They were changing a frog wire to an anchor wire. It was deceased's business to prepare the tools and wire on the ground, so that witness might go on with the work. He should not have gone up the ladder, or have touched the wires. He did not know whether Horne was specifically warned of the danger of touching the live wires, but generally the foreman told the men to be very careful while working with live wires.

The CORONER asked if there were no precautions to prevent labourers meeting with an accident, and witness said they were never allowed to go on the platform when there was any danger unless they knew the business. They were supposed to work on the ground. They had insulating gloves and slippers supplied to them by the Corporation, but deceased had no gloves as they were not necessary in his case.

JOHN MURRAY, foreman linesman, said he did not think Horne knew of the danger of touching live wires.

The CORONER: Why did not you warn him?

WITNESS:—I was not there; there was a man in charge. The deceased ought not to have had a ladder. There had been no written notice warning deceased. The men had not been called together and warned, but they had been warned individually.

The CORONER: I do not think the evidence is sufficient to satisfy the jury that the men have been specifically warned.

Mr. J. J. M'MAHON (the engineer) said: The men had been personally warned by him. He left the duty of cautioning them to the respective foremen. Only experienced men were allowed on the wagons or to deal with live wires. With regard to the current carried by the wires, he had never heard of a voltage of 500 killing a person unless he had fallen. He accepted the Coroner's recommendation to warn all workmen specifically.

Mr. BELL, who appeared for the Corporation, added that he would convey the recommendation to the Tramways committee, and the general manager would see that each workman had a written warning.

The jury returned a verdict of accidental death.

**Municipal Telephony.**—Walsall Council have appointed a subcommittee to consider and report on the advisability of (1) establishing a municipal telephone service, or (2) of entering into an agreement with a company to erect an exchange in opposition to the National Telephone Co.

**Norwich.**—The Norwich Electricity Co. (Ltd.) recently applied to the Council for permission to alter the pressure of supply from 110 and 220 to 220 and 440 volts, and this was considered to be a good opportunity for the Council to purchase the undertaking. The Executive committee were accordingly instructed to consider and report on the matter. At a special Council meeting on Monday the committee presented a report which dealt mainly with the early history of electric lighting in Norwich and the powers possessed by the company. After consulting Mr. W. C. C. Hawtayne, the committee recommended that negotiations should be opened up with the company for the purchase of their undertaking, and that the consideration of the company's application be postponed. The Council approved this course, and the committee have been entrusted with powers to negotiate.

**Paisley.**—The annual charge for arc lamps has been fixed at £30 each.

**Porto Rico.**—Considerable developments in the application of electricity to industrial uses in this newly-acquired territory of the United States are recorded. The short railway from the capital to Rio Piedras was in 1900 converted from steam to electric traction, and a line from Bayamou is about to be similarly converted.

At the town of Ponce, which is electrically lighted, on a capital expenditure of £12,000 the local company was able to declare a dividend for 1900 of 18 per cent.

A number of concessions for the putting down of electrical works for lighting, tramways and power transmission have been applied for; but, owing to the severity of a clause in an Act of Congress which gave the island its legislative assembly, and which necessitates the submission of all concessions to the amendment or veto of the Senate at Washington, few of these enterprises have advanced, as the concessionnaires, before commencing operations, insist upon the repeal of this clause.

**Presentation.**—On Saturday the staff of the South Shields electric lighting department made a presentation to their late chief engineer (Mr. J. A. Jeckell), who has left to take up a similar post at Coventry. The presentation (a gold watch and chain, spade guinea, sovereign purse and oak timepiece) was made by the chairman of the Electric Light committee (Ald. Rennoldson), who referred to the pleasant relations which had existed between Mr. Jeckell and the Corporation and also between him and his staff during his eight years' stay at South Shields. The electricity undertaking had been a success from beginning to end, and he was sure Mr. Jeckell deserved every credit for the splendid way in which the undertaking had been engineered. He was leaving when it had reached the stage of financial prosperity. He was going to a place where he would find ample work and opportunities for showing his ability, and he hoped he would be as successful there as he had been at South Shields. Mr. Jeckell, after thanking the donors for their handsome present, said the climate of South Shields was against him, and he desired to take up the commercial side of electricity supply, which he would be able to do at Coventry.

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**Provisional Order Notices.**—Notice of intention to apply for provisional electric lighting orders must be given before July 1. We give below particulars of some of these :—

*Birkenhead* Corporation for Higher and Lower Bebington and Prenton.

*Lower Bebington* District Council for Higher and Lower Bebington, Bromborough, and Poulton-cum-Spital.

*Provincial Electric Supply Co.* for Morley.

Two companies have notified the *Chichester* Council of their intention to apply for electric lighting powers.

*Newport* (*Fife*) Town Council have received notice from the local gas company.

*Poole* District Council have received notices from the Poole Electric Traction Co. and the Bournemouth Corporation.

For *Teignmouth* district notice has been given by the Provincial Electric Supply and Traction Co.

*Thornaby* Council have received notices from the Cleveland and Durham County Electric Supply Co. and the Northern Counties' Electricity Supply Co., but the Council have decided to themselves apply for an order,

*Yeadon* District Council have received notification from the Provincial Electric Supply and Traction Co.

**Provisional Order Transfer.**—Ilfracombe District Council give notice of intention to transfer their electric lighting provisional order to the Ilfracombe Electric Light and Power Co. (Ltd.) for 40 years. The right of purchase at intervals of seven years is reserved. The consideration for the transfer is £664. 15s. 11d., the expenses incurred by the Council and cost of transfer.

**Railway Carriage Lighting in India.**—The Bombay Electric Co. have contracted with the Bombay, Baroda and Central India Railway Co. for lighting the carriages of the Rajputana-Malwa Railway mail trains for six months, at Rs.9,300 (£581. 5s.).

**Romford.**—The District Council are anxious to emulate their neighbours at Ilford, and are considering the subject of obtaining powers for erecting electricity works and constructing electric tramways.

**Royal Assent.**—On 2nd inst. Royal Assent was given to the
Falkirk and District Tramways Order Confirmation Act, 1901.
Electric Lighting Orders Confirmation (Nos. 2, 3 and 4) Acts, 1901.
Gateshead and District Tramways Act, 1901.
Bury Corporation Tramways Act, 1901.
City and South London Railway Act, 1901.
Dublin St. James's Gate Brewery Tramways Act, 1901.

**Sheffield.**—The Corporation on Wednesday confirmed proposals of the Tramways committee to increase the salaries of Mr. A. L. C. Fell, general manager and electrical engineer, from £500 to £700 per annum ; that of Mr. J. Dugdale, traffic superintendent, from £200 to £250 ; that of Mr. H. Wilson and Mr. F. Heath, clerks in the department, from £150 to £175, and from £105 to £120 respectively.

**South Africa.**—The directors of the De Beers Consolidated Mines (Kimberley) propose to make considerable additions to their electric power plant. In addition to the present lighting of the whole of the overground and underground workings of the Kimberley and De Beers mines and the electric driving of this machinery, the Wesselton and other mines controlled by the corporation are to be supplied with electric current in the same manner. Besides lighting the mines the company will take over the existing plant of the Kimberley Council, which is to be supplied with current at net cost.

The Natal Government are spending a further £5,900 for electric light extension in connection with the Durban harbour works.

**Stourbridge.**—The electric tramway from Lower High-street to Hagley-road was officially inspected on Thursday last.

**Telephone Directory.**—There is no direct sign of any diminution in the popularity of the National Telephone Co. so far as its London connection is concerned, and the company may be pardoned if they regard the 1901-1902 Directory of Telephone Subscribers for the metropolitan section of their service as evidence of increased vitality. The publishing of the list in 8vo. form is a distinct improvement upon the somewhat clumsy volume of the previous year. The directory commences with some useful information to subscribers to the telephone in the form of rules and regulations, and the conditions under which the company's licence is held under the Postmaster-General. Following this is a list of public call offices, which extends over 36 closely packed pages, containing nearly 2,000 addresses of these offices, which give the facilities of the telephone alike to subscribers and non-subscribers. The main directory covers nearly 500 pages, and represents 25,000 subscriptions to the National Telephone metropolitan system, compared with about 22,000 in the last annual issue of the metropolitan list, not at all a bad showing for a company which is sometimes referred to as moribund. The new volume (for the metropolitan section of telephone subscribers) forms the first of eight books, which were previously included in the company's general list of subscribers. Each subscriber will receive gratis the volume relating to his own area, the remaining volumes, if required, being obtainable by subscribers, we understand, by purchase.

**Trowbridge.**—Messrs. Crompton & Co. have offered to take a transfer of the Council's provisional electric lighting order, and the Electricity committee has been requested to report on the matter.

**Wakefield.**—Owing to doubt of the legality of the resolution passed last month to pay the city electrical engineer (Mr. R. Backmore) a bonus on all completed work on capital account, the City Council have rescinded the resolution they had passed on the subject.

**West Bromwich.**—A special meeting of the Council has been convened to consider a report recommending the purchase of the undertakings within the borough of the Birmingham and Midlands Tramways Co. at £5,500, and of the South Staffordshire Tramways Co. at £32,000.

**Workhouse and Infirmary Lighting.**—A comparative statement of the relative cost of electric and gas lighting has been presented to the Pontefract Guardians. The cost of the electric light for the half-year ended June was £108, while the cost of gas for the corresponding half-year of 1900 was £117. 10s.

Marylebone (London) Guardians have considered a report on the electric lighting of their infirmary. Alternate schemes were submitted by the consulting engineer (Mr. T. W. Baker). The first provided for taking a supply of current from the Notting Hill Co., at 4d. per unit, the annual maintenance being put at £1,840. The second scheme involved the erection of independent plant at an estimated outlay of £9,030 with annual expenses at £1,083, and this scheme was recommended by the engineer. It was decided to adjourn consideration of the matter.

Kings Norton Guardians are recommended to light their workhouse electrically at an estimated cost of £1,478.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Hammersmith* (London) Borough Council invite tenders for six 50kw. transformers and for electricity meters. Specifications from the chief electrical engineer (Mr. G. G. Bell), 57, Fulham Palace-road, S.W., and tenders to the town clerk (Mr. H. Thompson), Town Hall, Broadway, Hammersmith, W., by 6 p.m., July 17. See advertisement.

The Electricity committee of the Metropolitan Borough of *Poplar* require high-tension continuous-current transforming plant and switch gear, &c. Specifications, &c, from the borough electrical engineer (Mr. Alfred Blackman), Electricity Works, Glaucus-street, Bromley-by-Bow, E., and tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, by 10 a.m., July 24. An advertisement contains further particulars.

The Electricity committee of *Poplar* also invite tenders for arc lamp carbons for one year. Specifications from Mr. Alfred Blackman, and tenders to the Town Clerk by July 24. See advertisement.

*Manchester* Electricity committee invite tenders for the supply, delivery, and erection of switchboards at their Stuart-street generating station and sub-stations. An advertisement contains further particulars. Specifications, &c., from the secretary (Mr. F. E. Hughes), Electricity Department, Town Hall, Manchester. Specifications and drawings may also be inspected at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, London, S.W. Tenders to chairman by noon Aug. 14.

*Great Yarmouth* Corporation invite tenders for the supply, delivery and erection of steel poles, brackets, trolley wires, insulators, &c. ; and rail bonding ; battery switchboard and reversible booster, cables and joint boxes. An advertisement contains some further particulars. Specifications, &c., of the consulting engineers, Messrs. Preece and Cardew, 13, Queen Anne's Gate, Westminster, S.W. Tenders to the town clerk (Mr. A. H. Miller), Town Hall, Great Yarmouth, by noon July 27.

*Kearsley* District Council require tenders for steel tramway poles, bases, section boxes, overhead line material and accessories for the equipment of 1¾ miles of tramway. An advertisement gives further particulars, and specifications, &c., may be had of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and may be seen at (but not obtained from) the Manchester address of the engineers, 78, King-street. Tenders to the clerk (Mr. T. A. Martin) by Aug. 1.

*Blackburn* Town Council invite tenders for three steam 775kw. dynamos. Specificatons from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, after 15th inst., and the specification may also be seen at (but not obtained from) the Manchester offices of the engineers, 78, King-street. Tenders to the town clerk (Mr. Robt. E. Fox) by July 29. See advertisement.

*Ilford* Urban District Council invite tenders for work to be done in connection with the electric lighting of the new town hall. Specification, &c., from Mr. W. C. C. Hawtayne, 9, Queen-street-place, London, E.C., or from Mr. J. W. Benton, Council Offices, Ilford, to whom tenders by 5 p.m. 25th inst. See advertisement.

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*Kirkcaldy* Corporation invite tenders for feeders, mains and road-work and arc lamps. Specifications from the town clerk (Mr. Wm. L. Macindoe), to whom tenders by 10 a.m. July 20. Specifications can also be seen, but not obtained, at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. An advertisement gives additional particulars.

*Lancaster* Corporation require tenders for water tank, electric pumps, ejector condenser, steam exhaust and water piping with valves. Specifications, &c., from the borough electrical engineer (Mr. Wm. A. Tester), and tenders to the town clerk (Mr. T. Cann Hughes) by July 22. Further particulars are given in an advertisement.

*Aston Manor* District Council notify in an advertisement that they are prepared to receive tenders for the supply and erection of electrical generating and distributing plant at their hospitals at Upper Witton. Specifications, &c, from the Council's surveyor (Mr. G. H. Jack) after Monday next, and tenders to chairman of Health committee, Council House, Aston Manor, by noon, 25th inst.

*Bradford* Corporation invite tenders for the supply and delivery of 100 electric tramcars. Specification from the tramways manager (Mr. C. J. Spencer), 5, Forster-square, Bradford, and tenders to the town clerk (Mr. Frederick Stevens) by 31st inst. An advertisement gives further particulars.

*Dundee* Gas Commissioners require surface condensers, electrically-driven air and circulating pumps, cooling towers, &c.; electrically and steam-driven feed pumps and feed-water heaters and fittings. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders to the clerk to the Commissioners (Sir Thomas Thornton, LL.D.), City-chambers, Dundee, by Aug. 5. An advertisement gives additional particulars.

*Gravesend* Town Council invite tenders for boiler-house plant, steam and exhaust pipes, engine-house plant, switchboard, underground mains, lamp posts, accumulators, meters, cranes, dust destructor, and well and water-lifting apparatus. An advertisement contains further particulars. Specifications, &c., from the consulting engineer (Mr. W. H. Trentham), 39, Victoria-street, Westminster, S.W., and tenders to the town clerk (Mr. Charles E. Hatten) by 10 a.m. July 30.

*London County Council* Asylums committee require steam boilers, pumps and fittings, cooking apparatus and fittings, and an installation of electric lighting (including generating plant) at the Epileptic Colony, Horton Estate, Epsom. Tenders by July 23.

*Plymouth* Corporation invite tenders for tramcars, trucks, motors, trolley arms, &c. Specifications from the borough electrical engineer (Mr. E. G. Okell), Prince Rock, Plymouth, to whom tenders by noon, July 19. An advertisement contains further particulars.

*Ilkeston* Corporation invite tenders for construction of permanent way and electrical equipment of tramways. Tenders to town clerk by July 16.

The Electrical Committee of the *Stepney* (London) Borough Council invite tenders for steam and other pipework, paper insulated cables, earthenware conduits, &c. Tenders to chairman by noon July 18.

*Wallasey* District Council require machinery and tools for their electric tramways department. Tenders to Mr. H. W. Cook, Public Offices, Egremont, Cheshire, by July 18.

*Birkenhead* Corporation require 15 electric tramcar bodies and electrical equipments and trucks and trolleys for 15 cars. Tenders by July 16.

Tenders are invited for the electric lighting of *Hapton* (Lancs.) from Sept. 1, 1901, to April 30, 1902. Tenders to clerk, 16, Hammond-terrace, Padiham, by 31st inst.

*Cardiff* Corporation require tenders for 2,000 tons of steel tramway rails, fish and sole plates, tie-bars, bolts, nuts, points and crossings, drain rails, &c. Tenders by July 25.

Tenders are invited for electric lighting of new pavilion of Knightstone, *Weston-super-Mare*. Tenders to clerk of council by 18th inst.

The Visiting committee of the *Brecon and Radnor* Joint Asylum invite schemes, specifications and tenders for the electric lighting of the asylum. Schemes, &c., to clerk, County Hall, Brecon, by Aug. 5.

*Pontypridd* Guardians invite tenders for electric lighting of union workhouse, infirmary and other buildings. Tenders to clerk by July 23.

*Dartford* Council require tenders for direct-current meters and cutouts. Tenders by noon 24th inst.

*Bury* (Lancs.) Council invite tenders until 30th inst. for extending the electricity station buildings.

*Sunderland* Corporation require tenders for the erection of electric tramcar sheds. Tenders by Aug. 2.

*Glasgow* Corporation require tenders for the construction of new tramways. Tenders by 5 p.m. of July 18.

*Edinburgh* Corporation require tenders for arc lamp posts. Tenders by July 17.

The *East Indian Railway Co.*, Nicholas-lane, London, E.C., require tenders for electric motors. Tenders by 24th inst.

Tenders are invited until Sept. 2 by the *Amsterdam* Municipal Council for 5,000 tons steel tramrails and accessories. Tenders to Le Directeur des Tramways Municipaux, Meuive Achtergracht 161, Amsterdam.

The Spanish Ministry of Public Works, *Madrid*, require tenders until July 30 for the concession for constructing and working an electric tramway from Cadiz to San Fernando and Carraca.

## TENDERS RECEIVED AND ACCEPTED.

Nelson Corporation have received the following tenders for electrical plant:—

*Steam Dynamo* (engineer's estimate, £2,100).*

| | |
|---|---|
| D. Bruce Peebles & Co. (Willans engine) (*accepted*) | £2,180 |
| Brush Company (Universal) | 2,280 |
| Johnson and Phillips (Willans) | 2,170 |
| Clayton Engineering Co. (Clayton) | 1,904 |
| Johnson-Lundell Co. (Willans) | 1,874 |
| Frank Suter & Co. (Willans) | 1,835 |
| W. H. Allen, Son & Co. (Allen) | 1,737 |

*25kw. Balancer* (engineer's estimate, £250).

| | | | |
|---|---|---|---|
| Frank Suter & Co. | £457 0 | Electric Construction Co... | £290 0 |
| Crompton & Co. | 430 0 | Thomas Parker (Ltd.) | 280 0 |
| Siemens Bros. & Co. | 420 0 | Thomas Barton | 272 0 |
| British Westinghouse Co... | 362 0 | Phœnix Dynamo Co. | 268 0 |
| Read Holliday & Sons | 340 0 | Laurence, Scott & Co. | 260 0 |
| Mather and Platt | 324 0 | Morley Elec. Eng. Co. | 225 0 |
| Brit. Thomson-Houston Co. | 323 0 | Greenwood and Batley | 209 10 |
| D. Bruce Peebles & Co. ... | 319 0 | British Schuckert Co. | 203 10 |
| Lancs. Dynamo & Motor Co. | 309 0 | | |

Tenders not yet settled.

*Cables (Solid System).*

| | | | |
|---|---|---|---|
| Callender's Co. (*accepted*) | £9,560 | W. T. Henley's Telegraph Works Co. | £8,699 |
| W. T. Glover & Co. | 9,649 | St. Helens Cable Co. | 8,681 |
| Telegraph Manufacturing Co. | 9,543 | Western Electric Co. | 7,816 |
| British Insulated Wire Co.... | 9,007 | | |

*Two Lancashire Boilers, Weir Pumps, and Economisers* (engineer's estimate £1,066).

| | Boilers. | Pumps and economisers. |
|---|---|---|
| J. Carter & Sons | £1,360 | £540 |
| Davy Bros. | 1,195 | 530 |
| Meldrum Bros. | 1,163 | 573 |
| Yates and Thom | 1,134 | 566 |
| Anderton & Sons | 1,115 | 538 |
| Tinkers Limited | 1,040 | 540 |
| Danks & Co. | 1,005 | 525 |

Contract not yet settled.

*Travelling Crane* (engineer's estimate £200).

| | | | |
|---|---|---|---|
| Carrick and Ritchie (*accepted*) | £205 | Marshall, Fleming and Jack | £215 |
| T. Broadbent & Sons | 345 | Rushworth Bros. | 205 |
| J. Spencer & Co. | 246 | H. Morris and Bastert | 198 |
| Jas. Carrick & Sons | 215 | | |

### Nelson Corporation Steam Dynamo Tenders.

*In addition to the single tenders set out above, the following tenders were received for the supply of various types of engines for dynamo sets:

| | Willans. | Clayton. | Belliss 2-crank. | Belliss 3-crank. | Galloway. | Browett. | Alley and McLellan. | Reavell. | Allen. |
|---|---|---|---|---|---|---|---|---|---|
| British Thomson-Houston Co. | £2,406 | — | — | — | — | £2,242 | — | — | — |
| Phœnix Dynamo Co. | 2,397 | — | — | £2,597 | — | — | £2,197 | — | |
| D. Bruce Peebles & Co. (this firm's tender for Willans engine was accepted) | | | | 2,436 | — | 1,895 | — | — | |
| Greenwood and Batley | 2,102 | — | — | — | — | — | 1,800 | — | |
| Electric Construction Co. | 2,102 | — | £2,244 | 2,466 | £1,890 | 1,975 | — | — | — |
| T. Parker (Ltd.) | 2,088 | — | — | — | 1,855 | — | 1,868 | — | — |
| Geipel and Lange | 2,060 | — | — | 2,505 | — | — | — | £2,090 | £2,100 |
| Crompton & Co. | 2,003 | — | — | — | 1,785 | 1,838 | — | — | — |
| Mather and Platt | 2,000 | — | 2,170 | 2,360 | 1,750 | 1,820 | — | — | — |
| Siemens Bros. & Co. | 1,970 | — | 2,805 | 2,300 | — | 1,832 | — | — | — |
| International Electrical Co. | 1,969 | £1,877 | 2,161 | 2,376 | 1,650 | 1,785 | — | — | 1,822 |
| Laurence, Scott & Co. | 1,943 | — | 2,065 | 2,231 | — | 1,575 | 1,685 | 1,905 | 1,925 |
| Thos. Barton | 1,942 | — | — | — | — | — | 1,750 | — | — |
| British Schuckert Co. | 1,763 | — | 2,092 | — | — | — | — | — | 1,777 |
| Lancashire Dynamo & Motor Co. | — | — | — | — | 1,701 | 1,811 | — | — | — |

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Barking District Council have received the following tenders for condensing plant :—

| | |
|---|---|
| W. H. Allen, Son & Co. (*accepted*) Koppel tower, £305 ; condensing plant, Edwards pump and Baker separator, £1,750 ..... | £2,055 |
| Worthington Pumping Engine Co., tower, £920 ; condensing plant, £1,816 ..... | 2,736 |
| Wheeler Engineering and Condenser Co., tower, £878 ; condensing plant, £1,696 ..... | 2,574 |
| J. Fraser & Co., evaporative condensing plant ..... | 2,375 |
| Mirrlees-Watson Co., Koppel tower, £340 ; condensing plant, £1,728 ..... | 2,068 |
| Klein Engineering Co., natural draught tower, £377 ; condensing plant, £1,688 ..... | 2,065 |
| Pulsometer Engineering Co., condensing plant only ..... | 1,744 |
| Arthur Koppel, natural draught tower, £305 ; condensing plant, £1,080 ..... | 1,385 |
| Doherty & Donat, tower only ..... | 490 |

Several firms submitted alternative tenders for steam-driven plant, but the above figures refer to electrically-driven plant only, as per specification.

Bermondsey (London) Borough Council have accepted the tender of Messrs. W. Brown & Son for artesian well and pumping machinery for their electricity station at £1,860, and that of the Stanhope Engineering Co. for water-softening plant at £395.

Aldershot District Council have accepted the tender of Messrs. Spear and King for erecting chimney shaft, &c., at their electric lighting station for £795.

Hendon District Council have accepted the tender of the Coley Electric Works Co. for wiring the new Council offices at £186. 1s.

Wigan Corporation have accepted the tender of Messrs. Dick, Kerr & Co. for the supply of 12 double deck single truck electric tramcars.

Liverpool Corporation have accepted the tender of Messrs. Willans and Robinson for the supply of three sets of generating plant for the Lister-drive station at £6,939 per set, less 2½ per cent.

Eastbourne Town Council have accepted the tender of Messrs. Geipel and Lange for 400 Vulcan electricity meters at £1,517. 15s.

Great Yarmouth Town Council have accepted the tender of Mr. R. Easto for additions to the generating station buildings at £1,167.

Kirkcaldy Town Council have accepted the tender of Messrs. George Smith & Sons for the construction of the permanent way of the tramways at £21,224. 3s. 10d.

## BUSINESS NOTICES.

Messrs. A. Baxter and T. H. R. Wray (trading as Baxter & Wray), electrical engineers, 5, Macclesfield-street, London, W., have dissolved partnership. Debts by Mr. Baxter.

Messrs. J. C. Mewburn and Ellis, chartered patent agents, have taken into partnership Mr. R. E. Ellis, M.I.C.E., and Mr. Pryor, chartered patent agent. The business will in future be conducted under the style of Mewburn, Ellis and Pryor, at 70, Chancery-lane, London, W.C.

The New Brotherton Tube Co. have appointed Mr. James Gray, 19, Waterloo-street, Glasgow, their sole agent for Scotland for the sale of their enamelled steel conduit tubes and fittings, and arrangements have been made for keeping stocks in Glasgow, Edinburgh and Dundee.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 1s. 10¾d. is payable at 33, Carey-street, London, W.C., in the liquidation of the Electric Exploitation Co. (Ltd.).

Claims against the Kalgoorlie Power Syndicate (Ltd.) must be sent by Aug. 16 to Mr. H. J. Dixon, 257, Winchester House, E.C., or Mr. W. A. Smith, 28, St. Swithin's-lane, London, E.C.

In the course of the examination in the London Bankruptcy Court of Sir E. Ashmead Bartlett, M.P., the debtor stated that he had obtained valuable concessions from the Sultan of Turkey in relation to the introduction of electric lighting and electric traction into that country.

Henry George Massingham, electrical engineer, Torquay, was publicly examined on Thursday last. Debtor said the total sum he derived from the Taunton electric traction works was £75. He expected to receive a much larger sum, but he was unable to raise the money locally. The undertaking, with which his connection had ceased, had been transferred to a company. The £75 barely covered his out-of-pocket expenses. He had, during the past 20 years, been associated with electrical undertakings at Taunton, Bath, Exeter, and Torquay. He lost £8,000 or £9,000 by the Bath undertaking, and £1,000 in the Exeter Electric Lighting Co. In the ordinary way of business he had made money, but lost £11,000 by investments in the various companies which took over the electricity undertakings. There was a contract for a light railway at Torquay, but debtor advised the Receiver to make a disclaimer with respect to it, and in consequence of opposition the scheme was dropped. Examination closed

**Electric Tramways for Sale.**—The liquidator of the Isle of Man Tramways and Electric Power Co., Ltd. (Mr. Wm. Henderson Walker, C.A.), notifies in an advertisement elsewhere that he has been authorised by the Chancery Division to offer for sale by tender the following undertakings of the company, *i.e.*, the Douglas and Laxey, Laxey and Ramsey and the Snaefell Mountain electric tramways, the Douglas Bay horse tramway and the Upper Douglas cable tramway. Tenders addressed to his Honour the Clerk of the Rolls, Rolls Office, Douglas, Isle of Man, by 11 a.m. Sept. 7.

**Electric Light and Power on Steamships.**—The Electrical Co., 122, Charing Cross-road, London, W.C., forward an excellently-illustrated description of the installation of electric light and power on the celebrated Hamburg-American line mail steamer "Deutschland," the largest and fastest passenger ship in the world. The work comprised in this installation was designed and constructed by the Allgemeine Electricitäts Gesellschaft, Berlin, whose agents in this country are the Electrical Co. ; 2,550 incandescents are used for lighting, and 23 motors are installed for operating the various supplementary machines. The plant consists of five steam dynamo sets, four of which are placed in a dynamo room, behind the main engines and between the propeller shafts. The fifth machine is located in a room to itself on the main deck. This arrangement suffices for securing the lighting of the upper part of the vessel in the event of any accident happening to the group of machines below. All the signal lights are operated by electric lamps, including side lights and masthead light. A large proportion of the motors are used in fan-driving and some of the remainder for driving the domestic machinery. The engine room is supplied with two electrically-driven drilling machines for small repairs.

**Oil Engine Competition.**—In the competitive trials of oil engines at the Royal Agricultural Society's Show, held at Cardiff, and referred to in our last issue, Messrs. Crossley Bros. obtained the first prize of £40 for their 15 B H P. portable oil engine.

**Glasgow Exhibition Souvenir.**—An interesting souvenir of the General Electric Co.'s exhibit at Glasgow has been issued, embellished with a number of excellent photographic prints of plant which has been put down by the company, especially in connection with mining and power transmission. In addition, there are several illustrations of special types of generating machines which the company are manufacturing. The driving and haulage plant supplied to the Collins Green Colliery Co, near Earlestown, includes a fine set driven by enclosed motors, illustrated on page 28 of the catalogue and described on page 18. Lighting and traction sets supplied by the company to many of the principal corporations of the country are also illustrated. The large works now being erected at Wilton, near Birmingham, in connection with which 100 acres of land have been acquired, are nearing completion, and are expected to be in full working order within the next few months.

A very useful plan of Glasgow, showing the principal public buildings, railway stations, tramways and routes to and from the exhibition, has been issued by Messrs. W. & A. K. Johnston, price 6d. Visitors who are strangers in the city will find the plan of much service.

**Main Switch List.**—Messrs. Atkinson, Schmahl & Co., of St. Nicholas-buildings, Newcastle-on-Tyne, have just issued a new trade list of main switches, fuse blocks, cutouts, battery switches, regulators, terminals, &c. The list is in handy form and is well illustrated.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 3 to July 9, with the ports of destination :—

*Africa*—Alexandria, £63 ; Cape Town, £119 ; Durban, £864 (including £188 telegraph apparatus) ; East London, £128. *Argentina*—Buenos Ayres £2,323 (including £1,223 telegraph cable). *Australasia*—Auckland, £30 ; Brisbane, £547 (telegraph instruments and material) ; Christchurch, £24 ; Maryborough, £1,161 (telegraph material) ; Melbourne, £318 ; Perth, £520 ; Sydney, £1,586 (including £307 telegraph cable) ; Townsville, £848 (telegraph material) ; Wellington, £3,184 (including £3,065 telegraph material). *Ceylon*—Colombo, £10. *Denmark*—Copenhagen, £92 (telegraph wire). *France*—Boulogne, £100. *Germany*—Hamburgh, £704 (including £630 telegraph material). *Holland*—Amsterdam, £30 ; Rotterdam, £120 (telegraph material). *Hong Kong*, £24. *India*—Calcutta, £317. *Japan*—Kobe, £5,444 (telegraph cable) ; Yokohama, £420. *Malta*, £1,000 ; *Morocco*—Masagan, £812. *Norway*—Christiania, £50 (including £26 telegraph wire). *Siam*—Bangkok, £529. *Straits Settlements*—Singapore, £72. *Sweden*—Gothenburg, £35. Total, £21,474, against £7,356 in the corresponding week last year (July 4 to 10).

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during June was £54,367, against £90,281 in the preceding month and £86,171 in June last year. The total for the six months ended June 30 was £552,966, against £420,253 for the corresponding period last year.

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# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

3,343. MUIRHEAD. Telegraphic transmitting, receiving, and translating arrangements.
3,481. NEWITT. Resistances for electric circuits.
3,535. HOOKHAM. Electricity meters and electric clocks.
3,600. ELLIS and SMITH. Switches or cutouts for overhead electric wires.
6,312. COHU and GEISENBERGER. Apparatus for the production of soda and chlorine by the electrolysis of chloride of sodium, also applicable for the production of potassium, sodium, aluminium, or other metals of the same class.
6,671. FRANKE. Machine for filling accumulator plates with active material.
6,701. STRECKER. Process of electrolytically preparing metals or alloys for lithographic purposes.
7,392. LEHNER and DAUBER. Electric motors of optional speed.
7,433. HIRST and COLLINGS. Joints for rods carrying electric lamps and other purposes.
7,608. RASCH. Production of electric arc light.
7,675. LAKE (Cuénod). Electrical time-distributing apparatus.
7,691. JOHNSON (Hartmann and Braun). Electrical work measuring instruments.
7,768. JUNGNER. Negative accumulator electrode.
7,777. MARCONI and MARCONI'S WIRELESS TELEGRAPH CO. (LTD.). Apparatus for wireless telegraphy.
7,784. DAVIS. System of distribution and collection of current for electric traction.
7,795. CALDERBANK. Electric light fittings.
7,989. JONES. Electric switches.
8,111. BRITISH ELECTRIC WORKS CO. (LTD.) and BRANDER. Parts of telephone instruments.
8,179. JONES. Electric switch apparatus.
8,207. BRITISH THOMSON-HOUSTON CO. (LTD). (Clark and Rupley). Insulated electric conductors and process of and apparatus for making the same.
8,241. KALLMANN. Electricity meters.
8,274. HADDAN (Fabrik Elektrischer Zünder, G.m.b.H.). Manufacture of electrical fuses for blasting and mining purposes.
8,289. HEYL-DIA. Insulated electric cables or conductors and the manufacture thereof.
8,290. HEYL-DIA. Insulated electric cables or conductors and the manufacture thereof.
8,315. JONES. Electric switches.
8,361. GILL, GILMOUR and CLAXTON. Apparatus for switching electric currents on and off, especially suitable for lighting telephone switchboards.
8,393. CERREBOTANI and MORADELLI. Automatic telegraphic receiving instruments for Morse characters.
8,779. JAMES WHITCHER, A. H. LEA, D. J. EVANS and E. P. TOLLER (Executors of the late C. H. Warren). Electric switches and fuses.
8,780. EUGENE-BROWN. Dynamo-electric machines.
8,781. SNELGROVE. Electric cash register tills.
9,033. MALLETT. Strap coils for electrical machines. (Date applied for under International Convention, Oct. 7, 1900.)
9,058. NEWELL. Electric brakes for electric railway vehicles.
9,059. NEWELL. Electro-magnetic brakes for railway and tramway vehicles.
9,060. NEWELL. Electro-magnetic brake-shoes for railway and tramway vehicles.
9,061. NEWELL. Electric brakes for electrically-propelled vehicles.
9,084. STOCKWELL. Electric arc lamps.
9,133. LOMBARDI. Process for manufacturing thin homogeneous plates, more particularly applicable for use in electrical condensers. (Date applied for under International Convention, October 31, 1899.)
9,203. PARSONS and STONEY. Dynamos.
9,212. KILLIP. Trolley or like current collectors for electric railways and tramways.
9,229. WILLANS AND ROBINSON (LTD.) and ADDENBROOKE. Method of and means or apparatus for testing alternating current generators, transformers, meters and analogous apparatus.
9,263. ALEXANDER RITCHIE, LEASK, and PERCY MORGAN BELLIS. Electric heaters.
9,279. LORAIN and DENNERY. Supports for electric conductors.
9,339. EVANS (Faller). Multiplex telephony.
9,492. DOUGLAS. Ceiling-roses and other similar electrical connections.
9,533. BOUCHEROT. Method of exciting alternating-current machines.
9,563. ABEL (Soc. des Piles Electriques). Process of depolarising by liquid circulation in galvanic batteries.
9,567. THOMPSON (partly by Walker). Electric traction on a road contact or like systems.
9,579. VEYSEY. Telephonic apparatus. (Date applied for under International Convention, Oct. 24, 1899.)
9,612. JOEL. Commutating switch and combinations of electric motors and batteries for controlling electric carriages and like purposes.
9,631. BASTIAN. Detective lock or seal for gas and electric meters, electrical demand indicators and fuse boxes, or for any other uses or purposes to which same may be applicable.
9,647. ABEL (Soc. des Piles Electriques). Process of depolarising by liquid circulation in galvanic batteries.
9,744. LEA and TAYLOR. Electric signalling apparatus.
9,746. WRIGHT and REASON MANUFACTURING CO. (LTD.). Electricity meters of the electrolytic type.
9,760. HOOKHAM. Electrical maximum demand indicators.
9,781. MORS. Primary batteries.
9,870. SWAIT. Covers for street gulleys, service boxes and the like.
9,944. DRAKE and NERNST ELECTRIC LIGHT (LTD.). Incandescent electric lamps.
9,962. MONEY. Alternate-current induction motors.
9,975. GRISSON. Electrical transformers.
9,982. SHEPPARD and NERNST ELECTRIC LIGHT (LTD.). Electric incandescent lampholders.
9,983. DEL MONACO. Electric signalling device for preventing railway collisions.
10,029. STORER. Distribution of electric current. (Date applied for under International Convention, November, 1, 1899).

# COMPANIES' MEETINGS AND REPORTS.

## Electric Construction Co. (Ltd.).

The eighth annual general meeting of this Company was held yesterday under the presidency of Mr. J. W. BARCLAY (Deputy-Chairman).

The SECRETARY (Mr. James Gray) having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: Gentlemen, the result of the business of the year is a net profit of £20,449. 6s. 5d., whereof we propose to divide £17,165, being less than the amount earned by £3,284. 6s. 5d. The profits, however, which we have to deal with amount to £30,018. 18s. 2d., made up of the profit on the business of the year, £4,777. 1s. 9d. brought from last year, and £4,792. 10s. the premium on the issue of 6,390 preference shares. These profits we recommend should be appropriated in the payment of 7 per cent. dividend on the preference shares and 6 per cent. on the ordinary shares, requiring together £17,165; and, further, that the premium of £4,792. 10s. on the preference shares and £5,207. 10s. out of surplus profits (together £10,000) be added to the general reserve fund, which will then amount to £30,000, a very fair provision with which to meet any reverse or unexpected loss in realising our assets. The interest on loans and debentures shows an increase of £3,200, but on the other side of the account there is a new credit for profit on the Madras electric tramways of £3,023. 19s. 2d. In former years, when the amount standing against the tramway company was a debt, the interest on it was deducted from the interest paid, so that the increased interest charge is substantially met by the tramway profits. The general charges show a reduction which is more apparent than real, because part of the general charges, which formerly appeared on the debit side of the account, has been charged to the work in respect of which the expenditure was made, our object being to ascertain as closely as practicable the prime cost of our manufactures. I may mention that the higher price of coal diminished our profits by some £750, but we expect this year a benefit of £500 from the lower prices now current. The substantial amount of £5,000 has been placed to depreciation account. This fund now amounts to £38,000, and has all been appropriated from profits during the past eight years. There is an increase of £800 in the maintenance of the works—£2,943. 8s. 6d. having been expended to keep the buildings and plant in first-rate order. Turning to the balance-sheet, the expenditure on the new workshop and plant during the year amounts to £15,763. 10s. 2d. This is in addition to £26,250 which appeared in the accounts for 1900, making the expenditure upon the new shops upwards of £42,000—an increase of £2,000 on the original estimate. I am happy to think that our important capital expenditure is drawing to a close. No doubt there will be some further expenditure involved in extending other departments of the works to meet the increased demands upon them, but I do not think the further expenditure will come to a serious amount. With these outlays you may feel assured that the Company is provided with workshops and tools of the most improved description, to enable us to meet the severe competition which we are told is coming. The new workshop is capable of turning out the largest electrical machinery that can be required. The item "sundry debtors" has increased by £40,850. This is largely due to the Company's increased business. Practically no part of this large amount of £106,000 is in the nature of a bad or doubtful debt. It is largely made up of balances retained under contracts for installations till 12 months after the plant is running. The "work in progress" shows an increase of over £15,000, which you will understand also arises from the large amount of work passing through the factories. These three items account for the increases during the year in capital and liabilities of the Company which appear on the other side of the account. There are no other items that seem to call for explanation, but before passing from the accounts I may observe that we are coming to be of opinion that it is injudicious, in view of the competition of our rivals, to disclose the sources of our income so fully as we do in our desire to give the fullest information to our shareholders, and if the details are not stated so fully in coming years you will understand the reason why. We have been doing a satisfactory amount of general business during the year. You will be pleased to observe that our equipment of the City and South London Railway has proved satisfactory to the public as well as to the railway company.

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We have heard of no complaints as to vibration or otherwise from any quarter, and the best proof of the Company's satisfaction is that we have obtained a new contract for further extensions. It must also be very satisfactory to you, as well as to the Directors, that the relations between the Board and all classes of the Company's employés are thoroughly harmonious. The compensation to the workmen unfortunately shows a large increase this year, caused by a fatal accident which occurred through the breaking of the arm of a crane. The accident was of such a nature as could neither be foreseen nor averted, and it is satisfactory to know that this is the first fatal accident which has occurred in the works during the past nine years. With regard to the prospects of the business, you will, no doubt, have observed that some newspapers continually reiterate assertions that electrical manufacturers in this country are behind the time. The only ground they have to offer in support of this assertion, is, that the use of electricity for traction and motive purposes is much behind what it is in other countries. But if this is the case, as no doubt it is, the fault does not lie with the manufacturers, as you will understand when I again remind you that this Company equipped at Liverpool the first overhead electric railway in the world, and also, 10 years ago, the South Staffordshire electric tramways, both with complete success. The delay in the use of electricity is due to the vexatious restrictions imposed by Parliament through the Board of Trade, and to the reluctance of Corporations to allow private enterprise to develop the tramways and lighting of their towns. The newspapers ought, therefore, to put the saddle upon the right horse, for, so far as I know, the manufacturers of electrical machinery in this country have proved themselves equal to produce any description of plant that may be required. No capable workmen are idle who are willing to work, and if our exports do not increase at the rate they did some years ago, the true explanation, I believe, is that the masses of our population have so increased in wellbeing that they consume a much larger portion of our manufactures than was the case 20 or 30 years ago. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion.

A SHAREHOLDER referred to the item in the balance-sheet of £83,510 held in shares of other companies, and inquired if they were sound undertakings and if the Directors were satisfied that they were good investments.

The CHAIRMAN: There is one considerable sum held in the shares of the Electrical Power Storage Co., which was originally a sub-company of this Company, and so these shares came into our hands. We are taking the opportunity from time to time of reducing our holdings in subsidiary companies, because it is not especially our business. The shares are put in at what the Directors consider a fair price.

Dr. DRYSDALE inquired if the Company had any overhead tramway contracts. Recently, at Glasgow, he found the tramways wholly equipped on the overhead system. He also asked if there were any chance of the Company being engaged on work connected with the London tramways.

The CHAIRMAN: The Glasgow Corporation employed a gentleman who was practically an American engineer, and he naturally recommended American plant. We shall be very pleased to contract or to tender for the London tramways if we can do so upon reasonable conditions; but the conditions imposed by the London County Council require very careful consideration.

A SHAREHOLDER enquired if there was any prospect of the Company getting rid of the Madras tramways.

A SHAREHOLDER asked if any steps had been taken with regard to the work on the Metropolitan District Railway.

The CHAIRMAN: We at one time thought that we had sold the Madras tramways to the Municipality; they were prepared to buy it, but the Government would not let them borrow the money to pay for it. The Metropolitan Railway work we tendered for, but financial considerations are mixed up with the contract, and we are not prepared to do financial business in conjunction with our manufacturing business. It may suit some people to do that kind of work, but we do not care about it. We prefer to do a straightforward manufacturing business, although sometimes we may have to make smaller profits than can be made occasionally by financing.

The motion was carried unanimously.

Sir HENRY C. MANCE proposed the re-election of the retiring directors, Mr. Barclay and Mr. John Irving Courtenay, and the motion was carried unanimously.

The CHAIRMAN then proposed the election as a Director of Mr. James Gray, who, he remarked, had been the secretary of the company for the last eight years. He had the greatest confidence in proposing Mr. Gray's election as a member of the Board. He had been in close contact with that gentleman for the last eight years, and had formed the highest opinion of his abilities and of his devotion to the interests of the Company. The appointment would not entail any additional burden on the Company, but rather the reverse.

Mr. COURTENAY seconding, the motion was carried unanimously.

The auditors, Messrs. James Meston & Co., were re-elected, and a vote of thanks to the Chairman and Directors terminated the proceedings.

## Electrical Power Storage Co. (Ltd.).

The twelfth ordinary general meeting of this Company was held yesterday, under the presidency of Mr. JOHN IRVING COURTENAY.

The SECRETARY (Mr. David Smith) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, the balance-sheet shows, after payment of debenture interest and adding £1,000 to the contingent fund, a balance of £4,665. 9s. 5d., which, added to the amount brought forward, gives a total of £4,923. 17s. 1d. available for distribution. Out of this sum the Directors recommend a similar dividend to that which has been paid since 1892, namely, 5 per cent., carrying forward £432. 9s. 1d. During the year the area of the Millwall works has been materially enlarged, and a fireproof building, three stories in height, erected for use as stores at a cost of £1,300. New labour-saving machinery and plant has been provided for the works at a total cost of £1,537. 7s. 10d.; the buildings, plant and tools have been maintained at a cost of £1,910. 2s.; and £788. 10s. 11d. has been written off for depreciation. You will thus see that everything is being done to keep the works in a first-rate condition, and to secure the most up-to-date plant. We are still adding to our contingent fund, which, as you will remember, was commenced to provide for any exceptional outlay which might occur on account of our numerous maintenance contracts. Although these maintenance contracts have been running since 1891, we have so far never had occasion to make use of the fund, and this is undoubtedly due to the fact that we steadfastly refuse to obtain immediate business by quoting such low maintenance rates as must inevitably entail serious loss in the course of a few years. We received a gold medal for our exhibit at Paris Exhibition, this being the highest class of award given to any accumulator manufacturer. The company was also represented at the Light Railways Exhibition held at the Agricultural Hall, London, last year, and at Glasgow Exhibition we are showing the only electrically-propelled automobile exhibited. With a view of removing the prejudice which has hitherto always associated ugly and cumbersome vehicles with anything connected with electric traction, we are exhibiting a victoria which, complete with a battery capable of running it 35 to 40 miles, weighs only 23 cwt.; and the accumulators are so neatly hidden away that the question is invariably asked, "Where are the batteries?" We have already received a large number of inquiries for similar and kindred vehicles. Considerable attention is still being devoted to perfecting both our Faure-King and other like forms of traction battery, and, so far as this country is concerned, we can certainly say that we manufacture practically the whole of the batteries which are supplied in connection with electrically-propelled vehicles. We have, during the past year, given much time and thought to motor car experiments, not only as regards the batteries, but also in connection with car bodies, frames, springs, chains, tyres and systems of controlling. By means of our own electric brougham we have been able to collect a quantity of reliable statistics and information. A company which has recently been established in London, and which has been successful enough to supply cars to Her Majesty the Queen and other notable personages, is now using E.P.S. cells, we having been able to give them a battery occupying the same space and of the same weight, but having an output 60 per cent. above that given by the battery of foreign manufacture which came over with the original vehicles.

New accumulators are continually being invented, and new companies formed with the object of exploiting them, but, in spite of the increased competition, the amount of business transacted during the past year has been greater than that of any previous year of the Company's existence. Amongst the larger contracts completed during the year are extensions for the Corporations or Urban District Councils of Wigan, Walsall, Bristol, Whitehaven, Doncaster, Bradford, Rotherham, Perth, Motherwell, and Ilford, and we commence the new financial year with work in hand for similar contracts sufficient to keep our factory busy for some considerable time to come. I think we may, therefore, congratulate ourselves on the position of the Company and its prospects, although the keen competition to which I have already referred leaves only a small margin of profit. This aspect of the industry demands continual effort towards economy in production and the equipping of our works with the latest machinery and appliances. I now move the adoption of the report and accounts, and the payment of the dividend specified therein.

Sir JAMES PENDER, Bart., seconded the motion.

Mr. J. W. BARCLAY said he congratulated the Directors on the very satisfactory report they had submitted. They heard from time to time of a new accumulator of such a superior type that, if all that was said about it was to be believed, it would send all existing accumulators out of the market. Such reports, however, always fizzled out, and the new invention never presented itself. The last statement which had been heard with regard to an accumulator was in reference to an invention said to be by Mr. Edison. He had no doubt that the Directors had made themselves acquainted with the nature of that accumulator, and the shareholders would be interested to hear the result.

The CHAIRMAN, in reply, said: As to new accumulators, I own that, having been in the accumulator business from the beginning, I am becoming rather hardened in regard to the reports and statements about new accumulators. With regard to the latest—the one said to have been invented by Mr. Edison—we have, of course, carefully studied what we have seen stated about it, and are of opinion that the ascertained results will not cause any material revolution in secondary battery practice. We obtain from the best lead cell an output, weight for weight, equal to Mr. Edison's. Of the cost of manufacture and durability of the cell—the most important factors—we have not as yet sufficient data to go upon to enable us to form a reliable opinion.

The motion was then carried unanimously.

The retiring Director, Sir James Pender, Bart., was re-elected, as were the auditors, Messrs. James Meston & Co.

This concluded the ordinary business, and a resolution followed for altering the Articles of Association to bring them into line with the Companies Act, 1900. The resolution was duly carried.

A vote of thanks to the Chairman and Directors terminated the proceedings.

## Eastern Telegraph Co. (Ltd.).

The report of the directors for the half-year to March 31 sets out the revenue for the period at £624,340. 9s., from which are deducted £135,790. 4s. 3d. for ordinary expenses and £46,055. 10s. for expenditure on repairs and renewals of cables, &c. After providing £5,248. 5s. 11d. for depreciation of spare cable. £67. 11s. 10d. for differences in exchange, and £11,369. 12s. 11d. for income tax, there is £425,809. 4s. 1d., to which is added £30,932. 9s. 11d. brought forward, making £456,741. 14s. From this has been already paid debenture interest £27.212. 19s. 8d., preference

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dividends £31,302. 14s. 8d., and an interim ordinary dividend of 1¼ per cent., £50.000, leaving £348,225. 19s. 8d., out of which £10,000 has been placed to reserve for maintenance ships, and £205,000 to general reserve.

The directors now recommend a final dividend on the ordinary stock for the year ended March 31 of 1¼ per cent. and a bonus of 2 per cent., amounting together to £130,000, payable on July 17, tax free, making a distribution of 7 per cent. for the year, £3.255. 19s. 8d. to be carried forward. The revenue includes £25,164. 10s. dividends for the half-year upon the company's investments in other telegraph companies.

The cable between the island of Ascension and Sierra Leone, under a subsidy from His Majesty's Government, was opened for traffic on April 24. The Durban-Mauritius section of the Cape-Australian cable was laid on May 28, thus completing this company's portion of the new through route between Great Britain and Australia. It is expected that the Eastern Extension, Australasia and China Telegraph Company's cable between Mauritius and Western Australia will be laid and opened for traffic in October.

## West African Telegraph Co. (Ltd.).

The directors' report for the year ended Dec. 31 states that the revenue amounted to £81,567. 13s. 11d., against which £20,387. 10s. 2d. is charged for ordinary expenses, and £9,034. 12s. 9d. for expenditure relating to repairs of cables, &c. After providing £436. 13s. for income tax there is a balance of £51,708. 18s., to which is added £293. 13s. 5d. brought forward, making together £52,007. 11s. 5d. From this has been deducted £7,918. 17s. 1d. debenture interest and £15,766. 13s. 4d. for sinking fund, leaving £28,322. 1s. The directors propose to place £28,000 to reserve and to carry forward £322. 1s.

The revenue includes a further £12,000 in respect of subsidy due from the French Government, but which has not yet been paid. This arrear now amounts to £68,415. Under these circumstances the directors have entered into provisional negotiations with the French Government for the purpose of surrendering to them the French concession now held by the company, together with the property now belonging to the company in connection therewith, and the shareholders will be asked to sanction such surrender.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ELECTRO-CARBIDE LAMP SYNDICATE (LTD.)**—Reg. July 5, capital £200 in £1 shares, to acquire patents and inventions relating to incandescent electric filaments, electric lamps and globes, and to carry on the business of electric lamp, globe, and fittings manufacturers, electrical and general engineers, electricians, suppliers of electric current for lighting, &c.

**FRINTON-ON-SEA AND DISTRICT ELECTRIC LIGHT AND POWER CO. (LTD.)**—Reg. July 1, capital £5,000 in £1 shares, to carry on the business of an electric light company in all its branches, to apply for and carry out provisional electric lighting orders and licences, and to manufacture and deal in electrical apparatus, &c. The subscribers include W. Webster, electrical engineer, W. Hayne, architect, G. D. Collins electrical engineer, P. Collins, S. Davis, and R. N. Sherwood (each with 50 shares).

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26⅛d. per oz. (July 11). Consols (2¾ per cent.) 92⅞—92⅞ for money, 92⅞—92¾ for account; 2½ per cent. 93⅛—93⅛ (July 11). Consols Pay Day, Aug. 1; Stocks and Shares Continuation Days, July 15 and 29; Ticket Days, July 16 and 30; Pay Days, July 17 and 31; Mining Share Carry-over Days, July 12 and 26

**ARON ELECTRICITY METER (LTD.)**—The directors of this company will shortly make an issue of £60,000 5 per cent. debentures at 95 per cent. to meet the growing business of the company. The company's operations have been largely extended, and new workshops have been started in London for the manufacture of meters for this country, besides new factories in Schweidnitz, Germany, these works having been equipped with the latest appliances for the most economical production of meters. The Berlin works have also been extended lately. The erection of a branch factory in Buda-Pesth is contemplated, and the new issue is to provide additional capital for the development of the growing business.

**CENTRAL ELECTRIC SUPPLY CO (LTD.)**—During the week this company has made an issue of £250,000 4 per cent. guaranteed debenture stock at 103, secured by a first charge on the undertaking and by guarantee of the St. James' and Pall Mall Electric Light Co. and the Westminster Electric Supply Corporation.

**CITY AND SOUTH LONDON RAILWAY CO.**—The accounts for the half-year ended June 30 show a balance sufficient to pay a dividend on the consolidated ordinary stock at the rate of 1¾ per cent. per annum, carrying forward £732. The dividend for the corresponding period last year was at the same rate, the balance forward being £788.

**EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)**—Including £4,158. 2s. 7d. brought forward, the net profit for the year, after payment of debenture interest, is £26,699. 5s. 7d. After deducting preference dividend (£1.719. 3s. 6d.) and an interim dividend at the rate of 5 per cent. on the ordinary shares (£4,215. 13s.), there remains £20,764. 9s. 1d. The directors recommend a final dividend on the ordinary shares at the rate of 9 per cent. per annum (making 7 per cent. for the year), a dividend on the deferred shares of 7 per cent., absorbing together £9,593; reduction of goodwill account, £5,000; to reserve, £4,000; carried forward, £1,171. 19s. 1d. Income from dividends and interest amount to £14,10[illegible]. [illegible] 4d, against £14,45[illegible]. 18s. 4d. last year. Since the last report central stations at Melton Mowbray, Lymington, Montrose, Brechin, and a joint station for Sandown and Shanklin have been opened.

**S. Z. DE FERRANTI (LTD.)**—Paragraphs in the financial journals announce that this company is about to be reconstructed, and will shortly offer to investors £100,000 6 per cent. cumulative preference shares, together with mortgage debenture stock. The new company will take over the company formed on June 26, 1890, with the freehold works at Hollinwood. The assets taken over are said to exceed the total capital of the new company, while the profits are certified as equal to a dividend of 7 per cent. on the ordinary capital, which is taken over by the vendors, and upon which no dividend is to be paid until, in addition to the interest on mortgage debentures and the preference dividend, a stipulated amount has been set aside each year for reserve. There is to be no cash consideration to the vendors.

**MAY-OATWAY FIRE APPLIANCES (LTD.)**—The statutory meeting of this company was held on Tuesday. The chairman (Sir Eyre Shaw, K.C.B.) said he regretted to say the material necessary for the commencement of operations was only then coming to hand. Delivery of stock had been, however, promised for the 12th, and the selling and canvassing staff was being engaged. Some progress had been made with the formation of a subsidiary company for Lancashire and Yorkshire. The licence of the Postmaster-General had been granted to the company, and they were advised that the patents would be sealed that day.

**NEW ELECTROLYTIC ALKALI CO. (LTD.)**—A circular has been issued to the shareholders stating that the first installation of plant has been successfully worked two months, that the directors' anticipations have been fully realised, and that bleaching powder and soda crystals, eminently satisfactory as regards strength and purity, have been produced and marketed at current prices, and the directors consider that the works should be extended with all speed.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed July 24 a special settling day in £1,969,800 ordinary stock, £440,100 4 per cent. preferred stock and £440,100 deferred stock of the *Central London Railway Co.* in lieu of the shares now quoted, and for £50,000 4 per cent. debenture stock of the *Oxford Electric Co. (Ltd.)*. The Committee has also been asked to allow the further issue of £250,000 5 per cent. perpetual debenture stock of the *British Electric Traction Co. (Ltd.)*, 40,000 £5 (£3 paid) shares (Nos. 1 to 7 and 20,008 to 60,000) of the *Johnson-Lundell Electric Traction Co. (Ltd.)*, £350,000 4 per cent. first mortgage debenture stock of the *London United Tramways* (in lieu of the provisional certificates now quoted), and 7,500 ordinary £10 fully-paid shares of *Thomas Parker (Ltd.)* to be quoted in the official list.

**TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)**—The transfer books are closed from 8th to 16th inst. inclusive, preparatory to the payment of an interim dividend of 12s. per share.

**THOMAS PARKER (LTD.)**—At the annual meeting last week, the directors' report and accounts, which appeared in our last issue, were adopted.

**WEST AFRICAN TELEGRAPH CO. (LTD.)**—Particulars will be found elsewhere of a drawing of 163 5 per cent. mortgage debentures of £100 each in this company, for payment at par on Sept. 2 at the National Bank of Scotland, Nicholas-lane, London, E.C.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways. | July 6 | 4,889 | + 240 | 26 | 113,913 | + 2,674 |
| *Blackburn Corporation.. | ,, 5 | 531 | + 45 | 27 | 12,588 | + 1,100 |
| Blackpool Corporation... | ,, 4 | 1,100 | + 278 | †14 | 10,489 | + 2,349 |
| Blackpool and Fleetwood | ,, 6 | 785 | - 16 | 1 | 785 | - 16 |
| Bolton Corporation ..... | ,, 7 | 1 608 | + 138 | 14 | 21,192 | + 3,114 |
| Bradford Corporation... | ,, 7 | 1.147 | + 674 | 14 | 14,481 | + 7,592 |
| Brisbane Trams ..... | May 22 | 3,523 | +1,820 | 20 | 52,042 | + 5,814 |
| *Bristol Trams & Carriage | July 5 | 4,873 | +1,651 | 26 | 112,056 | +33,615 |
| *Buenos Ayres & Belgrano | June 9 | 2,861 | + 695 | 23 | 44,256 | +12.144 |
| Calcutta Trams. Co. ... | July 6 | R20,101 | + R193 | 1 | R20,101 | + R193 |
| Carlisle Trams. Co. ..... | ,, 6 | 274 | - 10 | 27 | 4,084 | .. |
| Central London Railway | ,, 6 | 6,079 | ... | 1 | 6,079 | ... |
| City & South London Ry. | ,, 7 | 1,972 | + 525 | 1 | 1,972 | + 525 |
| Cork Elec. Trams ..... | ,, 4 | 644 | + 118 | 26 | 11,584 | + 1,520 |
| Dover Corporation ..... | ,, 6 | 254 | + 18 | 14 | 3,110 | + 241 |
| Dublin & Lucan Rly. .. | ,, 7 | 143 | - 31 | 1 | 143 | + 31 |
| Dublin United ..... ‡ | ,, 5 | 2,828 | + 355 | ‡1 | 2,828 | + 408 |
| Dublin Southern Dist... ‡ | ,, 5 | 664 | + 53 | ‡1 | 664 | |
| *Dundee Corporation ... | ,, 3 | 700 | + 281 | 1 | 700 | + 281 |
| *Glasgow Corporation ... | ,, 6 | 12,354 | +2,945 | 5 | 59,259 | +10,462 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 6 | 999 | + 296 | 14 | 12,560 | + 2,777 |
| Hull Corporation ..... | ,, 6 | 1,726 | + 414 | 1 | 1,726 | + 414 |
| Liverpool Corporation... | June 29 | 9,633 | +1,833 | 26 | 221,639 | +31,611 |
| *Liverpool Overhead Rly. | July 7 | 1,732 | + 45 | 1 | 1,732 | + 45 |
| *Manchester Corporation | ,, 6 | 1.718 | ... | §4 | 5,012 | + 665 |
| Perth (W.A.) Elec. Trams | ,, 5 | 830 | + 448 | ‡1 | 593 | + 266 |
| Portsmouth Corporation | ... | ... | ... | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 6 | 3,596 | +1,177 | 1 | 3,596 | + 1,177 |
| Southampton Corporat'n | ,, 4 | 344 | + 287 | 1 | 344 | + 287 |

Except where otherwise indicated all amounts are in sterling.
(a) These comparisons are for the corresponding week last year
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 3. | Price Wednesday, July 10. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending July 10. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ ⅝ | ⅜ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) .. | 95 100 | 95 100 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. ..... | 12½ 13½ | 12½ 13½ | 4 9 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. ..... | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) .. xd | 101 104 | 101 104 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord ..... | 7⅞ 8¼ | 7⅞ 8¼ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 8⅞ 9 | 8⅞ 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) ..... | 7¼ 7¾ | 7¼ 7¾ | 2 5 2 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp.... | 9 10 | 9 10 | 4 10 0 | February and August | 2⅜ | 2⅛ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... | 5¼ 5⅝ | 5¼ 5⅝ | 3 18 3 | ,, ,, | 5⅛ | 5⅛ |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) ...xd | 102 104 | 102 104 | ... | ... | 103½ | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary..... xd | 5¾ 6¼ | 5¾ 6¼ | 4 8 0 | March ..... | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.)... xd | 107 110 | 107 110 | 4 2 0 | June and December... | 108 | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. ..... | 8 9 | 8 9 | 4 8 11 | February and August | 8¼ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. ..... | 12½ 13½ | 12½ 13½ | 4 12 2 | January and July ..... | 13⅜ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) .. xd | 120 125 | 120 125 | 4 0 0 | June and December ... | 123¾ | 121 |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) .... xd | 100 102 | 100 102 | 4 8 3 | ... | 100 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary..... ... | 8½ 9⅛ | 8½ 9⅛ | 4 4 3 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference..... | 12 13 | 12 13 | 4 13 4 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ..... ....xd | 103 106 | 103 106 | 4 5 1 | ... | 105½ | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary ..... | 5 5⅛ | 5 5⅛ | 3 12 9 | ... | ... | ... |
| 11,000 | 5 | 4/3 | Hove Electric Lighting Ordinary ..... | 7⅛ 8⅛ | 7⅛ 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary..... | 11⅛ 12⅛ | 11⅛ 12⅛ | 4 4 0 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. ..... ..... | 6⅞ 7 | 6⅞ 7 | 4 2 7 | January and July ..... | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)..... [Deb. Stk. (red.) | 102 105 | 101 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin.& Knigtbg.Co.& Notting Hill Co.(J't.St'n.) 4% | 102 104 | 103 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary ..... ..... | 1½ 1⅝ | 1½ 1⅝ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference ..... ..... | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ..... | 96 100 | 96 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) ..... | 13 14 | 13½ 14½ | 4 5 9 | April and October..... | 14 | 13½ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) ..... ..... | 13 14 | 13½ 14½ | .. | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage xd | 108 111 | 108 111 | 4 1 0 | June and December ... | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) .. xd | 94 97 | 94 97 | 3 12 0 | ... | 97 | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary ..... ..... xd | 15 16 | 15 16 | 4 7 6 | March ..... | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary ..... | 5⅛ 6⅛ | 5⅛ 6⅛ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | ... | Do. 4% Debenture Stock ..... ..... | ... | 101 104 | ... | ... | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric ..... ..... | ⅛ ⅜ | ⅛ ⅜ | 11 13 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El.Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb.... | 65 75 | 65 75 | ... | January and July ..... | 65½ | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 104 | 102 104 | 4 6 2 | April and October..... | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary ..... | 14½ 15½ | 14½ 15⅝ | 4 13 7 | February and August | 15½ | 14⅝ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 9 10 | 9 10 | 3 10 0 | ,, ,, | 9 | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) .. xd | 97 100 | 97 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 | 2 | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ..... | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2⅜ 3⅛ | 2⅜ 3⅛ | ... | ... | ... | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary ..... | 12 13 | 11½ 12½ | 4 4 0 | March and September | 12⅜ | 11⅝ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... | 4½ 4⅝ | 4⅛ 4⅜ | 4 9 0 | April and October..... | 4⅜ | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock.....xd | 123 128 | 123 128 | 4 14 0 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary ..... | 8 10 | 8 10 | 2 0 0 | ... | 8¼ | 8¼ |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference .....xd | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures ..... | 97 102 | 97 102 | 4 18 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) ..... | 93 98 | 93 98 | 4 12 0 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways..... | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2½ 3⅛ | 2½ 3⅛ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. ..... ..... | 4 4⅛ | 4 4⅛ | ... | ... | 4⅛ | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. ..... ..... | 99 101 | 100 102 | 4 8 0 | ... | 101½ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary ..... | 22½ 23 | 21 22 | 3 17 1 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. CumulativePreference(fully pd) ..... | 10¾ 11 | 10⅜ 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... | 114 116 | 113 115 | 3 19 7 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary ..... | 6½ 7 | 6⅝ 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference ..... ..... | 9½ 9⅝ | 9½ 9⅝ | 5 2 7 | May and November ... | 9⅝ | 9⅜ |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs.... ..... ..... | 100% 102% | 100% 102% | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 6/0 | British Electric Traction Ordinary ..... ..... | 15 16 | 14½ 15½ | 5 16 2 | ... | 15½ | 15½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref..... | 12 13 | 12 13 | 4 12 4 | February and August | 12⅝ | 12⅝ |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... | 122 125 | 122 125 | 4 0 10 | ... | 124½ | 123½ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary ..... | 1⅜ 1⅝ | 1⅝ 1⅞ | ... | ... | 1⅝ | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. ..... | 5⅛ 5⅜ | 5⅛ 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" ..... | 5¼ 5½ | 5¼ 5½ | 2 3 6 | ... | 5⅜ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures ..... | 102 105 | 102 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) ..... | 10½ 11½ | 10½ 11½ | 2 12 2 | ... | 11½ | 11 |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) .....xd | 102 104 | 103 105 | 4 5 9 | ... | 104 | ... |
| 400,000 | 1 | ... | Cape Electric Tramways Shares ..... | 1⅜ 2 | 1⅝ 2 | ... | ... | 1⅝ | ... |
| £1,969,800 | Stock | ... | Central London Ordinary Stock ..... ..... | ... | 93 96 | 3 2 6 | June and December... | ... | ... |
| £440,100 | Stock | ... | Do. 4% Preferred Stock ..... ..... | ... | 98 101 | ... | ... | 101 | 100 |
| £440,100 | Stock | ... | Do. Deferred Stock ..... ..... ..... | ... | 93 93 | ... | ... | ... | ... |
| £698,201 | 100 | ... | Do. 4% Deb. Prov. Scrip. Certs ..... ..... | 113 118 | 113 118 | ... | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5⅛ 5⅜ | 5⅛ 5⅜ | 4 10 11 | ... | 5⅜ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. ..... ..... | 100 103 | 100 103 | 3 17 10 | ... | ... | ... |
| £855,000 | Stock | 1½% | City and South London Railway Con. Ordinary .. | 54 56 | 54 56 | 2 4 6 | February and August | 55 | 54½ |
| 47,500 | 10 | 2/0⅜ | Do. Ordinary (Nos. 22,501 to 70,000) ..... | 5⅛ 5⅜ | 5⅛ 5⅜ | 2 3 6 | ,, ,, | 5⅜ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) .. | 132 137 | 132 137 | 3 13 0 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) ..... ..... | 124 128 | 124 128 | 3 18 0 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... ... | 112 117 | 112 117 | 3 8 6 | May and November ... | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Tramways (1896) Ltd., Ordinary ... | 12 13 | 11⅛ 12⅛ | 5 4 0 | ... | ... | ... |
| 59,987 | 10 | 6/0 | Do. 6 per Cent. Preference ..... ..... | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) ..... ..... | 98 102 | 98 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5⅛ | 5⅛ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ 4⅝ | 4½ 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary..... ..... | 22 22⅜ | 21½ 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference..... ..... | 14½ 15⅜ | 14½ 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... ..... | 112 114 | 111 113 | 3 19 8 | January an 1 July ..... | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. ... | ... | ... | ... | May and November ... | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary ..... ..... | 8⅛ 8½ | 8⅛ 8½ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ..... ..... | 13 13½ | 13 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... ..... | 100 102 | 102 104 | 3 18 3 | January an 1 July ..... | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 101 103 | xd104 106 | 3 15 6 | ... | 105⅞ | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) ... | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) ..... ..... | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary ..... ..... | 3 3⅛ | 3 3⅛ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference ..... | 4⅛ 5 | 4⅛ 5 | 6 0 0 | May ..... ..... | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord..... | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference ..... ..... | ... | ... | ... | ,, ,, | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary ..... ..... | 12 13 | 12 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference..... | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £175,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... ..... | 105 108 | 105 108 | 4 3 4 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6 0 paid) ..... ..... | ... | ... | ... | April and October..... | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) ..... ..... | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) ..... ..... | ... | ... | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary ..... ..... ..... | 92 95 | 91 94 | 3 3 2 | June and December .. | ... | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 3. | | Price Wednesday, July 10. | | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending July 10. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) xd | 98 | 101 | 98 | 101 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ | 4⅛ | 3⅜ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 53 | 56 | 53 | 56 | 5 12 7 | Feb., May, Aug., Nov. | 53 | ... |
| £3,097,640 | Stock | 20/0 | Do. Preferred | 98 | 100 | 98 | 100 | 6 2 0 | ,, ,, | 99⅛ | 98⅛ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 | 10⅛ | 9⅞ | 10⅛ | 2 8 9 | ,, ,, | 10⅛ | 9⅞ |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock xd | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock xd | 100 | 102 | 100 | 102 | 3 18 3 | ,, ,, | 101⅛ | 101⅛ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14⅜ | 15½ | 6 9 0 | ,, ,, | 14⅜ | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,600 | 50 | 4½% | Do. 4½ per Cent. Debentures xd | 99⅞ | 103⅞ | 99⅞ | 103⅞ | 4 7 6 | January and July | ... | ... |
| £9,710 | 20 | 3/0 | Direct United States Cable | 10⅜ | 11⅛ | 10⅜ | 11 | 6 7 3 | Jan., Apr., July, Oct. | 11⅛ | 10⅜ |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | xd 99 | 102 | 99 | 102 | 4 6 3 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 140 | 145 | 141 | 146 | 4 16 0 | Jan., Apr., July, Oct. | 145⅛ | 143 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 89 | 92 | 89 | 92 | 3 16 0 | ,, ,, | 90⅜ | 89 |
| £1,482,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 109 | 113 | 109 | 113 | 3 11 1 | May and November | 111⅛ | ... |
| 300,000 | 10 | 6/6 | Eastern Extension | 13½ | 14 | 13⅜ | 14⅛ | 4 15 0 | Jan., Apr., July, Oct. | 13⅞ | 13⅜ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 116 | 3 9 3 | February and August | ... | ... |
| £200,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 100⅞ | 103⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November | 104⅜ | 104 |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen ex coupon 52 | 30 | 32 | 30 | 32 | 4 13 9 | January and July | 30⅜ | 30⅛ |
| £78,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos | xd 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red. | 43 | 47 | 43 | 47 | 5 6 5 | May and November | 43 | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) xd | 99 | 103 | 99 | 102 | 3 18 6 | June and December | ... | ... |
| 15,600 | 10/0 | ... | West African Telegraph | 2 | 3 | 2 | 3 | 4 9 2 | December and July | ... | ... |
| £155,600 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 7 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ¼ | ¾ | ¼ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures xd | 99 | 102 | 99 | 102 | 3 18 6 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅜ | ⅝ | ⅜ | ⅝ | ... | May and November | ... | ... |
| 24,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | 10 0 0 | ,, ,, | 5 | ... |
| 4,000 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | 12 0 0 | ,, ,, | ... | ... |
| £20,000 | 100 | 5% | * Do. 5 per Cent. Debentures x d | 101 | 104 | 101 | 104 | 4 16 2 | January and July | ... | ... |
| 207,980 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) xd | 13⅜ | 14⅛ | 13⅜ | 14⅛ | 4 18 3 | Mar., June, Oct., Dec. | 14⅛ | 13⅜ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1908) xd | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) xd | 100 | 103 | 100 | 103 | 3 17 8 | ... | 101½ | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 41,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅜ | 4⅛ | 3⅜ | 4⅛ | 4 14 2 | August | ... | ... |
| 234,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 3/0 | 3/6 | 3/0 | 3/6 | 8 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ | ¼ | ⅛ | ¼ | 5 0 0 | November | ... | ... |
| 96,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3⅛ | 3⅜ | 3⅜ | 3⅜ | 7 11 9 | February and August | 3⅜ | 3⅜ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 12 | 11 | 12 | 5 0 0 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 12 | 11 | 12 | 5 0 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ | 4⅜ | 4⅛ | 4⅜ | 5 14 3 | ,, ,, | 4⅛ | ... |
| £1000,000 | Stock | 2½% | * Do. Debenture Stock 2½ per Cent. (red.) x | 87 | 90 | 89 | 91 | 3 16 1 | June and December | 90 | 87 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) xd | 94 | 97 | 95 | 99 | 4 1 8 | ... | 97 | 9 3 |
| 171,504 | 1 | 0 3 | Oriental | ¼ | 1 | ¼ | 1 | 6 0 0 | April and October | ¼ | ... |
| 58,000 | 5 | 2/6 | United River Plate | 5 | 5½ | 5 | 5½ | 6 7 3 | July | 5⅛ | 5⅜ |
| 40,000 | 5 | 3/6 | Do. 5% Cumulative Pref. x | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) x | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ | ½ | ⅜ | ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ | ½ | ⅜ | ½ | 8 0 0 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 6 16 4 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6 | 6⅜ | 6⅛ | 6⅜ | 4 9 0 | January and July | 6⅜ | 6⅛ |
| 100,000 | 5 | 3/0 | British Westinghouse 5% Preference | 4⅛ | 5⅛ | 4⅛ | 5⅛ | 5 14 3 | ... | ... | ... |
| 90,000 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ | 1⅝ | 1⅜ | 1⅝ | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2⅛ | 2⅜ | 2 | 2⅛ | 5 6 8 | ,, | 2⅛ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock x | 99 | 103 | 99 | 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 | 15 | 14 | 15 | 5 0 0 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference xd | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ,, ,, | 5⅛ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) x | 107 | 111 | 107 | 111 | 4 1 0 | November and May | ... | ... |
| 450,000 | 1 | 0 2 | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £2,000 | Stock | 4½% | Do. 4½ First Mort. Deb. (red.) | 93 | 97 | 93 | 97 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary x | ⅝ | 1⅛ | ⅝ | 1⅛ | 5 15 7 | March | ⅝ | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ⅝ | 1⅛ | ⅝ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅞ | 4 | 3⅞ | 4 | 5 12 7 | January and July | 3⅞ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red. xd | 100 | 105 | 100 | 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1 | 1⅛ | 1 | 1⅛ | 10 12 0 | February and August | 1⅛ | 1⅛ |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2 | 3 | 2 | 3 | 8 16 6 | ,, ,, | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb.Stock(red.) xd | 80 | 85 | 80 | 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 94 | 98 | 92 | 96 | 5 4 0 | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 5⅛ | 6 | 5⅛ | 6 | 4 12 0 | Half-yearly | 5⅛ | 5⅛ |
| 20,000 | 5 | 1 6⅛ | Do. 6% Cumulative Preference | 5⅛ | 5⅜ | 5⅛ | 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 5 | ... | ... | ... |
| 1,112,100 | 5 | 1/2½ | Electric ConstructionCo. (Limited) | 1⅜ | 2⅛ | 1⅜ | 2⅛ | 5 6 8 | January and July | 2 | ... |
| 25,000 | 2 | 2/9⅛ | Do. 7 per Cent. Cumulative Preference | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 19 0 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd., 5% Cum. Pref. | 9⅜ | 10⅛ | 9⅞ | 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Hanley's Telegraph Works Ordinary | 15⅛ | 16⅛ | 15⅛ | 16⅛ | 6 1 3 | February and August | 16⅛ | 15⅛ |
| 35,000 | 5 | 2/8 | Do. 4½ per Cent. Preference | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb.Stock(red.) | 107 | 111 | 107 | 111 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | ... | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintenance | 36 | 40 | 36 | 40 | 5 4 11 | March and July | 38 | 37½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 xd | 101 | 104 | 101 | 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 3/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 5 9 1 | ... | 10⅛ | 10⅛ |
| 20,000 | 5 | 2/6 | Do. 5 per Cent.Cumulative Preference | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | 5⅛ | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 | 11 | 10 | 11 | 5 9 0 | April and October | 10⅛ | 10⅛ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6⅛ | 7 | 6⅛ | 7 | 4 5 9 | ,, ,, | 6⅛ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | | | |
| 19,200 | 5 | 0/6 | Electric and General Investment Co. Cum. Pref. | ... | ... | 5 | 6 | 5 0 0 | ... | ... | ... |
| 180,237 | 10 | 2/6 | Globe Telegraph and Trust | 9⅜ | 10⅛ | 9⅜ | 10⅛ | 5 2 5 | Jan., Apr., July, Oct. | 10⅛ | 9⅜ |
| 150,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14⅜ | 15⅛ | 14⅜ | 15⅛ | 3 19 8 | ,, ,, | 15⅛ | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 10 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,209. [No. 13. Vol. XLVII.] FRIDAY, JULY 19, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

WE tender our heartiest congratulations to Prof. A. W. RÜCKER upon his election by the Senate to the responsible post of Principal of the University of London. Sweeping as the assertion may seem, we unhesitatingly say that no more fitting choice could have been made. Added to his mature experience and learning as a leading scientist, Prof. RÜCKER carries into his new official life a wealth of experience in business and public affairs, gathered partly from his arduous duties as secretary to the Royal Society, and partly from other national services which his versatility has enabled him to perform. It may not be known to some of our readers that on two occasions Prof. RÜCKER has stood for election into Parliament. An accomplished scientist, an experienced teacher, an authority on the inter-relations between the modern and the classical in education, a practical business man, a tactful diplomat, Prof. RÜCKER combines in greatest number and in highest degree the qualities that go to make the successful principal of a modern university.

A HEALTHY sign of British electrical progress, and one that comes all the more cheeringly amidst so much lamentation about foreign trade, is the reconstruction of Messrs. S. Z. DE FERRANTI (LTD.) upon a much broader financial basis than heretofore. Particulars of this change are set forth in the prospectus, which will be found on another page. The new company, styled FERRANTI LIMITED, has a total authorised capital of £500,000. Briefly commenting upon the prospectus of the new company, we may say that it has every appearance of a sound and promising investment. Gradually, but surely, Messrs. S. Z. DE FERRANTI (LTD.) have built up a large and solid business, the various departments of which supply electrical plant that is becoming almost indispensable in certain classes of electrical work. The ingenious, yet simple, switchgear invented by Mr. FERRANTI is fast replacing more complicated switch arrangements where heavy alternate-current work is being done. His arc lighting rectifier stands unique. His steam engine is finding a prominent place in many a new central station, to say nothing of extensions of older works. Mr. FERRANTI led the way in large dynamo building years ago—so long ago, indeed, that few were bold enough even to follow him; and to-day his large alternator practice is still in the vanguard, followed at length by all other important builders. We repeat that this reconstruction is a decidedly healthful sign; and not only are those immediately concerned in it to be congratulated upon past successes and future rosy prospects, but British electrical industry as a whole may share also in the congratulation.

THE Association of Chambers of Commerce of the United Kingdom having recently made representations to the Postmaster-General, urging the need for a more efficient telegraphic and telephonic service between our great manufacturing centres, his lordship has replied at considerable length and in terms which virtually admit that there are some grounds for public complaint. As regards the telegraphs, Lord LONDONDERRY states that two experts of great experience are now examining the working at all the large offices with a view of effecting any necessary and possible improvements in the service. The growth of traffic, however, has been so unusually great that the department finds difficulty in keeping pace with it, although in the near future the additional lines which are in process of erection will, on completion, not only meet present requirements, but furnish reserve lines of communication to meet all contingencies of breakdowns by storm or other causes. The extension of the underground system already established between London and Birmingham will greatly contribute to this desirable result.

OF the telephone service, notably of the trunk lines, the Post Office cannot speak so confidently. Much pains is taken to show the number of circuits opened since 1896–7, and the still greater number in course of erection. The list is a formidable one, and the tremendous character of the undertaking is indicated by the fact that with all its prestige and

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experience the Post Office is hampered by an insufficient supply of skilled labour capable of carrying out the work satisfactorily. Already there are nearly 77,000 miles of trunk lines in actual operation; but this total, great though it is, would have been much augmented had the facilities for wayleaves been less difficult to obtain. On this point the POSTMASTER-GENERAL makes an earnest appeal to public bodies and others to render all possible assistance for the erection of overhead lines, without which telephone service between distant towns cannot be provided. Among the causes of telephonic delays on these trunk lines three are specially mentioned: one is said to be due to "unavoidable interruptions to the circuits"—a statement which would seem to suggest that these lines are more liable to interruptions than ordinary telegraph lines. If this be the case some further explanation is needed. A second cause is attributed to "the inadequacy of the National Telephone Co.'s junction system"—a very deplorable statement, if true, after all these years of close relations between the Post Office and its subsidiary lessees. The third cause is of a more commonplace kind, and is not to be remedied by any ordinary methods. It is described as "subscribers being engaged on other trunk calls." As subscribers cannot be in two places at once, and never will be, it was hardly worth while to mention the fact unless there was a possible substitute. A substitute there certainly is in the beautiful discovery of POULSEN, whose telegraphone—if only it were on the market—would go a long way to render the actual presence of subscribers not indispensable.

As was to be expected, the National Telephone Co. is not disposed to sit still under the aboved-named imputation so far as that company's "junction system" is concerned. The letter which the manager of the company has addressed to the Kidderminster Chamber of Commerce leaves us, however, very much in doubt as to who is most to blame in the matter, the Post Office for expecting too much from the Company, or the Company for not co-operating more amicably with the Post Office. One thing only is clear, namely, the existence of a wide divergence of opinion between the respective parties as to whose duty it is to make the necessary junctions between the main trunk lines and the towns comprised within the area served. That such a vital matter as this is still in dispute strikes one as being most discreditable, though perhaps not so very surprising considering the treatment which the Company has latterly suffered at the hands of the Government.

**The Society of Arts.**—The council elected Sir W. H. Preece, on the 8th inst., to be chairman of council for the ensuing year.

**East Ham Electric Tramways.**—The municipal electric tramways, equipped by Messrs. Dick, Kerr & Co., were formally inaugurated yesterday evening.

**Heriot-Watt College.**—Some particulars of the three years' courses of instruction in mechanical and electrical engineering and technical chemistry at Heriot-Watt College, Edinburgh, are given in an advertisement. The session is from October to June.

**Chamonix Railway.**—Messrs. Cook learn by telegram from their agents that the opening of the electric railway from Le Fayet to Chamonix is fixed for the 25th inst. This will shorten the journey from London to Chamonix to about 25 hours.

**Proposed International Exhibition at Wolverhampton.**—It is proposed to hold an international exhibition at Wolverhampton next year. The guaranteed fund now amounts to about £30,000, and promises of support have already been received from Canada, Russia, and other foreign countries.

**Durham College of Science, Newcastle-on-Tyne.**—Particulars will be found set out in an advertisement of the complete courses of instruction provided for students of both sexes proceeding to degrees in science, &c. The matriculation and exhibition examinations begin September 30th; lectures, October 9th.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... | Mar. 2, 1900 ... | — |
| Cayenne—Pinheiros .. ..... | April 21, 1901 ... | — |
| Bali—Lombok ..... | July 3, 1901 ... | July 12, 1901 |
| San Domingo—Curaçao..... | July 12, 1901 ... | — |

**Safety Device for Electrical Instruments.**—We are informed that Signor Olivetti, of Ivrea, Italy, has lately placed on the market a device for protecting electrical instruments, which consists of a silver spring connected to one of the terminals. When the pointer of the instrument passes the maximum reading it presses this spring against a small stud connected with the other terminal, so that the instrument is short-circuited.

**Iron and Steel Institute.**—The autumn meeting of the Iron and Steel Institute will be held at Glasgow on September 3rd, 4th, 5th and 6th. The meeting will be held simultaneously with the International Engineering Congress, Section V. The subscription for membership of the Congress is 10s. 6d., which should be remitted to the general secretary of the Congress, Mr. J. D. Cormack, the University, Glasgow. The subscription includes free entry to the exhibition during the week, the privilege of taking part in any of the sectional meetings, the various visits and social gatherings, as arranged by the Congress, and of receiving a volume of abstracts of the Papers read in all the sections.

**A New Phonographic Principle.**—We have been informed by Mr. G. W. Littlehales, of the Navy Department, U.S. Hydrographic Office, Washington, that he was working on the same lines as W. Nernst and R. von Lieben (see *The Electrician*, June 7th, p. 260) in 1887-8, and he has forwarded us a specification of the patent granted him in 1889 by the United States. This specification embodies the same principles as those described in the article mentioned above, but the details vary. Mr. Littlehales apparently had not made use of two batteries or of the induction coil, which Herr R. von Lieben found not unimportant, but there is no doubt that he anticipated these authors in the general principle of an electrolytic phonograph.

**National Physical Laboratory.**—The Executive Committee have made the following appointments:—*Superintendent of the Engineering Department*—T. E. Stanton, D.Sc. (Victoria). *Assistants in the Physics Department*—J. A. Harker, D.Sc. (Victoria), A. Campbell, B.A. (Cambridge), and H. C. H. Carpenter, M.A., Oxon., Ph.D. (Leipzig). *Junior Assistants*—B. F. E. Keeling, B.A. (Cambridge), and F. E. Smith (Royal College of Science).

It is expected that one or two more junior assistants will be appointed shortly. The alterations to Bushy House and the new buildings for the engineering laboratory are well advanced, and it is hoped to commence work early in October. Of the staff, Dr. Stanton, after serving an apprenticeship with an engineering firm in the Midlands, has had a distinguished career at Manchester and Liverpool, and is now Professor of Engineering at University College, Bristol. His Paper on "Surface Condensers," published in the *Phil. Trans.*, is well known to engineers. Dr. Harker and Mr. Campbell have both done work of real value on thermometry and electric measurements; while Dr. Carpenter, who will have charge of the chemical researches, after a successful course at Oxford, has gained further experience at Leipzig, under Ostwald, and

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more recently at Owens College. Mr. Keeling obtained a double-first in Natural Science and Mechanical Science, respectively, at Cambridge, while Mr. Smith was the most distinguished student of his year at South Kensington and for two years has been one of Prof. Rücker's assistants.

**Curious Incident in a Thunderstorm.**—A correspodent writes thus from Camberley in *The Times* of the 10th inst. :—

An incident of the thunderstorm which raged over this neighbourhood on the night of Saturday, June 29th, will doubtless interest scientists. The sewer in Portsberry-road is terminated at the upper end by a manhole closed by a circular heavy iron cover. From the manhole one pipe drain, some 18in. below the surface, leads to an ordinary wrought-iron ventilating column, surmounted by a galvanised wire balloon ; and 16ft. from the manhole two other drains, provided with traps and vents, take the drainage from the last two cottages in the road. The sewer and drains are glazed earthenware pipes, the sewer 9in. in diameter, the pipes 6in. On Saturday night a vivid flash of lightning with a simultaneous burst of thunder was followed immediately by an explosion in these pipes and the sewer. The balloon was scorched, but the column sustained no damage. The walls of the manhole, which is 3ft. deep, were shattered, and the manhole had to be entirely rebuilt ; the iron cover was blown 4ft. away. The drain pipes from the manhole to the ventilating shaft were blown to fragments, as were altogether 40ft. of the two other 6in. pipes and the 9in. sewer. The earth over the pipe from the manhole to the shaft was lifted bodily 2in. The damage in one of the cottage drains stopped at the trap and vent ; in the other, some distance short of the trap and vent. The practical question arises whether ventilating shafts are a possible source of danger. I may add that parallel to the sewer runs a gas main. For the above details I am indebted to Mr. F. C. Uren, the surveyor to the Urban District Council of Frimley, who will, I am sure, be pleased to reply to any questions put to him by scientists on this incident, which, so far as I can ascertain, is of a totally novel character.

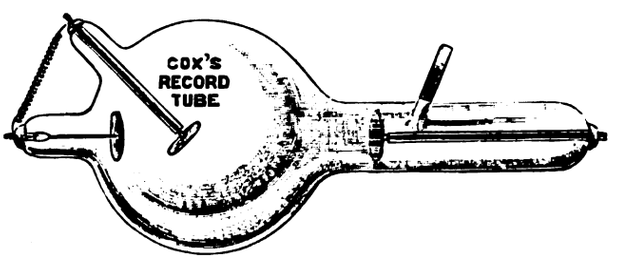
**Electrolysis of Gas and Water Mains.**—With reference to the decision of the House of Commons Committee with regard to the electrolysis clause in the London United Tramways Bill, it may be of interest to our readers to see the views of the *Journal of Gas Lighting*, which are as follows :—

The hope we all cherished that this session would yield to gas and water companies proper defence in the matter of electrolysis is not likely now to be realised. Excepting in the Sheffield case, the companies' plea has fallen all along the line ; and they have received little encouragement from committees to persevere in their endeavour. In less than 10 days after the brave but abortive fight the metropolitan water companies made on the London Tramways Bill, the Bexhill bill came before a Committee of the Upper House, presided over by Lord Clonbrock ; and the South Metropolitan Gas Co. and the Kent Water Co. appeared, as they did in the Lower House, with a petition for greater protection than the bill at present accords them. Counsel opened the case for the bill ; but even before he had arrived at the end of his speech, the Committee clearly gave the companies to understand that they would not receive any favourable consideration at their hands. In consequence of this intimation, counsel for the petitioners withdrew. The action of the Committee is not exactly what an Englishman calls fair play. The companies had gone to some trouble and expense in fortifying their case for the occasion ; and they ought certainly to have been heard. But the time will come when they must be heard ; and day by day they will be able to strengthen their already strong claim to better consideration than they have had this year. This is a case in which deferred hope must not be allowed to make the heart sick ; and no opportunity should be lost by gas and water suppliers in making their voices heard on the subject. The Paper on electrolysis which Dr. Leybold will read before the gas section of the Glasgow Engineering Congress may produce some supporting material.

**Electrical Transmission in a Paper Mill.**—The *Electrical World* of New York for June 27th describes the electrical installation for lighting and power in the works of the Great Northern Paper Co. at Millinocket, Maine. The mill is devoted to the manufacture of newspaper stock from wood. This process involves the reduction of the wood to pulp by grinding, and the subsequent passage of the pulp through a variety of processes to obtain the finished product. Though the reduction of the wood to pulp is done in a comparatively small space, yet it takes more power than do all the subsequent processes put together. Electric motors are used in all departments except the grinder room and the paper machines. At present about 14,600 H P. is used for the grinding, whilst the aggregate nominal capacity of the electric motors is 3,690 H P., though they are capable of temporory overloads. The sulphate screen, wet machines, an 18in. centifrugal pump, and the screen scrapers are operated by one 300 H.P. synchronous motor. Each of two 300 H.P. synchronous motors, and each of two 300 H.P. induction motors drives four beating engines, two refining engines and two stuff chests. One 24in. centrifugal stock pump, one 18in. centrifugal white water pump, a small vacuum pump and silver and millard screens, form the load of another 300 H.P. induction motor. One 8in. special white water pump, two 8in. centrifugal stock pumps and two agitator shafts are driven by an induction motor of 250 H.P. An induction motor of 250 H.P. drives the ground wood screens, 27 Decker wet machines, six felt wet machines, one elevator and screen scrapers. Two conveyors, three chippers, a re-chipper, two chip crushers and a rotary chip screen are all driven by another 250 H.P. induction motor. Two induction motors of 250 H.P. each do the work of driving two loghauls, four sets of live rolls, four swing saws, a 4ft. wood saw, with platform conveyor, two chain conveyors, four splitters and four waste conveyors. The entire acid plant, including four lime tanks, two absorbing tanks, four large vacuum pumps, two small lime pumps, and a small acid pump, are driven by one 250 H.P. induction motor. A 100 H.P. induction motor is required for an 8in. centrifugal acid pump. A special 8in. centrifugal stock pump is driven by the 75 H.P. induction motor. All of the following motors are of the induction type. A 50 H.P. motor is employed to drive a 6in. centrifugal pump for washing filters. Another 50 H.P. motor drives the machine shops. Two chain conveyors to carry blocks to the grinder room are operated by a third 50 H.P. motor. Of three 30 H.P. motors one drives the belt conveyor for chips, another operates the belt conveyor that takes waste wood to the boiler house, and the third is required for the calender roll grinder. The 10 H.P. motor runs an elevator. Each of three 5 H.P. motors operates a section of the cleaners for the economisers.

**Röntgen Society.**—The Council have presented their annual report for the year ended June 30, 1901. The membership is now six honorary and 192 ordinary. Mr. Herbert Jackson has been nominated president for the coming session. The following is from the report of the jury on the tube competition :—

The number of tubes sent in for competition was 28. Of these five were of British manufacture, eight from America, and 15 from Germany. The tubes were almost without exception of excellent make, some of them being very fine specimens of glass-blowing. Several of them had special arrangements for taking heavy discharges, and others had more or less ingenious devices for regulating the vacuum.




The attention of the jury was mainly directed to the four points mentioned in the conditions of the competition, viz. :—

(1) Definition, (2) Penetration,
(3) Photographic effect, (4) Price,

the predominant requirement being that the tube selected should be "practical," by which the jury understood a good all-round instrument for any of the purposes for which X-rays are employed. About 75 per cent. of the tubes failed to satisfy the required tests for definition, and in the opinion of the jury, the attention of makers of tubes should be drawn to this defect, because unless a tube defines well, all other advantages it may possess are to a great extent valueless for most of the purposes to which X-ray tubes are put. Thus the arrangements provided in some of the tubes for heavy discharges and the regeneration or regulation of vacuum, which might in themselves have been good, could not receive the recognition they might have deserved had the tubes to which they were attached have given satisfactory definition. The tubes which stood the test for definition were subjected to a very severe trial for penetration and photographic effect, and the jury are glad to be able to report that a much higher standard of excellence was attained in this respect than in that of definition. The element of price did not require very serious consideration. The prices of the tube sent in varied from £4. 5s. to 16s. Many of the high-priced tubes were eliminated by the first test, and the jury think it will be satisfactory to X-ray workers to know that, though the price was not the determining feature, yet the tube selected as the best is also one of the most moderate in price. The tube which has best satisfied all the tests applied by the jury is the one sent in as Cox's Record Tube, made by C. H. F. Müller, of Hamburg, price 18s. 6d., and to this the jury award the medal.

We have received from H. W. Cox (Ltd.), of 9, Cursitor-street, Chancery-lane, London, an illustration of the winning tube, which we give.



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## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 441.*)

Monday, July 1st, was occupied by the journey from Dresden to Nuremberg, and on the following day time was found to visit the quaint old town after Messrs. Schuckert & Co.'s works had been inspected. In the evening the municipal electricity works were first visited, and the Institution members had then an opportunity of fraternising with the engineers of the Schuckert works at a dinner given by the firm in our honour at the Stadt park. Our welcome was most cordial everywhere; in the works (an article on which will appear later) we were shown the various departments by the experts and engineers in charge of them, and at the luncheon at the works and the dinner in the evening, although speeches were forbidden and were laudably short in consequence, Herr Bissinger (the managing director) and all his colleagues made us feel thoroughly at home. Such intercourse with our German "Fachgenossen," when conversation, commencing with the most technical subjects, straying incidentally to the inevitable "Wein, Weib und Gesang," and then back again to the consideration of engineering and commercial questions, has been one of the most interesting parts of the Institution tour, and while it is almost as instructive as the actual visits to the works themselves, it has the advantage of being equally profitable to the hosts and their guests.

The situation and history of the Nuremberg electricity works remind one of a more or less parallel case in a little town in Essex. Until within the last few years Messrs. Schuckert & Co. were what has been termed continuous-current men. Their continuous-current dynamos had long been famous in all parts of Germany, but they had concerned themselves comparatively little with alternating-current machinery. Thus the electricity works which were started in the town of Nuremberg in 1896, represent the first Schuckert alternating-current supply station of a considerable size. Since that time, the firm has gone in largely for the manufacture of alternating-current machinery, and has developed this part of its business with considerable success.

The electricity works, a view of whose engine-room is given in Fig. 4, supply current on the single-phase system with primary and secondary pressures of 2,000 and 115 volts respectively and a frequency of 50 ~ per sec. There are four vertical compound piston-valve engines driving 350kw. dynamos at 125 revs. per min., and two similar engines with trip-valves running at 94 revs. per min., and driving 650kw. dynamos. The latter two sets are seen in the foreground of the illustration, and it will be noticed that they have the same armature (stator) with radial struts as the alternator exhibited by the firm in Paris. I believe that this design is being discontinued in favour of a simple armature casting of sufficient stiffness. A battery of 300 ampere-hours' capacity has been installed for lighting the works on emergency.

The connections to the mains approach 5,000kw., and to a large extent are supplied from a secondary network fed from transformers placed in street pillars and other sub-stations. Some of the larger consumers have separate transformers, however, and in connection with these is an interesting device for switching out the primaries of the transformers when the secondaries are on open circuit. A description of this device will be given in the subsequent article on Messrs. Schuckert's works. It has been installed comparatively recently, and, so far, is said to have worked well. The length of feeders is 12km., of high-pressure distributors 48km., and low-pressure distributors 72km. In order not to disfigure the classical old town, the works had to be erected at a point a mile or more from the centre of the distribution area. Yet there are electric tramways with overhead trolley wires in the main streets, which are also lit with arc lamps.

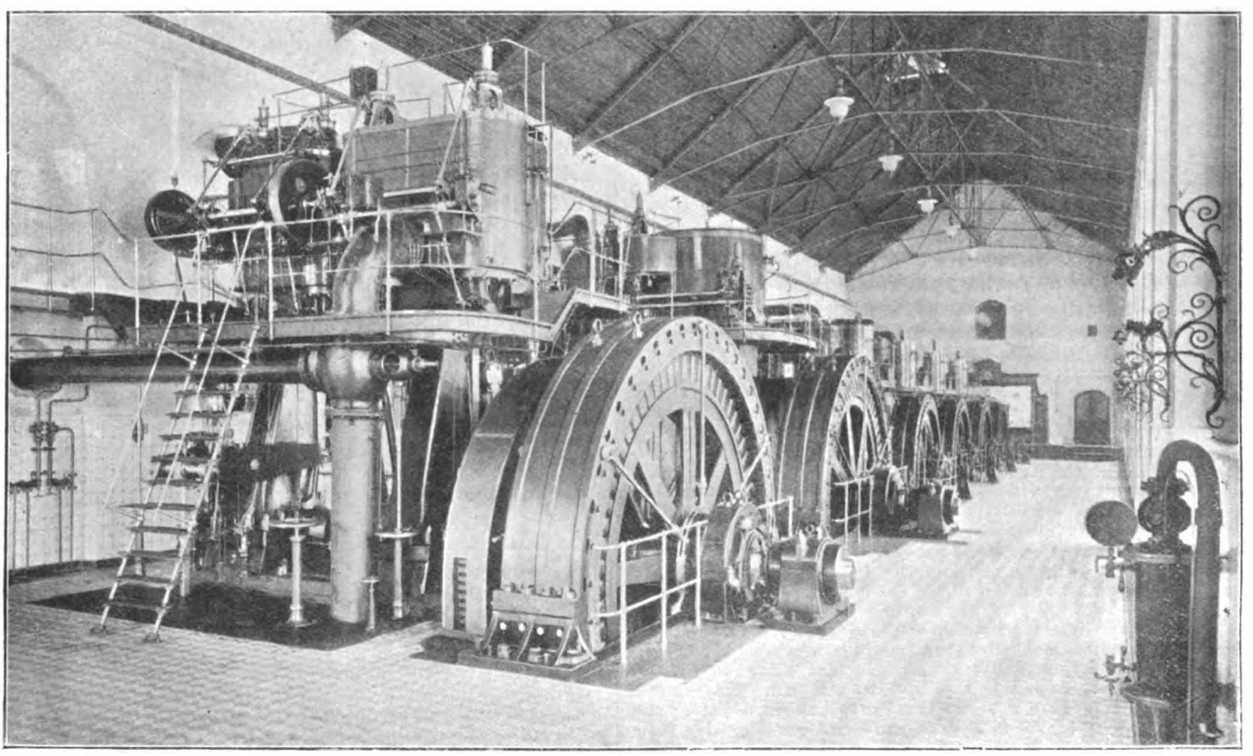

FIG. 4.—THE NUREMBERG MUNICIPAL ELECTRICITY WORKS.

Leaving Nuremberg early on Wednesday, July 3rd, we arrived at Frankfort in time to be received and entertained at luncheon by the directors of Messrs. Lahmeyer & Co., who exerted themselves to the utmost to do us honour during our stay at Frankfort. The manufacturing works of this firm, which were then visited, offered several features new to the visitors, in spite of the number of factories of a similar character that had been inspected during the previous days. Especial interest was directed towards the fine machines in course of construction for the Charing Cross and Strand Electricity Corporation.

In the evening the Elektrotechnische Gesellschaft, of Frankfort, gave a grand dinner in our honour in the Palmen-

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garten. Some 150 ladies and gentlemen took part in it, and besides the directors and engineers of the various electrical works in the town and our own party, several distinguished guests were present. These included Burgomeister Dr. Barrentrapp, Herr Andreae (president of the Frankfort Chamber of Commerce) and Mr. F. Oppenheimer (the British Consul). Herr F. Hasslacher, president of the society, who occupied the chair, made the first speech, bidding us welcome and proposing the toast of the British and German electrical industry. He mentioned that Sömmering had lived in Frankfort, that it was also in this town that Reiss had made his famous experiments in the electric transmission of sound, and that Frankfort had shown the pioneer high-pressure long distance power transmission in the Frankfort-Lauffen installation at the exhibition of 1891. At the conclusion of his speech, a singing arc manipulated by Dr. Th. Simon, whose researches in this direction are well known, sang "God Save the King," in excellent time and tune. Mr. Alexander Siemens, who proposed the Frankfort Elektrotechnische Gesellschaft, said that electrical engineering was the most international profession there was. The members of the Institution had been welcomed with hospitality in every town they came to, in Frankfort no less than in those they had previously stopped at. They had seen much and learnt much in Germany, and he hoped that an opportunity would soon present itself to show German electrical engineers that there was also something to see in England. "The Ladies" was proposed by Herr Hanswald in excellent English, and this gave Mr. Raworth an opportunity to reply with his characteristic humour.

The next morning the party divided into two groups, one visiting the electricity works in the town, and the other going over to Wiesbaden to see the electric lighting station there. A considerable number had preferred the former works, as Frankfort possesses a single-phase system noted for the large number of motors connected to it. The roominess of the engine room is a prominent feature of the generating station itself, as in all the electricity works we visited except those in the centre of Berlin. There are eight large directly-connected flywheel alternators, all of the Brown-Boveri make and driven by slow-speed horizontal engines, some of 1,000kw. and others of 500kw. capacity. Among the points noticeable on some of the machines were the bare copper coils of the field magnets, overhung exciters, the employment of a barring engine both for starting the flywheel field-magnets and for turning the stator, the latter being mounted, as in a large number of the more recent continental machines, in such a way that it can be rotated if desired to allow of the inspection and repair of the armature coils. Some of the machines had the field circuit slip rings in a particularly accessible position outside the exciter which was on a hollow extension of the main shaft of the generator, the wires connecting these to the alternator field apparently passing through this hollow shaft; in others, on the other hand, the slip rings were peculiarly inaccessible, close to flywheel field itself and to the inside of the bearing. The majority of the machines were driven by tandem Sulzer engines, others by Kühn engines. Current is generated at 3,000 volts, and the usual frequency of 50~ per sec. is employed. An interesting device is used to assist in synchronising. On each alternator a contact piece is attached to a point on one arm of the flywheel and a simple contact brush is fixed in a corresponding position on the stator. By a simple electrical device on the switchboard it is, therefore, possible to see if the engines themselves are in synchronism.

As has already been mentioned, there is a large motor load on the station, the connections to the mains in the shape of motors amounting to 5,300 H.P. With the exception of large synchronous motor generators in the main substation at Schillerplatz, all the motors are asynchronous, but notwithstanding this I was informed that the average power-factor of the network amounted to 0·8. The motors at Frankfort show that large asynchronous motors are a possibility on single-phase mains, but their disadvantages are also apparent. To start them the phase is "split" by a condenser consisting of iron plates in soda solution, a resistance being inserted in the rotor at the same time, and the motor being run up to speed on a loose pulley.

The resistance is gradually switched out of the rotor circuit, and as soon as the motor is run up to speed the condenser and the auxiliary winding of the stator, which is in series with it and provides the second phase for starting, are switched out and the load is put on. In the case of a large pumping motor we saw the switching had to be done on an actual switchboard step by step, as mentioned above, and the motor was belted to the pump and a loose pulley was provided. For some lifts, the gear of which was shown us, an automatic switch is provided to put the load in gear, this being a "time element" arrangement so connected by a sprocket chain that, after the motor has turned for a certain time, or, rather, has made a certain number of revolutions with the starting switch in its furthest forward position, the clutch comes into gear and the load is put on. These devices are said to work well; but it is only necessary to compare them with the simple starting switches for continuous-current motors, and the still simpler ones for three-phase motors, to condemn the single-phase system for motor loads until at least a more suitable single-phase motor or a more reliable condenser has been devised. The ideal single-phase motor is presumably a two-phase machine, with a good condenser of sufficient capacity, durability and efficiency to enable it to be left permanently in circuit to furnish the second phase.

There is a fine sub-station under the Schillerplatz, where the single-phase alternating current is conveted into continuous current for the tramways and the arc lighting. The tramways are, by the way, the fastest I have seen in any city; they frequently travel at what appears to be 12 or 14 miles an hour, or even more, between stopping places through the broad main streets, where the general traffic does not impede their progress. The motor-generators in the sub-station are ordinary synchronous motor-generators of a fairly large size, receiving single-phase alternating current at 3,000 volts, and generating continuous current at 500 volts for the tramways. They are started from the continuous-current 'bus bars, the continuous-current machine running them as a motor, and the high-pressure side is switched in when in synchronism, the ordinary synchronising lamp and voltmeter being used. On week-days the arcs are fed from the 500-volt tramway 'bus bars, no exception being taken to the earthing of one terminal; but on Sundays the traffic on the tramways and the number of cars running is greater, so that the motor-generators are running at their full load without the arc circuits. Then another machine is employed, which also on other occasions charges the accumulators. It consists of an alternating-current motor, coupled to a separately-excited continuous-current dynamo with two commutators. At one of these current at 500 volts can be taken off for the arc circuits, and from the other current at 600 volts for charging the cells. The current for the field of this set is supplied by a small machine on the same shaft. The battery is merely used as a "buffer" battery, being permanently connected across the tramway terminals to take the peaks of the load. There is no booster or cell switch. The capacity of the battery is 900 ampere-hours.

The Wiesbaden municipal electricity works was one of the first central stations at which the three-phase system was principally used for lighting purposes. At the time great doubts were entertained regarding the suitability of this system for lighting plants, and the municipal authorities had insisted on precise guarantees regarding the steam consumption per kilowatt-hour and the drop of volts of the machines between no load and full load. The reception tests gave even better values than had been guaranteed, and it was also ascertained that the generators could be worked satisfactorily in parallel. Values of 5·4 to 6 per cent. were measured for the drop of volts between no load and maximum load.

The works, which were erected in 1897-8 by Messrs. Lahmeyer & Co., contained at first four three-phase generators with a total output of 875 kilovoltamperes directly coupled to horizontal compound tandem engines running at 90 revs. per min. The number of lamps connected to the mains having steadily increased from year to year, at the beginning of 1900 a very considerable extension had to be made, and this was also carried out by Messrs. Lahmeyer & Co. Meanwhile a contract had been signed between the city of Wiesbaden and the "Süddeutsche Eisenbahngesellschaft," which company

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bound itself to take the current for the tramways about to be constructed in and around Wiesbaden from the municipal electricity works. Besides the extension of the three-phase plant, a continuous-current plant had, therefore, to be provided for. Two 900–1,200 B.H.P. compound tandem engines, running at 90 revs. per min., each coupled with an 800kw. continuous-current generator and a three-phase alternator of the same capacity were erected. A 200kw. continuous-current dynamo was also built on to one of the existing three-phase generators, so that the same engine could supply the lighting load during the daylight hours, the employment of a lightly-loaded engine for the day lighting load being thus avoided.

The station now contains one steam engine of 120-150 B.H.P., coupled to a 125 kilovoltampere three-phase generator; one steam engine of 240-300 B.H.P., coupled to a 250 kilovoltampere three-phase generator and a 250kw. continuous-current dynamo; two steam engines of 240-300 B.H.P. each, coupled to a 250 kilovoltampere three-phase generator; and two steam engines of 900-1,200 B.H.P. each, coupled to a 800 kilovoltampere three-phase generator and a 800kw. continuous-current machine.

Besides the tramways, 98 transformers, with a total capacity of 1,430kw. and a transformation ratio of 2,400 : 120 volts, 300 arcs, 29,650 incandescent lamps of 16 c.p., 150 motors

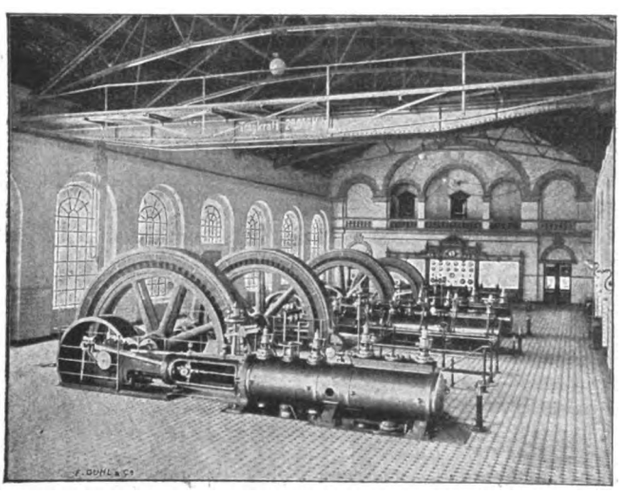

FIG. 5.—ENGINE ROOM OF THE WIESBADEN ELECTRICITY WORKS.

totalling 520 B.H.P., and 40 other apparatus consuming 42kw., are connected to the mains.

Messrs. Lahmeyer & Co. acted as hosts to us during the whole day, entertaining both the Wiesbaden and the Frankfort contingents at luncheon, and after the two parties and their ladies had joined forces, we were all taken to Homburg whence a pleasant trip was made to the Saalburg on the Homburg-Saalburg electric railway. At Saalburg the Roman remains and the Roman village in course of reconstruction were visited; on the way home the power-house was inspected, and the day finished with a convivial dinner at the Curhaus.

The Homburg electricity works were originally built by Messrs. Lahmeyer & Co. in 1898 on the three-wire system, being intended only for lighting and power transmission. The first contract included three 90kw. direct-coupled continuous-current sets running at 160 revs. per min. In the year 1899 a further set for 250-300 B.H.P. was added, to supply the current for the electric tramway, which had meanwhile been built by Messrs. Lahmeyer & Co. This track has a total length of about 6·2km., and connects Homburg to Kirdorf, Dornholzhausen and the Gothic House. Owing to the great interest taken in the Saalburg excavations, it was decided to extend the track from Dornholzhausen into the Taunus mountain district as far as the Saalburg. A further set of machines of 250-300 B.H.P. was erected to cope with this increased demand for energy, and one of the older lighting generators was removed from the station. In the near future a very large extension of the works will be necessary, a contract having been entered between Messrs. Lahmeyer & Co. and the Frankfort Localbahn-Gesellschaft for building an electric railway from Frankfort to Homburg, which distance will be traversed in half-an-hour. The present plant, therefore, consists of two vertical 150 B.H.P. engines, coupled to 90kw. 250 volt dynamos, two vertical 300 B.H.P. engines, each coupled both to a 90kw. 250 volt dynamo, and a 180kw. 600 volt traction generator. The last two machines are of the wheel type, although for continuous current. The two continuous-current generators are coupled to the same steam engine, and the armature of the traction generator acts as flywheel to the whole set. By this means a very compact construction has been achieved, the total ground area required for the whole set only being 24 sq. metres. A "buffer" battery, consisting of 275 cells for a maximum charge and discharge current of 105 amperes was also added when the railway to the Saalburg was opened. Two boosters of 60kw. output each were also provided to balance the drop of pressure on the 4km. track from Dornholzhausen to Saalburg.

The connections to the lighting mains are an equivalent of 21,595 16 c.p. incandescent lamps; this includes 53 motors aggregating about 300 H.P. and 180 arc lamps. Seven motor cars of the tramway are fitted with two 20 B.H.P. motors each, eight with two 27 B.H.P., and there are 12 trailers. The first-mentioned motor-cars run in Homburg proper and on the other tracks as far as Dornholzhausen, whilst for the mountain track

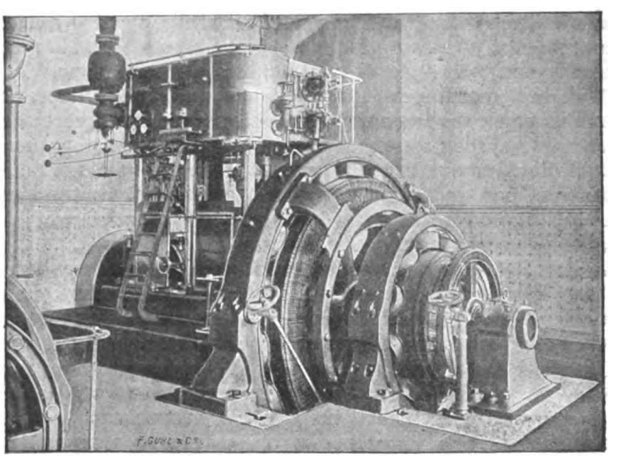

FIG. 6.—ONE OF THE DOUBLE GENERATING SETS IN THE HOMBURG ELECTRICITY WORKS.

the heavier cars are necessary. Through traffic between the Saalburg and the Homburg railway station is, however, possible with the last-mentioned motor cars, as the whole plant is built with standard gauge. The mountain track is especially interesting, as a gradient of 1:18 has to be overcome over a length of 2km. No rack is employed. As already mentioned, the total length of the track is 4km. and the difference of levels between Dornholzhausen and the Saalburg is about 200 metres. Whilst building this plant, extensive earthworks were necessary, as the track partly runs on its own embankment and partly in deep cuttings. The railway station at the Saalburg is situated in the centre of a loop having a 20 metre radius to obviate shunting the trains. The overhead conduit system is fixed to lattice-work iron pillars, and the rails are used as return. The cars are fitted with three brakes, one electric short-circuiting brake, one magnetic brake, and one mechanical brake, so that the train can be brought to a standstill even on the steepest incline. In the year 1900 the Homburg electricity works and the Homburg-Saalburg mountain railroad became the property of the Actien-Gesellschaft Elektrizitätswerk, Homburg, with a capital of 1,250,000 marks.

On leaving Frankfort on Friday, July 5th, the party divided. The majority took train to Bielbriech, and there travelled down the Rhine in a steamer to Bonn, and thence by train to Cologne, while those who wished to see the Elberfeld-Barmen monorail suspended railway, went directly by train to Cologne, and thence to Elberfeld-Vohwinkel. Those who preferred the latter were only about

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a dozen, headed by our indefatigable chairman, Mr. Alexander Siemens. About two-thirds of the Elberfeld-Barmen line is now completed, and cars have been running for some time on this portion (about 2½ miles in length) at frequent intervals. They are self-contained motor cars, and they run at intervals of a few minutes, a loop of short radius connecting the up and down lines at the terminus. A brief illustrated description of the railway was published in *The Electrician*, Vol. XLV., p. 395, and those who wish to study the constructional details should read an excellent article by Herr G. Lüdorf in the *Elektrotechnische Zeitschrift* of June 27th last. Mr. Kapp, the general secretary of the Verband Deutscher Elektrotechniker, and editor of the above journal, kindly distributed copies of this number to our members at Dresden.

In the evening the main party departed for England, leaving only eight to visit the works in the neighbourhood of Essen and Dortmund. Meeting the representative of Messrs. Lahmeyer & Co., at Duisburg, we travelled to Essen, where the electricity works were inspected. This visit was followed by an excellent luncheon at Messrs. Krupp's private hotel, presided over by Mr. Heddaens, chief engineer of the Essen works, after which six of our party were obliged to leave in order to catch the boat train for London, and the representatives of the *Engineer* and *The Electrician* alone remained to visit the interesting mine-pumping plant at the Zollverein colliery, and on the following day the electrically-operated lock on the Dortmund-Ems canal. These will be dealt with in a later article, as they offer several points of novelty. The Dortmund electricity works were not visited—those interested in them will find an excellent descriptive article from the pen of Mr. John R. Dick, in *The Electrician*, Vol. XLV., pp. 42 and 81.

In concluding this general account of the Institution tour, and before commencing the articles specially devoted to individual works, I would like to express my thanks to all the firms whose works we visited and their engineers (whom space prevents me from mentioning by name) for the extreme courtesy they showed me throughout, and their endeavours to put all possible information before me. Coming as the representative of a foreign technical paper, it would not have been surprising had they withheld certain matters, and wished me to abstain from visiting certain departments of the various works; but, on the contrary, I was shown everything, and the amount of detail I should publish was left completely to my discretion. It will therefore be my endeavour in the articles which follow to give a general sketch of each works, of the operations carried on there, and the class of apparatus manufactured, and in fairness to our hosts the detail of methods of manufacture and workshop practice, which it was impossible not to observe—and to admire—will not be dwelt upon. If my notes do not furnish those who have stayed at home with a complete account of the works visited, they will at least suffice to show them what they have missed in not taking part in the tour.

As regards the leadership of our own party, Mr. Alexander Siemens was a most energetic chairman. He attended all the visits and social functions and took the major share of the speech-making. His energy was second only to that of our secretary, Mr. McMillan, to whose credit it should be stated that everything went off without a hitch (excepting some important details in the hotel and luggage arrangements, for which Messrs. Cook & Son appear to have been responsible). The visit of the Institution of Electrical Engineers to Germany must be written down a complete success from all points of view. Should our German colleagues pay us a return visit, as hinted by Mr. Siemens in one of his speeches, we shall have to do our utmost to give them a similar reception.

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[*Errata.*—Fig. 2, on page 440 of the last issue of *The Electrician*, represents the new generating station for the Dresden tramways, and not the electric lighting station, as stated in the foot-line. The sets seen in the foreground are engines made by the Dresdner Maschinenwerk und Schiffswerft driving Kummer shunt-wound dynamos. In the second paragraph on page 441, the alternate capacity of the Dresden telephone exchange switchboard should have been given as *about 10,000* instead of 70,000.]

## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 439.*)

Having reviewed the general arrangements for electric lighting and power supply in my introductory article (July 12th, p. 437), I will now proceed to deal with the various exhibits in detail. The ideal course would be to commence with the steam-raising plant and proceed, on the lines laid down in my first article, through the power-generating plant and distributing systems to the various stalls. Unfortunately, as in most earthly things, it is impossible to comply absolutely with an ideal, but I shall do so as closely as possible. Owing to certain exhibitors not yet being able to supply me with illustrations and full particulars of their exhibits, I shall have to depart from this arrangement in a few instances.

§ 1. Stirling Water-tube Boiler.—The Stirling Boiler Co. have erected two of their boilers in the steam-raising department, one being fired by Vicars' mechanical stokers and the other by gas fuel generated by a Duff gas producer described in the next section. The general construction of the Stirling water-tube boiler is shown in Fig. 2.

It will be seen that the heating surface is supplied with water tubes 3¼in. external diameter, and that the main tubes connect three steam drums above with two water drums below and are nearly vertical, being grouped in three banks with fine brick baffles between. These cause the hot furnace gases to take a course along and between the tubes. The three steam drums are connected together above the water level by tubes, and likewise between the front and mid drum, below the water level. The main tubes are straight throughout the greater part of their length, but curve with easy bends toward each end to enable them to enter the drum perpendicularly, the ends being expanded into the drums. There are no brickwork supports under the lower drums, which hang by the tubes to the upper drums, these latter being supported on iron girders. In the large combustion chamber with its three sides lined with firebrick the refractory action assists to perfect the combustion caused by the mixing of the furnace gases in this chamber before the gases give out their heat to the water tubes. The boiler is simple to repair, being so designed that any single tube can be readily replaced without disturbing others in the event of a tube giving out, and this can be easily done within an hour's time. A new feature of the boiler is the ease with which it can be got at. By removing a mandoor (of the internal pressure type) on each drum, access is gained to the inside of every part of the drums, which, being from 3ft. to 3ft. 6in. in diameter, are of ample size.

Four of these boilers have been working for two years at the Edinburgh electric light station, where they are fitted with chain grate stokers. I understand that they have given great satisfaction and have had to carry an extremely heavy load during the trying winter months at these works. Stirling boilers have also been erected at a number of other electric power stations. As this boiler is perhaps less known to readers of *The Electrician* than some of the other types used in power stations, I append the following particulars from a report on a trial of it by Prof. J. A. Ewing, F.R.S. :—

| | *Trial A.* | | *Trial B.* |
|---|---|---|---|
| Duration of trial | 4·93 hours. | ... | 1·283 hours. |
| Water evaporated: total | 39,520lb. | ... | 15,860lb. |
| Ditto per hour | 8,020lb. | ... | 12,360lb. |
| Coal: total | 4,704lb. | ... | 1,890lb. |
| Ditto per hour | 954lb. | ... | 1,472lb. |
| Ditto ditto per square foot of grate | 22·2lb. | ... | 34·3lb. |
| Water evaporated per lb. of coal | 8·41lb. | ... | 8·40lb. |
| Pressure in boiler, by gauge | 155lbs. per sq. in. | ... | 155lb. per sq. in. |
| Temperature of feed | 74°F. | ... | 76½°F. |
| Ditto flue | 455°F. | ... | 590°F. |
| Water collected in separator | 39lb. | ... | 10lb. |
| Proportion of water collected in separator | 1/1,000 | ... | 1/1,500 |
| Draught gauge, inches of water | 0·4 | ... | 0·75 |
| Equivalent evaporation from and at 212°F., per hour | 9,560lb. | ... | 14,710lb. |
| Equivalent evaporation from and at 212°F., per lb. of coal | 10·03lb. | ... | 10·0lb. |
| Equivalent evaporation from and at 212°F., per hour per square foot of heating surface | 4·8 | ... | 7·4 |

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The boiler tested was guaranteed to evaporate 6,000lb. per hour with a flue temperature not exceeding 600°F. During the trials a much larger evaporation was given, with a much lower flue temperature. "Nixon's Navigation" coal was used throughout the trials, and was weighed out in parcels of 3 cwt. at a time. In the calorimeter steam was throttled and superheated by escaping through a small hole in a non-conducting plate into a small chamber at atmospheric pressure where its temperature was taken. The readings of the calorimeter were interpreted by comparing the temperatures observed during the trial with those shown by the same apparatus under conditions such that dry steam of the same pressure was supplied. The result may at once be stated here. It was found throughout the trials that the steam which had passed the separator was indistinguishable from perfectly dry steam. The water collected in the separator—a very small amount, as will appear from the figures given below—represents all the water present in the steam. On September 14, 1900, a preliminary trial was made, using feed-water which had been heated by exhaust steam. Owing to a defect in the arrangements for passing this hot feed through the measuring tanks the trial was discontinued after a short time, during which one boiler had been steaming at the rate of 11,000lb. per hour. Arrangements were then made for supplying cold water to the measuring tanks, and in the subsequent trials the feed was cold. The final trials were carried out on September 18th. In the first and principal trial of that date (Trial A) natural draught was used, and the trial was continued for five hours to give good data in regard to coal consumption. This was followed by a short trial under forced draught (Trial B) which was carried out mainly for the purpose of finding the greatest amount of evaporation which could be effected under that condition. The general results of the two trials are tabulated on p. 477.

§ 2. **Duff Gas-Producing Plant.**—Messrs. W. F. Mason (Ltd.), of Manchester, have erected in a yard adjoining the boiler house a small gas-producing plant for firing one of the Stirling boilers. The exterior of this plant is shown in Fig. 3, but without the water seal tank over which it is erected at the exhibition. I have been supplied by the makers with the following particulars of its construction, &c.: The producer at the Glasgow Exhibition is 12ft. diameter by 11ft. 6in. high, and is capable of gasifying about 15 cwt. of coal per hour.

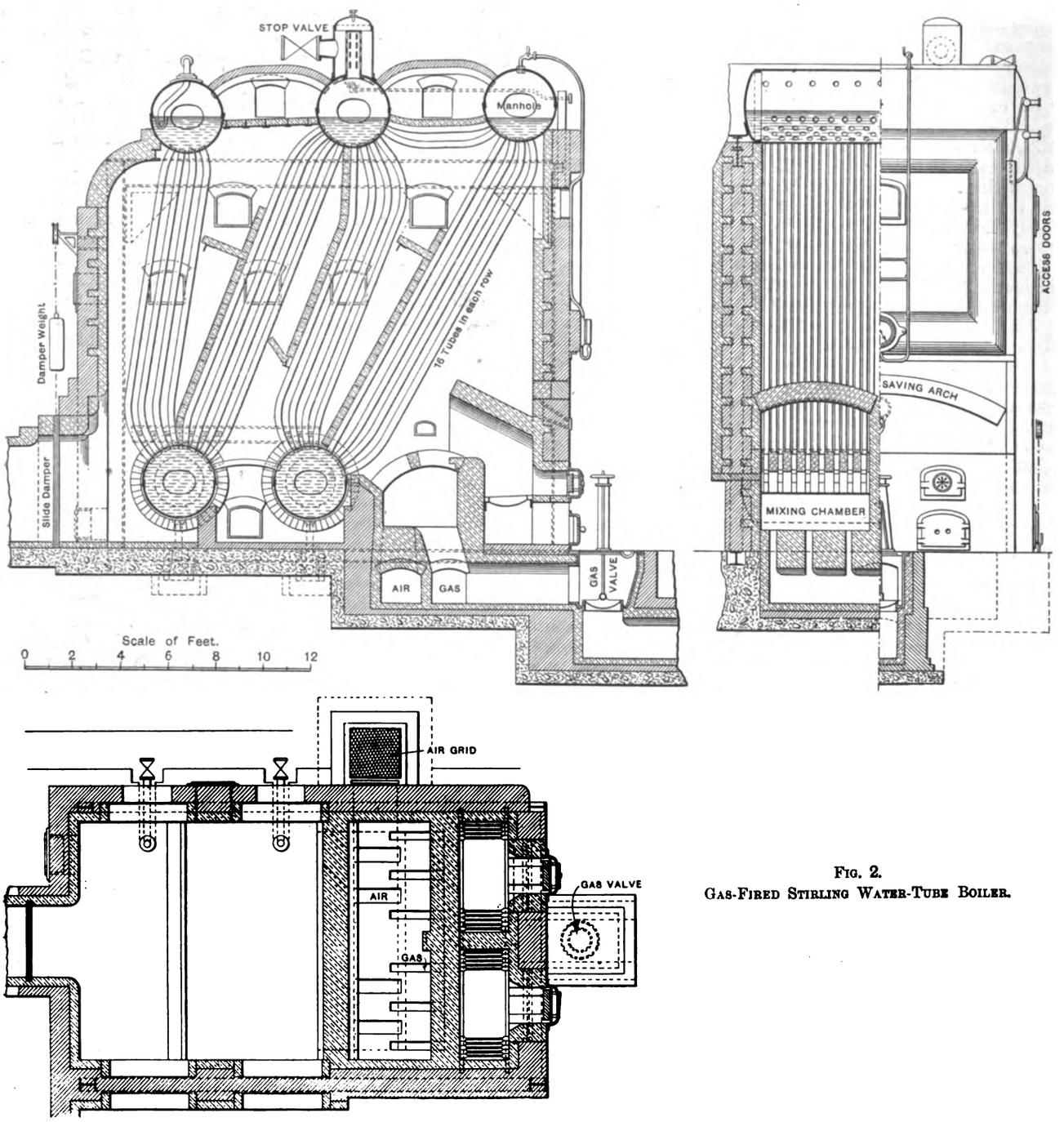


FIG. 2.
GAS-FIRED STIRLING WATER-TUBE BOILER.

The grate is formed of perforated cast-iron grids set at an angle of 45deg., through which the air is forced by a steam jet blower. The advantages of this grate over other types is that the air is evenly distributed through the whole mass of the fuel, so keeping an even temperature in the producer and preventing the fire burning through in holes, and the forma-

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tion of the large masses of clinker which occur where a large volume of air is directed against one particular part of the fire. The producer is continuous working, and the ash falls from the inclined grates into the water trough, and is raked out from either end. The air is prevented from escaping by two steel girders across the trough which dip into the

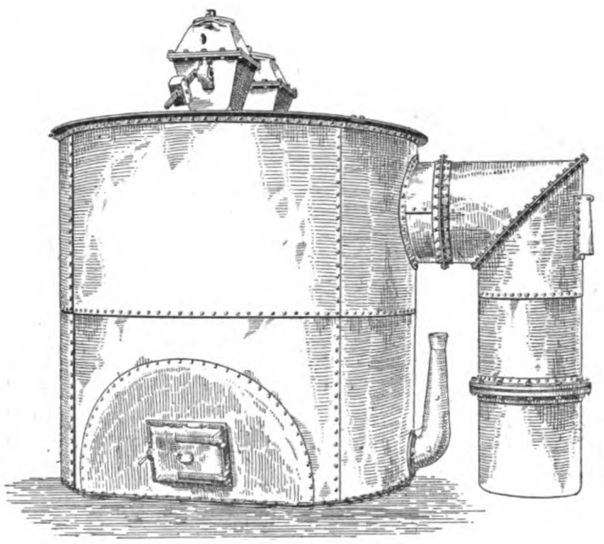

FIG. 3.—DUFF GAS PRODUCER FOR FIRING STIRLING BOILER.

water, and on which the brick lining of the producer is built. There are two coal-charging hoppers on the top of the producer with poking holes situated round them for stirring the fuel.

The economy in firing with gas is effected by being able to burn a far cheaper class of coal in the producer than can be used on a hand-fired grate. There is also the advantage that the life of the boiler is increased as a more even temperature can be maintained by the gas in the combustion chamber, so lessening the strains which the tubes in a water-tube boiler and the flues in a Lancashire or Cornish boiler are subjected to when the firing doors are opened and a large volume of cold air is drawn over the fuel.

§ 3. Davey, Paxman & Co.'s Superheated Steam Plant Exhibit.—This exhibit comprises an "Economic" boiler, capable of raising 8,000lb. of steam per hour, together with the special type of tubular superheater designed by the firm to produce a superheat of 230°F. to 300°F. The steam raised in this exhibit is used in the Davey-Paxman engine described in the next paragraph. Accordingly, for this exhibit there is a special arrangement of steam piping. Fig. 4 shows the boiler

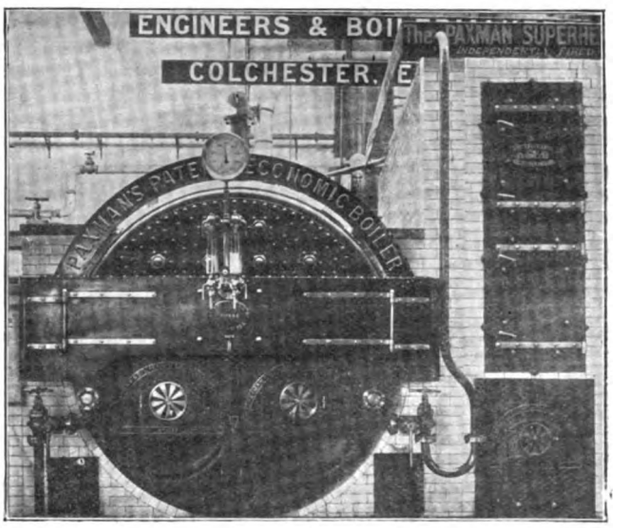


FIG. 4.—DAVEY, PAXMAN "ECONOMIC" BOILER AND SUPERHEATER.

front and exterior of the superheater. In the boiler each flue is provided with Paxman's expansion flue, which gives it such strength that thinner plates can be used than would be safe in the plain flue. The flue is built up of a series of short lengths, which are composed of fine, soft, tough steel. The plates are bent in such a way as to be perfectly cylindrical when finished, thus adding to the strength of the flue. They are then carefully welded. When welded, the ends are heated in a suitable furnace, and enlarged in a powerful flanging machine in such a way that the end of one plate fits exactly within that of the next, the holes are then drilled through both, and riveting completes the work. The new arrangement of smoke tubes, which Davey, Paxman & Co. have recently patented, enables a thorough inspection internally to be made of every part of the boiler.

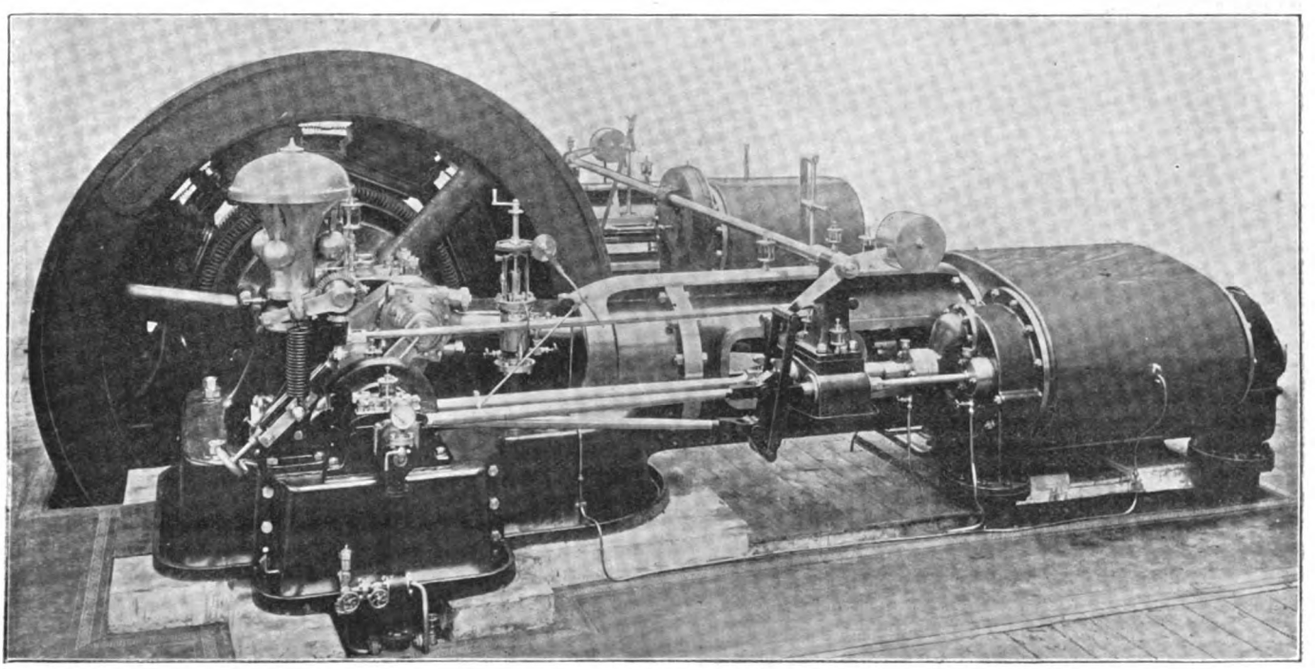

FIG. 5.—DAVEY, PAXMAN-E.C.C. STEAM DYNAMO SET.

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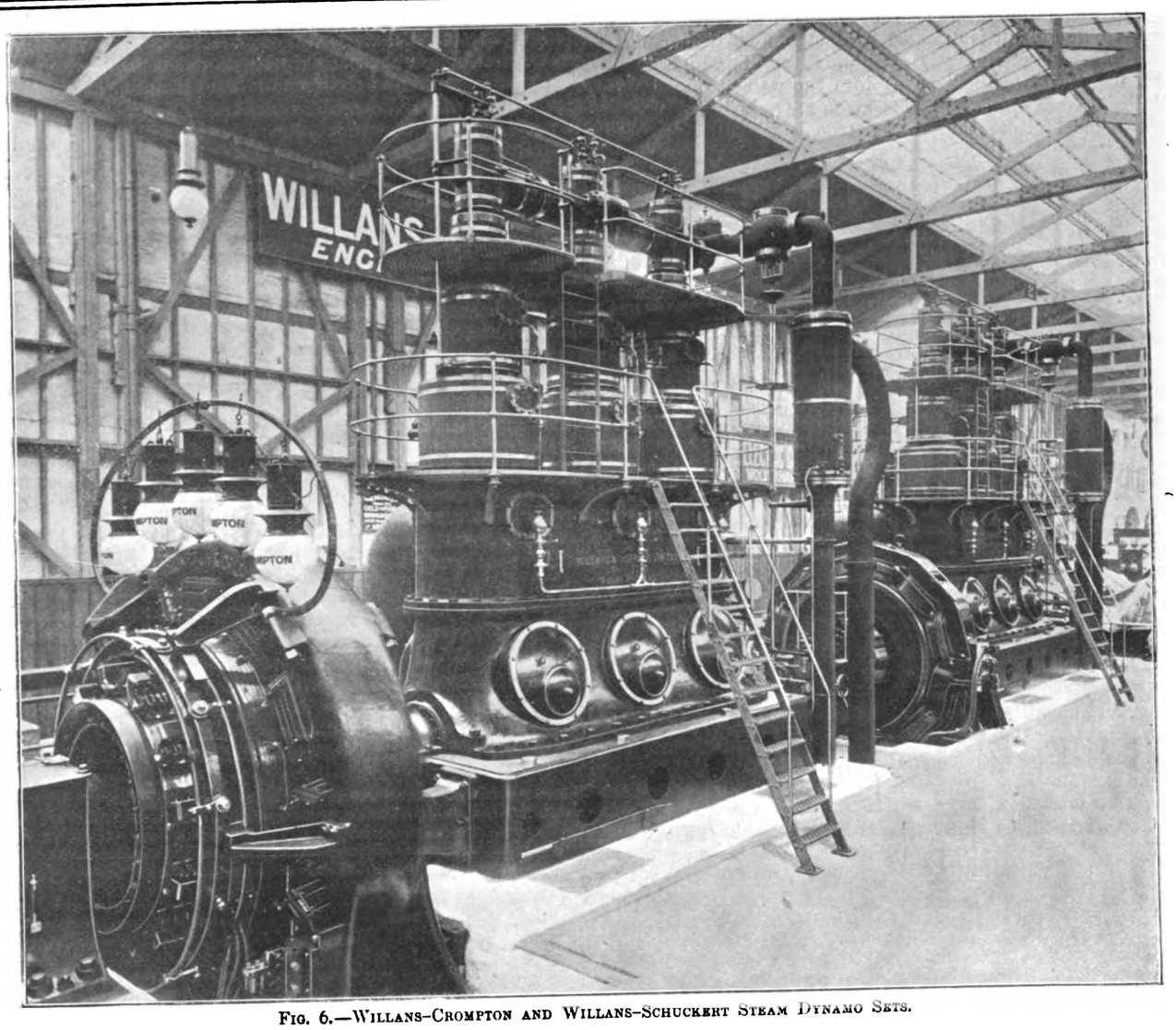


FIG. 6.—WILLANS-CROMPTON AND WILLANS-SCHUCKERT STEAM DYNAMO SETS.

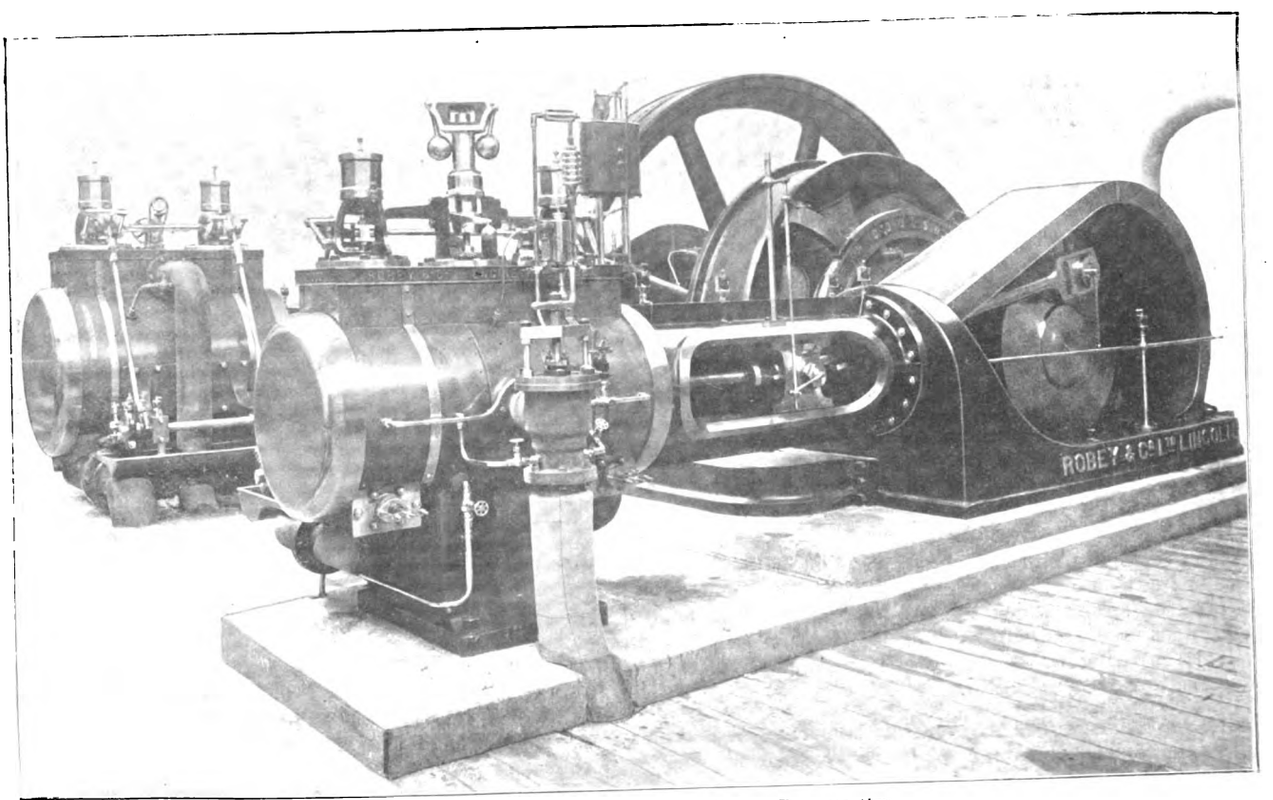


FIG. 7.—ROBEY-MAVOR AND COULSON STEAM DYNAMO SET.

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The superheater is placed alongside of the boiler, and is connected with the steam pipe so that the engine can be run with saturated or superheated steam as may be desirable. The superheater is composed of seven elments, each consisting of one divided header, the compartments of which are connected by a series or single-loop tubes extending into the superheating space. The headers are connected together by elbows in the rear, and the steam is compelled to flow through the superheating chamber to and fro seven times. The superheater is independently fired with coke or anthracite coal, and has the flues arranged so that the tail gases can be delivered under the "Economic" boiler, and thence through the economiser to the chimney, or direct to the economiser or chimney. The whole of the hot gases from the superheater furnace can be passed into the main flue, and the superheater instantly thrown out of action in emergency or when the fire is being lighted. The heat in the chamber is controlled by six registers regulating the emission of the gases into the down flues forming cavity walls around the furnace and heating chamber, and by this construction the hot gases can be held in the superheater, and the amount of superheat given to the steam can be finely graded to the requirements of the engine. The superheater as at present arranged is suitable for adding 300°F. to 8,000lb. of steam per hour at a pressure of 160lb. per square inch, but is adaptable and can be arranged to superheat large quantities of steam to a proportionately lower degree of superheat dependent upon the variations of temperatures on the inside and outside of the tubes and the volume of steam passed through the superheater. It is intended to carry out a series of certified steam trials of the plant in actual work at the exhibition in order to demonstrate the economies effected when non-condensing.

§ 4. Davey, Paxman-E.C.C. Steam Dynamo Set.—This set, shown in Fig. 5, consists of a 650 B.H.P. horizontal cross-compound Davey-Paxman engine direct-coupled to a continuous current multipolar dynamo manufactured by the Electric Construction Co. An interesting feature of this exhibit is that the feed heater is placed close to the engine set instead of being near the boiler. The engine is provided with a re-heater between the cylinders, fed with superheated steam, raising the temperature of the high pressure exhaust steam above saturation temperature before it enters the low-pressure cylinder.

The engine is one of Paxman's 650 B.H.P. traction generators running at 150 revs. per min., and the general design evidences very careful adaptation to meet the special running conditions encountered in electric traction service. The valve driving gears are placed in the front of each main crank instead of being keyed on the crank shaft on the inner side of the main bearing. The reason for this is obvious after consideration of the advantages obtained in having the whole of the valve motion driving in direct line on the valves and the great reduction of the centres of the main bearings, with the consequent shortening of the main shaft on which the heavy flywheel and the armature of the generator are mounted. In connection with the last-named improvement, to show its value, I may quote in comparison a case recently brought under my notice of an electric traction engine bearing the name of a well-known American maker in which the main bearings of a 1,000 B.H.P. engine were 22ft. 6in. centres, and the static deflection measured midway between the bearings was 0·025in. In the "Paxman" electric traction engine the centres of the main bearings are 8ft. 6in. apart, and the static deflection is 0·008in., and thus maintains the concentricity of the armature in an almost unvarying magnetic field, largely minimising the irregular inductive loads arising from shaft deflection. The steam distribution to the engine is effected by Paxman's automatic expansion gear, operating the piston valves, which admit steam into the cored recesses around the main piston valves. The expansion gear is applied to the high and low-pressure cylinders, and is specially arranged to maintain an approximate constant receiver pressure, and is held in reserve when driving light loads, so that the maximum power of the engine is instantly available to deal with suddenly imposed overloads. The governing mechanism is a fine example of a well-thought-out gear to meet the actual conditions of electric traction service, inasmuch that the work done against gravity by the governor balls moving in an arc is compensated by varying the increments of the load imposed on the spring, so that the variation factor of the governor speed is constant for each portion of the movement throughout the whole range of the governor. The arrangement of the speed-adjusting gear on the governor is distinctly novel, and admirably fulfils its purpose of maintaining a constant percentage of variation of speed at all speeds within the limit of the gear.

*Leading Dimensions of Engine.*

| | |
|---|---|
| Diameter of high-pressure cylinder | 15½in. |
| Diameter of low-pressure cylinder | 27in. |
| Length of stroke | 30in. |
| Revolutions per minute | 150 |
| Diameter of flywheel | 10ft. 6in. |
| Width of flywheel | 12in. |
| Weight of flywheel | 8½ tons |
| Main bearings | 11in. diameter by 20in. long |
| Diameter of piston rod | 3½in. |
| Crank pin | 6½in. diameter by 8½in. long |
| Gudgeon | 5½in. diameter by 7½in. long |

The electric generator exhibited is the Electric Construction Co.'s standard 500kw. machine, of the high-speed type, but wound in this case for a speed of 150 revs., giving an output of 300kw. at the usual electric traction E.M.F. of 500 volts, and over-compounded 10 per cent. The machine, which is eight-polar, is noteworthy for the care with which details have been worked out, and for massive construction combined with perfect symmetry and high finish. The yoke frame, or magnet ring, is circular and of approximately elliptical section of high permeability cast iron, this material being adopted in order to obtain the utmost rigidity, together with the necessary measure of magnetic stability. It is suitably divided for erection and accessibility, on the horizontal plane passing through the centre of the shaft. The lower half is provided with substantial feet, which are bolted to and adjustable from independent foundation plates. There are eight interior projecting magnet cores, formed of the highest permeability rolled steel plates, laminated sufficiently to secure average equality of material throughout. The plates are cast into the ring, and provided with removable pole faces of special shape, which form a means of magnetic adjustment should this be necessary. The armature is mounted approximately midway upon the engine crank shaft, and is in the form of a massive cast-iron barrel, rigidly keyed to the shaft, and terminating in an enlarged flange coupling, which is bolted direct to the flywheel, and which practically carries the whole of the torsional stresses. The armature core is of finely laminated charcoal iron, specially selected for low hysteresis loss, the whole being suitably divided into narrow discs, between each of which air is forced by an internal fan arrangement for ventilating purposes, the shaft being grooved below the core boss for the air intake. This method is very efficient, and permits of considerable excess load being carried with comparatively small range of temperature. The armature winding is of the usual barrel type, the conductors being machine formed, and the loops are jointless. The slots are straight-sided, and the insulation is ample for the voltage, each loop being subjected to an independent pressure test of 3,000 volts. The winding is secured by the usual hard wood wedges in the slots and by metal bands, with cottered joints for the end connections. The magnet coils are wound with pyramidic winding, which is a feature of most of the Electric Construction Co.'s larger machines. The ferrules are detachable, and provided with massive gunmetal flanges, heavily insulated. The series coils are of high conductivity rectangular section copper, formed into two spirals on each limb, and are removable without interference with the shunt coils. The commutator is of ample proportions, the carbon brush-holders being carefully designed with a view to flexibility, lightness and durability. The brush connections are concealed from view by being placed in a cast-iron ring, which also carries the brush pillars and is supported by brackets attached to the yoke. The brush ring is adjustable by the usual hand-wheel arrangement in connection with a worm and rack, and rides upon friction rollers fitted in the lower guides. The design of the machine throughout is on very liberal lines, and the electric and mag-



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netic proportions are such that the machine is sparkless at all loads with the brushes in a fixed position.

§ 5. Willans-Crompton Steam Dynamo Set.—Messrs. Willans and Robinson have an imposing exhibit consisting of the two 1,200 H.P. engines shown in Fig. 6, one of the engines being direct-coupled to a Crompton dynamo and the other to a machine constructed by the British Schuckert Electric Co. The two steam engines are similar in design and are of the 3V type. Each engine is rated at 1,200 H.P., running at 230 revs. and at 160lb. pressure, non-condensing. It may here be mentioned that there are no condensing arrangements in the exhibition so that the rating is, in every instance, on the assumption that the engines are unprovided with condensers.

Messrs. Willans and Robinson's exhibit is one of the largest steam electrical plants ever shown in operation by a single firm at an exhibition, with the exception, perhaps, of the Paris Exposition of 1900, where, it may be noted, they were also largely represented, and showed a 3,000 H.P. engine coupled to a dynamo. This set, which obtained a grand prix, was employed in supplying light and power, and was one of the largest steam dynamos there. The exhibit at Glasgow is of the same total power as that at Paris, but is divided into two engines, each having a normal output of 1,200 H.P. and a maximum of 1,500 H.P. The engines are triple-expansion, of the firm's usual vertical central-valve type, and run at a speed of 230 revs. per min. Each engine has three cranks at 120deg., with a complete tandem engine placed over each, having low-pressure, intermediate-pressure, and high-pressure cylinders, 37·5in. (950mm.), 23·6in. (600mm), and 15in. (380mm.) in diameter respectively, thus giving the same turning moment on each at all loads. The stroke is 17in. (430mm.). The weights of the three sets of moving parts are equal, a property which, for reasons now well known, ensures complete freedom from vibration. The cranks run in an oil bath contained in the bedplate, and by their splash, afford copious and automatic lubrication to the moving parts. As the engines are single-acting, caps are not required upon the bearings, which are, therefore, continuously exposed to the lubricant. In fact, the engines differ in no way from smaller sizes, except that the crank chamber is divided longitudinally to facilitate removal of the crank shaft without complete dismantling. The total floor space required by each engine is 16ft. by 8ft. 6in., and the weight about 34 tons. One engine has a flywheel faced to form a coupling, and the other merely a coupling disc, the necessary flywheel power being provided by the revolving part of the dynamo. In both cases the couplings are bolted directly to flanges upon the armature castings, not to couplings upon the shafts.

By the side of one of these engines Messrs. Willans and Robinson exhibit probably the smallest Willans engine ever built—a toy engine of accurate proportions, running at 1,000 revs., and rated at 1¼ B.H.P.; in fact, it is a compound two-crank standard GG type diminished, and is marked No. 1A. It stands about 2ft. over-all, and is direct coupled to a two-pole Crompton dynamo developing 80 volts. This little set is run occasionally, much to the amusement of the visitors, but naturally, with the very limited supply of steam afforded by the exhibition authorities, visitors are sometimes disappointed at finding it standing idle!

The large Crompton dynamo is rated at 1,000kw., and is built with 12 poles and 12 sets of carbon brushes. It develops from between 1,910 and 1,620 amperes at from 510 to 600 volts respectively, being over-compounded for electric traction, though at the exhibition it runs on the shunt only. The armature of this dynamo weighs 19 tons, and owing to this ample mass no flywheel has been added, a feature in which this set differs from the companion set coupled to a Schuckert dynamo where the flywheel weighs 8 tons.

§ 6. Willans-Schuckert Steam Generator Set.—The engine in this set has been described in the previous paragraph. The dynamo is of the 12-pole type, compound-wound, giving 1,920 amperes at 600 volts. A feature of this machine is that it is doubly connected to the engine—viz., both at the shaft and at the flywheel. The pole-pieces are cast solid, with the pole tips screwed on. The carbon brushes are fitted with aluminium holders. The armature, which weighs about 11 tons, is slot-wound, and is provided with a commutator of 480 segments. Both the shunt and series windings are in two parts, coupled in parallel.

§ 7. Robey-Mavor and Coulson Steam Dynamo Set.—Fig. 7 shows a 500 H.P. combination of horizontal slow-speed Robey engine direct-coupled to a multipolar Mavor and Coulson continuous current dynamo.

The engine is fitted with the "Richardson" automatic trip gear the cylinders being 20in. by 35in. diameter by 42in stroke, designed to give 500 I.H.P. to 550 I.H.P. as an economical load when running at 90 revs. per min. with 150lb. steam pressure. The frame of the engine is of massive construction, having bored guides for crossheads and four part main bearings, lined with a special plastic metal, fitted with side adjustment. The bearings can be easily removed for inspection and adjustment when required, and are of large size and two diameters in length. The disc shaft is of steel, swelled in centre to receive the flywheel and armature. The discs are of massive section shrunk and keyed on the shaft, the total weight of the shaft, with discs and armature, being 20 tons. The flywheel, to which is bolted the armature, thus relieving the keys from a large portion of the strain, is proportioned to give an angular variation of 1 in 200, or ½ per cent. The steam admission is controlled by "Richardson" mechanical and electric governor, which automatically gives a steam admission from 0 to 0·60 of the stroke, according to the load. It is so arranged that in the event of a "short" in the mains, or total cessation of the current from whatever cause, the electric regulator will stop the engine, and when used for electric power driving in factories the engine can be stopped from any point by the turning of a switch. Continuous lubrication is fitted to all working parts. The steam consumption per indicated horse-power-hour is 17lb. at full load, non-condensing, and the combined full load efficiency is 86 per cent.

The dynamo, which is the largest yet built in Scotland, was built by Messrs. Mavor and Coulson, and is mounted upon the crankshaft of the engine between its main bearings. It is designed to give an output of 630 amperes at 550 volts, at a speed of 90 revs. The dynamo armature is of the slotted drum type, with a core built up of charcoal iron annealed discs insulated with varnish and keyed to a cast-iron spider detachable from the armature shaft. The discs are pressed together by hydraulic power, and air ducts are provided for the efficient ventilation of the core. The armature coils are of high conductivity laminated copper bars wound on formers and insulated before being laid into the slots of the core, which are themselves lined with insulating channels. The commutator is carried on a cast-iron sleeve which is bolted directly to the armature core. The joints of the armature conductors with the commutator are soldered by being dipped in a trough of molten metal, thus ensuring the thorough heating and floating of the joints. The insulation of the commutator is of mica and micanite throughout. The magnets are of high permeability cast-steel of channel section with pole shoes bolted to the poles. The magnet coils are wound on formers detachable from the pole arms, and together with the armature are stove baked in dry air and treated with insulating varnish. The brushes are of the "Reaction" type, and are mounted on a cast-iron ring supported from the magnets by brackets. The field magnets are of Messrs. Charles Cammell & Co.'s steel, the armature discs are by Messrs. Joseph Sankey & Son, the micanite by Messrs. Bergtheil and Young, and the conductors by the Telegraph Manufacturing Co.

§ 8. The Berryman Feed Heater.—Returning, briefly, to the boiler department, I may notice the Berryman and "Excelsior" feed heaters exhibited by Messrs. J. Wright & Co., of Tipton, Staffs. The construction of the Berryman feed heater is shown in Fig. 8. The Berryman heaters are working under a pressure of 150lb. per square inch, and the Excelsior heaters are non-pressure working and contain a filter and oil separator, enabling all the condensed steam to be used in the heater, all the oil being extracted from it. As regards the Berryman heaters, each heater has a 12in. steam inlet and outlet is 16ft. high by 8ft. 6in. diameter. Each heater is nearly filled with solid drawn brass tubes. The feed water is forced,

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under pressure, by the pump at the bottom of the steel casing and is discharged from the top by a 5ft. outlet. As regards the Excelsior type of heater, the water is supplied at gravitation pressure through a 4ft. automatic feed valve and falls

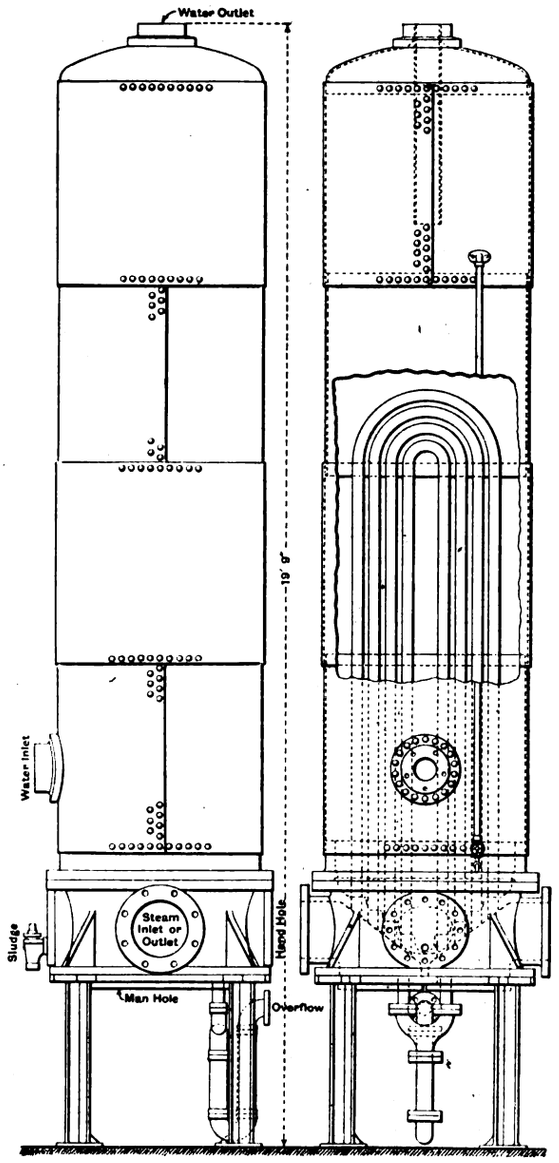



FIG. 8.—BERRYMAN FEED WATER HEATER.

over spreaders on to a steam baffle plate, and then through perforated grease plates and large filtering medium into the chamber from whence it is drawn by the pump.

*(To be continued.)*

## THE CHAUDIÈRE FALLS TRANSMISSION PLANT.

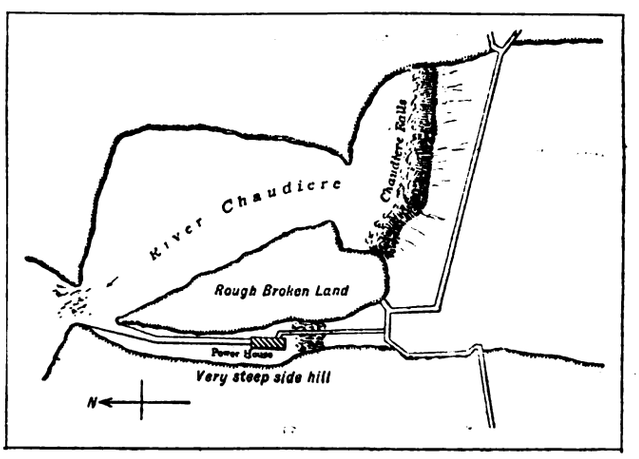
A recent number of the *Electrical World* of New York describes the plant at the Chaudière Falls for supplying power to Levis and Etchemin, south of Quebec.

As will be seen by the small map of falls and surroundings the conditions existing at the falls for an easy and inexpensive development were ideal. The small channel shown to the right of the island was at all times, except during high freshets, free from water. This channel ran for a few hundred feet below the head of the island, when it, like the river, plunged through a gully some 800ft. long and almost at the level of the water below the falls. At the point immediately where the channel made its descent to the lower level, the gully widened out sufficiently to allow the power house to be built, as well as room for three 8ft. 3in. flumes, which it is intended to use when the full power of the falls is utilised.

The main dam from the eastern abutment to the point where it connects to the wing dam is 824ft. long, with an average height of 19ft. on a base of 20ft. This dam, as well as all other works connected with the water development, was built of concrete composed of cement one part, sand two parts and broken stone four parts. The foundation of the dam was carried well into the rock, the concrete being placed on a thick bed of cement mortar after the bedrock had been thoroughly scrubbed from all adhering dirt. From the main dam the wing dam was carried down 159ft. to the bulkhead, the crest of the wing dam being at the same level as that of the main dam.

The bulkhead which closes the inlet of the small channel is a massive structure of concrete 120ft. long and 30ft. wide at the base, and connects on the western shore of the river to an earthen embankment with a concrete core wall, this last being carried some 200ft. up the river and then running into a side hill some 300ft. from the original river bank. The bulkhead is provided with three inlet cones, which pass through at the base, one of these being connected to the existing flume. The centre of these cones is 15ft. below normal water level. The rack and headgates are in front of this bulkhead, steel being the only material employed in construction of this part of the work. The flume, of a diameter of 8ft. 3in. and supported on steel piers, runs 175ft. from the bulkhead, then dips at an angle, finally ending at the power house at floor level and at a distance of 340ft. The tail race, which extends 800ft. from the power house to the end of the island, is partly natural and partly artificial. The difference of level between still water in the pond at dam and in tail race is 115ft., affording a working head of about 112ft.

The power house, which is built partly over a concrete arch which spans the tail race and partly over natural rock foundation, has been planned for an ultimate capacity of 5,000 H.P. At present the plant consists of two 1,400 H.P. and two 50 H.P. waterwheels. The larger wheels are directly connected to two 755kw. three-phase 10,500 volt generators. The smaller wheels are directly connected to two 30kw. direct-current dynamos, which serve as exciters. Governing is




obtained by two Lombard governors on the larger wheels and by common pawl governors on the smaller wheels. The generators are of the revolving field type, three-phase, with a normal voltage of 10,500, 66 ∼, and a speed of 400 revs. per min. ; they were made, as well as all other electrical plant in the power house, by the Canadian General Electric Co., of Peterborough, Ontario.

The transmission line extends from the power house to the city of Levis, 9 miles away. Poles are of cedar, 35ft. to 45ft. long, and with 7in. tops. The pole line is designed to carry three circuits of three wires each for 4 miles (one circuit being connected to a sub-station at that distance), and two circuits for the remaining distance of 5 miles. Poles are spaced 100ft. No. 4 medium drawn copper is used on the circuits. There are two long spans on the line, one 500ft. long over the River Chaudière a few hundred feet from the power house, and another of 300ft. over the Etchemin River. In the first case hard drawn No. 1 wire is used, and the problem of anchoring and insulating the end of the wires was solved by bringing the wires a complete turn over an 8in. by 10in. beam, and tying the free end to the wire spanning the river, the wire in its turn over the beam being supported by porcelain insulators of triple petticoat pattern. The object of making the complete turn around the beam was to obtain a compressive strain on the insulators instead of the usual side strain, which, with the span in question, would have sheared the tops of any insulator. The strain is also evenly distributed, a condition never obtained where the insulators are in series. The span over the river Etchemin is made in the ordinary way, the wire on this being smaller and distance less. There are two sub-stations, one at Levis and the other at Etchemin. The first is provided with two three-phase–two-phase 150kw. oil-cooled transformers made by the Westinghouse Company, and reducing the pressure from 10,000 volts to 2,080 volts. The Etchemin sub-station is provided with a duplicate equipment of the Levis station, but for one-half the capacity.



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## THE DESIGN OF ELECTRICALLY-DRIVEN FACTORIES.

In last week's issue of *Engineering* there is an abstract of a Paper, read by Mr. W. S. Aldrich at a recent meeting of the American Society of Mechanical Engineers, on the "Requirements of Electricity in Manufacturing Work." One matter dealt with in the Paper is the "influence of electric transmission upon factory buildings." The author when dealing with this subject points out that the electric drive does not require the heavy wall construction and overhead work generally which is necessary when only shafting is used, and goes on to say that "the site for buildings may be chosen independent of power considerations and located on most suitable ground. There is no necessity for buildings being placed around or adjacent to the power-house, as required for mechanical connections to engines or turbines. Grouped shops may be arranged in best manner to facilitate economic production and the handling, conveying and transportation of material and work. Detached buildings—a tendency of certain lines of modern manufacturing development—are feasible, and the work therein facilitated by electric transmission. The isolation of various shops, departments, and workrooms for manufacturing or insurance reasons may be carried to any extent with the electric system without impairing its efficiency or economy. The output per square foot of floor space is a maximum with electric transmission." We are afraid that too often the British manufacturer designs his buildings and groups his shops first, and only when the construction work has commenced does he start to consider whether he will transmit the power by shafting or by electricity. Even if he has gone thoroughly into the question with an electrical expert, it is probable that with timorous uncertainty, while deciding to utilise electrical transmission, he will arrange his shops so that, should it prove a failure, he may revert to the antiquated method of his childhood. It is of the utmost importance if England wishes to keep her commercial supremacy that she should awaken to the fact that every possible economy, both of time and money, should be utilised to its fullest extent; and this

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can only be done if her workshops are built on the latest and most improved lines. Electrical driving for large works has been proved to be the most economical method, and it is decidedly one of the chief merits of electric transmission that the producer can arrange both his buildings and machinery as best suits the economic production of his wares. We trust that every manufacturer will in the near future realise this advantage.

There is no doubt that in the case of new works of considerable size, where electrical transmission is unquestionably best, the general arrangement of shops and machinery should be worked out first; the electrical engineer should then be called in to advise on the arrangement of motors and shafting, and at the same time the electrical system to be employed should be settled. This latter consideration would naturally depend greatly on whether electrical energy was being supplied at a low enough price to dispense with the necessity of the manufacturer installing his own plant. If the price was low enough the scheme would, of course, depend on the method of supply; but if their user had to instal his own plant, the relative advantages of the direct and polyphase current systems would have to be carefully weighed for the particular works on hand. The question of slight alterations of the arrangement of the machinery might be next considered, if necessary, to permit of full advantage being taken with relation to the most economical grouping of the motors; but, as a rule, it will be found that the grouping which is best from the manufacturer's point of view will be admirably suited for electrical driving. The weights and strains of the motors and shafting should then be calculated, when the designs of the buildings can be put in hand. In the case of small shops these considerations do not hold good, though, where electricity is being supplied in bulk at a low enough price to compete with isolated steam plants, it would often amply pay the manufacturer to plan out the arrangement for electric driving before the architect commences his work.

There is another point in connection with the influence of electrical transmission in factory design on which Mr. ALDRICH dwells, and which is, at the same time, an advantage in favour of the use of electric driving. It is the ease with which future areas of work may be planned, irrespective of power considerations. This convenience, we consider, gives electrical transmission alone a great superiority over belt driving where future extensions are probable, but it is with the use of electric power from an outside source that the unlimited expansion by small steps may be utilised to the greatest extent, as pointed out by Mr. J. S. RAWORTH in his Paper read before the Manchester Association of Engineers on October 28, 1899 (see *The Electrician*, Vol. XLIV., page 42). Mr. RAWORTH showed that with all rapidly-expanding manufacturing businesses additions to the steam plant always became necessary at intervals recurring more or less rapidly, and this trouble would be felt with isolated electric plants just as much as with isolated steam plants. This last point should most certainly be taken into account when the question of installing plant or taking energy from the mains is under consideration; but we do not look on it as of such primary importance as the designing of the factory. Thus every probable extension to the buildings may be allowed for without overcrowding and without interfering with the existing conditions; more especially as these extensions may be arranged without taking into account the power requirements. This facility is practically the same, whether alternating or continuous-current systems are used, and it makes little difference whether an isolated plant be installed or the current be taken from the supply company's mains.

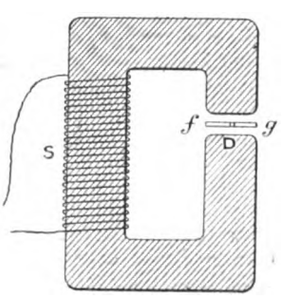
## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Hall Effect and Resistance of Bismuth.*—E. van Everdingen has made some careful researches on small columns of pure bismuth cut from the crystal which served Perrot for his interesting thermo-electric experiments. Some of them were cut parallel to the principal axis, and the others at right angles or at an angle of 60deg. to it. The results show that the Hall effect is large when the magnetic force is normal to the principal axis, very small when the two directions are parallel, and follows an ellipsoid of revolution for any intermediate angle. A similar ellipsoid, with axes in a ratio of about $\sqrt{5} : \sqrt{3}$, may be constructed for the resistivity when the substance is not placed in a magnetic field. When the magnetic field is parallel to the axes, the only difference made is that the ratio of the two axes of the ellipsoid is slightly changed. If, on the other hand, the magnetic field is normal to the crystalline axis, the three axes of the ellipsoid are all different. For a field of 4,600 units the ratio of the three axes would be about $\sqrt{5{\cdot}7} : \sqrt{3{\cdot}2} : \sqrt{3{\cdot}1}$. The percentage increase of resistance is 18·5 for the direction of the crystalline axis, 4·5 for the direction of the field, and 8·0 for a direction normal to both. A novel observation is that of a positive Hall effect in a field of 4,600 units, with the field parallel to the crystalline axis.

[E. VAN EVERDINGEN, *Phys. Zeitschr.*, July 6, 1901.]

*Rectifier based upon the Hall Effect.*—A somewhat sensational application of the Hall effect is proposed by T. des Coudres. He points out that if an alternating current is sent through an electromagnet and at the same time through a Hall plate, the lateral electrodes will convey a constant current, since the reversal of the main current is compensated by a simultaneous reversal of the magnetising current. A simple rectifier based on this fact is shown in the diagram,




where a bismuth plate *fg* is placed in the air-gap D of an electromagnet excited by an alternate current. Lest any rash electrician should plan the commercial application of this elegant device, the author shows by figures that a practical utilisation is not to be thought of, as the efficiency would necessarily be very low. But an alternate-current investigation of the Hall effect promises interesting theoretical results, and the new device may profitably be employed not only as an electrodynamometer or wattmeter, but also for the harmonic analysis of current curves with the aid of a sine inductor. The bismuth plate must be very thin for all these applications, but it offers the advantage of a very small inductance.

[T. DES COURDES, *Phys. Zeitschr.*, July 6, 1901.]

*Hertzian Waves in Thunderstorms.*—The influence which thunderstorms exercise at a distance of thousands of miles upon persons affected by certain nervous diseases, long before any physical instrument announces an atmospheric disturbance, suggested to F. Larroque that Hertzian waves emitted by thunderstorms might possibly be propagated over enormous distances through the middle and higher atmosphere by means of something corresponding to relays. He, therefore, constructed an elementary kind of "receiver" in the shape of a horizontal plate of zinc, 40cm. in diameter, earthed by a thin copper wire containing a spark gap in a dark cellar. During the great atmospheric disturbances of June, 1901,

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several series of nocturnal observations were made. One of them coincided with the blizzard in the Grampians, and the other was carried out during a thunderstorm which, in the night of June 18, was visible over Corsica from the Département des Alpes Maritimes. In both cases the sky was serene at the place of observation. The author points out the great importance which this kind of meteorology may acquire, without, however, venturing an explanation of the actual transmission of Hertzian waves over the enormous distances specified.

[F. Labroque, *Comptes Rendus*, July 1, 1901.]

*Effect of Annealing upon X-Ray Transparency.*—Faraday observed that a sheet of silver or gold foil could be annealed in such a manner as to lose its metallic reflection and become transparent to white light, subsequently regaining its original state on being compressed between two slabs of agate. This curious observation has not been explained, but R. Malagoli has made observations on plates of gold and silver, with a view of determining whether similar modifications of transparency could be produced with respect to Röntgen rays. In most cases the annealed plates underwent a slight increase of opacity. The same observations was made in the case of gold or silver foil. But when the latter was used in the form of some 50 sheets pressed together a great increase of transparency was observed. This is the exact equivalent of Faraday's effect. It is probably explained by differences of physical structure, which, in the case of plates and uncompressed films, produce an increased surface reflection, and in the case of compressed films, a decreased surface reflection. That the action in question is a surface effect is made very probable by the disappearance of surface colour in Faraday's experiment.

[R. Malagoli, *N. Cimento*, June, 1901.]

*Calorimetric Measurements of Electric Oscillations.*—F. Harms made some experiments with the bridge arrangement for rapid electric oscillations suggested by Nernst. Working with waves 10m. long, he found that in the case of alcohol the telephone minimum became very bad—much worse indeed than in the case of substances conducting 100 times better. This could only be due to anomalous absorption in alcohol. The author therefore employed a calorimetric method for proving the existence of such absorption. The difference between the observed evolution of heat and that calculated from the resistance would be the heat of absorption. If, on the other hand, Ohm's law is to preserve its validity in the domain of anomalous absorption, the resistivity must be taken as varying with the frequency. The author used a bulb provided with platinum electrodes and a narrow thermometer tube, and proved the existence of anomalous absorption in five different alcohols. The anomalous absorption, regarded as an increase in the conductivity, may be used for calculating the anomalous index of absorption with and of the formulæ used for calculating the normal index of absorption from the electrolytic conductivity.

[F. Harms, *Ann. der Physik*, No. 7, 1901.]

*Natural and Radio-Active Air.*—J. Elster and H. Geitel find a number of analogies between air in its natural state and air which has been blown over radio-active substances. Such air imparts to other substances a temporary radio-activity, which can be considerably enhanced by giving those other substances a negative charge during exposure to the air. A similar kind of radio-activity may be produced by ordinary air. It is only necessary to expose, say, a negatively charge piece of wire gauze for several hours to the open air. The wire gauze then behaves like a body of feeble but distinct radio activity. It imparts electric conductivity to air, even across a piece of aluminium foil, and the authors claim even to have obtained photographic effects. The natural conclusion is that, wherever the potential gradient of the atmosphere produces a negative charge of the earth (as on mountain tops), there must exist a radio-activity of the earth and an increased conductivity of the air above it. The author's researches leave it an open question whether this "emanation" of the air is due to its known constituents or to a radio-active gas unknown. In any case there is an attractive field for further investigation.

[Elster and Geitel, *Phys. Zeitschr.*, July 6, 1901.]

*Space Telegraphy.*—Skunkichi Kimura, a Japanese naval electrician, has made some valuable researches on the influence of the earth on wireless signalling. This influence cannot be determined by means of the Marconi apparatus, since neither the coherer itself nor its tapping mechanism work uniformly. The author therefore employed his "sound receiver," which indicates all variations of the current by variations of the intensity, sharpness, or duration of the tone. He used five different earth contacts for the mast-wire, comprising plates, cylinders, and wires of various materials and dimensions. The best results were obtained with a tin cylinder put in a ground saturated with sea water. The author believes that the earth connection works by its capacity rather than its conductivity, and a large earthing plate is therefore advantageous. Signals over 50 miles were obtained with an earthing device consisting of three oil cans placed on grass. He points out that the induced E.M.F. cannot be the sole cause of the decrease of resistance in the coherer, and that a node of potential cannot exist at the other end. The problem of "tuning" must in any case take into account the capacity of the earthing arrangement.

[S. Kimura, *Phys. Zeitschr.*, June 29, 1901.]

## ELECTRICITY WORKS ACCOUNTS.

### Worcester Municipal Electric Supply Works.

On the whole the operations of the Worcester undertaking during 1900 were satisfactory. The aggregate costs show an increase of no more than 0·304d. per unit, with a rise in the fuel item of 0·32d. The interesting report of the engineer states that the amount of £1,051, by which the coal bill of last year exceeded that of 1899, was almost entirely due to the higher price, and not to increased consumption. In fact, the coal consumption for 1899 was 2,068 tons, and for 1900 2,157 tons—figures which work out respectively at 11·19lb. and 11·27lb. per unit generated by steam. This slight increase in fuel consumption is accounted for by the different class of coal used. It must be confessed that, at 1·03d. per total unit sold, the fuel charge at this place is surprisingly high considering that no more than 57·87 per cent. of the output was generated by steam, and that the remainder, or 49·13 per cent., was by water power. Owing to a comparative absence of floods of long duration and to a rainy summer, the water power available was above the average.

It should be stated that there was a breakdown of one of the engines, necessitating its being run for about eight weeks on the high pressure side only and thereby increasing the coal used by some 50 tons according to the report.

Owing to increases in the tariff, which came into force in the last quarter of the year, the revenue per unit shows an increase, and it is therefore hardly surprising that the additional lamp connections were below those of 1899—the percentage increase being 10·6, and that of the output 13·5. The load factor was 14 per cent. as against 14·3 per cent. in 1899.

The contract with the Free Wiring Company was determined in June, when the Corporation introduced a free wiring scheme of their own.

The following table indicates the progress of the undertaking:—

| Year. | No. of consumers | Equiv. 8 c.p. lamp connections. | Output units sold. | Total revenue. | Total costs. | Profit after paying int. and sinking fund charges. | Total costs per unit. |
|---|---|---|---|---|---|---|---|
| 1895 | 181 | 13,522 | 246,912 | £3,254 | £3,061 | -£1,977* | 2·975d. |
| 1896 | 241 | 21,958 | 333,644 | 4,758 | 3,155 | - 1,616* | 2·270d. |
| 1897 | 291 | 24,712 | 429,270 | 6,292 | 4,097 | - 1,475* | 2·290d. |
| 1898 | 382 | 28,496 | 474,344 | 7,154 | 3,944 | - 460* | 1·996d. |
| 1899 | 433 | 31,202 | 551,437 | 8,331 | 4,540 | + 91 | 1·976d. |
| 1900 | 475 | 34,494 | 625,739 | 9,613 | 5,944 | + 3 | 2·280d. |

* Deficit.

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| | WORCESTER. | WINDSOR AND ETON. |
|---|---|---|
| *Undertaking Worked by* | Worcester Corporation. | Windsor Electrical Installation Co. (Ltd.). |
| *Date of Commencement of Supply* | October 11, 1894. | November, 1896. |
| *System of Supply* | Alt.-curr. trans. in sub-stations and houses. | Continuous-current 3-wire. |
| *Chief Engineer* | C. J. Sutherland. | A. E. Farrow. |

| YEAR ENDED | DEC. 31, 1899. | DEC. 31, 1900. | DEC. 31, 1899. | DEC. 31, 1900. |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 710,416 | 842,132 | 280,000 | — |
| „ SOLD (TOTAL) | 551,437 | 625,739 | 272,535 | 336,523 |
| „ sold to consumers | 441,837[a] | 519,690[a] | — | 214,338 |
| „ sold for public lighting, &c. | 109,600 | 106,049 | — | 122,185 |
| „ used on works | 8,495 | 8,605 | 6,500 | 6,500 |
| UNITS SOLD PER 8-C.P. LAMP CAPACITY | 19·6 | 22·2 | 14 | 16·2 |
| Maximum supply demanded | 440 kilowatts | 510 kilowatts | 244 kilowatts | 312 kilowatts |
| Number of public lamps | 57 arc, 3 glow[b] | 57 arc, 16 glow[h] | 34 arc, 296 glow | 44 arc, 300 glow[b] |
| Number of consumers | 433 | 475 | 230 | 318 |
| Connections to mains in 8-c.p. lamps | 31,202 | 34,494 | 13,878[a] | 18,133 |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 28,100 | 28,100 | 19,500 | 20,760 |
| CAPACITY OF PLANT IN KILOWATTS | 900 | 900 | 625 | 665 |

| CAPITAL— | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| AUTHORISED (TOTAL) | £74,738 | £83·1 | £79,688 | £88·5 | — | — | — | — |
| Share | — | — | — | — | £50,000 | £80·0 | £50,000 | £75·2 |
| Loan (including Debenture charges) | 74,738 | 83·1 | 79,688 | 88·5 | — | — | — | — |
| RECEIVED (TOTAL) | 63,175[c] | 70·2 | 68,210[c] | 75·8 | 35,000 | 56 0 | 50,000 | 75·2 |
| Share | — | — | — | — | 35,000 | 56·0 | 50,000 | 75·2 |
| Loan (including Debenture charges) | 63,175 | 70·2 | 64,840 | 72 1 | — | — | — | — |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | 11,563 | 12·8 | 12,940 | 14·4 | — | — | nil | — |
| Share (unissued) | — | — | — | — | 15,000 | 24·0 | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | 11,563 | 12·8 | 12,940 | 14·4 | — | — | — | — |
| REPAID (TOTAL) | — | — | — | — | — | — | — | — |
| RESERVE OR SINKING FUND | 8,022 | 8 91 | 9,908 | 11·0 | 2,922[j] | 4·68 | 5,920[e] | 8·90 |
| DEPRECIATION FUND | — | — | — | — | 46,905 | 75·1 | 53,670 | 80·7 |
| EXPENDED (TOTAL) | 79,236 | 88·0 | 82,622 | 91·7 | 7,056 | 11·3 | 8,274 | 12·4 |
| Lands and buildings | 26,245 | 29·2 | 26,245 | 29·2 | 19,319 | 30·9 | 22,435 | 33·7 |
| Plant | 51,960 | 57·5 | 55,243 | 61·4 | 19,298 | 30·9 | 21,677 | 32·6 |
| Mains | | | | | 1,233 | 1·97 | 1,285 | 1·93 |
| Miscellaneous | 1,031 | 1·15 | 1,135 | 1·26 | | | | |
| BALANCE OF CAPITAL ACCOUNT | −16,061[d] | −17·8 | −14,412[d] | −16·0 | −11,905[d] | −19·1 | −3,670[d] | −5·52 |

| REVENUE— | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
|---|---|---|---|---|---|---|---|---|
| TOTAL | £8,331 | 3·626d. | £9,613 | 3·687d. | £7,529 | 6·628d. | £8,473 | 6·043d. |
| Revenue from supply | 6,767 | 2·944d. | 7,935 | 3·044d. | 4,506 | 3·968d. | 5,502 | 3·923d. |
| „ meters, &c. | 182 | 0·079d. | 220 | 0·084d. | 121 | 0·106d. | 185 | 0·132d. |
| „ public lighting | 1,322 | 0·575d. | 1,379 | 0·529d. | 979 | 0·863d. | 1,674 | 1·194d. |
| „ sale of lamps, &c. | — | — | 39 | 0·015d. | 1,811[f] | 1·594d. | 1,071[l] | 0·764d. |
| „ miscellaneous sources | 60 | 0·026d. | 40 | 0·015d. | 112 | 0·099d. | 41 | 0·029d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £4,540 | 1·976d. | £5,944 | 2·280d. | £3,750 | 3·303d. | £4,431 | 3·159d |
| WORKS COSTS | 3,558 | 1·549d. | 4,861 | 1·865d. | 2,804 | 2·470d. | 3,179 | 2·267d. |
| *Generation of electricity* | *3,115* | *1·356d.* | *4,440* | *1·703d.* | *2,543* | *2·239d.* | *2,754* | *1·964d.* |
| Fuel (including cartage, &c.) | 1,626 | 0·708d. | 2,678 | 1·028d. | 1,802 | 1·596d. | 1,826 | 1·302d. |
| Oil, waste, water, stores | 157 | 0·068d. | 218 | 0·084d. | 242 | 0·213d. | 252 | 0·180d. |
| Wages at station | 953 | 0·415d. | 1,037 | 0·398d. | 276 | 0 243d. | 334 | 0·238d. |
| Repairs and maintenance at station | 379 | 0·165d. | 508 | 0·195d. | 224 | 0·197d. | 343 | 0·245d. |
| *Distribution of electricity* | *133* | *0·058d.* | *88* | *0·034d.* | *151* | *0·133d.* | *129* | *0·092d.* |
| Wages, &c. | 133 | 0·058d. | 3 | 0·001d. | 83 | 0·073d. | 129 | 0·092d. |
| Repairs, renewals of mains, &c. | | | 85 | 0·033d. | 68 | 0·060d. | | |
| *Public lighting* | *310* | *0·135d.* | *333* | *0·128d.* | *110* | *0·097d.* | *296* | *0·211d.* |
| Attendance | 310 | 0·135d. | 333 | 0·128d. | 110 | 0·097d. | 296 | 0·211d. |
| Renewals | | | | | | | | |
| MANAGEMENT AND PROPERTY CHARGES | 982 | 0·428d. | 1,083 | 0·415d. | 946 | 0·833d. | 1,252 | 0·893d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *47* | *0·020d.* | *49* | *0·019d.* | *106* | *0·093d.* | *244* | *0·174d.* |
| *Management* | *935* | *0·407d.* | *1,034* | *0·397d.* | *840* | *0·740d.* | *1,008* | *0·719d.* |
| Salaries | 460 | 0·200d. | 482 | 0·185d. | 635[h] | 0·559d. | 750[h] | 0·535d. |
| Stationery, &c. | 64 | 0·028d. | 64 | 0·025d. | 45 | 0·040d. | 39 | 0·028d. |
| Establishment charges | 32 | 0·014d. | 23 | 0·009d. | 78 | 0·069d. | 81 | 0·058d. |
| Law charges, &c. | 379[c] | 0·165d. | 465[i] | 0·178d. | 82[g] | 0·072d. | 138[m] | 0·098d. |

| FINANCIAL RESULTS— | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
|---|---|---|---|---|---|---|---|---|
| WORKING PROFIT FOR YEAR | £3,791 | 4·94% | £3,670 | 4·53% | £3,780 | 10·5% | £4,042 | 8·04% |
| Sum carried to Depreciation Fund | — | — | — | — | 750 | 2·08% | 750 | 1·49% |
| Sum carried to Reserve or Sinking Fund | 1,756 | 2·29% | 1,721 | 2·13% | | | | |
| Net interest on loans (incl. Debenture charges) | 1,945 | 2·53% | 1,945 | 2·40% | 31 | 0·086% | 20 | 0·40% |
| BALANCE FROM LAST ACCOUNT | nil | — | 91 | 0·112 | 492 | 1·37% | 691 | 1·37% |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 91 | 0·118% | 94 | 0·116% | 2,991[i] | 8·31% | 3,963 | 7·88% |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | 8%[k] | — | 8% | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 54·5% | | 61·9% | | 49·8% | | 52·3% | |
| Expenditure per kilowatt capacity | £5. 0s. 10½d. | | £6. 12s. 2d. | | £6. 0s. 0d. | | £6. 13s. 4d. | |
| REVENUE PER KILOWATT CAPACITY | £9. 5s. 2½d. | | £10. 13s. 7d. | | £12. 0s. 10d. | | £12. 15s. 0d. | |
| Expenditure per 8-c.p. lamp capacity | 3s. 3d. | | 4s. 2¾d. | | 3s. 10¼d. | | 4s. 3¼d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 5s. 11d. | | 6s. 10d. | | 7s. 8½d. | | 8s. 2d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 5s. 4d. | | 5s. 7d. | | 10s. 10¼d. | | 9s. 4¼d. | |
| Price charged for lighting, per unit | 6d. to 2½d.[f] | | 6½d. to 3 l. | | 6½d. | | 6½d. | |
| Price charged for power, per unit | | | | | 4d. | | 4d. | |
| Price charged for public lighting | £22. 16s. 0d. per arc.[g] | | £22. 5s. 0d.[j] | | £22 per arc per ann. | | £22 per arc per ann.[c] | |

WORCESTER.—REMARKS—*a* Includes 116,918 units in 1899 and 145,246 units in 1900 taken by waterworks motors. *b* The arcs are 500 watts each and the glow lamps 200 watts. *c* Inclusive of premiums £1,908, miscellaneous sources £385 and £1,042 from General District Fund. *d* Over-expended. *e* Insurance £50 net, law £102. Free Wiring Co. £47, and "lamps" £199. *f* 6d. for first hour of maximum demand, 2½d. after. *g* Assuming an equivalent of 58 arcs in 1899. *h* The arcs are of 500 watts each, 13 glow lamps of 60 watts and three of 600 watts. *i* Law £16, compensation for accident £75; Insurance £50; free-wiring £57, and "lamps" £267. *j* Per equivalent 50 J watt lamp

WINDSOR AND ETON.—REMARKS—*a* Of which 869 represents motors. *b* Ten 10 ampere arcs and 34 5 ampere arcs; the glow lamps are of 16 c.p. *c* For the 10 ampere arcs; for the 5 ampere arcs £16 is charged, and for the public glow lamps in Windsor £3, 7s. 6d. each, and in Eton £3. 12s. 6d. each per annum. *d* Over-expended. *e* After adding £2,247 from premiums on share issues, there is also a reserve fund—the "dividend equalisation account" with a credit balance of £1,000 after adding £1,500 from premiums. *f* £233 from sale of steam and £1,578 profit on installation work. *g* Inclusive of £17 to auditing, £34 insurance, and £31 law. *h* Including £350 directors' fees. *i* After deducting £500 placed to "dividend equilisation account." *j* After adding £1,272 from premiums. *k* 4 per cent. out of profit of lighting department and 4 per cent. from installation work. *l* Includes £134 from sale of steam, and £937 profit on installation work. *m* Law £24, insurance £92, auditing £22.

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**Windsor Electrical Installation Co. (Ltd.).**

This company, fortunately, managed to effect a reduction in the fuel costs last year, an achievement quite possible considering the already high value of the coal item in 1899. Other economies—in the oil, &c., and wages—were neutralised by the increase in the repairs item at the station. The rents, rates and taxes were also responsible for a rise of 0·084d., which set at nought the improvement in the management charges, and thus the net result was a reduction in the aggregate costs of about 0·14d. per unit.

The diminution in the total receipts per unit was due to the smaller amounts received from sale of steam and for installation work. It is natural, therefore, that in respect to the capital the working profit has fallen, and that, while a dividend of 8 per cent. was distributed, £691 of the distribution came from the preceding year, and nothing was carried forward towards the current year.

Of the total equivalent lamp connection given, 1,083 represents the equivalent in motors connected.

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**The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—**

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Bath (Municipal) | April 20, 1900 | Leith (Municipal) | May 17, 1901 |
| Bedford (Municipal) | Aug. 3, 1900 | Leyton (Municipal) | Jan. 19, 1901 |
| Belfast (Municipal) | July 6, 1900 | Liverpool (Municipal) | Mar. 22, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | London (Company) | June 8, 1900 |
| Blackburn (Municipal) | Jan. 19, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bournemouth (Company) | May 3, 1901 | Morley (Municipal) | June 14, 1901 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | July 12, 1901 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 10, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | May 3, 1901 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 28, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | April 19, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Municipal) | July 5, 1901 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 26, 1901 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | South London (Company) | May 31, 1901 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | Southport (Municipal) | July 7, 1899 |
| Folkestone (Company) | April 26, 1901 | Stafford (Municipal) | Aug. 17, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Guildford (Company) | Oct. 19, 1900 | Taunton (Municipal) | June 16, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Hammersmith (Vestry) | June 29, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hanley (Municipal) | July 27, 1900 | Wandsworth (Company) | April 19, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Hast'gs & St. Leonards (Mun.) | July 12, 1901 | Winchester (Company) | May 17, 1901 |
| Hove (Company) | May 10, 1901 | Windsor (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woking (Company) | Dec. 22, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Kensington & Knightsbr'(Co.) | Mar. 16, 1900 | Woolwich (Company) | May 31, 1901 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-on-Thames (Mun.) | July 20, 1900 | Great Yarmouth (Mun.) | Dec. 26, 1900 |
| Lancaster (Municipal) | Feb. 15, 1901 | | |

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## THE EQUITABLE ALLOCATION OF COSTS IN COMBINED LIGHTING AND TRACTION STATIONS.*

BY W. H. TITTENSOR

(Electrical Engineer, Dundee Corporation.)

In bringing this subject before the Association, the author feels that the present time and place are particularly suitable for its consideration and discussion.† Owing to the rapid development of municipal enterprise in this country within recent years, local authorities, duly armed with the necessary (and in some cases unnecessary) powers, find themselves, as undertakers, face to face with problems, upon the proper solution of which the degree of commercial success attending a given undertaking may depend.

The question as to whether power for traction should be generated by a combined lighting and power plant or in a station specially erected and fitted up with plant for that purpose alone, is one of these problems, and it is the one perhaps which at the present moment is most urgently in need of the attention alike of the local authority and the electrical engineer. The two modes of procedure generally adopted in such a case are neither of them quite without more or less serious objections. (1) The outside expert, carefully formed as his opinion may be, is liable to be biassed by the "personal element," and this may be responsible to a great extent for the expert's decision in favour of a separate station. (2) In the case of the resident engineer responsible for the running of the lighting station the personal element, together with a better load factor, larger plant and correspondingly increased allocations to management expenses, may influence his decision in favour of a combined station. In view of these facts it is hardly to be wondered at that local authorities find it difficult to decide which is the better course to adopt. The author feels that in such cases the ultimate decision is too often due to the engineer's point of view being unduly emphasised at the expense of the commercial and purely business aspect of the question. Many successful engineering schemes will not bear to be thus looked at, and yet it is undoubtedly the standpoint from which all such questions should be determined. If a local authority were asking for a supply either of electrical energy or of any other commodity from two or more outside companies, it would, without hesitation, decide to buy from the cheaper source. The questions that the undertakers have to decide therefore are (1) Can the combined station *generate* as cheaply as the separate station? and (2) Which of these two stations can *supply* at the cheaper rate? The first question is one that any qualified adviser *with a knowledge of local conditions* can advise upon and be able to produce facts and figures to support his conclusions. The second question is one that many people would naturally expect to be dependent upon the first, but such is by no means the case, since that unknown element, "policy," has to be reckoned with.

Many people look upon an electric tramways undertaking, owned by a local authority, as a veritable "municipal Klondyke." If it leak out that the committee which is to be responsible for the running of the future combined station (generally the Lighting committee) takes this view, even in a modified form, then unfortunately there is every likelihood that the Tramways committee will put down its own generating plant.

The author has always held that supplies of a *purely public nature* should be given at *cost price*. Under this head would be included, for example—(1) public street lighting, (2) sewage pumping, (3) tramways, &c. On the other hand, however, no public works or department should be run on the lines of a "philanthropic institution."

The particular question dealt with in this Paper is the cost of generation in a combined station. When the existing station is provided with *suitable plant*, and the "centre of gravity" of the lighting and traction systems coincide, the cost of generation should be cheaper in a combined station than in a separate station, *if the costs are equitably allocated*. These should be in proportion to the plant used for tramway purposes, and not according to the total output of the station for both lighting and traction, or, in other words, the costs should be allocated on the basis of the maximum demand upon the plant only used for supplying the tramways and not on the whole of the generating plant in the station. The traction department should be treated as an individual consumer, and supplied at a rate proportionate to the cost of generating the power required. Treated in this manner the tramways are in an unique position inasmuch as their maximum demand can be pretty accurately foretold and provided for. On the other hand, the cost of supplying a lighting system, spread over some hundreds of consumers with a variable maximum demand, must necessarily be greater than the cost of supply to a traction system. The method adopted for determining the *selling price* of current to consumers supplied on the maximum demand system is pretty generally understood, and has been fully described and discussed elsewhere. The method of arriving at the *cost of generation* may, however, be dealt with on simpler lines, owing to the fact that in most stations the plant capacity is, or should be, well in excess of the actual maximum demand at any one time, in order to provide against interruption to the supply arising from breakdowns. The cost of "generating" and "supplying" electrical energy constitute two separate and distinct problems, and as such must be treated in accordance with attendant circumstances. In a given station the total standing charges will be the same, whatever the number of consumers connected may be or their total maximum kilowatt demand on the plant; but the cost of generation will vary in inverse ratio to the *number of units generated*, and it is unnecessary to take into consideration the maximum kilowatt demand in determining the cost per unit generated. It is, however, necessary in "supplying" individual consumers to differentiate in accordance with their maximum kilowatt demands in order to arrive at the cost per unit delivered at their terminals.

In considering the present subject the author deals only with the *cost of generation per unit*, and, in order to state the case more clearly, an example will be given of a station just commencing operations. One of the first questions asked will be: "What number of units

* Paper read before the Incorporated Municipal Electrical Association at Edinburgh.

† The author here refers to Glasgow.—ED. *E.*

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must be generated and sold at the 'maximum' rate charged in order to meet expenses?"

To determine this we will assume that cost of generation = standing + running charges, then let $x$ = number of units which must be sold at the maximum price in order to equal standing + running charges.

$a$ = The maximum price per unit *in pence.*
$b$ = The "running" cost per unit *in pence.*
$c$ = The total "standing" charges *in pence.*
then $x = c/(a-b)$.

*Example.*—The standing charges ($c$) in a particular station were £1,052. 8s. 2d. per annum.

The running charges ($b$) were 0·435d. per unit.

The maximum price ($a$) to be charged was 2d. per unit.

then $x = 252{,}578/(2\text{d.} - 0{\cdot}435\text{d.}) = 161{,}391$ units.

Therefore it is necessary, *in this particular case,* to sell 161,391 units per annum before all expenses are met, after which each unit will cost 0·435d.

The station referred to has an annual output of 322,782 units, therefore the total cost per unit generated would be

$$(252{,}578/322{,}782) + 0{\cdot}435 = 1{\cdot}217\text{d.}$$

It is generally understood that the total cost is divided into standing charges and running charges, and in order to arrive at the relative cost of generating electrical energy for lighting and tramway purposes respectively, it is necessary to remember that the standing charges allocated to the tramways as a consumer are not affected by the actual maximum demand at any one time on the plant, but are dependent upon the total plant capacity *installed for tramway purposes only.* This is owing to the fact that up to the present it has not been found advisible to run tramways and lighting simultaneously from the same generators.

Taking as an example a combined station supplying both lighting and traction, it will be found that certain plant is set aside and used for tramway work only, and it does not matter, therefore, what the load-factor may be, the standing charges on such plant will be constant. In determining the cost of generation, the crux of the matter lies in the allocation of costs. For the purpose of comparison the following headings will be used :—

| | | | | | |
|---|---|---|---|---|---|
| Interest, Sinking Fund, Management Expenses, | Insurance, Rents, Rates, Wages. | Standing Charges. | Fuel, Oil, &c. Repairs. | Running Charges. |

Dealing with these headings singly the amount allocated to the tramways account under each item should be determined on the following lines :—

### Standing Charges.

(*a*) *Interest and Sinking Fund.*—Charged on the full value of the plant and apparatus in use. Ditto ditto one half of the value of the stand-by plant required and available for lighting purposes also.

(*b*) *Management Expenses.*—Charged in proportion to the value of the plant included in the above and inclusive of clerical expenses actually involved.

(*c*) *Insurance.*—Charged in proportion to the value of the plant (*a*).

(*d*) *Rents, Rates, &c.*—Charged in proportion to the ground space occupied by plant included in (*a*).

(*e*) *Wages.*—Charged in accordance with the actual proportion paid to firemen, drivers, and attendants required on each shift during the hours that tramway plant is running.

### Running Charges.

(*f*) *Fuel.*—Charged on the actual fuel required for the running of the tramway plant. When steam is taken from a common bank of boilers the cost of fuel per unit must not be obtained by dividing the total weight of fuel used by the total number of units generated; this would be unfair to the traction plant, for, assuming that the latter is kept in proper repair, its efficiency will remain practically constant and the fuel consumption will vary but slightly, whereas in the case of the lighting plant the active stand-by losses vary considerably according to the lighting season of the year. By "active stand-by losses" is meant such losses as occur in the winter months when boilers have to be kept banked for several hours per day in readiness for the peak of the load in the evening. In the author's opinion it would be to the advantage of the traction plant to have its own boilers separate and entirely shut off from those of the lighting plant, as by this arrangement the proportionate consumption of fuel for traction could be ascertained without any difficulty. Where it is considered desirable, however, to have only one steaming plant for both traction and lighting, periodical tests of the efficiency of the traction plant should be made, when the actual fuel consumption per unit can be ascertained and apportioned accordingly.

(*g*) *Oil, &c.*—Charged on the actual quantity used on the plant in operation.

(*h*) *Repairs.*—Charged in accordance with the actual material used plus the cost of labour (as shown on time sheets) necessary to maintain the plant in good order.

As an illustration let a combined station be taken as follows :—

| | |
|---|---|
| Annual output for lighting..... | 835,000 units. |
| Do. do. traction..... | 500,000 do. |
| Total output..... | 1,335,000 do. |

Total capacity of plant, 1,300kw. Maximum demand for traction purposes, 300kw. Total capital spent on plant, buildings, &c., £63,662, or an average of £48 9 per kilowatt. The actual value of plant installed for tramway purposes was £15·6 per kilowatt (exclusive of mains and outdoor appliances). The total cost of generation was £11,125 per annum, made up as follows :—

| | | | | | | |
|---|---|---|---|---|---|---|
| Interest ..... | £1,401 | 15 | 0 = 0·252d. | per unit generated | | Standing charges. |
| Sinking fund ... | 967 | 17 | 6 = 0·174d. | do. | do. | |
| Management ... | 912 | 5 | 0 = 0·164d. | do. | do. | |
| Rent, taxes, &c. | 1,223 | 15 | 0 = 0·22d. | do. | do. | |
| Wages ..... | 912 | 5 | 0 = 0·164d. | do. | do. | |
| | 5,417 | 17 | 6 = 0·974d. | do. | do. or £4. 3s. 4d. per kilowatt installed. | |
| Fuel, &c. ..... | 3,726 | 17 | 6 = 0·67d. | per unit generated | | Running charges. |
| Oil, &c..... | 367 | 2 | 6 = 0·066d. | do. | do. | |
| Repairs ..... | 1,613 | 2 | 6 = 0·29d. | do. | do. | |
| Total .....£11,125 | | 0 | 0 = 2,000d. | do. | do. | |

The cost of generating 500,000 units under these conditions for tramway purposes was

$$\frac{450{,}000}{500{,}000} + 1{\cdot}026 = 0{\cdot}9 + 1{\cdot}026 = 1{\cdot}926\text{d. per unit generated.}$$

Under these apparently most favourable circumstances the tramway plant appears to be charged with a large portion of the capital and standing costs of the lighting plant and actually earns a profit of £1,312. 10s. per annum, which is appropriated for lighting purposes, whereas if the costs are equitably allocated, the actual cost of generation will be as follows :—

| | | | | | | |
|---|---|---|---|---|---|---|
| Interest ..... | £210 | 12 | 0 = 0·101d. | per unit generated | | Standing charges. |
| Sinking Fund ... | 140 | 8 | 0 = 0·067d. | do. | do. | |
| Management ..... | 158 | 10 | 0 = 0·076d. | do. | do. | |
| Rent, taxes, &c.... | 219 | 0 | 0 = 0·105d. | do. | do. | |
| Wages..... ..... | 273 | 0 | 0 = 0·131d. | do. | do. | |
| | 1,001 | 10 | 0 = 0·480d. | do. | do. | |
| Fuel, &c..... | 1,041 | 13 | 4 = 0·5d. | do. | do. | Running charges. |
| Oil, &c. ..... | 54 | 3 | 4 = 0·026d. | do. | do. | |
| Repairs ..... | 608 | 8 | 0 = 0·29d. | do. | do. | |
| | £2,705 | 14 | 8 = 1·296d. | do. | do. | |

In submitting the above figures, the author does not wish them to be regarded as model costs to be accepted as station records, as they would be proportionately lower in larger and better equipped installations. They are, however, intended to illustrate the application of the principles enunciated in this Paper to actual working conditions.

Having ascertained in a given case the actual cost of generation, the percentage of profit to be charged on the supply may then be determined. It would be well for those responsible for combined stations to see that the profit charged does not make the cost of the supply to the tramways undertaking too largely in excess of the amount for which the tramway people could generate their own current, or the chances are that this consumer will be lost to the station. In fact the advocates of the combined station, if they are to successfully combat the counter proposals which are almost sure to be forthcoming from the tramways department, must be prepared to show that they can supply power for traction cheaper than it could be produced by a separate station. The anthor's contention is that this can be done and profitably. In the combined station economies are effected in management and attendance (especially in the earlier stages), as a better paid and more competent staff can be employed in one station than in two separate stations, sharing the same amount of work between them: the management can, of course, be more efficiently carried out for the same reason. The cost of buildings and stand-by plant will also be less, as the latter being available for either lighting or traction need not be installed to the same extent as would be necessary in two separate stations.

Although some resident engineers may not look favourably upon a proposal to supply current for *any* purpose practically at cost price and may recommend separate stations, because of the greater amount of "management" required by the latter arrangement and the consequently increased remuneration likely to accrue therefrom, local authorities can hardly be expected to accept such recommendations, if before doing so they analyse them from a commercial and business standpoint. In bringing forward this subject—and it is one of vital importance at the present time—the author has done so more with the object of gaining for it the benefits of criticism and broader experience than with the desire to lay down any hard and fast rules, which might require modifying in order to suit certain localities and conditions.

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# PARLIAMENTARY INTELLIGENCE.

## CLYDE VALLEY ELECTRIC POWER BILL.

This bill, which has already passed the House of Commons, came, on July 10, before the Select Committee of the House of Lords presided over by Lord Welby. (The House of Commons proceedings were reported in *The Electrician* for April 5 and 26, and May 3, 10, 17 and 24.)

Mr. FREEMAN, K.C. (for the bill), said the whole of the promoters of this bill were persons who would take energy when the scheme was ready to supply. The area of the bill was 700 sq miles. There were 1,200 works in the area, many of which would themselves take a larger supply of electricity than was supplied by many burgh authorities for the electric lighting of their towns. There was no doubt the necessary capital would be found. The promoters would be able to supply electricity at 2d. as a maximum down to a 1d. per unit from their three generating stations at Motherwell, Yoker and Halfway House (between Paisley and Glasgow). From Motherwell would be supplied Coatbridge, Airdrie, Motherwell, Lanark, Uishaw and Hamilton; from Yoker supply would be made to all the shipbuilding yards on both sides of the Clyde, the proposed new docks, and the Singer Manufacturing Co.'s and other engineering works; and the Halfway House station would serve the shipbuilding yards and engine works on the south side of the river Clyde and the industrial interests of Renfrew. The only opposition now remaining was that of certain burghs on two points. Paisley complained of the power taken in the bill to carry the supply mains through Paisley; and certain other burghs, within which the right to supply was taken, asked that they might be excluded, and that, similarly to Paisley, the promoters should not be able to supply without their consent. Paisley and Motherwell had provisional orders authorising them to supply electricity, and they had erected generating stations; Clydebank was applying for a provisional order, and Dumbarton had not yet applied. The opposition of Airdrie and Coatswell was confined to clauses. If, however, the company's mains did not pass through Paisley, it would add many miles to the length of them, and they would pass through an agricultural district where current would not be required, and great inconvenience would be caused. The other burghs desired to be able to supply in their own districts. The answer to the request was that small burghs such as these were, although authorised to carry out works for electric lighting, were unsuited for the supply of electricity to the gigantic works which it was proposed to supply under the bill. One of two things would happen. Either they would be unable to supply at a reasonable price, or they would have to engage in what would be for them a reckless expenditure. In some cases one set of works would require more electricity than these burghs produced for their whole supply, and should such a set of works, if supplied by a burgh, leave the neighbourhood, the burgh would be left with enormous plant on their hands which would probably mean ruin. On the other hand, the company's enterprise would be divided over a larger area. The only other point was in regard to the control of the roads, but the burghs had power to prescribe the route, and to go before the Board of Trade should any question arise. He asked their lordships to confirm the proceedings in the other House.

Sir D. RICHMOND (ex-Lord Provost of Glasgow), a promoter, was thoroughly satisfied with the scheme incorporated in the bill, and considered it a necessity for the district, which was the most important industrial centre in Scotland. There was no promoting company, the bill being brought forward by those who really wanted the energy for their own purposes.

Mr. R. ROBERTSON, C.E. (Messrs. Strain and Robertson, Glasgow, engineers to the scheme with Messrs. Preece and Cardew), said his attention had been called for some years past to the necessity for some such scheme as the present to supply electricity cheaply for power in this district. If a small burgh wished to supply large works with power, they must of necessity go in for a separate installation and supply the works on a system quite apart from the ordinary lighting system and that for small workshops. Hence it was more economical and better in every way to supply from large central works. It was not the wish of the promoters to interfere with domestic lighting at all. They sought to do something which they thought the local authorities had no intention or power to do—to supply power to large works. The area of the scheme covered a large part of Dumbarton, Stirling, Renfrew and Lanark. Of the 19 burghs included originally in the area of the bill, the House of Commons Committee had excluded five—Govan, Partick, Port Glasgow, Paisley and Hamilton—but allowed the transit of mains in the case of Paisley. The three generating stations would have a capacity of—Motherwell, 10,000kw.; Yoker, 10,000kw.; Crookston, 5,000kw. By going outside towns for their generating stations, they estimated that the total cost per kilowatt would be one-third less than that estimated for municipal stations. They were quite satisfied that the capital proposed—about £1,200,000—was sufficient for the purposes. The difference in the cost per yard of laying cables in the paved street as compared with macadamised road was covered by 1s. per yard or £88 per mile. If the company's cable were taken outside Paisley, the cost of the additional 4 or 5 miles would be from £15,000 to £20,000.

Mr. A. H. PREECE (Messrs. Preece and Cardew) asked as to the comparative cost of taking cables through various kinds of roads, said that from contracts entered into by his firm he put the cost at 3s. a yard in the case of granite sets or macadam, and 1s. 9d. per yard for gravel with an 18in. trench. Those figures included temporary and permanent reinstatement. Where granite sets were placed upon concrete it would probably be 4s., and in the case of wood 10s. a square yard.

Bailie SHEARER, shipbuilder, Glasgow, said he had been considering the question of power for his yard for years, and had come to the conclusion that electricity was the most economical. If he provided it for himself he must spend some £23,000, and he was, therefore, glad to become a promoter of the present company, and intended to take his power from them. The owners of works in his neighbourhood would only be too glad to get the supply this company would give. Small burghs were quite incapable of supplying these large works, and it would be most unreasonable for them to attempt to do so in the interests of the ratepayers. It was possible that works might be removed, and that frequently happened on the Clyde. If the small burghs succeeded in defeating the scheme they would be putting a veto on enterprise.

Mr. GEO. F. LOWDON (Messrs. Lowdon Bros.) supported the bill.

Sir CHARLES W. COYZER, M.P., chairman of the Clan Line of steamers, said he did not believe in local authorities having a monopoly unless they met thoroughly the needs of the locality. He considered Paisley was shortsighted in not wishing to allow the company's mains to pass through the town, as, if they succeeded, it would debar them from obtaining a supplemental supply from the company should it be required in the future.

The case for the promoters was then closed, and

Mr. BALFOUR BROWNE, K.C. (for Motherwell Corporation), contended that Motherwell should be left entirely out of the area of the bill. The Corporation got an order in 1895 to supply the burgh with electricity, not merely for lighting, but for power also. Two or three years ago the Board of Trade consented not to revoke the order on the understanding that, if the Corporation did nothing soon, a company should be allowed to supply the district. Under that compulsion of the Board of Trade they had set up an installation of 550 H.P. for lighting and power, and had spent upwards of £30,000. The Corporation had thus put themselves in a position to supply the whole of the manufacturers, excepting six, in their district, and those six were such large users that they could supply themselves more cheaply than the local authority or the company could. The Corporation were supplying electricity at moderate prices for power, ranging from 2½d. to 1½d. per unit where 20,000 to 50,000 units were taken. They now asked the Committee to be left their diversity factor, which was essential to the success of their undertaking, and that this company should not be allowed to come in and steal from them that upon the strength of which they had spent the ratepayers' money. It was important that there should not be competition in this district.

After a number of local witnesses had given evidence in support of the Motherwell petitioner,

Mr. W. M. MORDEY (Messrs. Mordey and Dawbarn) said it was cheaper for large works to supply themselves with power. What little was gained in such cases by the production of electricity at large central stations was balanced by the losses in transmission and transformation and the cost of cables. Under the bill there was no guarantee that the company would not offer to sell in Motherwell at a price that was not determined by fair limits of competition.

Mr. B. JENKINS, C.E., and Mr. S. E. BRITTON, electrical engineer to Motherwell Corporation, also gave evidence, and the case was closed.

The opposition of Clydebank and Dumbarton, who also asked to be excluded from the scope of the bill, having been heard,

Mr. ERSKINE POLLOCK, K.C., addressed the committee on behalf of Paisley, which, although struck out of the bill in the House of Commons for purposes of supply was left in for the transit of mains. The Corporation now asked that that power should also be deleted from the bill.

Mr. W. M. MORDEY said there were several routes other than that through the principal streets of Paisley along which the company's mains could be taken, and besides there was the railway route which would equally well serve the purposes of the company.

Without calling upon Mr. Freeman, K.C., to reply for the promoters,

The CHAIRMAN announced that the Committee were satisfied the preamble of the bill was proved, subject to two alterations—first, that Dumbarton should be placed on the same footing as Motherwell as to refusing on reasonable grounds to allow the company to enter, and should be given an opportunity to obtain a provisional order; second, that the question as to communication with Johnston, whether inside or outside Paisley, should be left to the decision of the Board of Trade.

On Wednesday the Committee considered the clauses of the Clyde Valley Bill, and an application was made by Motherwell and Clydebank that clause 5 of the Electric Lighting Act, 1899, should be inserted in the bill, relating to security for carrying out the works under the scheme.

Mr. FREEMAN, K.C., said in clause 20 of the bill there was ample protection given, as £20,000 capital must be subscribed before the company could begin any works or interfere with any authority. He objected to the insertion of the clause asked for. It had been omitted both in the Cleveland and Yorkshire bills of this session.

The Committee decided not to insert Sec. 5 of the Electric Lighting Act.

On the clause of the bill limiting to 20 per cent. of the supply the amount allowed to be used by any consumer for lighting, an amendment was proposed on behalf of Motherwell and Clydebank to change the words "total amount of energy supplied" to "maximum at any time." The effect of the amendment, it was explained, would be that if a man took 1 H.P. for power purposes for eight hours he would not be allowed to use 20 per cent. of the whole supply in perhaps two hours for lighting, but 20 per cent. of the maximum supplied at any one time. That was an important matter in the question of competition for lighting. Under the bill, as it stood, 140 8-c.p. lamps might be used by a man taking 1 H.P.; by the alteration he would be entitled to use eight or nine lamps, which was a reasonable number.

The CHAIRMAN said the question had been before the Committee on the preamble, and they could not reopen the question.

The following amendment was inserted in clause 47:—

"Provided that in case of failure of the supply at any time by the company, such distributor shall not be liable to any consumers of such

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distributor for the consequences of such failure, or for any loss or damage sustained in respect thereof,"

the object being to extend the same indemnity to the burghs retailing current from bulk supply as was given in the bill to the company.

The remaining clauses were disposed of, and the bill ordered to be reported.

## MOND GAS BILL.

On July 11 the Select Committee of the House of Lords of which Lord Hatherton is chairman, had under consideration this bill. (The House of Commons Committee proceedings were very fully reported in *The Electrician* for May 3, 10 and 17.)

Mr. BALFOUR BROWNE, K.C. (for the bill), said Mond gas could only be used for heating and power purposes, not as an illuminant. One great advantage in connection with it was that in the process of its manufacture from slack, which only costs in normal times about 6s. per ton, as much sulphate of ammonia could be obtained as would fetch 4s. 6d., thus reducing the cost of the fuel to about 1s. 6d. per ton. The object of the bill was to give the public the benefit of this very cheap gas for heating and power purposes, and with that object to establish five different stations in Staffordshire at which to manufacture and distribute the gas. The gas could be used directly or indirectly for motive power in all cases where steam was now used, and in all heating operations, and it was especially valuable where the flame had to be brought into direct contact with the matter to be heated, as in the manufacture of bricks, glass, china, and glazed earthenware. In the manufacture of open hearth steel it produced better results than ordinary firing by means of coal, or even ordinary gas, because it contained less sulphur. It could be used in the manufacture of iron and steel, and in conjunction with the gas engine it was far superior to steam. Up to the present time the gas engine had not had a fair chance. With cheap gas, said counsel, the gas engine could beat the steam engine out of the field altogether. In Staffordshire the cost of ordinary coal gas was about 2s. per 1,000 cubic ft., and at that price its use was out of the queston. Mond gas could be produced and sold at 2d. per 1,000 cubic ft., and though manufacturers would have to burn four times as much Mond gas as they would of ordinary gas to produce the same result, it was clear that the relative prices of gas stood as 2s. to 8d. Other advantages of the gas were that there was an entire absence of smoke, a saving of the expense of boilers and of the space they occupied, immunity from boiler explosions, since no boilers would be used, and saving of labour. Counsel believed it could be proved that by using Mond gas we could get the same power with a consumption of 10,000,000 tons of coal as was now obtained with a consumption of 50,000,000 tons, and, if that was so, obviously the saving to the country would be enormous, and a very great boon would be conferred on manufacturers generally. A large number of firms had already adopted Mond gas. The Corporation of Walsall opposed the bill, as they wished to be left out of the area of the company's operations, so that the company could not compete with them in the supply of gas for power and heating. Counsel, however, urged that the supply by a corporation of gas for these purposes was almost beyond their function, and certainly not a matter in which they ought to be allowed a monopoly when there were manufacturers who desired to take it. Power was now supplied over certain districts of England by electricity, and no doubt electric power had the great advantage that, while it was not cheap to generate, it was most easy to convey. But if Mond gas were used continuously, night and day, 1 I.H.P. could be produced for £4. 7s. 7d. per annum, while an electric horse-power under exactly the same conditions would cost £24. 4s. Walsall should not, therefore, be excluded from the purview of the bill.

Sir F. BRAMWELL emphasised counsel's point that, besides obtaining practically three times the value out of the fuel in power by using Mond gas, as compared with the ordinary use of fuel, you get also a very large amount of valuable manure—sulphate of ammonia.

On Friday, Mr. HUMPHREY, civil and electrical engineer, chief engineer to Messrs. Brunner, Mond & Co., Winnington, Cheshire, said Mond gas had passed the experimental stage since the Mond plant had been working with great regularity and continued success at Winnington for a number of years. He regarded the plant as the most practical, economical and scientific method of dealing with fuel ever invented. He did not think there was any chance of Mond gas competing with ordinary lighting gas, because it was a non-illuminant, and he did not think it could be adopted to lighting purposes. As soon as the generating stations were in full working order, the company expected to be able to supply not at 2d. but at 1½d. per 1.000 cubic ft.

Mr. F. BROWN, M.I.E.E., said the feeling of his firm was that its passing would be to their advantage. The corporation gas the firm used for a 23 B.H.P. engine was very high in price. The gas engine was used for developing electrical power and for driving machinery generally. The best motive power in Walsall, seeing that the trades are light ones, was electricity. His firm were using that power, but would use Mond gas if they could get it.

Several manufacturers from Walsall declared the Mond gas, if they could obtain it at the price originally suggested by the promoters (2d. per 1,000) would be useful to them, but the Mond Company must be required to enter into an undertaking not to neglect the supply of the town, and to supply small consumers equally with large ones, although it would be fair to make a small extra charge in the case of those taking only a small quantity.

Mr. WEDDERBURN (for Walsall Corporation) said if a clause embodying the views of the Walsall manufacturers were inserted he would withdraw his opposition.

Mr. BALFOUR BROWNE objected to the proposal on the ground that terms different from those proposed had been given to other districts, and it would be unfair to them now to single out Walsall for exceptional treatment.

Mr. WEDDERBURN said Walsall desired to be left out of the bill, or, if included, that it should only be on the terms that the company undertook to supply all consumers, large and small, at the promised price at 2d., subject to a provision as to an increase if the price of slack rose, and if the company did not do that at the end of three years the powers of the bill should lapse.

The CHAIRMAN, in announcing the decision of the Committee, said: The Committee are prepared to find the preamble of the bill proved, subject to the company being compelled to be in a position to supply Walsall by a given time and some protection being given to the small consumers, which the Committee suggest might be afforded by making sec. 34 read as follows:—

"Provided further that the company shall not be compelled to supply any person with a less quantity of gas than 1,000,000 cubic ft. in a year" instead of "Provided further that the company shall not supply any person with a less quantity of gas than 1,000,000 cubic ft. in a year."

If within four years from Jan. 1 next the works were not completed and gas delivered, the powers with regard to Walsall would cease. The chairman intimated that at the next sitting of the Committee they would hear counsel from several gas companies with regard to the effect their decision would have upon the supply by those companies of gas for power.

On July 15 Mr. TAHOURDIN, parliamentary agent, said that since the previous sitting of the Committee, his clients (several of the gas companies) had decided not to avail themselves of the permission of the Committee to appear by counsel with reference to the alteration in their status created by the decision of the Committee on this bill. They asked the Committee, however, to consider the fact that the proviso in the bill, which had been altered, was inserted for the protection of the gas companies; and further, that having regard to the difference in the power of Mond gas, as compared with ordinary coal gas, and to the fact that small consumers would probably have to pay considerably more than the 2d. per thousand so often mentioned, it was quite probable that the ordinary gas companies could supply to smaller consumer at as low a price as the Mond Company.

Mr. WEDDERBURN urged that it should be made compulsory on the company to supply anybody who would enter into a written contract with the company to take a supply, without limit as to amount or time.

The CHAIRMAN said the Committee had decided to strike out the amendment that had been proposed and to leave the latter part of clause 34 as it originally stood. The clause in the bill would therefore read:—

"Provided further that the company shall not supply any person with gas unless such person is willing to contract for a supply of nor less than 1,000,000 cubic ft. a year, nor shall the company supply gas for use in private dwelling houses"

The Committee further agreed to accept the following clause, proposed by Mr. Wedderburn:—

"(44A). If within four years from the 1st day of January, 1902, the company had not laid down distributing mains in the Borough of Walsall for a distance of not less than 3 miles from the south-western boundary of the borough, and are not in a position to afford therefrom such a supply of producer gas as may be required in that borough, the powers of the company under this Act within the said borough and the Walsall Rural District Council shall cease."

Mr. BAGGALLAY (for the promotors) said the sheaf of clauses which would be brought up by Walsall Corporation was a distinct attempt to go behind the decision of the Committee, and make it impossible for the promoters to go into Walsall or do any work there. These clauses provided amongst other things that the auction clauses should be applied to the raising of all the capital of the company after the first £100,000; that the Corporation should have power to purchase the portion of the undertaking in Walsall at the end of 21 years; that the Corporation should have power to take a supply in bulk from the company; that the British thermal units mentioned in the bill in connection with Mond gas should be increased for 125 to 150; and that the dividend on the original capital should be reduced from a maximum of 10 per cent. to a maximum of 6 per cent. All these matters, he said, would very seriously interfere with the company, and in some cases would prevent them commencing work. He urged their exclusion.

The Committee decided that these matters could not now be discussed.

Power was given to the Board of Trade to revise and reduce the maximum charges of the company for the supply of gas for power purposes, and the other clauses having been adjusted, the bill was ordered to be reported.

## SHIELDS BRIDGE BILL.

On July 4, before a Select Committee of the House of Commons, presided over by Sir R. Gunter, this bill, by which powers are sought to construct a girder bridge over the Tyne between South Shields and Tynemouth, was considered.

Mr. J. D. FITZGERALD, K.C. (for the promoters), said the proposed bridge was a "transporter bridge," peculiarly adapted for crossing navigable rivers, as it caused no obstruction to navigation. The transporter car would work from the level of the banks, and its bottom would be 60ft. above high water. It was suspended from a trolley travelling on the girder by electric power, the machinery for working being situated in the car. So simple was the mechanism that the car could be set in motion, stopped, or reversed with the greatest ease in its own length. Accommodation would be provided for vehicles as well as passengers. This kind of bridge was invented by M. Arnodin, a French engineer, and one had been working with great success over the Bilbao river between the port of Bilbao and the sea. The construction of such bridges had been sanctioned by three separate acts of last session: One, across the Manchester Ship Canal, one over the Usk at Newport, and one over the Ribble—connecting

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the towns of Lytham and St. Anne's with the opposite side. The Tyne Improvement Commissioners opposed on the ground that there was danger of collision between the car and ships passing up or down the river, the interruption of traffic, and the possibility of the bridge collapsing or being blown down in a storm and blocking the river. It was also contended that the height of the girder would for all time limit the height of masts of vessels using the port. The bill (continued counsel) was promoted by a number of gentlemen by whom a company would be formed to carry out the scheme. It had already passed the Upper House, and in their decision they had stipulated that the construction of the bridge should not be commenced until £100,000 had been subscribed.

M. ARNODIN, the inventor, said there were absolutely no engineering difficulties in the way of constructing a transporter bridge at the suggested spot; in fact, there were few places more favourable. The complete bridge and approaches were estimated to cost £123,000, of which £85,000 would be spent on the iron and steel portions. About one minute and a-half would be occupied in crossing the river, the cars travelling at about the speed of a trotting horse.

At the conclusion of the evidence, Mr. POPE, K.C. (for the Tyne Improvement Commissioners), said the scheme was opposed by the public authorities constituted by Parliament to look after the Tyne. The construction of the bridge would, he maintained, increase the perils of navigating one of the most important ports of the United Kingdom—a port of enormous importance to His Majesty's navy by reason of its being the only place, north of the Thames, on the east coast where battleships could go to refit. Apart from the question of free navigation being interrupted by the passage of the car, an enemy's ship in time of war could stand out at sea, and by striking any part of the structure with shell bring down the girder, so blocking the way to the important works on the Tyne where damaged war-vessels might go to rearm and refit. He contended that if a sufficient case was presented for the erection of the bridge, the only authority to whom power for its construction ought to be granted was the Tyne Commissioners. Counsel told a harrowing tale of passengers in the car in the event of a collision with a vessel which, he submitted, the evidence had shown was extremely probable.

The Committee found the preamble of the bill not proved. The bill was accordingly thrown out.

## MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

Sir Lewis M'Iver's Committee of the House of Commons on Friday last continued the consideration of this bill.

Dr. E. HOPKINSON said he had been engaged in a great number of electric railway schemes both at home and abroad. In regard to the scheme before the Committee he had no doubt it was possible to run with safety and economy at 110 miles an hour. The same difficulties which applied to the running of steam locomotives at a high rate of speed did not apply to electric traction. About 720 revs. of the driving wheels would go to make up 110 miles an hour, which would not be out of the ordinary. With electrically-propelled vehicles power could be applied to every axle, which was an advantage as compared with steam traction. On the proposed mono-railway the maximum speed would be attained in about 1min. 40sec., and in a distance of about 2 miles, a result which would be absolutely unattainable on the ordinary railway. A definite distance, which could not be encroached upon, would always exist between cars, and that would form an admirable provision against accidents. The system of power to be used was the triphase, and the current would be developed at high pressure at Warrington. This would be distributed to sub-stations, and so throughout the length of the line. The motors would develop a normal horse-power of 140, but, if required, double that would be possible. The motors would weigh about 2¾ tons. He estimated that the electrical equipment of the line would cost about £464,000. The only thing requisite to secure safety was an intelligent application of electrical principles. In regard to the question of derailment, the monorail possessed great advantages over the two-rail system, and he was of opinion that no extreme speed could be accomplished in going round curves by any system other than the monorail.

Mr. S. B. COTTRELL, engineer-in-chief and general manager of the Liverpool Overhead Electric Railway, said he was not representing his company in this matter, but was speaking as an engineer. In reference to a railway such as that proposed high speeds of 110 miles an hour could be attained with perfect safety. The scheme which had been propounded by Dr. Hopkinson was a feasible and safe scheme, and would, he believed, perform all that was claimed for it. He was well acquainted with Manchester and Liverpool, and he had no doubt that if a fast service of trains, such as that which was proposed, were provided there would be a large increase in the number of passengers.

By the COMMITTEE: Although increased facilities brought increased traffic, he should not say the 2s. 6d. fares would multiply as fast as the 2d. ones had in other cases. He was, however, acquainted with people who, if the monorail were constructed, would travel between Manchester and Liverpool several times a day.

Mr. J. W. CLOUD, chairman of the Westinghouse Brake Co., said it was incorrect to say that the Westinghouse brake could not be applied to trains running at more than 55 miles an hour. The quick-acting Westinghouse brake had been applied at much greater speeds, and it was particularly designed for application at very high speeds. Frequently he had known trains to be stopped by the Westinghouse brake at speeds between 70 and 80 miles per hour, the brake acting with efficiency as perfect as could be expected. He had been upon those trains. From his own experience he should say the brake could be applied to trains running at 110 miles an hour. They had experience up to 80 miles an hour, between 80 and 110 miles an hour was simply a theoretical curve—(Witness here handed in a diagram to the Committee)—projected from experience of the lower speeds, and showed what they could most reasonably expect at higher speeds. They confidently expected to be able to stop a train at 100 miles an hour in a distance of 3,330ft. The magneto-electric brake could be applied as well, but it was not expedient—bearing in mind the safety of the structure—to apply both at once. There was practically nothing in which the action of the one brake was retarded by the operation of the other, and they could both be applied at once if the structure would bear the strain. There was hardly any limit to the power of the magneto-electric brake, and if the two were applied at once the distance in which the train could be brought up could be reduced to 1,500ft. or 1,600ft.

Baron F. DE BEECKMAN gave evidence as to the experiments carried out in Belgium with the monorail. During the many occasions, he said, on which he was on the line there was never at any time any feeling of danger or apprehenson. It was as safe as travelling on any ordinary railway.

Sir WM. PREECE, questioned as to the system of signalling to be adopted on the mono-railway, said that it would not be possible for trains to come within a certain distance of each other. The system was a secure one, the principle being that the action of the current takes the signal off, and any accident puts the signal on, and thus safety was secured to the following trains. Of the causes of accidents, as set forth in the Board of Trade reports in regard to the ordinary lines, the monorail swept away the majority of them. The only ones that remained were trains meeting with obstructions on the line or leaving the rails, or those arising from defects of works, permanent way, and so forth.

Sir W. H. BAILEY (Messrs. W. H. Bailey & Co., Salford) said he was a member of the joint committee representing Manchester and Liverpool formed to investigate and report on the feasibility of this scheme, and also the sub-committee. He coincided with the resolutions come to both by the committee and the sub-committee. If the railway were made it would, in his opinion, be of great advantage to the public of both Liverpool and Manchester, and also to the inhabitants of Salford.

Mr. GUTHRIE, C.A., Manchester, chairman of the Finance committee of the Lancashire County Council, also supported the bill.

Mr. H. F. PARSHALL said he was of opinion that a speed of from 100 to 130 miles an hour could be attained with perfect safety by electricity, and he thought that the power proposed on the monorail would give the necessary acceleration. He did not believe there was any foundation for the suggestion that the motors would not be of sufficient power He was satisfied that the cars on the mono-railway could be run at 110 miles an hour, and that they could be perfectly braked. He had seen an electric railway running at 75 miles an hour, and at that speed it was a commercial success. There was a steam railway in America—the State Express—which had run a considerable distance at 117 miles an hour. There was scarcely any limit to the speed at which an electrically worked car could travel. It was entirely a question of competition and of commercial practicability. There was less danger of derailment on the mono-rail than on any other system yet invented. The distance which the State Express in America ran at 117 miles an hour was about 12 miles. It was on a straight line and the gradient was favourable.

Major CARDEW, C.E., said he could not see any difficulty in working the electric express railway at 110 miles an hour with perfect safety, or in applying the necessary brake power.

Sir FREDERICK BRAMWELL, C.E., also expressed the view that the high speed proposed by Mr. Behr could be attained by electricity on the monorail with perfect safety. In regard to comfort he thought the monorail was far ahead of the two-rail system. He did not anticipate that passengers would feel any inconvenience in going round curves. Under usual conditions there would be less need of brake power on the proposed mono-railway than on an ordinary railway, but in the event of a carriage breaking down the carriage following it would have automatic warning of the breakdown when it was at least seven miles off.

Mr. CAMPBELL (of Hunslet Ironworks, near Leeds) said there would be no difficulty in making the cars proposed to be used on the mono-railway.

Mr. PHILIP DAWSON said he was familiar with the subject of the application of electric traction to railways and tramways. He had been a member of the Belgian jury which had reported on Mr. Behr's railway at Brussels Exhibition. A speed of between 60 and 70 miles an hour was obtained, and the car went round curves with great smoothness. To his knowledge no other member of the jury went over the railway in the cars. No tests were asked for or submitted to the jury, nor were any calculations made by them. Though he protested, the rest of the jury came to the conclusion that the railway was dangerous. He could not see any danger about it. The jury did not wait for any results, and there were no tests made to enable the jury to come to any conclusion.

The CHAIRMAN: You are the last witness. I desire to ask of one of the engineers, before the promoters' case closes, one or two practical questions. You travelled on this railway three or four times, and as a practical engineer no doubt were able to form an opinion that a layman could not form?—Yes.

It has been suggested to you more than once that a railway of this kind would eliminate a certain proportion of accidents. Did it not suggest itself to you that with its high speed and peculiar form of construction the railway would bring in a new class of dangers?—There might be a new class of dangers, but I do not think they would be as great as the dangers inseparable from the two-rail system.

Can you suggest this new class of dangers?—Well, you have on the permanent way, besides the rail on which the driving wheel runs, four guiding rails. It would be, therefore, necessary that the structure on which they were placed should be very carefully built. If one of the rails broke there would be danger of a serious accident; but the danger would not be greater than the failure of a rail on the two-rail system.

What would happen if a guide rail broke?—That would have to be found out by experiments. If the rail broke inwards there might be no bad

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result, but if it brpke outwards, the momentum of the car would rip up the track and cause a disaster.

Would there necessarily be a disaster through the fracture of a guide-rail?—No, not necessarily.

This concluded the promoters' case.

For the opposition, M. FLAMACH, director of permanent way to the Belgian State railways, said he was a member of the Belgian Commission. The railway ran at a speed of 67 miles an hour, and he did not think it could have been run at a greater speed without danger. He had no doubt, however, that the permanent way could be constructed so as to resist any amount of centrifugal force. He thought that the great difficulty was that of oscillation, but that no doubt could be reduced to a minimum by lowering the centre of gravity. He did not think that the oscillation difficulty could be wholly eliminated on a railway of only one line. The efficiency of the line depended altogether on the way in which it was maintained.

Mr. JULES DERY, president of the Belgian Society of Electricians, and one of the chief engineers of the Belgian State Railways, said he travelled in one car, and experienced pronounced rolling and pitching movements.

Yesterday M. CHALLIE, a Belgian electrical engineer, in charge of the generating machinery which supplied current to the monorail trains at Brussels Exhibition, said there was on one occasion an accident through a dynamo getting out of order. There were also a number of small accidents such as might have occurred in any factory. Mr. Behr had to complain of an inadequate supply of current occasionally.

Mr. BULLIVANT, consulting engineer for the Paris Metropolitan Railway, said he had studied in the exhibition the monorail with the view of reporting on the proposed line between Antwerp and Brussels. In his opinion the high rate of speed proposed would be too dangerous for a public railway. For an ordinary service the proposed system could not attain a speed of 110 miles an hour. As a commercial undertaking an ordinary train travelling at 60 miles an hour would pay better from the larger number of passengers carried than the monorail train with a limited number of passengers. He considered the Behr system as very weak in construction and very liable to distortion by the elements. It was, practically, an impossibility to keep the monorail in order at anything like resonable cost. It would be madness to go round a curve of 30 chains radius at 110 miles an hour. In such a case the passengers would have to be strapped to their seats. With regard to signalling of the trains he thought the system propounded dangerously faulty. The brakes would be deficient in stopping power as at a high rate of speed their power became proportionately smaller. The question of brakes was about the most difficult to consider in connection with high speeds. The coefficient was three times as great at 10 miles an hour as at the speed of 60 miles an hour. Above that speed there was no experience. To obtain a retardation of 1 metre per second would require at least 50 sec. at the speed Mr. Behr proposed, and that would mean a distance of about 1 mile before the train stopped. A greater retardation than 1 metre per second would cause much inconvenience to the passengers. The Behr system complied neither with the requirements of safety nor comfort. The power necessary to be developed by the motors for such a speed as was proposed would be 1,500 H.P., which, distributed among four motors, meant that each would have to develop 375 H P. Such motors would weigh about 10 tons, or 40 tons the four. It would not be possible to put four motors of that kind on such a car as was proposed. From whatever point of view one examined it, he could see nothing in the Behr system but inconveniences without any corresponding advantages. The expense of running a railway increased nearly in the ratio of the cube of the speed. The permanent way of the proposed monorail was too weak. He had not calculated what weight would be upon each trestle; but anyone who had had the least experience in the construction of iron and steel would see that the construction of this line had been designed by someone who had had no experience in construction. The motors on the line were too small. The possibility of doubling the nominal horse-power of a motor temporarily depended on the design of the motor and the time for which the extra power was required. His opinion as to its being unsafe to go round a 30-chain curve at 110 miles an hour applied to an extraordinary railway like that of Mr. Behr as well as to an ordinary railway. He had had no actual experience of the working of the high-speed Westinghouse brake, but the brake had nothing to do with the working of a train on the Behr system. It would be of no use whatever on a short monorail train. It would be possible to stop a train running on the Behr system at 110 miles an hour in a quarter of a mile, but it would be uncommonly uncomfortable for the passenger.

By the COMMITTEE: The greater the strength of the construction of the line the more serious would the difficulty about the expansion of the rails become.

By Mr. FITZGERALD (in cross-examination): The maximum expansion allowed by engineers for a 30ft. rail was ½in. A similar allowance could be made on this railway.

M. SCHINDLER said with the monorail every accident must be a disaster. With the monorail there was considerable risk of derailment. Obviously the seriousness of an accident on any railway was increased as the speed increased. Having the centre of gravity below the rail had very little to do with lessening the risk of derailment.

Mr. D. MELDRUM, manager of the Cheshire Lines committee, which represents the Midland, Great Central and Great Northern Railway Companies, said there were at present 172 direct trains daily between Liverpool and Manchester; 99 per cent. of the trains were punctual, and both passenger and goods service were adequately catered for.

Mr. FRANCIS FOX, C.E., said he and his brother, Sir Douglas Fox, were the engineers for the Liverpool Overhead Railway. He did not think the monorail system was well adapted for high speeds. It was based upon unscientific principles, and he thought it was unpractical and unsafe. It was wrong to take the rails off the solid ground, and place them at an altitude of 4ft. 6in. above. The structure would be comparatively unstable, especially where—as would here be the case—it would have to cross certain mosses, and thus run risk of sinkage, such as the London and North-Western Railway Co. and the Cheshire Lines were exposed to. The line therefore would have to be constantly examined. There was from two and a-half to three times as much material used in the monorail as in the ordinary bi-rail line, and if a depression occurred there would be a series of sinuosities in the line which, in connection with high speeds, would be absolutely fatal to the safety of the line.

The Committee adjourned till to-day (Friday).

## WEST CUMBERLAND ELECTRIC TRAMWAYS BILL.

This bill came on Tuesday before the Committee of the House of Lords presided over by Lord Welby. The measure has already passed the House of Commons, and provides for the construction by the West Cumberland Electric Tramways Co. of a system of electric tramways from Cleator Moor to Silloth, a distance of 31 miles. The tramways would pass through Cleator Moor, Whitehaven, Workington and Maryport en route to Silloth. The cost is estimated at £361,579, and the tramways will traverse the districts of 17 local authorities. The only opposing authority was the Cleator Moor District Council, who sought to obtain the insertion of a clause providing for the widening of a bridge and the lighting of a portion of the route.

The Committee passed the preamble of the bill and refused the clause asked for, and declined to accede to an application for costs by the promoters on the ground of vexatious opposition.

## STALYBRIDGE, HYDE, MOSSLEY AND DUKINFIELD TRAMWAYS AND ELECTRICITY BOARD.

The bill to empower the Councils of the four boroughs of Stalybridge, Hyde, Mossley and Dukinfield to form a tramways and electricity board, and construct and work tramways within the district, came on Wednesday before the Select Committee of the House of Lords presided over by Lord Ribblesdale. The only opponents were the Oldham and Ashton Trammays Company.

Mr. FITZGERALD, K.C. (for the bill), said that in October, 1899, negotiations took place between the four councils with the intention of promoting a tramway to accommodate the population of the district. In November of the same year the opponents applied to the Board of Trade for a tramway order to construct a similar line, and applied to the Light Railway Commissioners. In June, 1900, a local inquiry was held. The application was opposed by all the corporations, and the chairman of the Commissioners—Lord Jersey—said it seemed of no use to go on with the proposed scheme in face of the opposition of all the local authorities. Afterwards the Corporations of Dukinfield and Hyde made an application for a tramway order, and this was granted, but it was never confirmed, because in the meantime the four Councils settled their scheme. The order was not proceeded with. They applied to the Board of Trade, for a provisional order, but the late Sir Courtenay Boyle advised them to promote a bill in Parliament, and the Councils adopted this course. The question for the Committee was whether the scheme should be stopped because of its competing with the existing Oldham and Ashton tramway. There had been no opposition in the other House, as the opponents' petition was presented too late, and the Standing Orders Committee refused to intervene.

Mr. T. L. BEELEY, mayor of Hyde, said he considered the connection of the tramway and electric lighting very useful, as the tramway provided a day load for the electric installation, and enabled them to supply electricity more economically. They would, of course, desire to make a profit on their electrical undertaking, but they principally desired to retain the management and control in their own hands.

The CHAIRMAN said it was unnecessary to call other evidence to the same effect.

Mr. CHARLES ALFRED BAKER (Messrs. Gibbings and Baker) said he was consulting engineer to the scheme both for electric lighting and tramways. He was responsible for the estimates, and was prepared to prove that the scheme was desirable and necessary.

Mr. MOON (for the opposing company) said the only question was as to who should construct the tramway. He urged that it was not fair that the promoters should make the tramways when his company were prepared to make them, and to take the current from the local authorities whose districts they passed through.

Mr. STEPHEN SELLON said he had been connected with the opposing tramway company since its formation. The line had cost £122,000. It was opened in June, 1899, and they started with 2,000,000 passengers the first year and 4,000,000 the second. The company had always contemplated the further development of the system, and at first the local authorities were anxious they should make the extensions. He estimated the loss by the competition would be £2,562, which was 15 per cent. of their entire receipts of £17,272 last year. As to the fairness of the proposed competition they felt that when they had shown by their enterprise that the tramway would be a success it was unjust to rob them of the through route from Ashton to Hyde which was clearly a line they should have made. The numerous company's and tramway undertakings he was associated with always pressed that they should be relieved from the onerous terms imposed upon promoters by the Tramway Act of 1870, namely, that at the end of 21 years the line could be bought up at practically scrap value, no matter whether it was making 10 per cent. or not. Parliament had generously looked into the matter, and now they got varying terms of purchase from 25 to 40 years, and on the terms of a going concern. In 17 years the town of Hyde could buy up the portion of their undertaking in their district, and they (the company) could be left in the cold. He therefore thought

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it unfair that the proposed tramway should be in the hands of a competitive municipal authority.

The CHAIRMAN intimated that the Committee found the preamble of the Bill proved.

The clauses were then gone through and the Bill was ordered to be reported.

## FACTORY ACTS AMENDMENT BILL.

The bill introduced into the House of Commons by the Home Secretary and Mr. Jesse Collings, to amend the Factory and Workshops Acts, has been considered for some weeks past by the Standing Committee on Trade, over which Mr. Lawrence Hardy presides. The clauses of the bill dealt with up to the present are concerned generally with the provisions and regulations affecting the textile trades and underground bakehouses.

On Monday the Committee considered clause 31, which provides that meals shall not be taken in any factory or workshop where lead, arsenic or other poisonous substance is used, and that suitable provision shall be made to enable the workpeople to take their meals elsewhere.

Mr. SETON KARR pointed out that the clause would apply to trades which were not dangerous, though lead or other poisonous substances were used in them. Of such were the printing, bookbinding, tea-packing and other trades, and the covering of electric cables. He proposed to limit the clause to trades in which preparations of lead, arsenic or other poisonous substances were manufactured.

Mr. RITCHIE said if the clause were given the interpretation which the hon. member mentioned it would no doubt be an extremely drastic provision. The words were, however, taken from the section of the act of 1895, and he was afraid if different words were used difficulty would arise in interpreting the section.

Mr. JOHN BURNS said in many of the trades in which lead was employed there was considerable danger. From the report of the factory inspectors he found that last year, in electric accumulator works, there were 31 cases of lead poisoning and one death, whilst in all the trades there had been 389 cases and six deaths. He claimed to know something of electric accumulator work. It was a new, a large, and an increasing industry, and they should try to improve it now. It was a new and a profitable industry, and it seemed to him that at the outset they should lay down health conditions—that the workers should have the best lavatory accommodation and should not be permitted to take their meals in the workshop. He appealed to the members not to undo the Dangerous Trades Act of 1895.

Mr. RITCHIE agreed to introduce words to meet the point raised by Mr. Seton-Karr, and the clause was agreed to.

Yesterday the clauses relating to the registers, notices, and returns were passed, and clause 35, which provides for the notice of accidents, was withdrawn by the Home Secretary, the law being left as at present. Exceptions were made to provide for overtime in the fish and fruit preserving trades, and in the case of Crown factories and workshops.

On clause 45, which adds to the list of non-textile factories, "electrical stations, that is to say, any premises in which electrical energy is generated or transformed, either for the purpose of supply by way of trade, or for any purpose incidental to any other business except the transmission of signals or messages."

Mr. SETON KARR proposed to omit "or transformed," which he said would take the electric transformer out of the purview of the Committee. The work of electricity supply differed from any other, as only few and highly-skilled hands were employed. At the electricity station at Chelsea only a very few hands were employed, and no women or unskilled workers. There were only about five skilled hands with this plant of 5,000 H.P. There was in the work some danger at some time but the men were guarded by indiarubber gloves and stood on indiarubber mats. No inspector would go there who would know more about the matter than the workmen there, and by their proposal they might be doing a great harm to a highly technical and highly skilled business. As to transforming stations, there was no danger, and in some instances only one person was employed. The Committee, urged Mr. Seton-Karr, should be very careful how they interfered with an industry just in its infancy.

Mr. JOHN BURNS said the hon. member had said the trade was in its infancy. That was the strongest argument for the rejection of his amendment. That time was just when the Home Office should take notice of the regulations. Mr. Seton-Karr must have forgotten the accidents which had occurred. They knew that in some places there were no gloves, no mats, and only the ordinary engineers' iron ladders instead of the wooden ladders which should be used. He appealed to the Committee to save the workers from being shocked or injured, or perhaps killed.

Sir CHARLES DILKE said it was a fact that many of the workmen considered they were under the Factory Acts at present.

Mr. TENNANT said it was not a question of machinery in motion. The danger was much greater; it was from a current you could not see. And he was informed that 65 per cent. of the accidents had taken place at transformer stations.

Mr. RITCHIE appealed to Mr. Seton Karr, having regard to the importance of the bill and the time of year, to withdraw his amendment.

Mr. SETON KARR said he would like to have some statistics. He had received no information as to the great number of accidents to which allusion had been made.

Mr. JOHN BURNS said the accidents were recorded on page 19 of the Factory Inspectors' Report.

A division was challenged, and the amendment was rejected by 28 to 6 votes.

The Committee then adjourned.

Yesterday, on the motion of the Home Secretary, it was agreed that the Standing Committee on Trade be empowered to consolidate the Factory Acts Amendment Bill and the Factory and Workshop Acts Consolidation Bill into one bill.

## ELECTRICITY IN THE NAVY.

In reply to a question by Mr. Harmsworth, in the House of Commons, on Monday, Mr. ARNOLD FOSTER said the turrets and barbettes of His Majesty's battleships were not worked by electrical, but by hydraulic power. The question of substituting electricity was being carefully considered, but up to the present hydraulic machinery had been preferred, and had given good results. Electricity was used on one or two ships in working various parts of the guns, and this electric working would be applied to the ships now under construction.

## ELECTRICITY SUPPLY CHARGES.

In the House of Commons on Friday Mr. STUART WORTLEY asked the President of the Board of Trade whether he had given any decision or made any order purporting to disentitle the Chelsea Electricity Supply Co. from recovering an increased price per unit for current supplied to consumers who had not consented to accept current at 200 volts in cases where the company had not offered to defray the expense of changing the voltage; and, if so, where the text of such order or decision can be found.

Mr. G. BALFOUR said the Board of Trade had issued amended regulations with respect to the change of pressure by electric lighting undertakers, which amended regulations provide in effect that when the regulations apply the undertakers must pay the reasonable costs of or incidental to a change of pressure on consumers' premises, but the regulations do not purport to affect the power of charging.

## POST OFFICE TELEPHONE SERVICE.

In the House of Commons on Monday Mr. A. CHAMBERLAIN, replying to a question by Mr. Bartley as to whether he could name an approximate date when the Post Office telephone service in London would commence business, said the Postmaster-General hoped to begin the connection of subscribers with the central exchange and some others at the beginning of October.

## THE PACIFIC CABLE.

In the House of Commons on Monday, Sir E. SASSOON asked the Secretary to the Treasury how much of the material for the pacific cable had been manufactured and delivered, what instalments of the total cost had been paid, and whether, in view of its completion by the end of 1902, satisfactory progress was being made towards the fulfilment of the contract.

Mr. A. CHAMBERLAIN replied that none of the cable had yet been manufactured or delivered. Several cable-houses had, however, been sent out, and were being erected at the selected landing places. The surveying ship had already sounded the route for over 1,500 miles, and was now employed on soundings between Norfolk Island and Fiji. The landing places of the cable in Queensland, New Zealand, Norfolk Island and Vancouver had been decided upon, and preliminary arrangements completed for the construction of quarters for the cable staffs and station buildings. He was informed that the manufacture of the cable would begin at once. Under the contract £207,463 was due on March 31 last, and had been paid. The engineers to the Pacific Cable Board were satisfied with the progress made and with the ability of the contractors to complete the work by the stipulated time, *i.e.*, the end of 1902.

## TRUNK TELEPHONE FACILITIES.

In the House of Commons last night, Mr. H. D. GREENE asked the Secretary to the Treasury whether telephonic messages between Shrewsbury and places south thereof had to pass through Liverpool or some towns far to the north of Shrewsbury; and whether direct communication by telephone could be provided between Shrewsbury and the city of Birmingham and other towns in the Midland counties in substitution for the present circuitous arrangement.

Mr. J. A. CHAMBERLAIN: Communication with Shrewsbury over the trunk wire system has recently been improved by the provision of new circuits from Liverpool to Birmingham and other places, but the Postmaster-General is also considering the question of providing a more direct route to the Midlands and the South.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Duncan's Manual of Tramways, Omnibuses and Electric Railways" for 1901. 24th Edition. (London: T. J. Whiting & Sons, Ltd.) 5s.

"Pocket Book of Electrical Rules and Tables." By John Munro, C.E., and Andrew Jamieson, M.I.C.E. (London: Charles Griffin & Co.) 8s. 6d.

"Calendar of the Glasgow and West of Scotland Technical College for Session 1901—1902." 1s.

"Proceedings of the Royal Society." No. 447. Vol. LXVIII. (London: Harrison & Sons). 2s.

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# ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 448.*)

In the next place, as regards the construction of these electro-variable conductors, it is impossible to describe a fraction of all the work that has already been done on them. No one has bestowed more minute attention to their practical construction than Mr. Marconi, and the result of his labours has been the evolution of a marvellously sensitive and certain instrument. As in many other electrical appliances, dimensions are an important factor in success, and Mr. Marconi has attained his results by the recognition that a sensitive or electrovariable conductor is best made by employing a very minute amount of nickel and silver filings included between silver plugs only one-fiftieth of an inch apart and sealed up in a vacuous glass vessel (see Fig. 8).

In the case of these positive electrovariable substances the usual method of bringing them back again into a condition of high resistance is by an appropriately administered tap so as to disturb the small metallic particles and break down the connection between them. There are other ways, however, by which a similar return to the high resistance condition can be effected. One of these is by heating; and another method in the case of magnetic particles such as those of iron or nickel, is the employment of an alternating or moving magnetic field.

For many laboratory experiments it is not necessary to place the metallic filings in a vacuum in making a sensitive tube. The following simple construction is one which I have found easy to make and reliable in use. Two small plates of silver are bent into the shape of the letter L, and then placed back to back, separated by a small slip of celluloid or ivory 1mm. in thickness, in which is cut out a deep U-shaped notch. The silver and ivory slips are bound together with silk. The arrangement then forms a very narrow cell with silver sides and open at the top. A wedge of ivory or fibre fits into the open end of the cell and forms a lid. Into the narrow

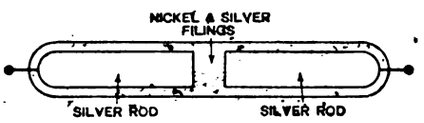


FIG. 8.—Marconi Coherer Tube.

crevice between the two silver plates is introduced a very small quantity of nickel filings and the right amount determined by trial. Two thin insulated wires are soldered to the L-shaped silver pieces. The whole arrangement is carried on an extension of the armature of an electric bell magnet which plays between two screw stops. If a current is sent through the magnet suddenly, it attracts the armature and gives the cell carried on it a jerk which, when properly adjusted, is sufficient to bring back the nickel filings to a non-conductive condition. A few trials with a small electric gas lighter and a galvanometer and cell in series with the sensitive cell are sufficient to enable one to adjust the quantity of nickel filings in the cell to the right amount. So arranged, the cell becomes conductive when an electric spark is made near it, and is brought back to a non-conductive condition by sending an intermittent current through the electro-magnet and giving the cell a few jerks or shakes. Much of the success depends upon the adjustment of the right amount of filings and the limitation of the vibrations of the electro-magnet armature.

A sensitive cell of this kind properly constructed is marvellously sensitive to the passage over it of an electro-magnetic impulse. For many purposes it cannot take the place of a Hertz resonator. The sensitive tube responds apparently equally well to electric waves of all wave length. It is, so to speak, *electrically colour blind*. On the other hand the Hertz resonator is, as we have seen, especially sympathetic to electric radiation, having a frequency equal to its own natural time period.

Turning then to the results of investigation with these and other electric ray detectors, we have in the first place to notice the proofs that have been given that the electric radiation sent out from a Hertz or similar oscillator, resembles in all respects plane polarised light. We are familar with the fact that the light transmitted through a thin crystal of tourmaline, or either of the two rays transmitted and produced from one incident ray by Iceland spar, is in a condition in which it is non-symmetrical with respect to the direction of the ray. The ray transmitted by one tourmaline crystal is incapable of passing through a similar crystal placed with its axis at right angles to the first. Moreover, this plane polarised light is susceptible of reflection, refraction, and of producing interference with other rays. Similar qualities characterise the electric radiation, and these can be demonstrated by remarkable experiments.

The ever-memorable achievement of Hertz was that he first threw open the entrance into this new and fertile field of investigation. It is a difficult matter even to repeat Hertz's experiments on this subject in a laboratory, and almost impossible to show them to an audience. Nevertheless, the facts are so important, and an experiment shown is so much more valuable than a statement, that I have devoted much attention to devising apparatus suitable for lecture purposes by which the principal facts of electro-optics can be shown even to large audiences. For this purpose I have constructed a special form of radiator and receiver. The radiator consists of a zinc box with one end closed, but open at the opposite end. From the sides of the box protrude zinc tubes. In these zinc tubes are fixed ebonite tubes, each of which contains a rod of brass 4in. long, ending in a brass ball 1in. in diameter. The rods are attached to long spirals of gutta-percha covered wire, which fill up the rest of the ebonite tube. The rods are so fixed that the balls are held about a millimetre apart in the interior of the zinc box. The outer ends of the wire spirals are connected with the secondary circuit of an induction coil. When the coil is in action sparks pass between the balls and create electric waves about 8in. in wave-length, which issue from the open mouth of the zinc box. The use of the wire spiral at the end of the rod is to prevent the waves from travelling out at the side tube. The receiver consists of a similar box, containing a simple form of nickel-filings coherer. The wires in connection with the coherer are brought out through a metal pipe, which must be screwed or soldered into the box. This pipe is a couple of yards in length, and leads to an open metal box, in which is placed an electric bell, battery, relay and relay battery, so joined up that when the metal filings in the sensitive tube become conductive the relay is traversed by a current and sets the electric bell in action. The sensitive tube is restored to non-conductivity by giving the receiver-box a smart knock with the fingers. The radiator-box is held on a stand, so that it can be placed with its axis at any angle.

Furnished with this apparatus, we can generate a nearly parallel beam of electric radiation, the wave length of which is only about 8in. By its aid we can follow out a series of demonstrations, proving, as Hertz first showed, that this radiation is capable of reflection, refraction, and interference, and that various substances are opaque to it and others transparent. Moreover, this radiation, he showed, was stopped by a grating of fine wires placed with their direction perpendicular to that of the electric force or axis of the radiator. Since Hertz's experiments were made, many have traversed the same ground, and gleaned much additional knowledge.

It is now well known that to produce successfully on a moderately small scale optical effects with electrical radiation, it is necessary to employ radiators of small dimensions. Prof. A. Rhigi, in 1894, described investigations made with an oscillator consisting of two small metallic spheres, 3·75 centimetres in diameter, immersed in oil. These, when actuated by a large induction coil, produced electric waves 10·6cm. in length. The resonator consisted of a piece of glass silvered along a certain strip 4cm. in length, and $\frac{1}{3}$th of a centimetre in diameter. Across the centre of this strip a minute scratch was made, forming the spark-gap, and a microscope was employed to observe the tiny sparks in this spark-gap. With this apparatus, or with another circular or ring-shaped resonator, formed in the same way, of silver deposited upon glass, Rhigi obtained electrical equivalents of all the familiar optical facts, the resonator acting as an eye to detect the invisible radiation. Since that, other workers, such as Lebedew and Lampa, have, by reducing the dimensions of the apparatus yet further, decreased the wave length of electrical waves to about 4cm, and obtained electrical radiation the wave length of which is only 50 to 60 times longer than that of the longest heat rays which have been sifted out by repeated reflection from a luminous source of radiation such as the Welsbach gas radiator.

This electrical radiation penetrates easily through dielectric bodies. It is completely reflected from metallic surfaces, and is also more or less reflected from the surface of insulators. These facts I can easily show to you with my apparatus. If the radiator box and receiver box are placed with their open ends towards each other and about a couple of feet apart, the axes being in the same straight line, we find that, on pressing a key in the primary circuit of the induction coil, the bell in the receiver circuit rings. If, however, a sheet of tin or tinfoil, or even of silvered paper, is interposed, the radiation is cut off. A sheet of perforated zinc, a wet duster, and even the human hand or body, are found to be perfectly opaque. On the other hand, a slab of wood, paraffin, wax, pitch, glass, ebonite, leather, dry cloth, and all other insulators, are transparent. Conductors of any kind are opaque. Amongst liquids, water, alcohol, glycerine and amyl alcohol are also opaque, whilst paraffin oil, turpentine, bisulphide of carbon and creosote are very transparent.

If we turn the radiator so that its open mouth is not directly towards that of the receiver we find that the receiver is not affected, showing that the radiation is not entering it. We can, however, reflect the radiation into the receiver by using as a reflector a sheet

* Cantor Lecture delivered before the Society of Arts, Dec. 17, 1900.



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of metal, a wet cloth, the hand, or a sheet of glass. We can easily prove that this radiation obeys the optical law, and that the angle of incidence is equal to the angle of reflection. All good reflectors are opaque to the radiation. It is curious to notice how much of the radiation is reflected from a sheet of window glass, even although glass is a very good non-conductor.

By examining the reflection from dielectrics such as glass and paraffin, FitzGerald and Trouton were enabled to settle the long disputed question as to the direction of the vibration in relation to the plane of polarisation in plane polarised light. According to Fresnel, the luminous vibration was at right angles to the plane of polarisation, that is, to the plane of reflection when light was polarised by reflection; whilst according to MacCullagh it was at right angles to that plane.

The theory of electric waves indicates, as we have seen, that we are concerned with two vectors, one the magnetic flux and the other the electric displacement, and that both these periodically vary. Theory indicates that the electric force is perpendicular to the plane of polarisation. This conclusion was verified by FitzGerald and Trouton, for electric waves were found not to be reflected at the polarising angle from the surface of a dielectric when the electric force is parallel to the plane of polarisation, but reflection occurred at all angles when the electric force is perpendicular to that plane. In the electric ray, therefore, the electric force is perpendicular to, and the magnetic force parallel to, the plane of polarisation.

Some of the most interesting results of the study of electric waves are those which have flowed from experiments on the refraction of these electric rays. By the use of a colossal prism of pitch, having a refracting angle of 30deg., Hertz was able to discern a refraction of 22deg. when long electric waves were incident on the prism indicating a refractive index of 1·69. It is convenient to call the refractive index so determined the electrical refractive index, and

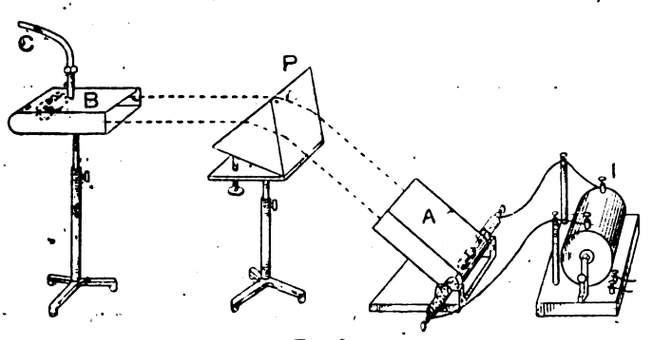


Fig. 9.

the refractive index for luminous or visible light the optical refractive index. With the apparatus before you it is very easy to exhibit the power of insulators to refract this radiation with a prism of quite small dimensions. I have here, as you see, a paraffin prism having a refracting angle of 60deg., the length of each side being about 6in. (see Fig. 9). If we set the radiator and receiver boxes in such positions that the electric ray emerging from the radiator just escapes the receiver, and so does not directly affect it, we shall find that on introducing the paraffin prism in the path the electric ray is refracted just as would be a ray of light by a glass prism. With a little care it is easy to measure the deviation of the ray produced by the prism, and hence to calculate the electric index of refracture of the material. I have in this manner measured with my apparatus the refractive index of paraffin wax and also of dry ice, employing for this purpose a large ice prism, cut with the saw out of a block of ice. The refracting angle ($i$) of the paraffin prism was 60deg., and the minimum deviation ($d$) of the electric ray produced by it was 45deg. to 50deg. In the case of the ice the refracting angle of the prism was 50deg., and the minimum deviation of the ray was also 50deg. Hence by the formula

$$r = \frac{\sin \frac{i+d}{2}}{\sin \frac{i}{2}}$$

we have for the paraffin a value of the electric refractive under $r$,

$$r = \frac{\sin \frac{60^\circ+50^\circ}{2}}{\sin \frac{60^\circ}{2}} = \frac{\sin 55^\circ}{\sin 30^\circ} = 2 \sin 55^\circ = 1{\cdot}64,$$

and for the ice,

$$r = \frac{\sin \frac{50+50}{2}}{\sin \frac{50}{2}} = \frac{\sin 50}{\sin 25} = 1{\cdot}83.$$

By Maxwell's law the squares of these indices should be equal to the dielectric constant. The square of 1·64 is nearly 1·8, and the square of 1·83 is nearly 3 34.

The values obtained by electrostatic methods for the dielectric constant of paraffin wax give numbers not far from 2. The values obtained for ice at or near 0°C. by low frequency or electrostatic methods give values near 80. If, however, the ice is taken at very low temperatures (−190°C.), then for low frequency or find values of the dielectric constant near 3·0 and under. (See Fleming and Dewar, *Proc.* Roy. Soc., Vol. LXI., p. 2, 1897, on the "Dielectric Constant of Ice at Low Temperatures.")

It is interesting to notice that M. C. Gutton (*Comptes Rendus* 130, p. 1119, 1900; or "Science Abstracts," Vol. III, p. 545) has, by another electrical wave method, determined the electrical refractive index of dry ice at a little below 0°C. He found, as I also have done, that ice did not perceptibly absorb electric waves. He determined the refractive index to be 1·76, corresponding to a dielectric constant 3·1. The wave length used was 14mm. He also measured the refractive index for waves of 25cm. in length and up to 2,000cm. He discovered that the electric refractive index progressively decreases from 1·76, corresponding to the 14mm. waves, down to 1·50 for waves 2·088cm. in length. This last gives a dielectric constant of 2·25, which is not far from the value, 2·0, found by M. Blondlot for still greater wave lengths. Hence the rather rough experiment made by me with an ice prism gives a result for the dielectric constant of ice which is not greatly different from those found by other electrical methods when the disturbing influence of temperature is eliminated. The observed values of the deviation of the ray by the prism used by me are unquestionably only approximate values, as the radiation emitted from the radiator is far from being a well-defined ray. It is remarkable, in fact, that when dealing with radiation, the wave-

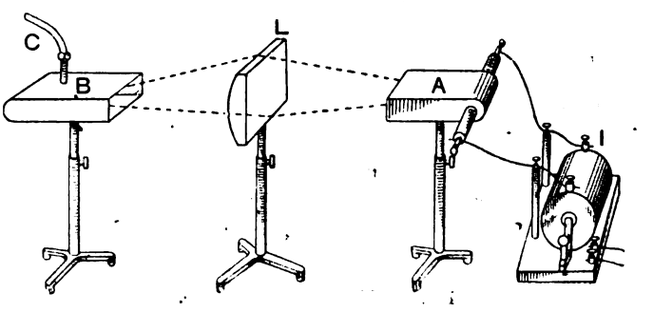


Fig. 10.

length of which is so large compared with the dimensions of the prism, one should be able to obtain any well-marked refraction at all.

I have also succeeded with the same apparatus in showing the total internal reflection of the ray by a right-angled prism of paraffin. Most interesting of all, however, is the concentration of the electric ray by paraffin lenses. I have here a plano-cylindrical lens of paraffin wax (see Fig. 10). The radius of curvature of the curved side is 6in., and the focal length is 12in. Two conjugate foci exist for such a lens (made of a material of refractive index 20) at distances 24in. on either side of the lens. If we place our radiator-box and receiver-box at a distance of 4ft. we may so adjust the receiver that the direct radiation is too weak to cause the bell to ring. If we interpose the paraffin lens half-way between, it converges the radiation on to the receiver and creates an electrical focus, and the bell of the receiver at once rings. This shows clearly that the paraffin lens gathers up the diverging electric radiation and focuses it on to the receiver.

With the same apparatus interesting experiments can be shown illustrating the action of gratings on this electric radiation. If we interpose in the path of the ray a grid made by winding wire over a frame it is found that this grid is opaque to the radiation if the wires are held parallel to the electric force of the ray, but transparent if they are held parallel to the magnetic force. The reason for this seems to be that in the former case secondary electric currents are set up in the wires, and these shield the receiver from the original radiation, because the magnetic force of the induced current is exactly opposite in phase to the magnetic force of the original ray at that point where the wire is situated, and hence a complete shielding takes place. I find that a set of large pins, arranged parallel to each other at a little distance apart, acts in a similar manner, but a set of very small or midget pins similarly arranged is not an effective screen. The use of small pins simply amounts to the cutting up of a large wire into very short lengths, and this effectually prevents the induction in it of any sensible current.

(*To be concluded.*)

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# LEGAL INTELLIGENCE.

## The Manufacture of Aluminium.—Application for the Extension of Patent.

On Saturday, before the Judicial Committee of the Privy Council, consisting of Lords Hobhouse, Macnaghten, Davey, Robertson, Lindley, and Sir Richard Couch, the British Aluminium Co. (Ltd.) presented a petition for the prolongation of letters patent granted to Mr. Arthur Charles Henderson in May, 1887, for a term of 14 years for an invention of "an improved process for the preparation of aluminium by electrolysis," communicated to him by M. Paul L. P. Hérault, of Paris. The petition stated that the company had expended large sums of money in the erection of works in various parts of England, Scotland, and Ireland, and that the invention would be one of great public importance and utility. Shortly, it was an invention by M. Hérault, who obtained patents in France and Belgium, both of which had expired. The English patent rights were first acquired by a Neuhausen company, which, however, did not work the invention, and the petitioners purchased the patent from the Neuhausen company, in 1894, as a commercial speculation, but, owing to the large outlay in the erection of works, they had not had time to obtain adequate remuneration for their capital. The inventor of the patented invention, it was admitted, had no interest, direct or indirect, in the success of the petitioners' business, but the petition stated that in the event of the letters patent being prolonged the petitioners intended to make some provision for the future remuneration of the inventor out of future profits of the company.

The prolongation was opposed by the Attorney-General and by Mr. W. F. Dennis, engineer and dealer in aluminum, Billiter-street, London, on the grounds (1) the position of the petitioners as assignees and purchasers of the patent as a commercial speculation; (2) that the statements in the petition and accompanying accounts did not supply any clear accounts of the profits made by the inventor, or even of those made by the petitioners themselves; (3) that no real attempt was made to introduce the patented article into this country for the first seven years of the life of the letters patent; and (4) the expiration of foreign patents, which would render the prolongation of the English patent detrimental to the commercial interests of the company.

The arguments and evidence were heard in May last before Lord Macnaghten, Lord Davey, Lord Robertson, Lord Lindley, and Sir Ford North, when their lordships rejected the petition.

Lord DAVEY, who now delivered the considered judgment of the committee, giving their lordships' reasons for advising His Majesty not to grant a prolongation of the patent, said: In this case the inventor of the process patented in 1887 was a French gentleman named Hérault, who also obtained patents in France and Belgium, which have since expired. The French patent was sold to the Froges company. The British patent was sold to a Swiss company, who afterwards sold it to the Neuhausen company. The Belgian patent has never been worked. Until the purchase of the British patent by the present petitioners it was not worked in this country, nor was any serious attempt made to introduce the invention here. The petitioners are an English company, and they purchased the patent from the Neuhausen company in 1894 as a commercial speculation. They have since erected works for the manufacture on a large scale of aluminium, and have manufactured and sold that article, but it is alleged that the financial results have so far not come up to their legitimate expectations. The inventor of the patented invention has no interest, direct or indirect, in the success of the petitioners' business; but it is stated that, in the event of letters patent being prolonged, the petitioners intend to make some provision for the future remuneration of the inventor out of their future profits. It was admitted that the invention was one of great merit, and would be not unworthy of exceptional consideration if the circumstances of the case were more favourable. The objections to the prolongation of the letters patent have been set out by the Attorney-General. Your lordships, thinking that these objections were well founded, have already intimated that this was not a case in which they could properly, or consistently with established principles advise His Majesty to grant any prolongation of the letters patent. The position of assignees who petitioned for a prolongation of letters patent has frequently been the subject of decision by the board, and the circumstances in which alone such an application would be entertained are not in doubt. In recent cases your lordships, following earlier decisions of the board, affirmed the principle that an assignee, who had acquired a patent as the subject of commercial adventure, is not entitled to a prolongation when the inventor himself could have no legitimate interest in making such an application. The distinction between an assignee who had assisted a patentee with funds to enable him to bring out his invention and one who merely had purchased the patent as a commercial adventure has been clearly laid down. Your lordships need not consider whether it is sufficient for the petitioners merely to state that they are willing to do something for the inventor as an inducement to their board to advise the grant of a prolongation, or in other words, as the price they were willing to pay for the grant because your lordships were of opinion that there is no clear or satisfactory evidence that the inventor had not been already adequately remunerated. I need only point out that persons who apply to this board for the prolongation of letters patent cannot be too frequently reminded of the law as laid down by Lord Cairns in Saxby's Patent, L.R. 3 P.C. 292, where he says:—

> It is the duty of every patentee who comes for the prolongation of his patent to take upon himself the onus of satisfying this committee, in a manner which admits of no controversy, what has been the amount of remuneration which in every point of view the invention has brought to him, in order that their lordships may be able to come to a conclusion whether that remuneration may fairly be considered as a sufficient reward for his invention, or not. It is not for this committee to send back the accounts for further particulars, nor to dissect the accounts for the purpose of surmising what might be their real outcome if they were differently cast; it is for the applicant to bring his accounts before the committee in a shape which will leave no doubt as to what the remuneration has been which he has received.

In my judgment the words of Lord Cairns are equally applicable where, as in the present case, the petitioners are bound to prove that the inventor has not been adequately remunerated. It might well be surmised, from the materials before your lordships, that the inventor has received or become entitled to receive something like 600,000fr., or, say, £24,000 for his patent rights, besides other advantages in the form of shares which might or might not be of value. But whether that is so or not, it is sufficient for the present purpose to say that the accounts are not before your lordships in a shape which enables your lordships to form any clear opinion on the subject. From what has been said already it is unnecessary for your lordships to consider the other points mentioned by the Attorney-General. Your lordships could only say that the failure of the patentee to push the patented invention in this country for seven years and the circumstances of the expiration of the foreign patents are also serious obstacles to the success of the present application. Neither of these circumstances would be in itself conclusive against the petitioners. But, my lords, it would require a very strong case to induce your lordships to recommend a prolongation of the patent where these circumstances occur. The principle upon which objections of that class should be dealt with are explained in the judgment of the board in Samet and Solway's Patent, 1895, a.c. 78 (where the extension was granted) and Pieper's Patent, 12, Pat. cas. 292 (where it was refused).

For these reasons your lordships humbly advised His Majesty that the petition should be dismissed, the petitioners to pay one set of costs to the two objectors.

## Taff Vale Railway Co. v. Amalgamated Society of Railway Servants.

In the House of Lords, on Tuesday, judgment was reserved in the important appeal of the Taff Vale Railway Co. against the decision of the Court of Appeal in the action brought by the company against the Amalgamated Society of Railway Servants and its agents and servants for "picketing."

## C. Bright & Co. (Ltd.) v. the River Plate Construction Co. (Ltd.) and others.

This case was down for hearing in the Court of Appeal yesterday, but an order was made for the action to stand over until Wednesday next.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The position of senior demonstrator in the department of electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session, in consequence of the appointment of Dr. E. W. Marchant as lecturer at Liverpool University College. An inspector in electrical engineering, with experience in polyphase and high-voltage work, is also required. Applications to Prof. S. P. Thompson, F.R.S., Technical College, Finsbury, E.C. See advertisements.

As announced in an advertisement elsewhere applications for three appointments of assistant superintendents in the Telegraph Department of the Goverment of India will be received by the Secretary, Public Works Department, India Office, Whitehall, London, S.W., until July 31.

The editorship of "Science Abstracts" is vacant, Mr. W. R. Cooper, M.A., who has been so closely identified with the progress of this useful work, having resigned. An official notification appears in our advertisement columns.

An electrical engineer is required, thoroughly trained, for a large electrical power scheme. See advertisement.

The governing body of the South-Western Polytechnic, Chelsea, London, S.W., invite applications for the position of demonstrator in electrical engineering. Applications to secretary by Aug. 6. See advertisement.

Salford Corporation Electricity committee require an electrical engineer to act as assistant to the borough electrical engineer. Salary, £250 per annum. An advertisement gives particulars, and applications have to be in by July 27 to Mr. L. C. Evans, town clerk, Town Hall, Salford.

A teacher of engineering workshop book-keeping and accounts is required at the City and Guilds Central Technical College, Exhibition-road, London, S.W. See advertisement.

An assistant storekeeper is required by the Newcastle-on-Tyne Electric Supply Co. (Ltd.). See advertisement.

A young electrical engineer is required by a firm engaged in the seasoning of wood by electricity. See advertisement.

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There are vacancies in the teaching staff (including the lecturership on electrical engineering) of the University of Glasgow. Particulars from Prof. Barr. See advertisement.

The Visitors committee of the County Asylum, Rainhill, Lancs., require an electrical engineer to take charge of their generating plant. Applications to Mr. T. L. Miller, 7, Tower-buildings, Water-street, Liverpool, by 25th inst. See advertisement.

A headmaster is required for the Swansea Intermediate and Technical Schools. Salary £600. Applications to secretary, Grammer School, Swansea, by Aug. 6.

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Mr. H. F. Foster, of Dover, has been appointed resident electrical engineer at Epsom.

Mr. A. Bryant has been appointed shift engineer at the Temple Black electricity works, Bristol.

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**Alicante (Spain).**—The existing electricity supply company here is threatened with the competition of a new company lately formed, and which is expected to be working during the current year.

**Ayamonte (Spain).**—Electricity supply works are to be erected in this town. The dynamos will be driven by Fielding and Platt gas engines operated by producer gas.

**Battersea (London).**—There is to be a formal opening of the electricity works. The charge for electric current supplied through prepayment meters has been fixed at 6½d. per unit, but no meter rent is to charged.

**Burton-on-Trent.**—The salary of the engineer and manager of the gas and electricity department (Mr. F. L. Ramsden) has been increased from £450 to £500 per annum as gas manager. Several members of the Council referred to Mr. Ramsden in eulogistic terms, and it was generally conceded that the increase was well deserved.

The price of gas has been reduced 3d. per thousand.

**Devonport.**—Owing to the increasing demand for current (especially for traction) the borough electrical engineer (Mr. Pilling) has been authorised to provide additional plant at the generating station.

**Electric Lighting Licence.**—The Ingleton Electric Light and Power Co. (Ltd.) have applied to the Board of Trade for a renewal of their licence for two years.

**Elland.**—The District Council has decided to erect electricity works on land at the sewage works, together with a Meldrum's destructor. Mr. Emmott, of Halifax, is consultant to the Council.

**Exhibition.**—An exhibition is now open at Gefle, an important shipping town in the north of Sweden, and will remain open till Aug. 15. Some excellent examples of Swedish industrial work are on show and included in the exhibits is that of the Gysinge Aktiebolag, a company established at Gysinge a few miles from Gefle. The company has a large separate pavilion where it exhibits an assortment of "electro-steel" goods, the product of a recently invented process of smelting by electricity. There are on show ingots, bars and manufactured articles produced direct from the raw material by electrical process. This process is being worked at Gefle, for the first time in Sweden, by a native of the country, who claims to have effected improvements in the process which are secret. Such finished articles as tools, scissors, &c., are shown. There is a section of the exhibition devoted to electro-technical industrial exhibits.

**Fatal Accident.**—An accident occurred on the Herne Bay pier electric tramway on Tuesday which resulted in the death of a passenger. Shortly before one o'clock a number of persons were waiting for the electric tram to take them down to the pier head to the steamer about to sail for Margate. The train, besides the passenger coaches, had in front an empty trolley, which was being taken to the pier-head to be filled with luggage. A short distance from the pier-head this trolley jumped the metals, tumbled against the palisade along the side of the pier, breaking it down, and toppled over 20ft. into the water, pulling the front passenger car with it. When the passengers in the car had been extricated and conveyed to the shore it was found that one of them (Mrs. Pearce) was dead, the other passengers being uninjured.

An inquest was held on Tuesday, when George Harrison, driver, said they were not going full speed, which was about 5 miles an hour. There was no motive power on the two end cars. The trolley jumped and threw the car off on the opposite side. He had never known the trolley jump before. The jury found that death was due to shock and concussion of the brain, adding a rider that the pushing of the trolley in front of the cars should be discontinued.

**Govan.**—The following scale of charges for electricity supply has been decided upon:—Ordinary consumers, 6d. per unit for the first hour's maximum demand, and 1d. after; domestic consumers, 3½d.; theatres, halls, &c., 3½d.; churches, 3d.; and motive power, 1½d. per unit.

**Huddersfield.**—The Council decided on Wednesday to apply for a further loan of £100,000 for extending the electricity generating plant and mains.

The Borough Treasurer has issued an abstract of the accounts of the tramway undertaking for the past year. The cost of running the steam cars was 18½d. per car-mile. The total receipts from all sources were just 14d. per car-mile, and the loss on the working, therefore, over 4½d. per mile. For the past three months there was a loss of £1,980, and if allowance were made for the amount to be carried to capital account there would still be a loss of over £1,000. For every mile that the steam cars had run during the quarter there was a loss of 4½d., and it was a question of whether the electric cars had lost a halfpenny per car-mile or made a farthing. The treasurer points out that the tramway men's wages for the year represented on the steam sections 5·8d. for every car-mile run, and in Glasgow the total expenses of the whole system were only 6·32d. per mile, so that Huddersfield was paying within ½d. per mile in wages alone of what the whole outlay was in Glasgow.

**Ipswich.**—The extension of the electricity works was debated by the Council on Wednesday. The consulting engineer (Prof. A. B. W. Kennedy) recommended the borrowing of an additional £58,000, to be applied as follows:—Boilers, £5,000; six steam dynamos, £13,200; battery of 300 ampere-hours' capacity, £900; switch-board, with boosters and connection, £2,400; station buildings, £22,000; distributing mains and feeders, £8,400; meters and house service connections, £800; 85 arc lamps and posts, £2,900; engineer's and architect's charges, £2,800.

**Kettering.**—The Council obtained a provisional order in 1896, and the Board of Trade are inquiring as to the probability of its being put in force. The consulting engineers (Messrs. Kennedy and Jenkin) have sent in to the Council a report on electric lighting, and this is under the consideration of the Lighting committee.

**Kingstown (Dublin).**—Before applying for sanction to a loan of £50,000 for electric lighting, the District Council have decided to obtain further particulars of the offer of the British Schuckert Co. to establish electricity works.

**Leeds.**—The electric lighting of Leeds covered markets has been transferred from a gas-driven plant to the Corporation's street mains. This necessitated changing the feeding point and generally altering the previous arrangements. The installation consists of two sections, public and private lighting, each again divided and balanced in two distinct circuits. The public section, consisting of 96 Lewis arc lamps arranged in circuits of five lamps in parallel on 200 volts on a pair of 2/16 cables give ample light for general purposes, whilst a pilot circuit of 10 lamps running across the bays enable the night sweepers to clear away the refuse in the early hours of the morning. Advantage has been taken of the private lighting facilities by the stall-holders, who find the electric light most convenient. The whole of the work has been carried out by the Corporation staff, under the direction of the city electrical engineer, Mr. Harold Dickinson.

**Leigh.**—The Council resolved on Tuesday to apply for a further loan of £11,250 for electric lighting extensions.

**Light Railways.**—The Light Railway Commissioners have sanctioned the scheme of the Middlesex County Council to construct extensions of their authorised light (electric) railways. Some particulars of the scheme appeared in our last issue, but the Hornsey lines have been omitted from the order.

The Southend and Bradwell Light Railway Co. propose to construct a light (electric) railway from Southend to Bradwell.

Objections to the confirmation of the order authorising the Middlesex County Council to construct a light electric railway in Finchley were heard by the Board of Trade on Wednesday:—

Mr. Wedderburn, K.C., stated that the Light Railway Commissioners had before them two schemes, one promoted by the Finchley Council and the other by the Middlesex County Council, and, without hearing the Finchley Council, decided in favour of the latter scheme. He submitted that the Commissioners had no power to do that without taking evidence as to the Finchley scheme, and that it was never intended by the Light Railway Act that the Commissioners should have the power of deciding against the local authority through whose district the railway proposed to run. The matter should have gone before Parliament. Mr. Cripps, K.C., contended it was within the jurisdiction of the Commissioners to make the order and therefore the Board of Trade should confirm it. Mr. Hopwood said the matter was important, and would be fully considered by the Board.

**Llandudno.**—An inquiry was held here last week into the application of the Council to borrow £1,027 for a new feeder. No opposition.

**London County Council.**—At Tuesday's meeting a loan of £10,065 was granted to Battersea, £88,579 to Hampstead, and £18,703 to Stepney for electric lighting.

The plans for the proposed electric lighting at the St. Pancras Baths were conditionally approved.

The Fire Brigade committee, reported having obtained tenders for the supply and fixing of an additional engine, dynamo, &c., from Messrs. Siemens Bros. & Co. (£950), Crompton & Co. (£992) and Drake and Gorham (£1,031). These amounts were much in excess of what was anticipated, and consequently they did not propose to embark on the expenditure. They proposed, instead, to order from

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Messrs. Crompton & Co., for £97, a spare armature. This expenditure was approved.

Difficulties having arisen regarding the acquisition of property at Camberwell for an electric generating station for the tramways, the Highways committee recommended that application be made the next session to Parliament for powers to enable the Council to acquire, compulsorily, certain land at Greenwich. The property includes the Greenwich tramways depôt. The matter stood over for a week.

**Manchester.**—The Mutual Telephone Co. have once more approached the Telephone committee with a view to induce them to approve the company's proposals to erect an independent telephone system in Manchester and district.

**Marylebone (London).**—The Borough Council have refused their consent to the Metropolitan Electric Supply Co. to lay their mains in and near Edgware-road, as they consider that the connecting up of Marylebone with a generating station in Paddington would be illegal in view of the terms of the agreement existing between the company and the Council. The company have appealed to the Board of Trade. The Board of Trade have also appointed Mr. A. P. Trotter to report on the Council's disapproval of the Central Electric Supply Co.'s proposed works in North Bank. Mr. E. Manville, consulting engineer, and the Council's solicitor will represent the Council at the inquiry.

**Middlesbrough.**—It has been decided to supply electric current to places of worship at a uniform rate of 5d. per unit, or 7d per unit for the first 100 hours per annum, and 2d. after. At present there are over 100 consumers with an equivalent of about 9,700 8 c.p. lamps connected for private lighting. The total connections are equal to over 14,000 8 c.p. lamps.

**Obituary.**—We regret to record the death of Mr. Wm. Whiteley, late of the firm of Wm. Whiteley & Sons, Ltd., electrical engineers, &c., Lockwood, Huddersfield, aged 51. The firm of which Mr. Whiteley was the head, are well known throughout the textile industries as makers of all classes of machinery for textile works. Of late the manufacture of electrical machinery has been added. Mr. Whiteley was until recently a director of the Blackman Ventilating Co.

**Oxford.**—Christ Church is being wired for the electric light. The cathedral is not included in this contract, but Peckwater, and Tom Quads and the Meadow buildings will all be lighted electrically. There will be about 1,200 8 c.p. lamps. The installation is to be completed by Oct. 1. Mr. Morgan Williams is the consulting engineer and Messrs. Hill and Upton have the contract for the wiring, and current will be supplied by the Oxford Electric Co. Several colleges are also having their installations extended.

**Paris.**—The Railway committee of the Municipal Council recommend that sanction be given to the project of the Lyons Omnium Co. to construct an underground electric railway from Montmartre to Montparnasse, crossing Paris from north to south (passing under the Seine), a distance of about 4 miles, at an estimated cost of 35,000,000fr.

**Pemba (East Africa).**—During 1900, among the public works carried out on the island of Pemba was the establishment of telephonic communication between Chaki Chaki and Weti which is said to have proved of the greatest convenience and utility. The telephone poles were cut free of charge and voluntarily by a tribe known as Wa-Pemba, and the poles were put up by an army of volunteers, mostly women, who completed the work in a hearty and willing manner in three days.

**Portsmouth.**—The accounts of the electricity department for the year ended March 31 were presented to the Council on Tuesday. The works have been in operation seven years, and the capital expenditure is £179,134. 4s. 1d., but the sinking fund amounts to £19,359. 9s. 7d., and £1,000 has been handed over towards reduction of rates. There was a deficit of £867. 11s. 8d. on last year's working, against a profit of £1,250 in the previous year.

**Provisional Order Revocation.**—The Board of Trade have revoked the City of Wells Corporation electric lighting order, 1896.

**St. Pancras (London).**—The Council are desirous of obtaining powers to wire and supply fittings on consumers' premises, and also to purchase and lend on hire electric motors and other apparatus. The Council will also seek powers to acquire compulsorily a site or sites for extensions of the generating stations.

**Southampton.**—An inquiry was held last week into the application of the Council to borrow £4,000 for electric lighting extensions. Technical details were supplied by the electrical engineer (Mr. F. H. Chaplin).

**Southport.**—The first report on the working of the tramways was presented to the Council last week. There are at present 2½ miles of double and 5 miles of single track open. The number of passengers carried has been 1,513,354, and the total receipts £7,568. Working expenses amounted to £7,487, leaving a profit of £81.

**Surbiton.**—An inquiry was held here last week into the application of the Council to borrow £50,000 for electricity supply. From a poll taken of the ratepayers it is considered that the demand to start with will be equal to about 10,000 lights :—

During the inquiry it was stated that the Council had given careful consideration to the question, but they felt that for the first two or three years the works would be a burden on the rates, and they had entered into a provisional agreement with Callenders' Company, under which the company undertook to supply the whole of the plant, the Council paying for same at schedule prices, the whole work to be carried out under the supervision of the consulting engineers of the Council. The company also undertook to pay interest and sinking fund, the Council, of course, providing the capital. The company also undertook to pay all running and other expenses for at least five years, or so much longer as the Council pleased, receiving in return all receipts for electricity sold. The Council are to have the option of taking over the undertaking at five years, at a premium of 2 per cent. per annum, or at the end of 7½ years at 13s. 4d. per cent. After the tenth or any subsequent year they would only be called upon to pay for extensions or additions that might have been made. In the event of the company making default, the agreement is to be forfeited, and the Council come into the undertaking free of all cost, and have the benefit of all the company paid towards the sinking fund. The company cannot assign the undertaking.

Opposition was offered on the ground that electric light was not needed, and that the agreement with the company was really a transfer of the Council's powers. The inspector (Col. Slacke) said if this were so the Council would have to obtain the sanction of the Board of Trade.

**Swansea.**—The question of the supply of electric current to the Harbour Trustees is to be referred to a consulting engineer, and the Council have submitted the names of Mr. Arthur Wright and Mr. C. H. Wordingham for selection. The charge for current for power has been reduced to 2d. per unit for five hours and 3d. for less consumption. Extensions of the plant at the electricity works, estimated to cost £15,820, are to be carried out on the recommendation of the electrical engineer, Mr. Cawthra.

**Telephone Way-leave Dispute.**—At the West London Police Court on Wednesday Mr. Lane, K.C., heard an adjourned summons against Mr. A. Barrett, shopkeeper, High-street, Kensington, at the instance of the Postmaster-General, in respect of a dispute concerning the laying down of pipes and wires in front of defendant's premises in connection with the Post Office telephone system in the metropolis. The case was reported in our issue of the 21st, and the point at issue was whether a particular part of the pavement had been dedicated to the public. There were two kerbs, and it was in respect of the inner that the dispute had arisen :—

Mr. Weaver, engineer and surveyor of Kensington, said he had known the spot since 1860. The piece of pavement was always open. Goods were displayed there. He had negotiated with defendant for the purpose of clearing the goods away for a public improvement, but was unable to come to terms. Mr. Hills, for the defence, contended that the Postmaster-General had not made out that the place was a street or part of a street. Defendant produced his lease to show that the forecourt, including the piece of pavement, formed part of the plan described in it, and said he had repaired it frequently. He had never increased the use of the pavement. Mr. Lane dismissed the summons, holding that the place was not proved to be a street. He allowed agreed costs.

**Marriage.**—On July 15, at North Shields, Mr. A. Hugh Seabrook, chief engineer of the Barking electricity supply works, was married to Miss Edith Strachan, of North Shields.

**Cricket.**—A match was played on Saturday at Clifton Junction between the cricket clubs of the Chloride Electrical Storage Syndicate and W. T. Glover's electric cable works, resulting in a win for the Chlorides by 56 to 41.

**Outing.**—The staff and employees of Messrs. Rawling Bros. (Ltd.), electrical engineers, Kensington, Belgravia, Blackheath and Chiswick, held their annual outing on Saturday last, at Cluer, near Windsor. The party numbered nearly 200.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Rochdale* Corporation invite tenders for the supply, delivery, and erection of steel poles, bases, section boxes, overhead line, and accessories for, approximately, 5 miles of tramway, and also for feeder cables and pilots. Specifications, &c., can be had of the engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen's Anne's-gate, Westminster, or may be seen at the Manchester offices of the engineers, 78, King-street. Tenders have to be in to Mr. James Leach, town clerk, Town Hall, Rochdale, by Aug. 1. An advertisement gives further particulars.

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*Cardiff* Corporation invites tenders for single-deck bogie cars, double-deck bogie cars and double-deck four-wheeled cars. Specifications, &c., will be ready on Monday, 22nd inst., from the borough electrical engineer and manager (Mr. Arthur Ellis), Old Post Office-buildings, Cardiff, and tenders are to be sent in to Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by Aug. 6. See advertisement.

*Cardiff* Corporation also require main switchboards, with instruments complete. Specifications on Monday from Mr. Arthur Ellis, and tenders have to be sent in to Mr. Wheatley by Aug. 6. See advertisement.

*Cardiff* Corporation also require tenders for 2,000 tons of steel tramway rails, fish and sole plates, tie-bars, bolts, nuts, points and crossings, drain rails, &c. Tenders by July 25.

*Dundee* Gas Commissioners require surface condensers, electrically-driven air and circulating pumps, cooling towers, &c.; electrically and steam-driven feed pumps and feed-water heaters and fittings. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders to the clerk to the Commissioners (Sir Thomas Thornton, LL.D.), City-chambers, Dundee, by Aug. 5. An advertisement gives additional particulars.

*Bradford* Corporation invite tenders for the supply and delivery of 100 electric tramcars. Specification from the tramways manager (Mr. C. J. Spencer), 5, Forster-square, Bradford, and tenders to the town clerk (Mr. Frederick Stevens) by 31st inst. An advertisement gives further particulars.

*Lancaster* Corporation require tenders for water tank, electric pumps, ejector condenser, steam exhaust and water piping with valves. Specifications, &c., from the borough electrical engineer (Mr. Wm. A. Tester), and tenders to the town clerk (Mr. T. Cann Hughes) by July 22. Further particulars are given in an advertisement.

*Manchester* Corporation Electricity committee require tenders for the supply, delivery and erection on the Manchester tramway routes of 70 feeder and section pillars. Specification, &c., of Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester, and can be inspected at the offices of the chief engineer (Mr. G. F. Metzger), Dickinson-street. Tenders to Mr. W. H. Talbot, town clerk, Town Hall, Manchester, by Aug. 7. See also advertisement.

*Manchester* Electricity committee also invite tenders for switchboards at their Stuart-street generating station and sub-stations. Tenders to chairman by noon Aug. 14.

*Partick* Town Council invite tenders for wiring the electricity supply station. Specifications can be obtained at the office of the town clerk (Mr. Jas. Donaldson), 97, West Regent-street, Glasgow, and specifications may be inspected, but not obtained, at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, London, S.W. Further particulars are given in an advertisement, and tenders must be received by Mr. Donaldson by noon of Tuesday, Aug. 6.

*Gravesend* Town Council invite tenders for boiler-house plant, steam and exhaust pipes, engine-house plant, switchboard, underground mains, lamp posts, accumulators, meters, cranes, dust destructor, and well and water-lifting apparatus. Tenders to town clerk by 10 a.m. July 30.

*London County Council* Asylums committee require steam boilers, pumps and fittings, cooking apparatus and fittings, and an installation of electric lighting (including generating plant) at the Epileptic Colony, Horton Estate, Epsom. Tenders by July 23.

*Great Yarmouth* Corporation invite tenders for steel poles, brackets, trolley wires, insulators, &c.; rail bonding; battery switchboard and reversible booster, cables and joint boxes. Tenders to town clerk by noon July 27.

The Electricity committee of the Metropolitan Borough of *Poplar* require high-tension continuous-current transforming plant and switch gear, &c. Tenders to town clerk by 10 a.m., July 24.

*Poplar* Electricity committee also invite tenders for arc lamp carbons for one year. Tenders to town clerk by July 24.

*Kearsley* District Council require tenders for steel tramway poles, bases, section boxes, overhead line material and accessories for the equipment of 1¾ miles of tramway. Tenders to clerk by Aug. 1.

*Ilford* Urban District Council invite tenders for work in connection with the electric lighting of the new town hall. Tenders to Mr. J. W. Benton, Council Offices, Ilford, by 5 p.m. 25th inst.

*Aston Manor* District Council invite tenders for electrical generating and distributing plant at their hospitals at Upper Witton. Tenders to chairman Health committee, by noon 25th inst.

*Gateshead Co-operative Society* require tenders for wiring their Askew-road branch. Tenders to committee, Jackson-street, Gateshead, by July 24.

*Blackburn* Town Council require three steam 775kw. dynamos. Tenders to town clerk by July 29.

*Shrewsbury* Lighting committee invite tenders for "free wiring." Tenders by July 25.

## TENDERS RECEIVED AND ACCEPTED.

St. Pancras (London) Borough Council have received the following tenders:—

*Three-Phase Plant.*

| | | | |
|---|---|---|---|
| Electrical Co. (*accepted*) | £7,310 0 | Internation'l Elec. Eng. Co. | £6,660 0 |
| Electric Construction Co. | 13,390 0 | British Schuckert Co. | ... incomplete |
| Johnson & Phillips | 11,782 0 | British Westinghouse Co. | ditto |
| General Electric Co. | 11,303 10 | | |

*Feeding Mains and Lighting Cables.*

| | Feeders. | Arc Mains. |
|---|---|---|
| Callender's Co. (*accepted*) | £5,004 | £2,577 |
| St. Helens Cable Co. | 7,275 | 2,881 |
| Western Electric Co. | 5,925 | 2,867 |
| British Insulated Wire Co. | 5,783 | 2,997 |
| W. T. Henley's Telegraph Works Co. | 5,656 | 2,784 |

Shoreditch (London) Council have received the following tenders:—

*High and Low-Tension Switchboards.*

| | | | |
|---|---|---|---|
| Cowans (Ltd.) (*accepted*) | £5,096 | S. Z. de Ferranti (Ltd.) | £6,426 |
| Crompton & Co. | 9,930 | Johnson and Phillips | 6,096 |
| Electric Construction Co. | 6,812 | Slatter & Co. | 5,470 |
| Bertram Thomas | 6,529 | Williamson and Joseph | 4,660 |

*Wrought Steel Flues.*

| | | | |
|---|---|---|---|
| Pierson & Co. (*accepted*) | £995 | Mechan & Sons | £1,200 |
| Westwood and Wrights | 1,939 | W. Jones & Sons | 1,070 |
| Babcock and Willcox | 1,400 | | |

Taunton Town Council have accepted the following tenders:—

| | |
|---|---|
| British Thomson-Houston Co. (250kw. steam alternator and 15kw. motor generator) | £2,954 0 0 |
| J. G. Statter & Co. (switchboard extensions) | 559 12 0 |
| Babcock and Wilcox (water-tube boiler, superheater, steam piping, &c.) | (?) |

Ipswich Town Council have received the following tenders for four boilers for the electricity works:—

| | | | |
|---|---|---|---|
| Richardsons, Westgarth & Co. | £8,600 | John Fraser & Son | £5,840 |
| Stephenson & Co. | 6,880 | Fraser and Fraser | 5,800 |
| J. P. Phibbs | 6,587 | Edwin Danks & Co. | 5,020 |
| Wallsend Slipway Eng. Co. | 6,000 | | |

The Electric Lighting committee recommend the acceptance of Messrs. Danks & Co.'s tender.

Bradford Electricity committee recommend the acceptance of the tender of Veritys Limited for the supply and erection of a switchboard at Valley-road electricity works.

West Ham Town Council have accepted the tender of Messrs Young and Marten for wiring and supplying fittings for the electric lighting of Plaistow hospital at £2,032.

The contract for the construction of the Houghton-le-Spring and Sunderland district electric tramways has been let to Messrs. Dick, Kerr & Co. at £170,000.

## BUSINESS NOTICES.

Mr. Edgar C. Thrupp, for nearly 19 years with Prof. H. Robinson, and for upwards of 15 years his chief assistant, has commenced practice as a consulting engineer at 39, Victoria-street, Westminster, S.W.

Messrs. A. F. R. Curteis and C. P. Wooler (trading as Curteis and Wooler), electrical engineers, 66, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. Wooler.

Messrs. G. D. Collins, T. C. Collins and H. E. Arkwright (trading as Collins Bros.), electricians, &c, 35, Electric-parade, Blackheath, London, S.E, have dissolved partnership. Debts by Messrs. T. C. Collins and H. E. Arkwright, who continue.

## BANKRUPTCIES, LIQUIDATIONS, &c.

It has been resolved to wind up voluntarily the Carbon (New) Syndicate (Ltd.), and to appoint Mr. A. Doig, 5 and 6, Great Winchester-street, London, E.C., as liquidator. Claims by Aug. 8.

A meeting of the Great Horseless Carriage Co. (Ltd.) will be held at Chiswell House, Finsbury Pavement, London, E.C., on Sept. 14, to receive an account of the winding-up.

The public examination of Alfred Sharp, electrical engineer, Barnsley, took place at Halifax on Monday. Liabilities £162. 8s., assets nil. Debtor commenced business in May, 1900, in partnership with John Savage, and traded under the style of Savage and Sharp. A month later Mr. Savage retired, and was paid out £52. The principal cause of insolvency was losses on contracts, owing, it was alleged, to the action of the Barnsley Corporation in insisting that "standard" instead of single wire should be used in installation contracts. Examination closed.

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**Sales by Tender.**—The Electric Supply and Tramways committee of St. Helens Corporation are open to receive tenders for the purchase of plant set out in an advertisement. The plant was new in 1896, and is in first-class condition.

Glasgow Tramways committee are prepared to dispose of the complete generating plant at their Springburn station, some particulars of which are given in an advertisement. The station is being shut

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down owing to the Pinkston power station being now ready for operating the whole tramway system. The general manager (Mr. John Young) will supply all further information required.

**Personal.**—Mr. F. Crew asks us to state that he has resigned his position as city representative of the Edison and Swan Co., in whose service he has been for many years, and is now acting as London representative of Messrs. Evered & Co. in their electrical department.

**Electric Fittings and Glass Ware Catalogue.**—From the Electrical Co.'s fitting department, 162, Shaftesbury-avenue, London, W.C., we have received a handsome and exhaustive catalogue of electric fittings and glass and enamelled iron goods for electrical installation work. Eighty large folio pages are crowded with illustrations of an immense variety of these goods, many of the designs being of special excellence. The list is strong in small accessories and also in some good designs of artistic figures in terra cotta and ornamental pedestals for carrying same. A great variety of pedestal and bracket lamps are shown, and the range of suspension lights and ceiling fittings is extensive. There are also shown some good portable accumulator sets, including a 4-volt motor car accumulator. A good index makes the list easy of reference and doubly useful.

**E.P.S. Batteries.**—A well-illustrated pamphlet showing some typical installations of E.P.S. cells is just issued, giving particulars of the batteries installed at Liverpool Corporation Works (three distinct sets), the Liverpool Overhead Railway, Bradford (two sets), Belfast (two sets), Nottingham, Gloucester, Perth and Dundee. The total watt-hour capacity of these sets is over 50 millions. One illustration shows the company's extensive works at Millwall. These works have been enlarged to twice their original size within the last three years.

**International Electrical Engineering Co.**—We have received a batch of 32 photo-prints of electric light and power machinery, manufactured by the Compagnie Internationale d'Electricité, of Liège, whose representatives in this country are the International Electrical Engineering Co, Clun House, Surrey-street, London, W.C. The illustration in each case gives a clear view of the subject, and the set of illustrations is particularly strong in electric cranes, motors, dynamos, transformers, three-phase plant, electric pumping plant, winches, &c. Accompanying the set of prints are circular price lists of C.I.E. entirely-enclosed continuous-current motors and C.I.E. arc light carbons, these latter being made at the company's own recently-reconstructed factory. Altogether a wide range of manufactures is shown, and the illustrations have considerable artistic merit.

**B.T.H. Apparatus.**—Pamphlets Nos. 101 and 102, issued by the British Thomson-Houston Co., deal with horizontal edgewise instruments and quick-break switches respectively.

**Twentieth Century Telephones.**—This is the name given to the manufactures of the Berliner Manufacturing Co., 117, Queen Victoria-street, London, E.C., who make the "Marvel" "Elite," "Eclipse," and "Premier" telephones. Illustrations and particulars of these instruments are given, together with diagrams of connections, in a circular just issued by the company. There is also a hanging sheet of illustrations portraying the telephone in use for various purposes, which the trade will find serviceable.

We have received a useful dating stamp from Messrs. Baker & Co., platinum refiners, Newark, N.J., U.S.A.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 10 to July 16, with the ports of destination :—

*Africa*—Alexandria, £2,700; Cape Town, £1,014; Durban, £1,054 (including £36 telegraph material); East London, £206 (telegraph sundries). *Argentina*—Buenos Ayres, £642. *Australasia*—Adelaide, £85; Brisbane, £435; Launceston, £128; Lyttleton, £115; Napier, £12; Perth, £250; Rockhampton, £738; Sydney, £594; Wellington, £174; *British Guiana*—Demerara, £480. *Ceylon*—Colombo, £687. *Chili*—Boca, £487 (including £265 telegraph material). *Cochin China*—Saigon, £19. *Gibraltar*—£71. *Holland*—Amsterdam, £50; Rotterdam, £150. *Hong Kong*—£50. *India*—Bombay, £50; Calcutta, £1,441 (including £100 telegraph wire). *Japan*—Kobe, £325; Yokohama, £101. *Russia*—St. Petersburg, £106 (telegraph material). *Straits Settlements*—Singapore, £10. *Sweden*—Stockholm, £191. *Uruguay*—Paysandu, £300. Total, £12,675, against £185,264 in the corresponding week last year (July 11 to 17).

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**MOND GAS.**—The prospectus of the Power Gas Corporation (Ltd.) will be issued to-morrow with a capital of £350,000 in £1 shares. The Right Hon. Sir Henry Fowler, M.P., is chairman, and Dr. Ludwig Mond (of Messrs. Brunner, Mond & Co.) and Mr. John Brock (the United Alkali Co.) as vice-chairmen. The company has been formed to develop "Mond gas."

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

10,065. LAKE (Scott). Automatic magnetic circuit-breakers.
10,074. NEWELL. Electric brakes for railway cars and the like.
10,124. KINGSBURY (Western Electric Co.) Calling appliances for telephone switchboards.
10,172. PREECE. Apparatus for starting and controlling electric motors.
10,214. MCMULLEN. Electrical ignition devices applicable to internal combustion and like engines.
10,219. WISE (Lux'sche Industriewerke Actiengesellschaft). Electric energy meters.
10,270. EVANS. Arrangement of voltaic battery for use in firing explosives.
10,361. HALFORD. Flexible electrical conductor from any point of which a current may be taken.
10,362. HALFORD. Caps for glow lamps.
10,363. HALFORD. Electric contacts.
10,375. GARASSINO. Construction of plates for accumulators or secondary batteries discharging heavy currents.
10,426. GARSIDE, CARTER and HYDRAULIC ENGINEERING CO. (LTD.). Electric safety appliances for lifts.
10,437. MACKENZIE. Electrodes for batteries.
10,511. ELECTRIC POWER STORAGE CO. (LTD.), BUTLER and MAY. Manufacture of negative or spongy lead plates or elements for secondary batteries or electrical accumulators.
10,542. OPPENHEIMER (Actiengesellschaft Mix and Genest). Electric couplings.
10,543. OPPENHEIMER (Actiengesellschaft Mix and Genest). Arrangement for limiting the length of the fuse of electric cutouts.
10,544. OPPENHEIMER (Actiengesellschaft Mix and Genest). Quick-break switches.
10,545. OPPENHEIMER (Actiengesellschaft Mix and Genest). Switches or keys for electric lamp-holders.
10,580. IMRAY (Marani). Electric furnaces of great power.
10,639. THOMPSON (Fraser Electric Elevator Co.). Electric controllers.
10,808. COUCHMAN. Electric arc lamps.
10,970. JUSTICE (Rowland Telegraphic Co.). Electric telegraphs.
11,011. CLOTHIER. Electrical switches and cutouts for heavy currents and high potentials.
11,054. GARLAND. Electrically-operated cloth-cutting machines.
11,207. ANDREWS. Distribution of electricity.
11,217. HEYL-DIA. Method of and material for covering electric cables, conductors or wires with insulating material.
11,260. TRIBELHORN. Electric accumulators and electrodes therefor.
11,263. HIRST. Electric lamps and fittings therefor.
11,287. JONES. Conduits for electric conductors.
11,500. SPIES. Arc lamps.
11,561. WURTS, POTTER, BENNETT and BEEBE. Nernst lamps and heating therefor.
11,571. BLUMENBERG. Electric battery compounds.
11,584. PAUTHONIER. Incandescent electric lamps. (Date applied for under International Convention, March 30, 1900.)
11,588. KENT. Electric railways on the sectional conductor system.
11,609. THOMAS. Means for protecting electrical apparatus from abrupt changes in static potential. (Date applied for under International Convention, Nov. 27, 1899.)
11,610. THOMAS. Means for protecting electrical apparatus from abrupt changes in static potential. (Date applied for under International Convention, Nov. 27, 1899.)
11,677. LEAKE. Parallel running of alternate-current machinery.
11,695. WISE (Union Electricitäts Gesellschaft). Alternating-current wattmeters.
11,720. DAWSON and DAWSON. Electrical ignition apparatus for exploding the charges in internal combustion motors and for other similar purposes.
11,941. SCOTT. Regulating appliances in connection with electric motors for turret turning, gun training, and analogous purposes.
12,074. SIEMENS BROS. & CO. (LTD.). (Siemens and Halske Actiengesellschaft). Static voltmeters.
12,179. HIRST. Electrical tramways or railways.
12,466. HARDINGHAM (Felten and Guilleaume Carlswerke Actiengesellschaft). Construction of rail bonds for electric railways and mode of applying same.
12,716. DALE. Electric switches.
12,743. BEHRENDT. Method of and apparatus for the local application of electrical treatment to the human body.
12,627. BARTLETT and ROBINSON. Electrical switches.
12,944. CLAYTON, BELL and BERRY. Electrical switch.
12,972. HIGHFIELD. Automatic booster in connection with a multiple wire system.
12,973. SIEMENS BROS. & CO. (LTD.) (Siemens and Halske, Actiengesellschaft). Indicator for high electrical tensions.
13,014. OPPENHEIMER (Actiengesellschaft Mix and Genest). Fuses or cut-out for high voltage circuits.

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13,015. OPPENHEIMER (Actiengesellschaft Mix and Genest). Insulated bases for switches.
13,515. HACKING. Overhead trolley wires or conductors for electric traction, overhead electric cables or the like.
13,573. PARKER. Apparatus for electrically lighting railway trains.
13,639. BLOXAM (Soc. Ch. Mildé, Fils and Cie.). Electric motor.
13,721. BRITISH THOMSON-HOUSTON Co. (LTD.) (Perry.) Systems of electric motor control.
13,805. WRIGHT and AALBORG. Insulating supports for electrical conductors. (Date applied for under International Convention, Jan. 2, 1900.)
13,810. BOSSHARDT (Gerard). Trolleys for electric traction having three wires for three-phase or other currents.
13,811. HILLISCHER Contact boxes for electric railways and tramways.
13,951. WEISS. Electric muffles or furnaces.
13,967. BRITISH THOMSON-HOUSTON Co. (LTD.) (Rice). Systems of electrical distribution.
13,999. BÉNARD. Arc lamps.
14,063. PILLINGER and VANDAM. Combined switches and fuses.
14,069. WISE (Actiengesellschaft Electricitätswerke vorm. O. L. Kummer & Co.) Lightning arresters.
14,161. TRAUN. Insulator.
14,409. HARRIS. Electric meters.
15,169. BRITISH THOMSON-HOUSTON Co. (LTD.). (Thomson). Rectifying alternating electric currents.
15,419. HADDAN (Sussmann-Kellborn). Supply of current to electric vehicles by inductive means.
15,642. HOLLUB and MIGNAL. Electric incandescent lamps.
15,888. FELL (Stanley). Method of suspending the moving parts of an electric integrating meter or other instruments.
16,127. BRITISH THOMSON-HOUSTON Co. (LTD.) (Steinmetz). Dynamo-electric machines.
17,724. BATCHELOR (Batchelor). Dynamo-electric generators.
18,059. MARZI. Electric railways and tramways on the closed conduit system.
18,617. BRITISH THOMSON-HOUSTON Co. (LTD.) (Hewlett). High potential electric circuit breakers.
19,425. DUCRETET. Electric coherers.
19,686. DE SALES and GUEUGNON. Accumulators.
20,311. BANKS. Electrical connections for tables and the like.
20,797. RIEGER. Sound-magnifying appliances for telephones, phonographs, and the like.
20,967. LAKE (Pinckard). Incandescent electric lamps.
21,478. BARKER and EWING. Electric meters.
21,533. MATTHEWS and DAVIES. Electrolytical apparatus.
21,669. HALL. Reflector for electric or other lights.
21,700. STERNE (Fowler). Telephony.
22,273. GAMBRELL and GAMBRELL. Electrical plug resistance boxes and like apparatus and switches therefor.
22,572. SCHALL (Messrs. Reiniger, Gebbert and Schall). Electrostatic machines.
22,692. OSBORN and BRITISH MOTOR TRACTION Co. (LTD.). Electric ignition devices for explosion engines.
23,240. COX, SMITH and SMITH. Gear cases for electric cars.
23,242. DE HOOR, REINITZ, and STARK. Regulating device for electric current generators.
23,361. SPERRYN and WOOD. Electrical fuse carriers for distribution boards and the like.
23,487. VON PLANTA. Electro-mechanical emergency brake for tramcars driven by electricity. (Date applied for under International Convention, June 23, 1900.)
23,649. KRAUS. Electric bell.
23,675. BRITZKE. Process and apparatus for obtaining electric current.
23,733. WOOLLEY. Test indicators for fire-alarm telegraphs.

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131. LUNDBERG and LUNDBERG. Electric light switches.
393. NEWTON (National Electrolytic Co.). Electrolysis and apparatus thereof.
486. LAKE (Globe Manufacturing Co.). Electric switches.
507. ELY. Electric switches.
1,011. DEL NERO and CAMINO. Apparatus for testing electric meters.
1,016. BRITISH THOMSON-HOUSTON Co. (LTD.) (Thomson). Dynamo-electric machines.
1,167. MATHIESEN. Electric meters.
1,330. ALLISON (Penberthy Injector Co.) Electric trolleys.
1,488. BROOKER and RUSSELL. Electric measuring instruments.
1,600. HORE, RYDL and VSETECKA. Electric tramways on a sectional conductor closed conduit system.
1,670. BERNDT. Eyeglasses or spectacles adapted for producing electrical currents.
2,240. CLAYTON. Trolley rope holders for electric cars.
[2,488. AXTELL. Apparatus fordisinfecting the transmitters and receivers of telephones.
2,490. EDISON. Storage batteries.
2,497. RICARD and GRAYS. Electric igniters.
2,570. MILDON. Electrical signalling apparatus.
2,659. HELIOS UPTON Co. and SPENCER. Electric arc lamps.
2,692. LOBENTHAL. Incandescent electric lamps.
2,835. HERMITE and COOPER. Manufacture of thermo-electric couples. (Date applied for under International Convention, Aug. 1, 1900).
2,900. H. M. SALMONY & Co. (LTD.). (Elektrizitäts-Actiengesellschaft vorm. W. Lahmeyer & Co.) Fusible cutouts for electric circuits.
3,026. DION. Closed conduit electric railways.
3,047. HIGHFIELD. Apparatus for regulating pressure in electric mains connected to storage batteries.
3,061. STRETCH. Electric generator.
3,192. JURIE. Electric furnaces.
3,288. HOWITT and P. R. JACKSON & Co. (LTD.). Dynamos and other electromagnetic machines.
3,313. THOMPSON (Soc. Mangano Electrique pour la Purification des Eaux et des Boissons). Purifying beverages and liquids by means of manganates under influence of the electric current.
3,370. LIDDLE (Globe Electric Co.). Battery electrodes.
3,388. THOMPSON (Boiron). Contact makers for electric igniters.

# COMPANIES' MEETINGS AND REPORTS.

## Eastern Telegraph Co. (Ltd.).

The fifty-eighth half-yearly general meeting of this Company was held on Wednesday under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. George Draper) having read the notice calling the meeting, and other formal business having been disposed of,

The CHAIRMAN said: It is now my pleasure to offer a few remarks on the report as submitted to the stockholders, who, I think and hope, will consider it a satisfactory one. For myself and the Directors, I think we may say that we are well satisfied with the position of the Company—the position it holds and the progress it has made. You will see that we recommend the declaration of a final dividend on the ordinary stock of 1¼ per cent., and a bonus of 2 per cent., amounting altogether to £130,000, and that those payments are free of income tax. They make, with the three previous payments on account, a total distribution of 7 per cent., but further than that, you see from the report that we are able to add a most substantial sum to the reserve fund. I will allude to these matters a little later on. Meantime I may observe that these matters, the dividend and the reserve fund, are the backbone of the report which we now submit to the shareholders, and which I hope will be thoroughly approved of by them. The gross revenue for the half-year has been £624,000, against £534,000 in the corresponding period of last year, showing the substantial increase of £80,000. In all cases I omit fractions of hundreds of pounds. They are very trying to read, and they do not add to the understanding of the figures. I am bound to say that this increase in the gross revenue is more apparent than real, because though there is that increase to the coffers of the Eastern Telegraph Co., it is to some extent taken out of those of the South African Company, owing to a readjustment of the joint-purse receipts, by which the Eastern Company, in consequence of work they have executed, take a larger proportion out of the joint-purse fund than they used to take. Therefore, what we absorb out of the joint-purse is to great extent at the expense of the South African Company, whose shares this Company holds. Therefore, as I said before, the increase of £80,000 is, to some extent, more apparent than real. However, as far as this Company is concerned, we have that increase. We have no doubt received extra revenue ever since the war in South Africa began. Perhaps our revenue in that direction is not so large now as it was, but, on the other hand, we hope we see signs of reviving activity in South Africa, which will be much more pronounced when the war is brought to a conclusion, as we hope it will be soon, and then we shall rely on the more sound basis of commercial activity than upon the more unusual and certainly less-to-be-desired revenue from warlike operations. There has also been a considerable increase in the China traffic owing also to the question of the disturbed relations with that country. There, again, the same remark applies—that we gain from these exceptional disturbances at the expense of our more regular commercial trade; and, of course, we as Directors would more willingly and more gratefully see commercial activity as the source of our revenue than a revenue derived from military exigencies. All other classes of traffic are fluctuating, some showing increases and some decreases. They call for no special remarks at the present time. On the whole, I think we may say that the net results are satisfactory, and I believe that the stockholders will agree with us in that. The ordinary expenses for the half-year amounted to £135,000 against £128,000 in the corresponding period of 1900, or an increase of £7,000. We cannot help these rises, seeing that the advance in working expenses is mainly due to the increased volume of traffic carried by us; and it is matter for congratulation that the percentage of working expenses, compared with the volume of the traffic, shows no sign of increase. We have had in connection with the new cable to the Cape to employ a larger staff to cope with the increased volume of traffic, and there is an inevitable tendency in that respect for the increase of wages to keep pace with the increase of revenue. Every care, however, has been exercised by the Board to keep the expenses within reasonable limits, and, as I have said, the proportion of working expenses to revenue shows no sign of increase. One charge which the stockholders authorised now comes into the accounts—namely, the staff pension fund. There is an increase in the charges on that account of about £1,500, owing to the remodelling of the pension scheme, in order to allow our staff to retire if necessary at the age of 55 instead of 60. That was passed by the stockholders on a former occasion, and I only note it now as an item of extra expense. We have also had some extra expenses owing to repairs. This last half-year we have repaired and maintained communication in a very satisfactory manner, but it has necessitated the employment of rather more cable than in the corresponding period last year. That, however, is a matter which we cannot control. If an examination of a cable through any fault is necessary, the repair has to be made for a sufficient length to keep the cable in an efficient condition. It is no use

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cutting out a small bit and leaving other bits in an ineffective state, and, therefore, when cable is put in, an amount is inserted sufficient to make the other portions of the cable satisfactory. In that way we have put in 244 knots in the past half-year, as against 107 knots in the corresponding period of 1900. That, of course, is a very wise thing to do, but it adds to the expense, and, therefore, you will see by the acccounts that the expenses attending the repairs and renewals of cables amounted to £46,000 last half-year, as against £28,000 in the corresponding period of 1900. There is an increase in the income tax of £3,574 due to circumstances which we cannot control, but which we all lament. The stockholders will no doubt observe that we have been able to put £205,000 to the general reserve fund; and I hope that our course of conduct in that respect will meet with your hearty approval (hear, hear). The necessities of the case are that the reserve fund must be largely increased from time to time if these cable companies are to be in a stable condition. We have also got this matter to face—that we are committed to very large cable extensions in various directions, so although we pay into the reserve fund £205,000, we have to take out of it £400,000 on account of the new cable forming the new through route to the Cape, and we thus reduce the general reserve fund, as you see by the accounts, to £853,000. You will also see, on reference to the balance-sheet, that there still remains an expenditure on account of new cables of £1,063,000 to be dealt with, and a further sum of about £70,000, the balance of our liability on account of the Durban-Mauritius cable, will appear in the accounts next half-year. We are also engaged in the renewal of our original Red Sea cables. There is, therefore, more than sufficient justification for our carrying this large sum to the reserve fund, and unless we did that, we should not be able to grapple with the question submitted to the Board of making extensions in order to meet the growing business of the Company. Our policy in this matter is this—that from time to time we draw on our reserve fund for these extensions with the view to improve our position as carriers of the messages of so large a portion of the population of the habitable globe and to be able to fulfil our public duties. If we were not in that position, and we had to take the chance of going into the money market whenever we thought an extension was necessary, we should not occupy the position in the commercial world which the Eastern Telegraph Co. does occupy and has occupied for so many years. We have to consider the interests of the whole of the stockholders, and our policy, as I have said before, is to keep pace with the duties we owe, not only to the stockholders, but also to keep pace with our public duties, feeling sure that so long as we fulfil our public duties we have not only the support of our stockholders, but of the whole mercantile world; and it is a great satisfaction to the Board to know that they are able to keep pace with all requirements and are able to fulfil the duties of a carrying company in a way that really leads to there being no complaints of a serious nature. Following out that idea, the cable between the Island of Ascension and Sierra Leone was opened for traffic in April last, and in May the Durban-Mauritius cable was laid, being that portion of the through route to Australia for which the Eastern Company was responsible. It is matter of congratulation that we have been able to get that portion ready, and we know that our friends, the Eastern Extension Company, are very forward with their work of completing the link with Australia. There is every hope that before the end of this year there will be communication between Mauritius and Western Australia by the direct line, and that the whole system contemplated by the two companies—the Eastern and the Eastern Extension—will be completed within a very short time after the beginning of next year—some time about next spring, I hope. Another matter I may mention is the Inter-Departmental Committee which was appointed some time ago by the Government, under the presidency of Lord Balfour of Burleigh, to look into the whole question of the cable companies *vis-à-vis* to the requirements of the Imperial and the Colonial Governments. That Committee have sat on several occasions. We have, through our Managing Director, Mr. Denison-Pender, been able to assist them very greatly by the vast amount of information we have given them deduced from our great experience of so many years; and we know that the Committee have been able fully to recognise the aid which we have been able to give them in the rather complicated subject which they have had to investigate. We have not yet heard what the result of the Committee's deliberations has been, but we have every reason to suppose that so far as we are concerned we have done our duty to the Committee. We have nothing to fear from the fullest investigation by competent authorities as to what we have done and propose to do, and we await the report of the Committee with the utmost confidence. Another matter which I may perhaps refer to is the Indian tariff. That has been more than once mentioned in this room. You note very often in the public prints that by certain enthusiastic men in Parliament or out of Parliament, who have very Utopian ideas on cable questions, it is contended that the Indian tariff requires reduction. So far as we are concerned we should rather welcome the reduction. We have been for a long time past desirous of reducing the Indian tariff, because we feel that that tariff, when considered in relation to the tariff to places further removed from this country than India, presents some anomalies, but we have been absolutely unable to make the reduction we should have been willing to make in consequence of relations with other parties—foreign governments and others interested in the joint-purse to India. The reduction could not be made until everyone interested was convinced that it could be done. We have been convinced for a long time that it ought to be done, and we have expressed our willingness to the India Office to concur with them and foreign governments as soon as they can get everyone into line. We have every reason to hope that these difficulties—which are none of our making—will shortly be brought to a settlement, and that we shall be able to make a substantial reduction in the tariff to India. Another matter I have mentioned once before in this room is the question of the coding of messages—a very interesting subject, and one which has attracted the attention of the Directors for some time. We all know that the bulk of the traffic of these companies—something like 95 per cent.—is carried by code, and we also know that merchants and others who have to correspond regularly by telegraph go to great expense in perfecting codes which will enable them to express their meaning in a copious way with a *minimum* of words. It is an expensive arrangement to undertake, and none but merchants and those who have command of capital can undertake to compile a code sufficiently elastic to do all the work that is necessary in connection with cable communications. Most of the merchants have these codes, and, as a matter of fact, more than nine-tenths of our traffic are carried on by means of code. The result is that merchants and others who have codes are really able to telegraph these huge distances by means of cables which have cost immense sums of money at the rate, after the code is transcribed, of about 1d. a word more or less in accordance with the perfection of the codes they employ. It does seem a most extraordinary thing that by the ingenuity of men applied in this way they should be able to telegraph, say from the furthest part of Australia to the middle of London at 1d. a word when we know that ½d. a word is what is charged for inland telegrams in this country. However, the result is that they are able to telegraph for about 1d. a word. We have felt for a long time that there is a hardship in private individuals being unable to approach such a price as this. If an officer in the army in India wishes to communicate with his family, or his family wishes to communicate with him, or if travellers desire to announce their arrival, unless they are able to go to some agency they are unable to send their telegrams for less than 2s. or 3s. a word, and the whole telegram may cost £4 or £5, which people cannot afford, or which they do not afford except in cases of extreme urgency. We have been anxious to redress this state of things, which produces about nine-tenths of the complaints against the Eastern and their associated companies, and we have thought out the matter so far as to lay a proposal before the Post Office in England and the Telegraph Administration in India—without which institutions we cannot proceed further—by which private individuals may go into the various telegraph offices and employ a code kept there for their use, and probably also employ the services of a clerk to assist them with the code, so that they may be able to telegraph on something like the same terms as merchants, and thus reduce the cost of social telegrams and telegrams of that nature to something like that charged for commercial telegrams. We hope to be able to carry this further. At the present time the matter is under discussion in India, and negotiations have also been opened with the Post Office in London. I am afraid that the Post Office in London have seen some difficulties in the way, which I hope may be removed, but at the same time we have every confidence that within certain limits, if the Indian Government agree—and we believe they will welcome the idea—we shall be able to confer a most substantial advantage on the Indian Government, or rather the people who are under the Indian Government, in respect of private telegrams. I cannot say any more on this matter at present except that I hope the stockholders and others will realise that it is an honest endeavour on the part of the directors to meet an anomaly, and one which presses very hard on people who cannot afford, perhaps, to pay the full rates, and an anomaly, moreover, which I am persuaded is the cause, as I have said, of the great majority of all the complaints we hear against these companies about high rates. If we can convey the bulk of our messages when transcribed, so as to be intelligible from the sender to the receiver, at a cost per word which will approximate the cost per word of commercial telegrams, no one will be able to complain of our charge for submarine communications, and, as I have said before, the stockholders need not be afraid of this affecting our revenue seriously, as it applies to only 5 per cent. of the traffic of these great companies. I believe, in fact, that so far from damaging the revenue, it may have an opposite effect, and produce a much larger number of social telegrams and messages of that kind than now pass over the wires on account of the high tariffs which are at present in force. The only other matter I need mention is, as you will observe from the accounts, that we have been paying for the building of Electra House, where the whole of these companies will in future be. We are happy to say that the building is making satisfactory progress, and we have every hope that by about this time next year we may have the pleasure of meeting you in our new premises. It will be a matter of great congratulation to ourselves here, because we feel daily that the office accommodation in this building is not what could be wished for, and that some increased accommodation is absolutely wanted. I think I have nothing further to say except that I shall be happy to answer any questions which may be put to me, and I will conclude by moving—

"*That the printed report and accounts of the Directors to 31st March, 1901, submitted to this meeting, be and the same are hereby received and adopted; that the dividend to be paid on the preference stock of the Company to June 30, 1901, at the rate of 3½ per cent. per annum, less income tax, be approved; and that in accordance with the Directors' recommendations, a dividend be and is now declared of 1¼ per cent., with a bonus of 2 per cent., both free of income tax, on the Ordinary stock of the Company, making, with previous payments by way of dividend on account, a total payment of 7 per cent. on that stock for the year ended March 31, 1901.*"

The VICE-CHAIRMAN and MANAGING DIRECTOR (Mr. J. Denison-Pender) seconded the motion, which was carried unanimously.

Mr. PARRITT, who stated that the Chairman's speech indicated progress on all hands, proposed a vote of thanks to the Chairman and the Directors.

Mr. JOHN NEWTON seconded the motion, which was carried unanimously.

The CHAIRMAN, in reply, observed that nothing gave the Board more confidence in the management of these large undertakings than the feeling that the stockholders were thoroughly with them.

The proceedings then terminated.

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## West African Telegraph Co. (Ltd.).

The 16th ordinary general meeting of this Company was held yesterday under the presidency of the Most Hon. the MARQUIS of TWEEDDALE, K.T.

The SECRETARY (Mr. John Cambrook) read the notice calling the meeting.

The CHAIRMAN: I have now to ask your approval of the report and accounts, and I propose to deal with them as they are before you in the first place, and having disposed of that portion of our business, I will refer separately to the important question connected with the French Government. The gross revenue for the year ended December 31, 1900, amounted to £81,568, as against £77,008 in 1899, or an increase of £4,560. The principal increase is due to the operation of the joint-purse with the Eastern and South African Co., and there is also an increase due to a reduction in the amount paid by this Company for the hire of cables belonging to other companies, owing to the Dakar cable not being in working order. The total working expenses for 1900 amount to £20,388, as against £20,298 in 1899, or an increase of £90. We find that the principal increases are due to the staff pension fund which was authorised at the last general meeting, £305, and this Company's proportion of the expenses of the associated telegraph companies electrical department, £149; and the principal decreases occur in the expenses under abstract A and B, foreign agency, &c., £364. The expenses attending repairs and renewals of cables amounted to £9,035 as against £11,482 in 1899, or a decrease of £2,447. Income tax shows an increase of £108, due to increased revenue and to the increase in the tax itself. After providing for debenture interest and sinking fund the net result of the year's working is to show a profit of £28,322, of which the Directors propose to place £28,000 to the reserve fund, and to carry the balance forward to next year. You will notice, however, that the revenue includes £12,000 in respect of the subsidy due from the French Government for 1900, and that the non-payment of this amount had been provided for by transferring a further amount of £12,000 from the general reserve fund to a special fund. The general reserve fund now stands at £45,332, of which £33,712 is invested; £14,000 was on deposit with our bankers at the date of making up the accounts. I now move the adoption of the report and accounts.

Sir H. C. MANCE seconded the motion, which was carried unanimously.

The CHAIRMAN: I now move that the Directors be authorised to negotiate with the French Government the transfer of their rights under concession from the French Government, together with the cables, &c., connected with such rights. You will remember that at the meeting this time last year we held out hopes that before very long the differences with the French Government would be removed, and I am glad to say that our hopes have been realised. In paragraph 4 of the report you will notice that the French Government have still withheld the subsidies, and the amount now due from them under this head is £68,415. You will recollect that the original French concession provides for the cable being laid between Conakry and Grand Bassam, but at the date the cable was laid by our predecessors, they made an arrangement with the French Administration by which the Company were permitted to make use of the African Direct Company's cable between Sierra Leone and Accra in lieu of laying a cable between Sierra Leone and Grand Bassam. You are no doubt aware that the African Direct Company is closely associated with this Company, as they are co-partners in the South African joint-purse. It was only about six years ago that a question arose with the French Government on this point. To lay this cable only meant throwing money away, as the communication with the French colonies was amply sufficient, and your Directors did not consider that they were justified in laying a cable which would not even earn the interest on the outlay. They, therefore, entered into negotiations with the French Government, which have continued ever since, but have lately taken a more definite form. It is now proposed that this Company should surrender the concession and hand over the following cables which connect the French colonies:—The Dakar-Conakry cable, the Grand Bassam-Kotonou cable, and the Kotonou-Gaboon cable, touching en route at San Thome. The Portuguese station at Bissau, which is at present connected with the Dakar-Conakry cable, will be disconnected, and will be connected with Bathurst direct by a new cable, the latter station being cut out of the Dakar-Conakry section. The French Government will have connection with the existing cables at Conakry, the Sierra Leone-Conakry cable remaining in the possession of the West African Telegraph Co. The Grand Bassam-Kotonou cable, which now touches en route at Accra, is to be disconnected at the latter place and the cable joined through. The French Government are to have the option of continuing the connection at San Thome. Under this arrangement—and this is an important part of it—the French Government are to pay £112,000 on the cancellation of the concession, and a further £32,000 as and when the cables are handed over. These sums, together with the moneys in the reserve, will be sufficient to pay off all the outstanding debentures, which it is intended at once to proceed to do. I need hardly tell you that this arrangement has not been arrived at without a considerable amount of negotiation and trouble and anxiety, but I am glad to see that it is now thoroughly completed; and, looking at it from all points of view, it is entirely in the interests of this Company.

The MANAGING DIRECTOR (Mr. J. Denison-Pender) seconded the motion, and said that in selling these cables to the French Government, the West African through line to the Cape will not be interrupted. This arrangement is for simply handing over to the French Government the cables which go into their settlements in that part of the world.

Mr. EAST inquired if the arrangement cancelled the £68,000 that was owing to the Company by the French Government. He assumed that it did.

The CHAIRMAN: Yes.

The resolution was carried unanimously.

After the re-election of the Marquis of Tweeddale as a Director, and the reappointment of the auditors, Messrs. Deloitte, Dever, Griffiths & Co., a vote of thanks to the Chairman and Directors terminated the proceedings.

## Electric and General Investment Co. (Ltd.).

The 12th ordinary general meeting was held yesterday under the presidency of Mr. G. HERRING.

The SECRETARY (Mr. J. C. Bull) read the notice calling the meeting, and the report of the Company's auditors.

The CHAIRMAN said: Gentlemen, you will note from the profit and loss account that the business was not so good as in the previous year. As you know, our profits are derived from making issues, principally of electrical industries. Those, I am happy to say, have always been on a sound basis, and I think that one of the principal causes why the public have not been investing in these, as I call them, good securities is that the fluctuations—if I may use the word, the "gamble"—in other shares, such as American shares, so bewilder the public that they have entirely lost sight of the fact that a good safe investment is, after all, the most profitable. In the balance-sheet you will see one item that is fresh—the issue of preference shares. On the other side are the investments at cost, Undoubtedly many of our investments have decreased in value, but I am happy to tell you that, despite that, the investments at cost price would realise this sum of money, and I hope more. Turning to the profit and loss account, you will notice another item that appears also for the first time—namely, the dividend on the preference shares. That dividend, roughly speaking, will take £6,000 every year out of our pockets. Of course, that is something we have to make up, but it gives us the possession of the £100,000 to use, and likewise it saves us a considerable sum of money, not quite £6,000, but certainly three-fourths of that amount, because the money we borrowed in previous years from our bankers we had to pay interest on, and we do not, of course, have to pay that now. I now move the adoption of the report and accounts.

Mr. J. B. BRAITHWAITE seconded the motion, which was carried unanimously.

Resolutions approving the distribution of the dividends and bonus on the ordinary and founders' and preference shares were adopted, and the re-election of Mr. J. B. Braithwaite as a director, and of Mr. G. T. Rait as auditor having been carried, the meeting terminated.

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## Telegraph Construction and Maintenance Co. (Ltd.).

The half-yearly general meeting of this company was held on Tuesday, at the offices, 38, Old Broad-street, under the presidency of Sir R. G. W. HERBERT, G.C.B.

The SECRETARY (Mr. E. Dickens) having read the notice convening the meeting,

The CHAIRMAN said: Ladies and gentlemen, I think you are all aware that for this half-yearly meeting we do not make up the accounts, and we present no formal report to the proprietors; but one of the objects of our meeting you to-day is to inform you that in pursuance of the deed of settlement, we are in a position to give you a dividend of 10 per cent. per annum for the half-yearly period. It is, of course, also our wish to give you any explanations with respect to the current affairs of the company that seem to you to deserve notice. We meet you to-day under the shadow of a grave calamity which has befallen the Company, and more immediately the Board of Directors, in the loss of our much-valued colleague, Sir Anthony Hoskins, who was a distinguished naval officer, as everybody knows, but you also have some knowledge of the great ability and energy with which he co-operated with the Board, more particularly in that province with which he was best acquainted—all matters connected with our sea-going work, the building of our ships, the surveying of our cable routes, and everything connected with the naval part of the Company's work. He will be very difficult to replace, and we do not pretend to have come to any conclusion with respect to a successor to him at the present time. We think it desirable that we should deliberate on that matter fully and carefully. It naturally would be our wish, if we could, to replace him ultimately by a member of the same profession, because we have always had upon this Board an Admiral or a Naval Officer of high standing. Beyond that I am sure that you would not wish me to say more at the present time. It must be a matter for great consideration where to look for the highest qualifications for your service. As regards the general affairs of your Company, you perhaps need hardly be assured—because you must be aware of it from what you have read in the Press—that we are carrying on a great deal of active work. Our factories are working harder than ever, and with their improved machinery they are turning out perhaps better work than ever. All our ships, and especially the "Anglia," are doing their work in full response to the work done by the factories, and we have laid a great many miles of cable since our last meeting, and in a very successful manner. You were informed on the last occasion of our meeting that we were constructing a new ship, which we hope will fully rival the "Anglia" in its capacity for carrying on our service. That work, I may tell you, has now made a fair start, and we feel no doubt that long before the necessity for laying the Pacific Cable arises next year, this ship will be afloat in a very efficient condition; and we have great hopes of her. You have, perhaps, seen in the newspapers this morning the answer given in the House of Commons last night by Mr. Austen Chamberlain to Sir Edward Sassoon, stating what has been done with respect to the preparations for the construction of the Pacific Cable. The Pacific Cable Board is actively engaged in making all the arrangements. You will have seen that the route has been surveyed to a great extent; 1,500 miles have already been surveyed, and the surveying ship "Britannia," is now engaged on this service between Norfolk Island and the Fijis. Block-houses have been erected on some of the islands to receive the cable, and the materials have been got together. We have plenty of time before us. We are not bound to produce, and we shall not produce, that cable until towards the end of next year, and we are fully confident that, without in any way interfering

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with our other work, which is more pressing, the cable will be constructed in due time. I do not think that I have anything further to say to you.'

Mr. CROFT said he felt sure that the proprietors would wish to associate themselves in the expression of the Chairman's regret at the great loss which the Company and more especially the Directors had sustained. He had been a shareholder for many years, and he knew that they had always had on the Board some very distinguished member of the naval profession, among whom the late Sir Anthony Hoskins was one of the most distinguished. He trusted, however, that the Board would be able to replace their late colleague by a gentleman fully as eminent. It was most important that the Company should have on the Board some Naval Officer, because the work done by them consisted very largely of matters which were within the experience of naval men. From what the chairman had said, as well as from what had appeared in the public Press, the shareholders would have gathered that this had been a very busy year for the Company, and that the next twelve months also promised to be busy. He was sure that the shareholders would wish to give expression to their feelings as to the way in which the Directors and the Staff had conducted the affairs of the company, and the manner in which the Staff had worked. He was sure that if there had not been co-operation on every side the enormous business which the Company had to transact would not have been so satisfactorily carried on. He had great pleasure in proposing a vote of thanks to the chairman, the Directors, and the Staff.

Mr. PHELAN briefly seconded the motion, which was carried unanimously.

The CHAIRMAN: We thank you very much for the manner in which you have recognised such work as we have been able to do for you in the period since we last met. I am sure it will be very acceptable to the family of our late friend Sir Anthony Hoskins to know that the proprietors fully share the feelings of the Board with reference to the loss that we have all sustained by his removal. I may add that we feel confident when the more critical time of the annual meeting next year arrives, we shall be able to present ourselves before you in a satisfactory position with regard to dividend and in every other respect.

The proceedings then terminated.

## City and South London Railway Co. (Ltd.)

The report of the directors of this company for the half-year to June 30 states that the receipts from all sources for the past half-year have amounted to £53,653. 19s. 2d., and the working cost has been £28,096. 8s. 4d., leaving a profit of £25,557. 10s. 10d. Inclusive of the balance brought forward, the net revenue was £26,906. 13s. 7d. After making provision for the debenture interest, and the transfer of £2,000 to a renewal fund, there is available for dividend £16,964. 1s. 8d. The full dividend on the 5 per cent. preference stocks, 1891 and 1896, and a dividend at the rate of 1¾ per cent. per annum on the consolidated ordinary stock is recommended, leaving £732. 16s. 8d. to be carried forward.

The number of passengers, exclusive of season ticket holders, carried, and the receipts of each corresponding half-year since the opening of the line is as follows:—

| | | | | | |
|---|---|---|---|---|---|
| Ended June 30, | 1891 ..... | 2,412,343 | ... £19,403 | 6 | 9 |
| " " | 1892 ..... | 2,813,162 | ... 20,931 | 4 | 2 |
| " " | 1893 ..... | 3,146,656 | ... 22,458 | 6 | 9 |
| " " | 1894 ..... | 3,383,154 | ... 23,564 | 10 | 6 |
| " " | 1895 ..... | 3,113,199 | ... 23,711 | 5 | 8 |
| " " | 1896 ..... | 3,192,672 | ... 24,021 | 13 | 0 |
| " " | 1897 ..... | 3,437,810 | ... 26,403 | 3 | 6 |
| " " | 1898 ..... | 3,478,977 | ... 26,356 | 16 | 4 |
| " " | 1899 ..... | 3,540,098 | ... 26,749 | 3 | 0 |
| " " | 1900 ..... | 4,169,717 | ... 33,608 | 2 | 3 |
| " " | 1901 ..... | 5,887,786 | ... 51,013 | 17 | 3 |

The traffic of the line has been steadily increasing during the whole of the half-year, and, notwithstanding the high price of coal and other materials, the percentage of working expenses has fallen considerably.

The extension to Islington is rapidly approaching completion, and will, it is anticipated, be open for traffic by the end of September next. The subway at London Bridge in connection with the Brighton Railway is nearly finished, and is waiting only for the completion of the lifts. In view of the opening of the Islington extension, 36 new coaches of an improved design have been ordered and arrangements have been made to run an additional coach on each train during the busy hours of the day.

The new engine and boilers at the generating station are now nearly ready. The engines and boilers that were provided at the opening of the railway, although still in good order, had been superseded by improved appliances, and it was thought better, both for economy and efficiency, to replace them by an entirely new plant, and the old engines and boilers have been sold. The original cost, £10,704, having, therefore, to be credited to capital and replaced out of revenue, the amount has been debited to a renewal account which, on the other hand, has been credited with £2,670, the proceeds of the sale, with £1,000 transferred from reserve, and £2,000 charged against the revenue of the past half-year, leaving £5,034 to be liquidated out of the revenue of future half-years.

The company's bill has received the Royal assent. The arbitrator has given his award in the matter of St. Mary Woolnoth Church, in the form of a special case, which raises certain questions of law to be determined by the Court. The necessary steps are being taken to bring the matter to a conclusion.

As it will be necessary to raise some additional capital to pay off various existing loans, and to provide additional rolling stock required to meet the increasing traffic, the proprietors, at the forthcoming meeting will be asked to sanction the issue of preference stock, to be raised from time to time as required.

No further progress has been made by the City and Brixton Company in the raising of capital for the construction of the line, and the powers, if not renewed, will shortly expire. A bill has been introduced into Parliament to extend the powers for another year, but it has not yet passed. The piece of this company's line between the old station at King William-street and the Borough remains, therefore, still unused.

## British Thomson-Houston Co. (Ltd.).

The report of the directors of this company for the year to March 31 is as follows:—

The erection of the Rugby works is expected to be completed by the end of 1901. During the past year further branch offices have been opened at Newcastle, Manchester and Cardiff.

Royal assent has been given to the Hamilton, Motherwell and Wishaw Tramways Bill, promoted by the company, and negotiations are pending for acquiring lands, erecting buildings, and carrying out the permanent way and construction of the whole system. An important contract has been entered into for the complete construction of the Chatham and District light railways, and it is hoped the line will be opened before the end of the present fiscal year. The British Thomson-Houston Co.'s investment in the Cork Electric Tramways and Lighting Co. continues to be a sound and valuable asset.

The maintenance period for which this company is liable in connection with the Central London Railway expires at the end of July instant. The plant supplied by the company has been running satisfactorily in every respect. The company has successfully carried out the electrical and other works of the London United and the Bristol Tramways, the former being the first in London electrically equipped and successfully running. The latter undertaking covers practically the whole of the city of Bristol, and is working most satisfactorily.

The company has secured, and has partly executed, important contracts in connection with the power distribution scheme on Tyneside. This is the first important scheme of power distribution in this country, and the supply has recently been inaugurated.

The company was successful in the patent action brought against it by Messrs. Chamberlain and Hookham for alleged infringement of certain meter patents. An appeal was, however, lodged, and is expected to be heard during July.

The profits, after deducting general and technical expenses, discounts and interest, amounted to £41,014. 8s. 11d., of which £13,659. 14s. 9d. has been already applied as set out in the statement of accounts accompanying the report. £28,758. 2s. 1d. is the available balance which the directors recommend be distributed as follows:—£18,000 to 7½ per cent. dividend on £240,000 fully-paid ordinary shares, £7,550 to 7½ per cent. dividend on £160,000 ordinary shares as called and paid from time to time, £2,050. 14s. 6d. to reserve (being 5 per cent. of £41,014. 8s. 11d.), and £1,157. 7s. 7d. to profit and loss new account.

**EDMUNDSON'S ELECTRICITY CORPORATION.**—An ordinary meeting of this company was held on Thursday last, under the presidency of Mr. J. R. Wigham, J.P. The chairman said: The directors have a favourable report to lay before the shareholders. The profits for the year, after paying debenture interest and preference dividend, amount, with the balance brought forward, to £24,980. An interim dividend at the rate of 5 per cent. on the ordinary shares for the half-year to Sept. 30 last has absorbed £4,215. 13s., and the dividend was now proposed at the rate of 9 per cent. for the half-year to March 31 (making 7 per cent. for the year). It was also recommended that a 7 per cent. dividend for the year should be paid on the deferred shares, and that a further £5,000 be written off goodwill account. £4,000 was to be placed to a reserve account, leaving £2,201 to be carried forward. The steady growth in profits, I think, justifies us in recommencing this increase in the dividends. A larger proportion of our interest in various undertakings is now producing a return, the amount in the present accounts being £11,108, comparing with £4,438 last year. Many of our investments have not yet reached the productive stage, so that still better results may be expected from year to year in that respect. From the balance-sheet you will see that further debenture stock has been issued since last year, making the total £120,000, and that the £100,000 6 per cent. preference shares authorised last year have also been issued. On the other hand, our investments in subsidiary companies now amount to £331,394, this increase being due to the completion of many of the works which were then only in course of construction, and also to the very considerable extensions which have been necessary in several of our older undertakings. The shares which are held in the various companies have all been taken at cost, and a large number of shares representing the profit made in carrying out our contracts have not been taken into account at all. If these investment were taken at par instead of at cost, the total value would be increased to nearly £400,000. As an example, I may take our interest in the Woolwich District Company, in which we hold about £35,000 out of the total capital of £50,000. This undertaking has grown very considerably, and the new Woolwich Borough Council are desirous of taking the electric lighting of the borough into their hands, and have made an offer of £80,000 for the undertaking. This offer has been accepted, and the whole matter will be adjusted between the parties in a few days. We have over £5,000 of Woolwich shares not taken into account in the balance-sheet., worth about £11,000, and we have about £9,000 of similar shares taken at par, but now worth about £20,000. During the past year the electricity works under our control have made satisfactory progress. New stations have been completed and opened and are working satisfactorily at Melton Mowbray, Lymington, Montrose, Brechin, and at Sandown and Shanklin. Formerly a separate local company was created to operate in each of the districts in which we were interested,

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but during last session we obtained powers for electric lighting in a number of towns and for constructing and equipping electric tramways in some of these districts, and these powers were obtained in the name of the Urban Electric Supply Co., which recently issued its capital, Edmundson's company retaining rather over one-third interest in the concern. The contracts for the erection of the different works for the Urban Company, and the management of them when erected, will be in our hands for a number of years, and we look to this, the largest of our subsidiary companies, to provide us with an additional source of profit. The report and accounts were then adopted, and Mr. J. W. Edmundson was re-elected a director.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ARC LAMPS (LTD.)**—Reg. July 11, capital £60,000 in £1 shares, to adopt an agreement for the acquisition from W. J. Davy and C. W. Milne of certain inventions for improvements in electric arc lamps, and to carry on the business of arc lamp manufacturers, electrical and mechanical engineers, machinists, metal founders, glass blowers and manufacturers, makers of cables and conductors, wire drawers, carbon manufacturers, metallurgists, stampers, porcelain and stoneware manufacturers, &c. The subscribers (each with 250 shares) are C. W. Milne, Capt. E. I. Bax, G. McFarlane (consulting engineer), A. E. Bennett (electrical engineer), W. J. Davy (consulting engineer), J. R. Whamond and W. R. Gaff. The first directors are C. W. Milne, Capt. E. I. Bax, G. McFarlane, A. E. Bennett and W. J. Davy.

**JOHN CAMERON (LTD.)**—Reg. July 8, capital £60,000 in £1 shares, to acquire the business of John Cameron, hydraulic, mechanical, electrical and marine engineer, machinery manufacturer, tool maker, &c.

**DU BOIS CO. (LTD.)**—Reg. July 12, capital £200,000 in £1 shares, to acquire the business of the British and Foreign Du Bois Co. (Ltd.) and the United Enterprises (Ltd.), and to carry on the business of lead workers, manufacturers of lead and other traps, mechanical and hydraulic engineers, electricians, &c. The first directors are E. S. Torrey, A. Rosenthal and J. B. Purchase.

**THOMAS HOWDEN & SONS (LTD.)**—Reg. July 12, capital £5,000 in £1 shares (3,000 preference), to acquire and carry on the business of engineers, steam engine and boiler makers, and makers of electrical machinery, plant, and appliances, &c.

**CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)**—According to the annual return to May 22 the capital is £200,000 in 40,000 shares of £5 each, 30,000 of which have been taken up. £5 per share has been called up on 20,000 and £3 per share on 10,000 shares, and £129,692 has been received, in addition to £3,537. 10s. paid in advance of calls. No mortgages or charges.

**KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION CO. (LTD.)**—In the annual return to May 31 the capital is given as £100,000 in £10 shares (5,000 preference), of which 3,000 ordinary and 3,000 preference have been taken up. £10 has been called up and paid on each share. No mortgages or charges.

**METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)**—The annual return to March 19 gives the capital as £1,000,000 in £10 shares, of which 98,775 have been taken up. £10 per share has been called up on 82,968 and £7. 10s. per share on 13,775 shares, and £932,992. 10s. has been received. 2,032 shares are considered as fully paid. Mortgages and charges—£470,000.

**OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LTD.)**—The annual return to April 4 gives the capital as £100,000 in £10 shares (5,000 preference), of which 4,000 ordinary and 4,000 preference have been taken up. £10 per share has been called up and paid. Mortgages and charges—£40,000.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26⅞d. per oz. (July 18). Consols (2¾ per cent.) 92⅜—92⅝ for money, 92⅝—92⅞ for account; 2½ per cent. 93—93¼ (July 18). Consols Pay Day Aug. 1; Stocks and Shares Continuation Days, July 29 and Aug. 13; Ticket Days, July 30 and Aug. 14; Pay Days, July 31 and Aug. 15; Mining Share Carry-over Days, July 26 and Aug. 15.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—The transfer books and register of holders of 6 per cent. cumulative preference shares will be closed from July 19 to Aug. 2 inclusive.

**DIRECT UNITED STATES CABLE CO. (LTD.)**—A final dividend of 3s. per share and a bonus of 1s. per share (both tax free) are recommended to be payable on and after 31st inst. This distribution makes, with three interim dividends already paid, 3¼ per cent. for the year ended June 30, after placing £10,000 to reserve and carrying forward about £3,532. The transfer books will be closed from 16th to 30th inst. inclusive.

**DUBLIN UNITED TRAMWAYS CO. (LTD.)**—A dividend at the rate of 4 per cent. per annum for the half-year ended 30th ult. is recommended, carrying forward £3,374. £6,337 has been charged against revenue during the half-year for compensation.

**EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH CO. (LTD.)**—The 4 per cent. mortgage debenture stock register will be closed from 27th to 31st inst. inclusive.

**FERRANTI LIMITED.**—The prospectus is set out on another page of Ferranti Limited, inviting subscriptions for debenture stock and preference shares of which particulars are there given. The capital of the company is £500,000, divided as to £200,000 in ordinary and £200,000 in 6 per cent. cumulative preference shares, both of £1 each, and £100,000 5 per cent. first mortgage debenture stock. Interest on the latter is payable half-yearly—in June and December. The company is formed to acquire as a going concern and to continue and extend the business of S. Z. de Ferranti (Ltd.), which is well known throughout the world as a pioneer electrical manufacturing firm. The original limited company was formed in June, 1890, and the new company acquires the business as from Dec. 31 last. The company is carried on under the old management, the directors being respectively heads of the several departments. 100,000 ordinary shares are to be subscribed for by members of the vendor company, and to be paid for in cash at par, and the directors and their friends will apply for 20,000 preference shares, which may be allotted in full. The profits for the past three years to December, 1900, are certified by Messrs. Chalmers, Wade & Co., chartered accountants, as averaging net annually £19,180. 15s. The total net profit for 1900 was £23,325. 6s. 7d. The prospectus shows a steadily increasing business and the necessity for additional capital to enable the company to execute many of the extensive contracts which are a feature of present-day electrical developments. The subscription list opens on Tuesday next, July 23, and closes the following day.

**LYMINGTON ELECTRIC LIGHT AND POWER CO. (LTD.)**—At the first annual meeting the chairman (Mr. Keppel Pulteney) stated that electricity supply was first given in December. The number of lamps connected to the mains at the end of the year were equivalent to 1,705 8 c.p. This number had increased to 3,251 by the end of April, and there were now 106 consumers connected to the mains. The expenditure was £11,259. 13s. 6d on capital account. The revenue account showed expenditure £157. 4s. 10d. and receipts £177. 8s. 3d., of which £140 represented the amount paid for public lighting. As the profit on the year's trading was not sufficient to pay a dividend of 4 per cent., Edmundson's Electricity Corporation provide a further sum to allow of that dividend being distributed.

**ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)**—An interim dividend on the preference at the rate of 7 per cent. per annum and on the ordinary shares at the rate of 10 per cent. per annum for the half-year to June 30 is notified. The share transfer books are closed from 18th inst. to Aug. 1 inclusive. The amount of electricity sold by the company for the quarter ended Midsummer, 1901, is returned at 1,115,593 units, estimated to produce £19,523, against 1,035,927 units, which produced £18,172, for the corresponding period last year.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed July 24 as a special settling day in 160,000 6 per cent. cumulative preference £1 fully paid shares (Nos. 1 to 160,000) and 54,000 ordinary £1 fully paid shares (Nos. 186,001 to 240,000) of *John I. Thornycroft & Co. (Ltd.)*, and has ordered £350,000 4 per cent. first mortgage debenture stock of the *London United Tramways (Ltd.)*, to be quoted in the official list in lieu of the provisional certificates now quoted. Application has also been made to the committee to appoint a special settling day in, and to grant a quotation to £250,000 4½ per cent. first mortgage debenture stock of the *British Insulated Wire Co. (Ltd.)*.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a). |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | July 13 | 949 | + 196 | 6 | 4,758 | + 445 |
| *Birmingham Tramways. | ,, 13 | 4,906 | + 230 | 1 | 4,906 | + 230 |
| *Blackburn Corporation.. | ,, 12 | 574 | + 54 | 28 | 13,162 | + 1,156 |
| Blackpool Corporation... | ,, 11 | 1,292 | + 402 | †15 | 11,781 | + 2,751 |
| Blackpool and Fleetwood | ,, 13 | 1,042 | + 93 | 2 | 1,827 | + 77 |
| Bolton Corporation ..... | ,, 14 | 1,690 | + 115 | 15 | 22,883 | + 2,729 |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ..... | May 29 | 2,748 | + 923 | 21 | 54,790 | + 6,737 |
| *Bristol Trams & Carriage | July 12 | 5,066 | +1,462 | 1 | 5,066 | + 1,462 |
| *Buenos Ayres & Belgrano | June 16 | 2,340 | + 128 | 24 | 46,596 | +12,272 |
| Calcutta Trams. Co. ... | July 13 | R19,787 | + R515 | 2 | R39,891 | + R711 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | ,, 13 | 6,145 | ... | 2 | 12,224 | ... |
| City & South London Ry. | ,, 14 | 1,872 | + 436 | 2 | 3,844 | + 961 |
| Cork Elec. Trams ..... | ,, 11 | 612 | + 86 | 27 | 12,206 | + 1,606 |
| Dover Corporation ..... | ,, 13 | 274 | + 1 | 15 | 3,384 | + 243 |
| Dublin & Lucan Rly. ... | ,, 14 | 159 | + 28 | 2 | 301 | + 59 |
| Dublin United ..... | ‡ ,, 12 | 4,173 | + 287 | ‡2 | 7,001 | + 432 |
| Dublin Southern Dist.... | ‡ ,, 12 | 1,205 | + 60 | ‡2 | 1,849 | |
| *Dundee Corporation ... | ,, 10 | 689 | + 283 | 2 | 1,389 | + 564 |
| *Glasgow Corporation ... | ,, 13 | 12,952 | +3,097 | 6 | 72,211 | +13,559 |
| Halifax Corporation..... | ¶ ,, 7 | 2,650 | + 938 | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 13 | 1,101 | + 376 | 15 | 13,662 | + 3,153 |
| Hull Corporation ..... | ,, 13 | 1,775 | + 418 | 2 | 3,502 | + 832 |
| Liverpool Corporation... | ,, 6 | 9,936 | +1,496 | 27 | 231,574 | +33,106 |
| *Liverpool Overhead Rly. | ,, 14 | 1,765 | + 10 | 2 | 3,497 | + 53 |
| *Manchester Corporation | ,, 13 | 2,521 | ... | §5 | 7,533 | + 803 |
| Perth (W.A.) Elec. Trams | ,, 15 | 864 | + 500 | ‡2 | 1,475 | ... |
| Portsmouth Corporation | ,, 13 | 979 | - 173 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 13 | 3,907 | +1,373 | 2 | 7,503 | + 2,550 |
| Southampton Corporat'n | ... | ... | ... | ... | ... | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical † Minus 3 days ‡ Minus 2 days. § Plus 2 days. ¶ Fortnig

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 10. | | Price Wednesday, July 17. | | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending July 17. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ½ | ⅜ | ½ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 4 9 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. | 7⅜ | 8½ | 7⅜ | 8½ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅝ | 9 | 8⅝ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7½ | 7⅝ | 7⅝ | 8⅛ | 2 2 6 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | 9⅝ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5⅝ | 5½ | 5⅝ | 3 18 3 | ,, ,, | 5⅞ | 5⅝ |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 102 | 104 | 102 | 104 | ... | ... | 103½ | 102½ |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5⅝ | 6⅛ | 5⅝ | 6 | 4 11 3 | March | 5⅝ | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 107 | 110 | 107 | 110 | 4 2 0 | June and December | ... | ... |
| 70,579 | 10 | 3/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 12½ | 13½ | 4 12 2 | January and July | 12⅝ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 120 | 125 | 120 | 125 | 4 0 0 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 100 | 102 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9⅛ | 8½ | 9⅛ | 4 4 3 | ... | 8⅝ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 13 4 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5 | 5⅛ | 5⅛ | 5⅛ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 4 4 0 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅝ | 7 | 6⅝ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13⅛ | 14⅛ | 13 | 14 | 4 5 9 | April and October | 13⅛ | 13⅛ |
| 12,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13⅛ | 14⅛ | 13 | 14 | ... | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 108 | 111 | 108 | 111 | 4 1 0 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 94 | 97 | 94 | 97 | 3 12 0 | ... | 97 | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15 | 16 | 4 7 6 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock xd | 101 | 104 | 99 | 103 | 3 18 5 | ... | ... | ... |
| 500,000 | 1 | 1/6 | Rand Electric | ⅜ | ½ | 7/16 | 9/16 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | 69½ | 69 |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | ... | ... |
| 30,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 9 | 10 | 8½ | 9½ | 3 13 8 | ,, ,, | 8⅝ | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | 98 | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | | 2 | | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 199,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 11½ | 12½ | 11½ | 12½ | 4 4 0 | March and September | 12 | 11½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4⅛ | 4⅜ | 4 | 4½ | 4 14 2 | April and October | 4 7/16 | 4⅜ |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 123 | 128 | 124 | 129 | 4 13 0 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 97 | 102 | 97 | 102 | 4 18 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 93 | 98 | 93 | 98 | 4 12 0 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2⅜ | 3⅛ | 2⅜ | 3⅛ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4 | 4⅜ | 4½ | 4⅝ | ... | ... | 4 3/16 | 4 1/16 |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 100 | 102 | 101 | 103 | 4 7 5 | ... | 102½ | 101½ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 21 | 22 | 21½ | 22½ | 3 9 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅛ | 11 | 3 12 9 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 113 | 115 | 114 | 116 | 3 9 0 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6⅛ | 7 | 6⅛ | 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9½ | 9⅝ | 9½ | 9⅝ | 5 2 7 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅞ | 102⅞ | 100⅝ | 102⅞ | 4 8 11 | ... | 101 | 100½ |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary xd | 14½ | 15½ | 14 | 15 | 6 0 0 | ... | 15⅛ | 14⅛ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 4 | February and August | 13⅝ | 12⅝ |
| £250,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 124 | 125 | 123 | 125 | 4 0 10 | ... | 124½ | 123⅝ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅜ | 1⅞ | 1⅜ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5½ | 5⅝ | 5½ | 5⅝ | 5 4 4 | ... | 5⅝ | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5½ | 5⅝ | 5½ | 5⅝ | 2 8 6 | ... | 5⅝ | ... |
| £220,000 | Stock | 5% | Do. 5 per Cent. Debentures | 102 | 105 | 102 | 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 98 | 99 | 98 | 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 10⅜ | 11⅛ | 10⅜ | 11⅛ | 2 14 2 | ... | 11⅛ | 11 1/16 |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 103 | 105 | 103 | 105 | 4 5 9 | ... | 104½ | ... |
| 400,000 | 1 | 1/2½ | Cape Electric Tramways Shares xd | 1⅜ | 2 | 1⅜ | 1⅞ | 3 4 0 | ... | ... | ... |
| £1,969,800 | Stock | ... | Central London Ordinary Stock | 93 | 96 | 90 | 93 | 3 2 6 | June and December | 94⅛ | ... |
| £440,100 | Stock | ... | Do. 4% Preferred Stock | 93 | 101 | 93 | 101 | ... | ... | ... | ... |
| £440,100 | Stock | ... | Do. Deferred Stock | 93 | 93 | 92 | 95 | ... | ... | ... | ... |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs xd | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/8 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 101 | 104 | 3 17 8 | ... | ... | ... |
| £355,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 54 | 56 | 54 | 56 | 2 4 6 | February and August | 54 | ... |
| 47,500 | 10 | 2/0 3/0 | Do. Ordinary (Nos. 22,501 to 70,000) | 5½ | 5⅝ | 5⅛ | 5⅜ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 134 | 137 | 3 13 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 5% | Do. (1896) | 124 | 128 | 124 | 128 | 3 18 0 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 112 | 117 | 112 | 117 | 3 8 6 | May and November | 112 | ... |
| 60,000 | 10 | 6/0 | Dublin United Tramways (1896) Ltd., Ordinary | 11½ | 12½ | 11½ | 12½ | 5 4 0 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 2¼% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5½ | | 5½ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 22 | 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15⅜ | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 8½ | 8⅝ | 8⅝ | 8⅞ | 3 18 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13⅜ | 13 | 13⅜ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 100 | 102 | 3 18 3 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 104 | 106 | 105 | 107 | 3 14 9 | ... | 106⅜ | 105 |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 12,234 | 10 | 4/0 | Potteries Electric Traction Ordinary | 12 | 13 | 12 | 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 8/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 | 108 | 105 | 108 | 4 3 4 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | | ... | | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | | ... | | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | | ... | | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | | ... | | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3⅞ | Waterloo and City Ordinary | 91 | 94 | 91 | 94 | 3 3 2 | June and December | ... | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 10. | Price Wednesday, July 10. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending July 17. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 98 101 | 98 101 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ 4⅛ | 3⅜ 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 56 | 53 56 | 5 12 7 | Feb., May, Aug., Nov. | 53 | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 100 | 98 100 | 6 2 0 | ,, ,, | 99⅝ | 98⅝ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 9⅞ 10⅛ | 9⅞ 10⅛ | 2 8 9 | ,, ,, | 9⅞ | ... |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 3 | ,, ,, | 101⅜ | 10 ⅜ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 8 | 7 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ 15½ | 14½ 15½ | 6 9 0 | ,, ,, | 14⅛ | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 99⅝ 103⅝ | 99⅝ 103⅝ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ 11 | 10⅝ 11⅛ | 6 1 9 | Jan., Apr., July, Oct. | ... | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 102 | 99 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) | 141 143 | 143 148 | 4 15 10 | Jan., Apr., July, Oct. | 146½ | 143½ |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock xd | 89 92 | 89 92 | 3 16 0 | ,, ,, | 90⅝ | 89 |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 109 113 | 1 0 114 | 3 10 10 | May and November | 111 | 109½ |
| 300,000 | 10 | 2/6 | Eastern Extension xd | 13⅞ 14⅛ | 13⅞ 14⅛ | 4 15 0 | Jan., Apr., July, Oct. | 14⅛ | 13½ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 115 | 110 115 | 3 19 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 103 | 100 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100% 103% | 100% 103% | 3 17 10 | May and November | 100⅛ | ... |
| 150,000 | 10 | 5.0 | Great Northern of Copenhagen | 30 32 | 30 32 | 4 13 9 | January and July | 30½ | ... |
| £78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos. | 99 102 | 99 102 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37.6 | Indo-European [1 to 1,200) (red.) | 43 47 | 43 47 | 5 6 5 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 102 | 99 102 | 3 18 6 | June and December | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2 3 | 2 3 | 4 9 3 | December and July | ... | ... |
| £155,600 | 100 | 6% | * Do. 5 per Cent. Debentures (red.) | 98 101 | 99 102 | 4 18 6 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ ⅜ | ¼ ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 102 | 99 102 | 3 18 6 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅜ ⅝ | ⅜ ⅝ | ... | May and November | ⅝ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 5 6 | 5 6 | 10 0 0 | ,, ,, | 5⅛ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | 12 0 0 | ,, ,, | 3⅛ | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 16 2 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zili'n Submarine) | 13⅞ 14½ | 13⅞ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | 13⅞ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 100 103 | 100 103 | 3 17 8 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅞ 4⅛ | 3⅞ 4⅛ | 4 14 2 | August | ... | ... |
| 324,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 3/0 3/6 | 3/0 3/6 | 8 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ ¼ | ⅛ ¼ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3⅜ 3⅝ | 3⅜ 3⅝ | 7 11 9 | February and August | 3½ | 3 7/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 12 | 11 12 | 5 0 0 | ,, ,, | 11⅝ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 12 | 11 12 | 5 0 0 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ 4⅜ | 4⅛ 4⅜ | 5 14 3 | ,, ,, | 4 5/16 | |
| £2000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 89 92 | 90 93 | 3 15 3 | June and December | 92 | 90 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 99 | 95 98 | 4 1 10 | ... | 99 | ... |
| 171,504 | 1 | 0/8½ | Oriental | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate xd | 5 5⅛ | 5 5⅛ | 6 7 3 | July | 5⅛ | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅞ 5⅛ | 4⅞ 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 1/16 ⅛ | 1/16 ⅛ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ ½ | ⅜ ½ | 8 0 0 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 11 | 10 11 | 6 16 4 | July and February | 10⅜ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference xd | 6½ 6⅝ | 6 6⅛ | 4 12 4 | January and July | 6⅜ | 6⅛ |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ 5½ | 4½ 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1½ 1⅝ | 1⅛ 1¾ | 5 14 3 | September | 1⅛ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2⅜ | Do. 5 per Cent. Pref. Non-Cum. | 2 2½ | 2 2½ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 15 | 14 15 | 5 0 0 | ,, ,, | 11⅜ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 107 111 | 107 111 | 4 1 0 | November and May | ... | ... |
| 450,000 | 1 | 0/2⅜ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 93 97 | 93 97 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ⅞ 1⅛ | ⅞ 1⅛ | 5 15 7 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¼ ⅜ | ¼ ⅜ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9⅜ | Crompton and Co. (Nos. 1 to 54,000) | 3⅞ 4 | 3⅞ 4 | 5 12 7 | January and July | 3⅞ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 105 | 100 105 | 4 15 3 | ,, ,, | 103 | 102½ |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1 1½ | 1 1½ | 10 12 0 | February and August | 1½ | 1 1/16 |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 2 3 | 2 3 | 8 16 6 | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 85 | 4 14 0 | June and December | 81 | 8 ⅛ |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 92 96 | 92 96 | 5 4 0 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. xd | 5½ 6 | 5½ 6 | 4 3 4 | Half-yearly | 6 | 5⅞ |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5½ 6 | 5½ 6 | 5 0 0 | ... | 5⅞ | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) xd | 104 107 | 102 105 | 4 5 9 | ... | ... | ... |
| £112,100 | 5 | 2/4½ | Electric Construction Co. xd | 1⅞ 2⅛ | 1⅞ 2⅛ | 5 6 8 | January and July | 2 | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference xd | 2⅝ 3 | 2⅝ 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) xd | 100 103 | 98 102 | 3 18 5 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd, 5% Cum. Pref. | 9⅛ 10⅛ | 9⅜ 1 ⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 102 | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15⅜ 16⅜ | 15⅜ 16⅜ | 6 1 3 | February and August | 16 | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6 | 5½ 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 111 | 108 112 | 4 1 5 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 13 0 | ,, ,, | 21 11/16 | 21⅝ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. xd | 36 40 | 36 40 | 5 4 11 | March and July | 3⅞ | 3⅞ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 104 | 101 104 | 3 17 0 | January and July | 104 | 103 |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10 11 | 10⅜ 11⅛ | 5 4 4 | ... | 11 | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | 11 | 10⅜ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | 6⅝ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. xd | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust | 9⅜ 10⅛ | 9⅜ 10⅛ | 5 2 5 | Jan., Apr., July, Oct. | 10⅛ | 9 15/16 |
| 120,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14⅜ 15⅛ | 14⅜ 15⅛ | 3 18 8 | ,, ,, | 15⅛ | 14⅜ |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | 7⅝ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 130 | 125 130 | 4 12 10 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these

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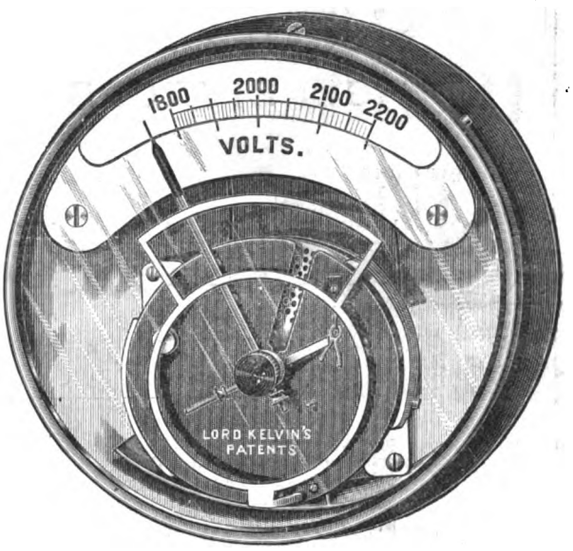


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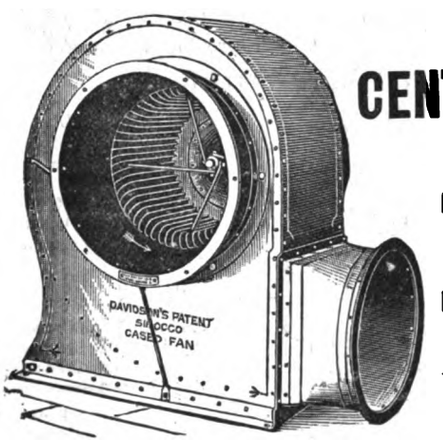


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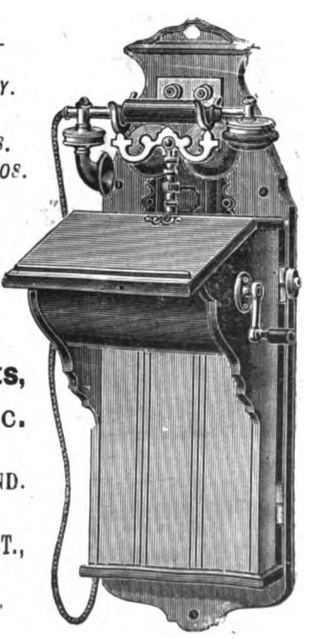

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LOAD ON GENERATORS ⋮ VOLTAGE ON THE LINE

ENSURED BY USING A

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UNDER OUR **PATENT SYSTEM** OF REGULATION.

*Full particulars can be had on application to*

## THE CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED,

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**CLIFTON JUNCTION,**
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BAKER'S PATENT

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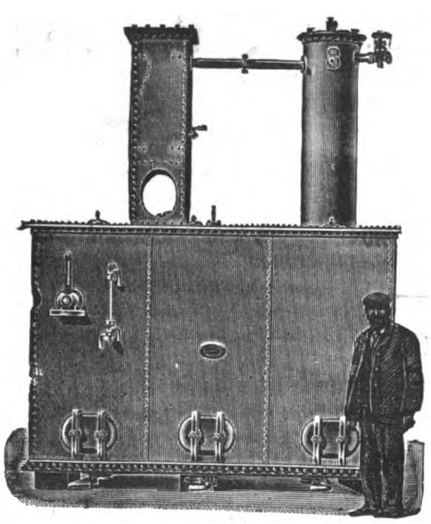
# WATER HEATER

AND

## SOFTENER.



Absolutely prevents the incrustation of Steam Boilers.

Removes all lime from water in whatever form.

Saves **15** to **30** per cent. of fuel by utilising the heat of exhaust steam.

Supplies a large quantity of hot soft water for Boilers, Breweries, Laundries and Manufactories.

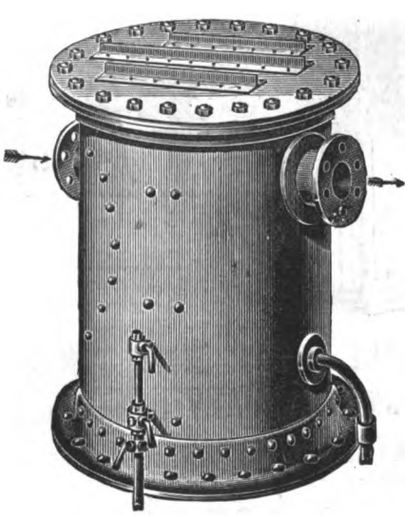
**NO ATTENTION**
AND
**SMALL COST.**

THE

## "STANDARD"

# OIL SEPARATOR.

W. J. BAKER'S PATENTS.



Will separate ALL grease from Exhaust Steam.

This Separator is in constant use upon engines of from **10 H.P.** to **3,000 I.H.P.**, both condensing and non-condensing.

Its action is perfect and reliable, and is both sanctioned and recommended by Boiler Insurance Companies and many of the largest steam users.

It lasts as long as the engine itself, and requires neither renewal or attention.

**"STANDARD"**

## STEAM DRIERS

Upon the same infallible principle.

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## QUEEN'S ENGINEERING WORKS, BEDFORD.

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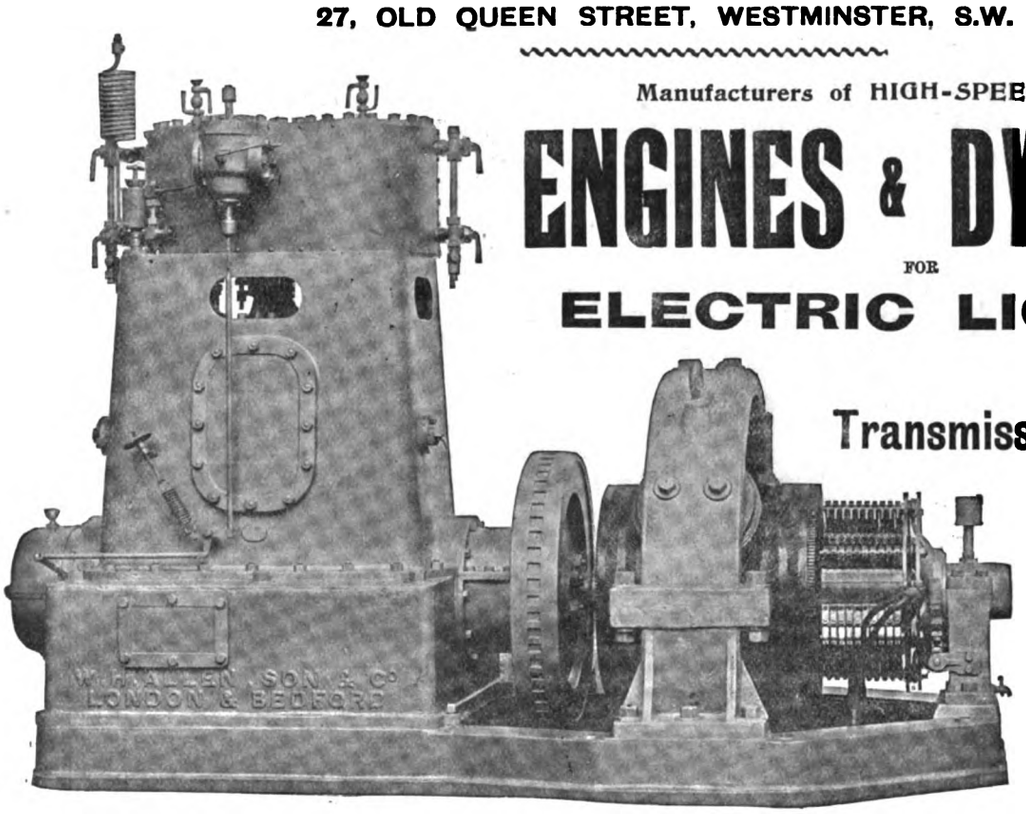


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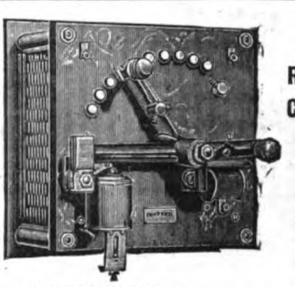

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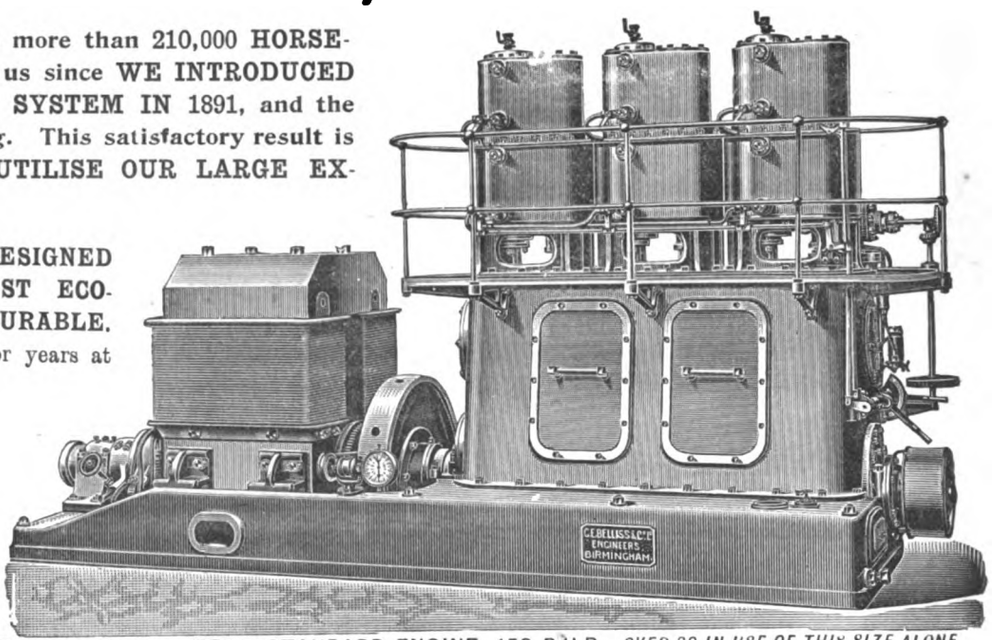


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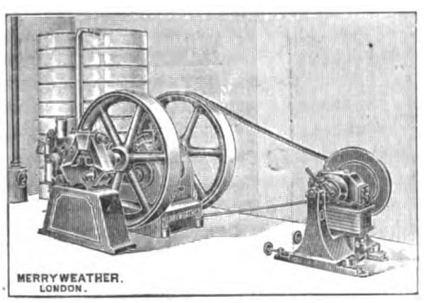


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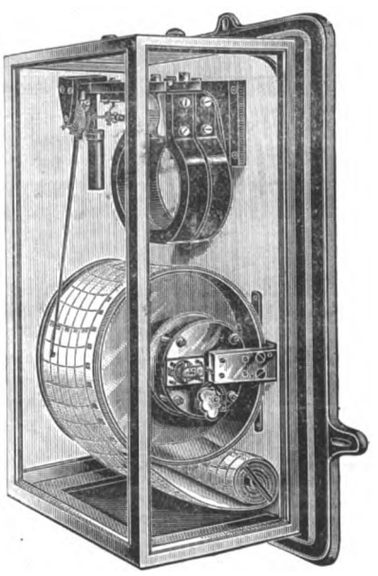

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Nine Brockie-Pell Arc Lamps, 10 Amp., 15 hour, fitted with automatic Cut-outs complete.

One Enamelled Slate Switchboard for above, fitted with Ammeter, Voltmeter, D.P. Main Switch, Voltmeter Key, D.P. Fuse.

Ten Contact Resistance Switch with Resistance Box for same.

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Tenders for the above, to be endorsed "Tender for Lamps" to be delivered to the Joint Committee of Management, on or before 2nd AUGUST, 1901.

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FARNHAM URBAN DISTRICT COUNCIL.

**ELECTRIC LIGHTING ORDER.**

The Farnham Urban District Council are desirous of contracting with a responsible Firm for the SUPPLY of ELECTRICITY under the requirements of their Electric Lighting Order, 1900, in their area.

The Council will require to have the option of cancelling the Contract at certain fixed dates and of purchasing the works established by the Contractor.

They will also be prepared to consider terms for the supply of Electricity for Street Lighting during the existence of the Contract.

Proposals must be lodged with the undersigned not later than noon on the 27th AUGUST, 1901.

By order,
RICHARD MASON, Clerk to the Council.

Farnham, 18th July, 1901.

BRADFORD CORPORATION TRAMWAYS.

**ELECTRIC TRAMCARS.**

The Corporation invite TENDERS for the Supply and Delivery at Bradford of ONE HUNDRED ELECTRIC TRAMCARS, in accordance with Specification and Form of Tender, which may be obtained of Mr. C. J. Spencer, Tramways Manager, 5, Forster Square, Bradford, on payment of One Guinea, which sum will be returned on receipt of a bona-fide Tender. Tenders may be either for complete Cars, or for Car Bodies, Trucks and Trollies, or Electrical Equipment separately.

Sealed Tenders, endorsed "Tender—Tramcars," to be sent to me on or before WEDNESDAY, the 31st instant.

Persons tendering must give an assurance that they have paid to their workmen for the three months preceding date of Tender not less than the minimum standard rate of wages, and undertake to continue to pay, during the Contract, the said rate of wages.

The lowest or any Tender will not necessarily be accepted.

FREDERICK STEVENS, Town Clerk.

Town Clerk's Office, Bradford, 4th July, 1901.

CITY OF WORCESTER.

**ELECTRICITY WORKS.**

The Corporation invite TENDERS for the Supply and Erection of the following Plant for the new Electricity Works:—

Section A.—WATER-TUBE BOILERS, ECONOMISER, STEAM and FEED PIPES and PUMPS.
Section B.—STEAM DYNAMOS, MOTOR ALTERNATOR and BOOSTER.
Section C.—KORTING CONDENSERS, ELECTRIC PUMPS, CAST-IRON SUCTION, DELIVERY and EXHAUST PIPES, and TANK.
Section D.—SWITCHBOARD.
Section E.—OVERHEAD TRAVELLING CRANE.
Section F.—ACCUMULATORS.

The whole bound up in one Specification.

Applicants must state for which section or sections they wish to Tender, in order that the requisite drawings may be forwarded to them.

Tenders may be for any section but not for part of a section.

The Contract will contain a clause adopted by the Corporation requiring the Contractor to pay to his men not less than the minimum standard rate of wages in the District. Copies of the Specification with General Conditions, Forms of Tender, and Plans, may be obtained from C. J. Sutherland, Esq., City Electrical Engineer, Guildhall, Worcester, on payment of a deposit of Two Guineas, which will be returned on receipt of a bona-fide Tender.

Sealed Tenders, endorsed "Tender for Electricity Works," must be delivered at my office at or before noon on FRIDAY, the 23rd AUGUST, 1901.

SAML. SOUTHALL, Town Clerk.

Guildhall, Worcester, 23rd August, 1901.

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**TENDERS INVITED**—*continued.*

DUNDEE GAS COMMISSIONERS.

ELECTRIC LIGHTING DEPARTMENT.

**TENDERS FOR CONDENSING PLANT, FEED PUMPS, &c.**

The Dundee Gas Commissioners are prepared to receive TENDERS for the ollowing, viz. :—

Contract 21.—SURFACE CONDENSERS, ELECTRICALLY-DRIVEN AIR and CIRCULATING PUMPS, COOLING TOWERS, &c.
Contract 22.—ELECTRICALLY and STEAM-DRIVEN FEED PUMPS.
Contract 23.—FEED-WATER HEATERS and FITTINGS.

Specification, Drawings and Form of Tender may be had on application to the undersigned on deposit of Two Guineas, which will be refunded on receipt of a bona-fide Tender accompanied by the Specification and Drawings

Tenders to be lodged with Sir Thomas Thornton, Clerk to the Commisssioners, City Chambers, Dundee, not later than MONDAY, August 5th, 1901.

The Commissioners do not bind themselves to accept the lowest or any Tender.

WALTER H. TITTENSOR, City Electrical Engineer.

Dudhope Crescent-road, Dundee, 10th July, 1901.

---

THE CORPORATION of WIGAN are prepared to receive TENDERS for the Supply of **ENCLOSED ELECTRICAL MOTORS AND STARTERS** as required during the ensuing 12 months.

Sizes: 1 H.P. to 50 H.P.

Particulars can be obtained from Mr. H. Collings Bishop, Electrical Engineer, Bradford Place, Wigan.

Tenders in sealed endorsed envelopes to reach me not later than AUGUST 10th, 1901.

H. COLLINGS BISHOP, Borough Electrical Engineer.

Bradford Place, Wigan.

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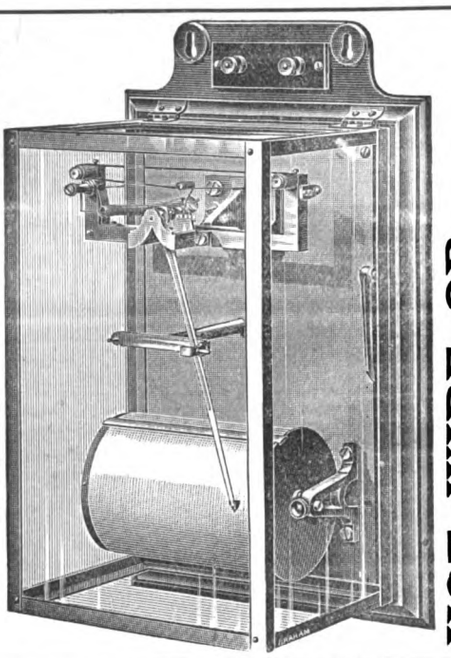

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,210. [No. 14. Vol. XLVII.] FRIDAY, JULY 26, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

THE half-yearly report of the Metropolitan Railway Co. for the period ended June 30th last reveals with startling clearness the influence of the Central London Railway upon the traffic receipts. The loss within the half-year has amounted to "about £42,000, a sum equal to £1. 9s. 4d. per cent. per annum on the consolidated ordinary stock." With regard to the remedy that is to be tried, in the adoption of electric traction, the report gives a summary of the negotiations that have taken place, but it adds no essential detail that our readers have not already been made acquainted with in these columns. Accompanying the report is a reprint of Sir WILLIAM PREECE and Mr. THOMAS PARKER'S report to the Electric Traction Joint Committee last February, in which the Ganz system was so strongly advocated. But since that report the American has intervened, and things are considerably more complicated. However, the erection of a power station at Neasden is to be proceeded with at once, as this will not be affected by the choice of the line equipment.

WITHIN a month of the inauguration of the first completed section of electric tramways worked by a company in the metropolitan area we have to record the opening of the first municipal electric tramway in London. In both undertakings the overhead trolley is used; but it must be noted that, whilst in the western district under the company's auspices American material is for the most part employed, in the eastern district plant manufactured in England has been used throughout. We must congratulate the East Ham District Council on being the pioneer of municipal electric tramway enterprise in the metropolis, and also on having had the undertaking so ably carried out by Messrs. Dick, Kerr & Co., under the superintendence of the Borough Council's engineer, Mr. WM. C. ULLMANN.

DURING the past week the promoters of the Mond ga enterprise have issued the prospectus of an undertaking styled the Power-Gas Corporation (Ltd.), the authorised capital of which is £350,000. Particulars as to the financial aspects of the promotion will be found in our City Notes this week. Possibly our readers may infer therefrom that the Mond gas bill in Parliament has already received Royal assent; in this, however, they would be mistaken, for the promoters have decided to apply to the public at once, and to risk not getting their bill after all. Not that the loss of the powers embodied in the bill would seriously curtail the field of practical commercial work, for the Power-Gas Corporation would still be able to do a good business in the supply of Mond gas plant for isolated electrical and other installations. In any case, we consider that the bulk of the profitable business will be of this character; and it is not at all improbable that after a rude awakening from the enchanting dream of long-distance power transmission by means of Mond gas, the Corporation will settle down to the prosaic but profitable business of supplying plant to those who require cheap gas for consumption on the premises. If only the gas-engine builder will render the material service of putting a really satisfactory 1,000 H.P. engine on the market, this development will be all the more certain of immediate realisation. But as for distributing power wholesale far and wide by Mond gas in place of electric high-pressure cables—well, we never expect to see it pay, and hardly expect to see it seriously attempted more than once.

MOND gas undoubtedly has its uses. It is by far the best solution, up to the present moment, of the problem of turning coal into cheap gas fuel for heating and power purposes. Ordinary gasworks make gas fuel of the volatile constituents of the richer and more expensive classes of coal, with sometimes the addition of carbon monoxide from a portion of the coke. The well-known Dowson water-gas plant utilises only the fixed carbon of the coal, and does not incorporate the volatile constituents. But in Mond gas both the fixed carbon and the volatile hydrocarbons are turned to account; in fact, all that is fuel in the coal is utilised, and only the residue of incombustible material is rejected. A portion of the crude gaseous

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product is employed in manufacturing sulphate of ammonia, for which there would appear to be a not inconsiderable market; the residue, after this by-product process, is the power-gas which it is intended to use in a number of industrial ways, including the driving of gas engines. Thus the Mond process has the merits of being able to utilise the cheapest classes of coal, of turning all the combustible constituents into fuel-gas, and of affording a marketable by-product.

We apprehend that in the near future there will be a large amount of long-distance power transmission by the aid of Mond gas—but the power will go through electric cables, not through gas pipes. There are many considerations which lead us to this conclusion, and not the least of them is the fact that Mond gas is a diluted gas—*i.e.*, a gas having a large percentage of nitrogen and other inert constituents. These serve as so much padding, as it were, in the gas pipes and reservoirs, and thereby necessitate proportionately larger sizes for all such works. It is surprising that at a stage of electrical power development at which long-distance transmission has become a proved commercial success, it should be seriously proposed to replace the cables by huge pipes conveying a decidedly low-grade gas fuel. No: the best interests of Mond gas promoters lie in a rational fraternisation with the electrical engineer; their worst mistake would be to attempt to oust him from the field of long-distance power transmission.

The *Journal of Gas Lighting* makes some decidedly pertinent remarks this week on the influence of trolley tramways on suburban railway traffic. Far as our contemporary normally is from being prejudiced in favour of electric traction, it is able to discern "the gravity of the situation into which the progress of electrical tramways is bringing one suburban railway after another." Incidentally our contemporary reflects that the gas industry 15 years ago suffered a similar trouble from the advent of electric lighting—a reminder that must be poor consolation to the doomed railway companies. Nevertheless, an attempt is made to cheer these latter, who are advised to adopt electric traction as a remedy:—

> Trains at half-hourly intervals during the morning and evening, and once an hour at other times, represent very fairly the usual suburban passenger service. There are several stations in West Middlesex where the solitude is not broken by a train even once an hour. Consequently, people almost forget the existence of the line. Contrast this with a service of 3-minute cars, running along the main road, at about one-half the cost, and the preference of the public for the newer system ceases to need further explanation. The District Railway, it will be remembered, is on the way to be converted to electric traction. Those who have experience of it in its existing state will think it high time that some radical change was made in the character of the service. Then will come the turn of the North London, the South London, and the Brighton lines. It is a serious prospect for the railway companies, although the electrical engineering firms are rejoicing greatly. An enormous amount of capital will have to be spent in this way during the ensuing 10 years, much of it without any prospect of increasing business but simply to retain old custom. There are drawbacks, of course, to the electric trams and tubes, from which the existing railways are free. This will be to their advantage, so far as it goes.

We admit that railway companies will be compelled to adopt electric traction, but the effect will not be to enable them to retain the traffic that would otherwise be diverted to tramways. When it is a question of short suburban or inter-urban journeys, standard railways, even if electrically equipped, cannot compete successfully with a properly worked service of electric tramcars. The London suburban railways will, undoubtedly, find this out in due time; but already their shortcomings and transgressions are so accumulated that they cannot expect the sympathy of the travelling public. To our railways, however, when converted to electric traction, there may still remain the fast-speed, long-distance traffic, whether of passengers or goods; though even this they run the risk of forfeiting to parallel new electric railways, such as the high-speed line to be erected between Manchester and Liverpool, if, as with their suburban traffic, they adopt a dangerous policy of procrastination.

**Tramways and Light Railways Association.**—The annual dinner, which will be held at the Windsor Hotel, Glasgow, has been fixed for Wednesday, September 4th.

**Personal.**—Mr. J. D. Cormack, B.Sc., M.I.C.E., has been appointed professor of mechanical engineering at University College, London, in succession to Prof. T. Hudson Beare, M.I.C.E.

**Erratum.**—We are informed that the name of the consulting engineer for the Paris Metropolitan Railway is Mr. R. Boulvin, not Mr. Bullivant, as given in *The Electrician*, Vol. XLVII., p. 493, line 26

**Obituary.**—We regret to announce the death of Mr. Samuel Pope, K.C., at the age of 74. He was very well known to a large circle of our readers in connection with his practice at the Parliamentary bar.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| San Domingo—Curaçao | July 12, 1901 |

**Northampton Institute (Clerkenwell).**—Full day courses in mechanical, electrical and horological engineering commence on Monday, September 30th. Entrance examination, September 25th and 26th. Some further particulars will be found in an announcement on another page.

**Owens College, Manchester.**—The engineering drawing room and Whitworth engineering laboratory opens on Tuesday, October 1st, and lectures commence on October 2nd. Some particulars are given as to the course of instruction, &c., in an advertisement on another page.

**University College (London).**—The session 1901–2 at this college in the engineering and architectural department, in which courses of instruction in mechanical, civil, municipal, and electrical engineering and architecture are given, commence on October 2nd. Some particulars will be found in an announcement elsewhere.

**Wireless Telegraphy in the French Navy.**—We understand that the experiments with wireless telegraphy carried out on board the French Mediterranean fleet have not proved successful; 14 ships have been fitted with the apparatus; messages were only sent 30 miles with anything like precision. Up to the present the men of the French Channel squadron have made more progress in the use of wireless telegraphy than the men of the Mediterranean fleet.

**A New Type of Current Regulator.**—The *Electrical Review* of New York for July 13th describes a new form of regulator brought out by the Erie Exploration Company. The apparatus consists of a make-and-break apparatus, which is rotated by an electric motor at a speed such that the frequency of interruption is not less than 20 times a second. It it claimed that great economy is ensured by this device in ordinary theatre work over the ordinary form of rheostat.

**Roads Improvement Association.**—We understand that this association will shortly approach the Government with a proposal to organise a central highway department to be

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directly responsible to Parliament. This body would have power to control and supervise the local authorities and all other bodies in charge of public highways. The Council of the Tramways and Light Railways Association will shortly consider the advisability of co-operation with the Roads Improvement Association.

King's College (London).—It is announced on another page that the session 1901-2 at this college in the engineering, architecture and applied science division of the Faculty of Science commences on Thursday, October 3rd. Evening classes are held in electrical engineering, mathematics, physics, &c.; and advanced evening and Saturday morning classes in civil, mechanical and electrical engineering are held in conjunction with the Technical Education Board of the London County Council.

Opening of the Tunbridge Wells Municipal Telephone System.—On the invitation of the Mayor and Corporation of Tunbridge Wells, the Lord Mayor of London has undertaken to publicly inaugurate to-morrow the municipal telephone system in that borough, the first of its kind established in England, and for which a licence has been obtained from the Postmaster-General. The ceremony will take place in the Great Hall, and afterwards the Lord Mayor and other guests will be entertained at luncheon in the Pump Room.

Institution of Junior Engineers.—A visit will be paid on Monday next at 6:30 p.m. to the electric lighting and tramways installation of the East Ham District Council, Nelson-street, East Ham.

Some of the members of the Institution of Junior Engineers, taking advantage of the presence in England of Mr. Edward Goffe, who, as chief draughtsman to the De Beers Consolidated Mines, so distinguished himself in connection with the design and construction of the famous "Long Cecil" gun, have made a presentation to him, bearing the following inscription:—"Presented to Edward Goffe by a few I.J.E. friends in token of their appreciation of his services during the siege of Kimberley, 1900."

Electric Railway between Milan and Varese.—We learn from the *Morning Post* that the electric railway between Milan and Varese has just been opened. The distance of 50 miles is covered in 50 minutes, and trial trips have been made with complete success, the train running at 66 miles an hour. Water power is obtained from the Ticino at Tornavento, where three 500 H.P. alternators have been fixed. The carriages, which resemble Pullman cars, are furnished with four motors connected with the axles of the four sets of wheels. At level crossings the third rail, along which the current passes, is interrupted, the ends being connected underground by means of a cable. At the stations the third rail is carefully protected from all possible contact with the travelling public.

The National Standardising Bureau, U.S.—We learn from the *Electrical World* of New York that the visiting committee of five members, to consist of men prominent in the various interests involved, and not in the employ of the Government, has been appointed by the Secretary of the Treasury, and consists of Prof. Elihu Thomson, Prof. E. L. Nichols, Prof. Ira Remsen, Dr. Henry S. Pritchett, president Massachusetts Institute of Technology, and Henry Ladd Colby, secretary American Association of Steel Manufacturers. The duty of the committee will be to visit the Bureau at least once a year and report to the Secretary of the Treasury on the efficiency of its scientific work and the condition of its equipment. We understand that Prof. E. B. Rosa has accepted the position of physicist to the Bureau.

The Carriage of Parcels by Electric Tramways.—According to the *Street Railway Journal*, the Metropolitan Street Railway Co., of New York, has taken the initiative in a plan for the general handling of express matter, which does not appear to have been put in operation on an extended scale in any large city. This plan contemplates the establishment of express depôts in various parts of the city, where electric express cars can be run and loaded with their packages, and where they can discharge their loads. Stub tracks for the proposed service will also be run into the incoming baggage departments of the various steam railroads and ferries, so that trunks and heavy express matter can be loaded directly on the electric cars without transference. The local deliveries and collections, which are not possible directly from the electric cars, will be provided through automobiles, and a complete system of caring for the delivery service of the large dry goods stores and other retailers will be consummated, if the plan proposed is followed to its logical conclusion. So far as is possible the express service will be carried on at night.

50,000 Volt Three-phase Transmission from the Missouri River.—The *Electrical World* of New York for July 13th publishes an illustrated article on the Missouri River Power Co.'s 50,000 volt transmission plant from Cannon Ferry to Butte, Mont. At Cannon Ferry the river valley is of such a shape that by building a dam 500ft. long and about 40ft. high a lake ½ mile wide and 6 miles long was formed. The available head is 32ft. Four units of 1,200 H.P. consisting of Westinghouse 60 cycle generators directly coupled to Dayton Globe Iron Works turbines have been installed, and at present supply Helena, Mont., over a 12,000 volt line, and six more units are being fixed. The distance to Butte is 70 miles. Two pole lines, 50ft. to 100ft. apart, will each carry one circuit, the wires being placed in a triangle 66in. apart. The pins will hold the insulators 9in. above the cross-arms, and are secured by ⅝in. bolts. The pins driven into the pole tips will have ⅜in. vents to drain water from the pin hole. At Butte there will be a sub-station containing six 980kw. oil transformers, water-cooled and connected delta fashion. The motors will be supplied at 2,000 volts, except in the case of very small machines. Ordinarily the whole system will be operated in parallel, but double 'bus bars will enable the lines to be operated independently.

Insulators and Pins used in the Western States.—According to the *Electrical World* of New York, there is a decided difference of opinion as to the relative advantages of porcelain and glass for high-tension insulators. The advocates of porcelain point to the fact that it is much stronger mechanically than glass, and that it may be shot at and chipped without cracking the whole insulator to make a leak. The advocates of glass urge its cheapness as one point in its favour and also its dielectric strength. They claim that porcelain must necessarily depend, to a large extent, on the strength of the outer coating or glaze for its insulating qualities, and if this becomes cracked by moisture working in will cause a puncture of the insulator in time. This was no doubt true with the first porcelain insulators built, but on recent work there appears to be little practical difference in the working of porcelain and glass. At Provo with 40,000 volts and a grounded neutral, glass insulators are used. That the leakage towards ground must be considerable on this line is shown by the fact that it is impossible to operate a telephone line on the same poles. The tendency for the current to seek ground via the telephone line (even though the telephone line was not intentionally grounded) was sufficient to burn the poles where it jumped from the poles to the telephone tie wires. On the 33,000 volt line into Los Angeles the neutral is also grounded, but the telephone line is perfectly satisfactory. Porcelain insulators of about the same diameter as the glass used on the Provo line (about 7½in.) are employed on this line, but the voltage not being the same it is hardly fair to compare results. Wooden pins boiled in paraffin or linseed oil are most commonly used, though on the 33,000 volt Los Angeles line, just referred to, iron pins are giving satisfaction.

Transmission Lines in the Western States.—From the *Electrical World* of New York, we take the following data with regard to the general practice for transmission lines in the western States of America, when the distance is great and the voltage necessarily high. The pole measures rarely less than 8in. diameter at the top of a single three-phase line. If there are two or more lines, or if the conductors are heavier than No. 1 B. and S. copper larger poles are used. In mountainous districts poles 30ft. to 35ft. are used; where the population is thicker, poles 35ft. to 40ft. is the practice; 50 poles to the mile are usual, but with aluminium 25 to 30 are common. Preservatives for pole butts have not.

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been used to any great extent. Some companies use hot tar, some *carbolineum avenarius*, and at Salt Lake City, salt is employed. Cross-arms are usually dipped in hot asphaltum compounds after being well seasoned and dried; another method is to boil both cross-arm and pin in linseed oil. Some companies patrol their transmission line every day, others every month or two. Barbed wire above the transmission line is used where thunderstorms are frequent. By mounting the barbed wire on insulators and placing it so that a reasonable amount of sag will not be put in dangerous proximity to the high-tension lines troubles from breaking and crosses have been eliminated. In running the two telephone wires on the transmission pole line and providing for transpositions, one method is to put the telephone lines on brackets with both brackets on the same side of the pole, and on one pole at transpositions, placing the brackets on opposite sides of the pole. Some object to brackets on the ground that they are more likely to prove defective than pins and cross-arms; these use a two-pin cross-arm and use a double tie groove insulator for insulating the two lines at transposition. Nothing smaller than No. 5 B. & S. copper wire is ever used. Solid aluminium wires have had to be replaced by stranded cable.

**Simultaneous Telephony and Hughes Type-Printer Telegraphy on the same Line.**—An article by Herr Otto Jentsch, in the *Elektrotechnische Zeitschrift* of April 18th, describes the system employed on some of the main German metallic circuit telephone trunk lines, by means of which these lines can carry simultaneously telephonic conversations and Hughes type-printing telegraph messages. Bridged across the two lines in addition to the usual telephonic apparatus, is an induction coil consisting of two similar coils wound in the same direction at the two ends of an iron wire core (not one over the other). These two coils are connected in series, and their junction point is connected to the telegraph apparatus, which works with an earth return; and the same point is connected through a condenser to earth, the condenser thus shunting the whole of the telegraph apparatus. The connections of the lines at the two ends are, of course, precisely the same. It is seen that when traversed in series by the telephone currents the two windings on the induction coil tend to magnetise the core in the same way, and therefore the joint inductance of the coil is great, and it does not shunt off much of the speaking current. On the other hand, the telegraphic currents traverse the windings in parallel, and as by this arrangement they offer less inductance, they only suffice to damp the current variations just enough to prevent their acting on neighbouring circuits without prejudicing the working of the Hughes apparatus. The condenser which assists this damping action can in some cases be omitted or diminished in capacity, as, for instance, when the telephone line is on a pole by itself. Thus on the bronze Berlin-Vienna line, the condenser at Berlin has been omitted, and at Vienna it has been reduced in capacity from 2 microfarads (which has normally been found the best value on such lines) to 0·25 microfarad. The condensers must also be carefully protected from lightning by sensitive lightning guards. Each of the windings of the coil has 15,700 turns, and a resistance of 1,150 ohms. This combined telephone and Hughes service has already been put in on the following lines:—Berlin-Vienna, Berlin-Budapest, Posen-Breslau, Dresden-Chemnitz, Frankfort-on-the-Maine-Strassburg (Alsace), and Hamburg-Lübeck.

**Electrical Transmission at Frongoch Mine.**—The Electrical Company have installed an interesting plant at the lead and zinc ore mine at Frongoch, near Devil Bridge, in Cardiganshire, about 18 months ago, which, we are informed, has been working day and night since without mishap. The power is transmitted and distributed over a distance of nearly 8 miles. Arrangements are made so that the generator can be driven either by an Escher Wyss pelton wheel or a Willans engine. Water power is usually available from September till May. During the summer months the steam engine has to do the work. The water for driving the pelton wheel of a maximum of 400 H.P. is solely derived from the hills, as the rain is collected there and forms several small lakes, which discharge into a water-way of over 8 miles in length. This water-way feeds the reservoir which has been partly formed by nature and partly excavated and dammed up on the top of the so-called Red Rock Mountain, 464ft. high. At the foot of the mountain is the power house. A line of steel pipes of 23in. diameter conveys the water to the pelton wheel. When the reservoir is once filled its supply is sufficient to drive the generator under full load day and night for at least two weeks. The pelton wheel can be easily uncoupled from the three-phase generator by means of a lever actuating a flexible band coupling. The three-phase current is generated at a potential of between 2,000 and 2,500 volts between each phase, and conducted from the switchboard in the generating station through a steel-armoured cable underground across the road to the cable tower behind the generating station. From there it passes on to the aerial line, which consists of three bare copper wires 5mm. diameter. The lighting of the pump room, as well as the 66 fathom level, is done by incandescent lamps, which take current from a small single-phase transformer, reducing the E.M.F. in one phase only to about 110 volts. A similar transformer is placed on one of the posts of the aerial line opposite the offices, and is properly protected against rain and damp. It supplies the current for lighting the offices, stores, &c. In all there are in use the following motors:—Two 50 H.P. at 2,000 volts, one 85 H.P. at 2,000 volts, one 35 H.P. at 2,000 volts, and one 85 H.P. at 200 volts. The bare overhead conductors are guarded, in case of breakage, by means of catchguards, which cause the current to be cut off by disrupting the safety fuses before the end of such broken wire could reach the ground.

**Electric Power for Printing in Chicago.**—A recent number of the *Western Electrician* of Chicago describes the power and lighting installation in the Chicago Inter-Ocean Building. Two 200 H.P boilers of the water-tube type are employed supplying steam to two tandem horizontal engines, the larger being rated at 300 H.P., and the smaller at 160 H.P. A 220 volt three-wire system is employed, the motors being connected across the outers, except those of the smallest outputs. In the type-setting department at the front of the third floor are located 23 duplex linotype machines, each belt driven by a ¼ H.P. motor. In this room a lathe is driven through a cone pulley by a 1 H.P. motor, two proof presses are belted to ¼ H.P. motors and a saw to a ½ H.P. motor. At the rear of this floor is the stereotyping department, in which a 3 H.P. motor drives a steam or drying table, used for drying and pressing the matrix. From this machine the matrix is taken to a semi-circular casting box, where the stereotype is cast from the matrix. The plates are then carried to two trimmers, geared to 2 H.P. motors. Two shavers, operated by 1 H.P. motors, shave the inside of the plates to a certain form. A splitting block, driven by a ¼ H.P. motor, consists of a travelling saw, operated by means of a worm and gear. This device is used for splitting the stereotype plates for a double-page advertisement. A Gordon press, also on this floor, is operated by a 1 H.P. motor, while another motor of the same size drives an exhaust fan. In the basement, besides the boiler and engine plant, is a large press room, with storage capacity for 600 1,000lb. rolls of paper. There are three Scott web perfecting cylinder presses, each having a capacity of 2,400 12-page papers an hour. Each press is at present driven by a 25 H.P. motor, but the presses are soon to be changed to the capacity of a 16-page paper, when 50 H.P. motors will be installed. There are also located on this floor a paper-cutting machine, driven by a 1 H.P. motor and a Bostedo blower for operating the pneumatic tubes connecting the building with the City and Associated Press offices, driven by a 7½ H.P. motor. Among the auxiliary apparatus that is installed in the engine room is an electrically-driven 10 H.P. air compressor for supplying air to operate four paper lifts at the presses, a sidewalk lift, an ash lift and two mailing lifts. The compressor is self-governing, and maintains a pressure of 80lb. in a large storage tank. A triplex house pump is electrically driven and automatically controlled by a float in the water tank on the roof. The seepage and boiler drainage in the basement are raised to the sewer level by a 3 H.P. electric rotary bilge pump.

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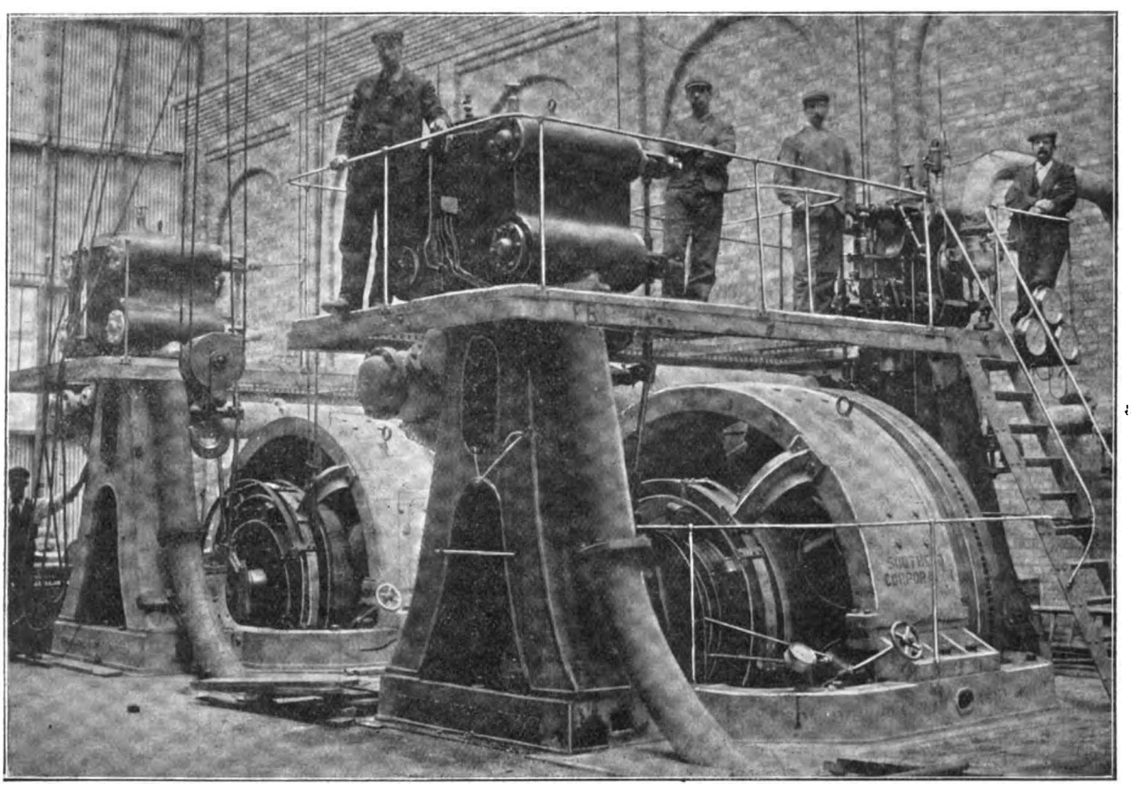
# SOUTHEND-ON-SEA CORPORATION ELECTRIC TRAMWAYS.

It is now some 10 years ago since the Corporation of Southend-on-Sea first obtained its electric lighting order, and as far as the lighting is concerned it will be some months before the same is turned on in the borough. The traction portion of the work is in a far happier state of progress, and by the time our readers see this article 14 cars will be on public service.

Commencing with the power-house at the boiler department, we may note that the three boilers are of Messrs. Davey, Paxman's "Economic" type, being 14ft. long and 8ft. diameter. They have an evaporation duty of 6,000lb. of water per hour, the shells being made up of mild steel $\frac{3}{4}$in. thick; each boiler has 92 lap-welded iron tubes of 3in. internal diameter; the flues consist of solid welded mild ductile steel plates $\frac{7}{16}$in. thick, being 2ft. 8in. in diameter, and each flue is provided with two conical circulating tubes, which are fitted with Paxman's patent expansion joint. The seatings employed are of cast steel, rivetted to the boiler. The total internal heating surface is 1,180 sq. ft. The valves on the boilers are of Hopkinson's type, with parallel slide, and fitted with composite glands and expansion spindles; one Hopkinson rotary valve is provided between the main steam header and the boiler. Each boiler has a duplicate feed, as one injector is fitted to each boiler; two electrically-driven three-throw pumps—built by the Blakeand Knowles Steam Pump Co.—are provided, which are so coupled as to pump either from the hot-well or direct from the cold water supply tank. The condenser consists of Voltz combined condenser and feed-water heater, as constructed by the Wheeler Condenser and Engineering Co., and is capable of dealing with 15,000lb. of steam per hour. Between the main exhaust and the condenser the oil separator is fixed, this being of the centrifugal type. The entire condensing plant is shut off from the boiler house by a wood and glass partition, which should add very materially to the wear and tear of the condenser and pumps, &c. Two small centrifugal pumps coupled direct to two small Lundall motors complete the plant in the pump room, the smallest of these being used to lift the water from the boiler house sump, and the larger, which is only of $\frac{1}{2}$ H.P., is used for lifting the water from the car shed pits through a filter to a storage tank on the accumulator roof, from which it again flows back to the car shed for the cleaning of trucks, &c. The cooling tower (of the Barnard type) is also placed on the roof of the accumulator room, this roof being constructed of H iron and concrete cement rendered, and finally asphalted to an extent of 1in. In addition to the cooling tower and tank previously mentioned, there is a large tank capable of holding 1,500 gallons of water, as an extra safeguard against failure of the water supply.

The general arrangement of steam pipes is such that the chance of complete failure would be very remote, as there is an 8in. steam header fed by 6in. pipes from each boiler, all the engines being coupled to this. Independent of this, each engine is fed by a 4in. pipe from one boiler. The pipes for feeding the boilers are arranged in duplicate, so that hot or cold water can be pumped into the boilers.



Interior of Machinery Room at Southend Electric Power Station.

The engine room, which measures 84ft. long by 45ft. 5in. wide by 35ft. high, is built of Fleton bricks, no glazed bricks being used. The overhead traveller was built by the Chatteris Engineering Co., and is capable of lifting and traversing with a safe load of 20 tons.

There are two steam generators of the vertical coupled cross-compound type, each of which has an output of 200kw., but both of these sets are capable of working for a period of two hours at an output of 300kw. with a temperature rise not exceeding 55deg. above the surrounding atmosphere. The generators are of the eight-pole divided frame type, compound wound, and the series winding is provided with a shunt for final adjustment. The armature is of the slot-wound type, the winding being of interchangeable form-wound coils. Carbon brushes are used, and are shifted by means of a hand wheel and worm gear. The engines are fitted with Corliss

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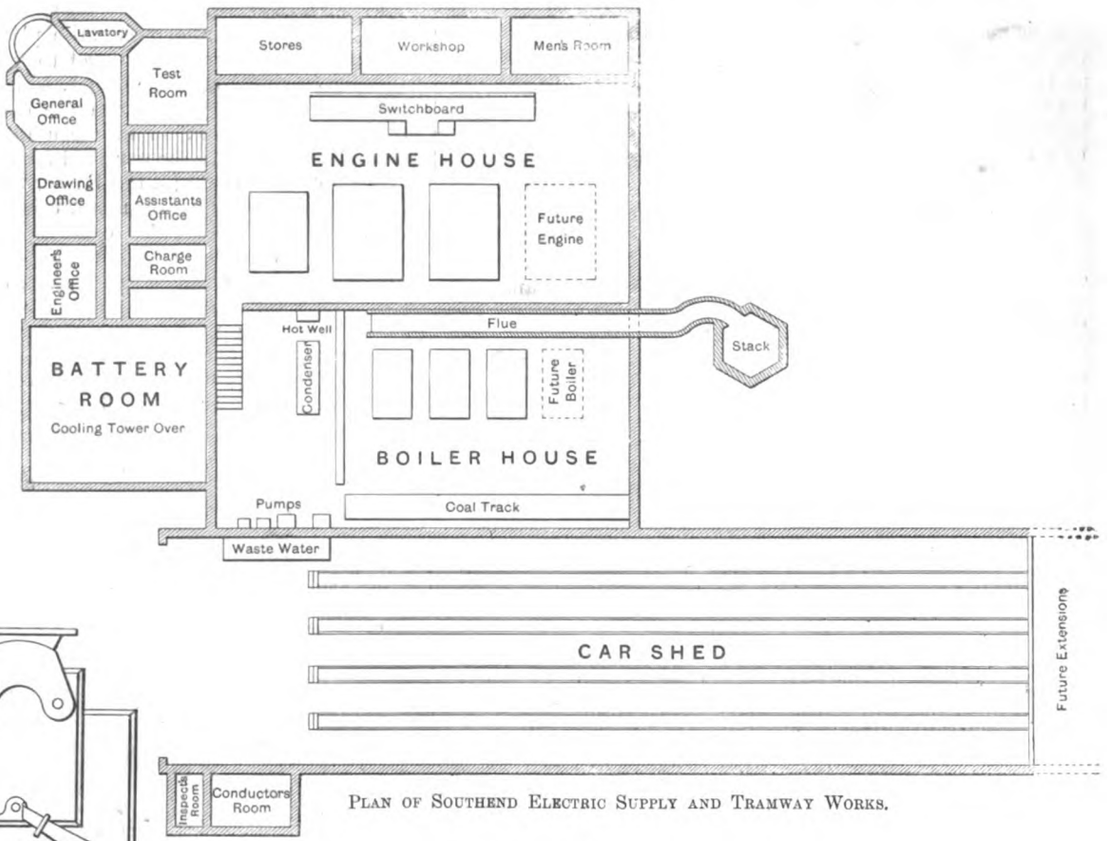
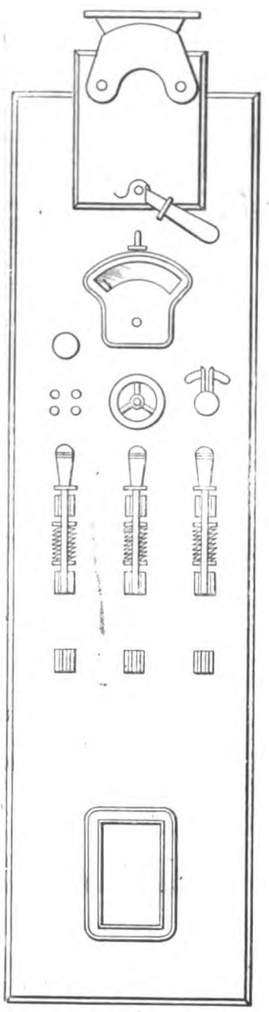
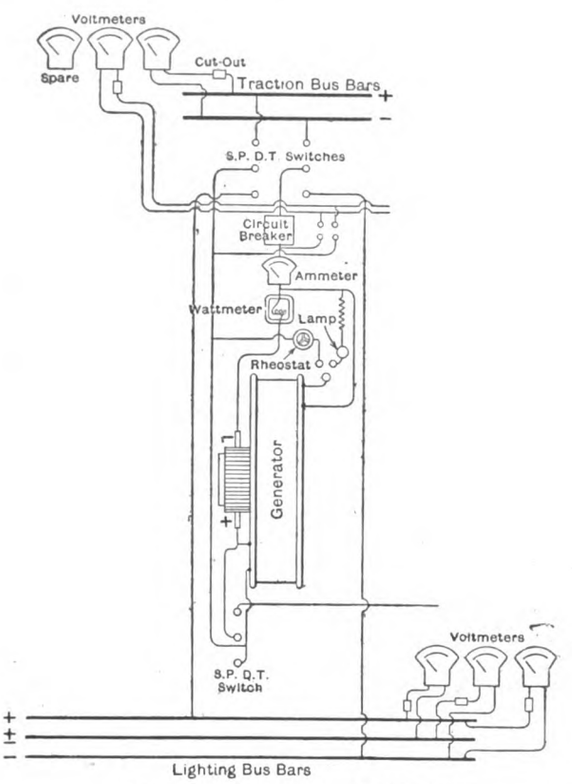
valve gear, the cylinders being respectively 14¼in. and 31in. The eccentrics for actuating the valves are placed on the inside of the A frames, and the piston rod guides are fixed inside the A frames. Two governors have been provided, the second being a Tate safety governor. The normal speed of the engines is 110 revs. per min. The diameter of the flywheel is 10ft., and its weight 8 tons, the total dead weight of the crank shaft, inclusive of crank discs, flywheel and armature, being 17 tons. These two engines and generators were built by Messrs. Bow, McLachlan, at their works at Paisley, and from their general appearance this firm should be well satisfied with their first production of this class of engine and generator, as we understand these are the largest of this type they have yet built. There is also another set built by the




PLAN OF SOUTHEND ELECTRIC SUPPLY AND TRAMWAY WORKS.



SOUTHEND: GENERATOR PANEL.




SOUTHEND: SWITCHBOARD CONNECTIONS.

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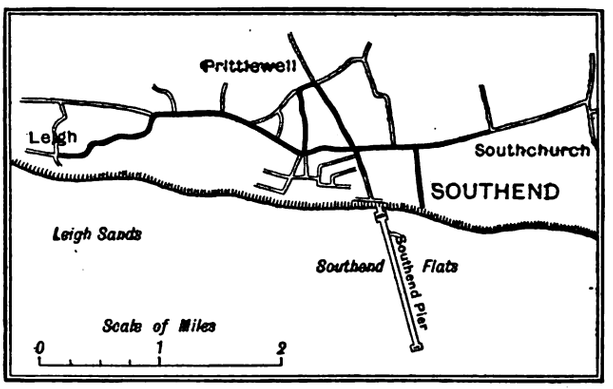
same makers, running at 360 revs. per min., the generator of which is a six-pole dynamo, coupled to the end of the crank shaft of an enclosed type engine. The normal output of this set is 125kw., but it works under the same conditions as the larger sets, *i.e.*, it will maintain 50 per cent. overload for two hours at a temperature rise not exceeding 55deg.

The switchboard, of which only one-half is as yet completed, is of single panel type. One of our illustrations shows the completed generator panel, and its connections of the same. White marble, 2in. thick, is used for the panels, of which there are four for the generators and four for traction feeders,




Map of Southend Electric Tramways.

three being pumping station panels. The feeder panels consist of the usual apparatus—viz., circuit breaker, ammeter, switch, lightning arrester and cutout. The remaining eight lighting feeder panels have not yet been erected.

The cars number 14 in all; two are of the single-deck type to carry 28 passengers, two are double-deck bogies for 58 passengers, and ten are double-deck single truck cars. All the trucks are equipped with Thomson-Houston motors and "B 18" controllers, and are fitted for rheostatic braking gear. The trucks are of the well-known Brill type, 12 being of the "21 E" type, and four of the "Maximum traction" type. The wheel bases are 6ft. and 4ft. respectively, the gauge being 3ft. 6in. Messrs. Lowdon Bros. carried out the entire overhead equipment, which consists of a double trolley line of 000 B. & S. gauge, and has been erected over about 7½ miles, including turnouts. The overhead brackets are of simple but effective design, and, in conjunction with a neat base, give a smart appearance to the poles. The line work being of a simple character there is not much to comment upon, except, perhaps, the double crossing by the Victoria Hotel, which must have required some manipulation, for, at this point, four roads meet, all at different angles, requiring four through roads and four curves. The track work has been carried out by Messrs. Chadwell & Co., under the direction of Mr. Picken, a single line being used, with turnouts at about every 300yd. 92lb. girder rails are laid, with sole plates consisting of a short length of inverted rail. The road bed consists of 8in. of concrete, the space between the rails being filled in with basaltic sets, as also for a distance of 18in. outside the rails. Except for the uneven appearance of these sets they appear to be far more satisfactory, as regards the sound of traffic, than can be said to be the case with ordinary granite sets.

The car shed is a brick building with a corrugated end for extensions, and is capable of holding 26 cars.

The contract for this tramway, inclusive of everything except the car bodies, has been executed by Messrs. Dutilh Smith, McMillan & Co., under the direction of Mr. Herbert Umney, their chief engineer. Mr. Alfred Fidler was responsible for the proper execution of the contract on behalf of the Corporation, and Mr. D. F. Adamson has acted as electrical engineer and technical adviser to the Corporation. Mr. Adamson is likely to be busy for some considerable time to come, as, besides the above initial traction scheme, extensions are already under contemplation. The whole of the public lighting of the borough is now in Mr. Adamson's hands, as also some electric pumping stations and a large elevator for the sea front.

## EAST HAM MUNICIPAL ELECTRIC TRAMWAYS AND LIGHTING.

The official opening of the combined electric tramway and lighting undertaking of the East Ham Urban District Council took place on the 18th inst., when the chair was taken by Mr. J. Savage, chairman to the Council; whilst Mr. T. L. Knight, chairman of the Electric Lighting and Tramways committee, formally inaugurated the enterprise. A large number of gentlemen interested in municipal enterprise were present, and after they had inspected the buildings and plant a tour of inspection was made over the tramway routes.

The district of East Ham, with an area of 8,266 acres, has, within the last 10 years, increased its population from 33,000 to 95,000 inhabitants. It is bounded on the south by the River Thames and North Woolwich, on the north by Manor Park and the Wanstead Flat, on the east by Ilford and Barking, and on the west by the county borough of West Ham.

It was in 1898 that the District Council obtained Parliamentary sanction for the equipment of the district with a system of electric lighting. Powers were at the same time obtained for the construction of the first sections of the electric tramways in the district, the total length of line arranged for being 1½ miles of double track and 2⅛ miles of single track, with passing places at frequent intervals. In 1900 further powers were obtained for extensions of the tramways, amounting to ¾ mile of double track and 4¾ miles of single track, making a total length of 9⅛ miles of line. Of this amount 4½ miles have have been completed, with tramcars running for the last four weeks, and the remainder will be constructed as soon as possible. In February, 1899, the Council obtained the services of Mr. W. C. Ullmann as their resident and consulting electrical engineer, authorising him to prepare a complete scheme for the carrying out of the works, and in April Mr. Ullmann presented his report, recommending the Council to adopt a combined system suitable for the working of both the lighting and tramway schemes, with the adoption of the overhead trolley system for the tramways. The estimated expenditure was, for the tramways £47,700, and for the lighting £41,418. A further estimated expenditure in connection with the Tramways Extension Order of 1900 to the extent of £42,220 has since been granted, together with £6,540 for extensions of lighting cables, and £2,645 for building extensions, making a total estimated expenditure of £140,593. The report was unanimously accepted by the Council, and Mr. Ullmann was instructed to proceed at once with the preparation of specifications and plans, and to make all the necessary preliminary arrangements for carrying out the work.

Sufficient land was found to be available for the generating station, car-sheds, and offices on a plot of 5 acres in the centre of the district which had been acquired for the municipal buildings now in course of erection. The whole of the buildings are contained in one block, and, with the exception of the chimney and iron roof construction, have been carried out by the Council's works department, under the supervision of Mr. A. H. Campbell, their engineer and surveyor, and Mr. W. H. Savage, consulting surveyor to the Council.

The engine room is 177ft. by 42ft., with a height of 26ft. The principal offices of the department are arranged at the south end, while workshops and men's mess rooms are provided at the north end, outside the main building. A 20-ton traveller runs the length of the building. The walls are lined with opalite tiling up to the level of the travelling girders.



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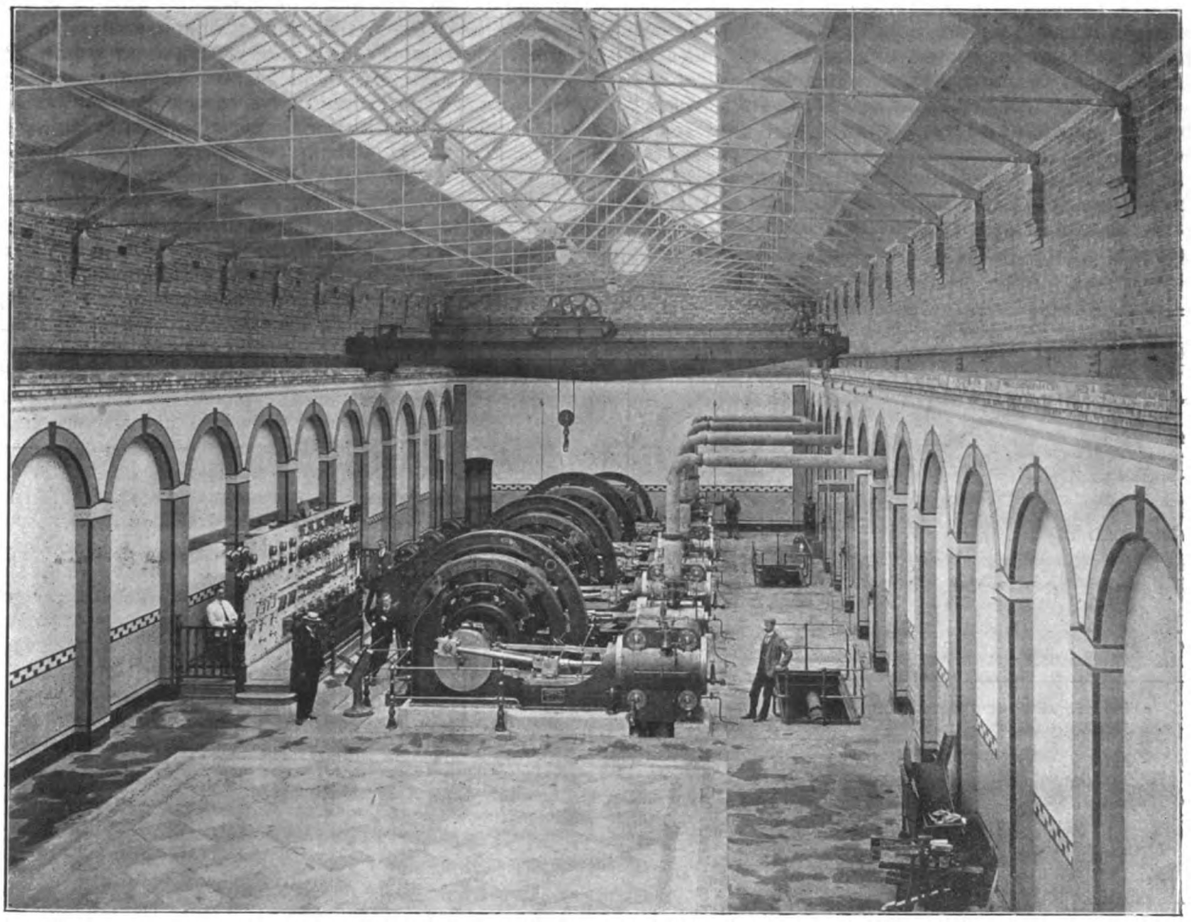
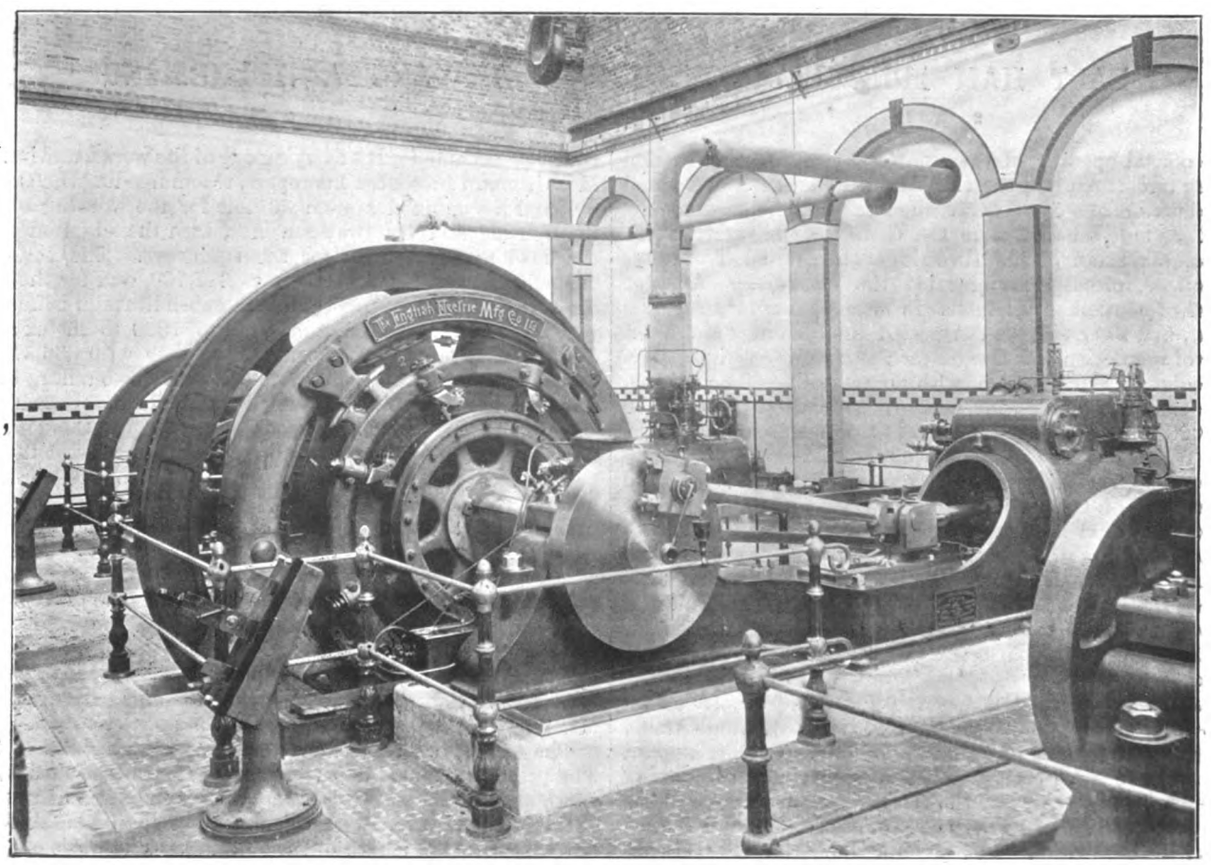


EAST HAM: GENERAL VIEW OF ENGINE ROOM.




EAST HAM: ONE OF THE 225KW. SETS.

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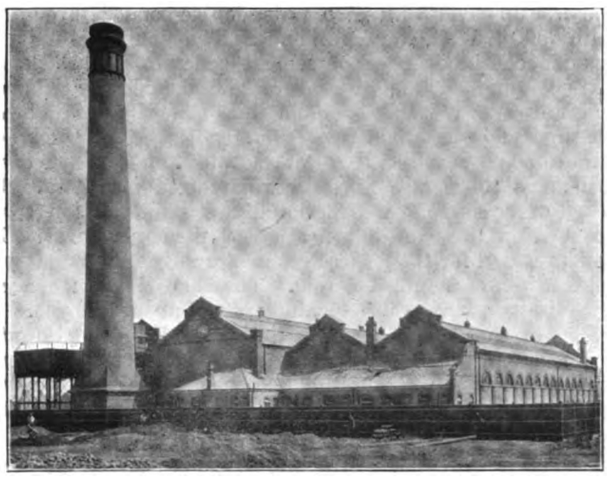
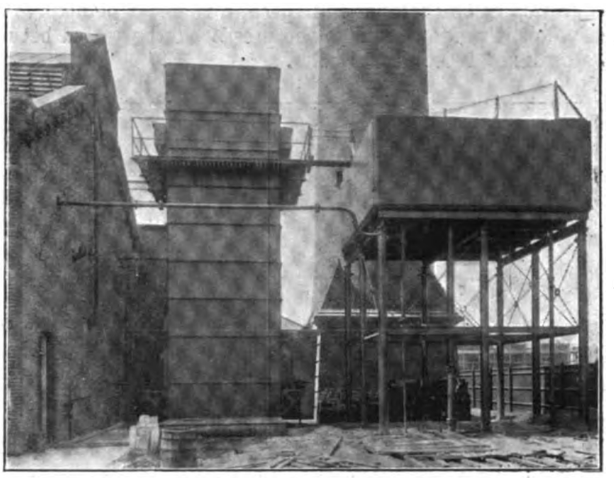
Adjoining the engine room is the boiler house, 148ft. long, 46ft. wide, by 22ft. 6in. clear height, having a main flue 12ft. high by 6ft. 8in. wide. The coal bunkers run parallel with the boiler house, with access in front of each boiler. The chimney is circular, 135ft. high, with an internal diameter of 9ft. 6in. A feature of the boiler house is an artesian well,



EAST HAM: GENERAL VIEW OF POWER STATION.



EAST HAM: COOLING TOWER AND TANK.

18½in. diameter, bored to a depth of 500ft., which, when completed, is expected to yield 12,000 gallons of water per hour. On the other side of the engine room is the car depot, 148ft. long by 65ft. Accommodation is provided for 25 motor cars with all the necessary pits for cleaning, repairing, &c. In

A "Boby" patent heater detartariser is also supplied capable of heating and purifying 8,000 gallons of water per hour. The feed pumps are of the Blake simplex Admiralty type, so arranged as to work separately or as one compound pump.

The plant at present installed in the engine-room consists of Musgrave engines coupled direct to dynamos made by the English Electric Manufacturing Co. There are three 225kw. generators coupled to 850 I.H.P. engines, and one 100kw. generator coupled to a 150 I.H.P. engine. The engines are of the horizontal cross compound type, having an ordinary piston valve controlled by an automatic crank shaft governor

EAST HAM: JUNCTION OF BARKING ROAD AND HIGH STREET.

the car shed are also offices for the traffic staff and rooms for inspectors, motormen, and conductors.

So far, four Babcock and Wilcox single-deck boilers have been fixed, each having a heating surface of 3,580 sq. ft., and capable of evaporating 10,000lb. of water per hour at 150lb. pressure. Babcock and Wilcox superheaters are supplied on each boiler.

on the high-pressure side, while the low-pressure side is fitted with Corliss valve gear. The 150 H.P. engine has cylinders of 9in. and 18in. diameter, with 24in. stroke, running at a speed of 150 revolutions. The 350 H.P. engines have cylinders of 13½in. and 27½in., with 27in. stroke, and a speed of 135 revolutions.

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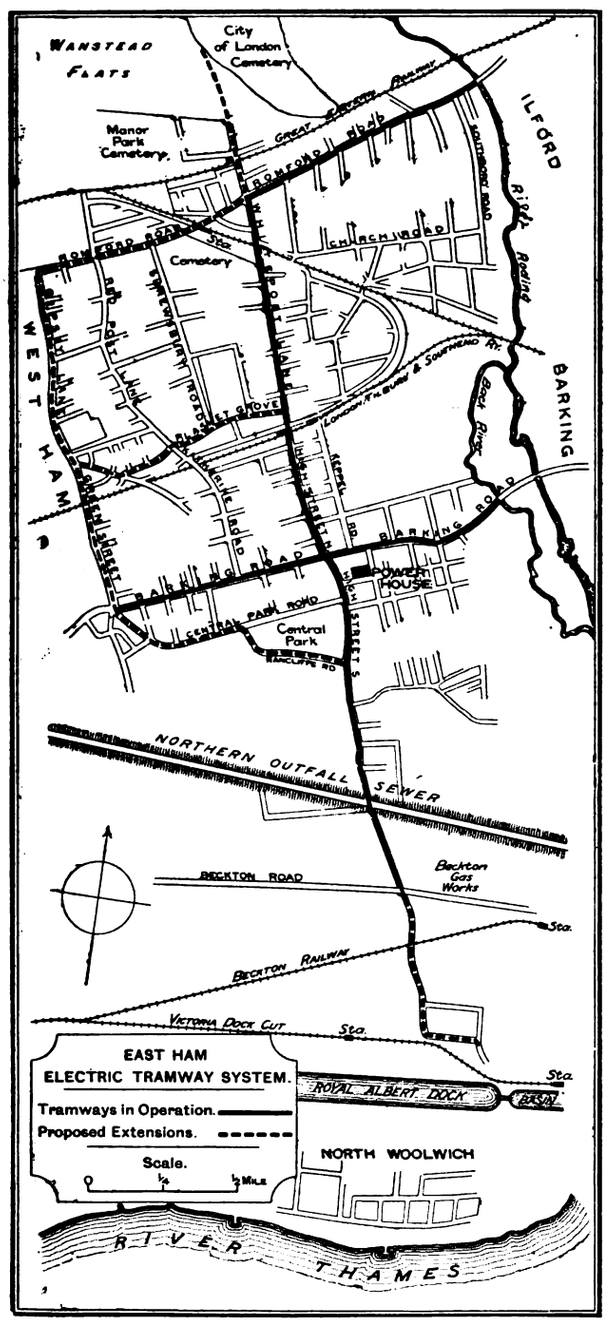
The dynamos are of the multipolar type with slotted drum-wound armatures and special ventilating ducts. When used for traction purposes they work as compound-wound generators, with a variation of from 500 to 550 volts, the winding being so proportioned as to give the variation of voltage without change of speed. When used for lighting they are run as shunt-wound generators, having a full load capacity with a maximum of 580 volts at full speed, a rheostat being provided of sufficient range to enable the pressure to be varied between the limits of 480 and 580 volts.




EAST HAM: MAP OF TRAMWAY SYSTEM.

The condensing plant consists of two Wheeler condensers with combined air and circulating pumps, so arranged as to be available for any one or two of the sets which may be running. In the engine room there is also a negative booster connected to a copper conductor 0·3 sq. in. to keep the fall of pressure along the tramway rails within the Board of Trade limits, and there are two 100 ampere balancers for the lighting service. The main switchboard consists of 18 panels of white marble mounted on a raised platform. It is composed of four generator panels, two balancer, two lighting feeder, two traction feeder, one station lighting, one booster, and one Board of Trade panel, with all the usual switches, instruments, &c.

The whole district is remarkably flat, there being scarcely any gradients except where the track crosses the railway lines, and the main north metropolitan sewer. The gauge is 4ft. 8½in. No curves are less than 40ft. radius. The whole of the track is laid with 87lb. rails, double-bonded throughout with 0000 S.W.G. Neptune bonds. The double track is laid upon a continuous bed of cement concrete, 6in. thick, and paved throughout to a distance of 18in. outside the rails with granite sets, while in the single track the rails are laid on a continuous bed of concrete 18in. wide by 9in. thick, the surface being paved with granite sets 9in. on each side of the rails, and the centre filled in with tarred macadam. The whole of the conduits used for both lighting and traction feeders are laid in the centre beneath the permanent way. The conduits used for the feeder system are "Sykes" patent with self-centreing Stanford joints. These are laid in concrete with draw-in boxes placed at intervals of about 100 yds.

The overhead line consists entirely of side pole and bracket construction, the maximum length of any bracket being 18ft. The poles, which are of the telescope joint type, are 31ft. long, weighing, without the base, either 990lb. or 1,321lb. The trolley wires are No. 0 B. and S. gauge tested to an actual breaking stress equal to 27·3 tons per square inch. The feeders are of Callender's fibre system, 0·3 sq. in. in area.

The rolling stock at present provided consists of 15 top seat cars, known as the Liverpool type, having the "Bellamy" reversed stairway. Each is mounted on a Brill 21E truck, and has a seating capacity of 56 passengers, 22 inside, and 34 outside. The two motors are of the 25 A "Short" type, designed to give a tractive effort of not less than 1,000lb. when running at 10 miles per hour. The cars have illuminated destination boards at each end above the top of the upper deck.

The controllers are also of the "Short" design, and are of the D.B.I. solenoid blow-out type, with rheostatic brake, capable of controlling the car in any emergency. Altogether 135 enclosed arc lamps will be fixed in the main thoroughfares. The lamps are run in series of five, connected across the outer of the three-wire distribution mains, each lamp being provided with a switch and substitution resistance to enable any single lamp to be cut out while on circuit. They are suspended from the tramway bracket arms, so as to be as near the centre of the street as possible.

The lighting feeders are of the same type as those for the tramways, the largest being 0·42 sq. in. in area. So far a total length of 18 miles of distributors have been laid in the district on the Callender solid system. Three-core pilot and telephone cables are also laid to the extreme ends of the district for both lighting and traction purposes.

Current is charged for on the Wright system, the price being 7d. for the first hour and 8d. after, and in order to popularise the tramways as much as possible, the Council have decided to institute ½d. stages throughout the system.

The following is a list of the principal contractors and sub-contractors:—

| | |
|---|---|
| Dick, Kerr & Co. | Permanent way and overhead equipment. |
| Babcock and Wilcox | Boilers, tank, and piping, &c. |
| Callender's Cable & Construction Co. | Cables. |
| Pierson & Co. | Steel work for the buildings. |
| Wilson Bros. | Chimney. |
| Musgrave & Sons | Engines. |
| English Manufacturing Co. | Dynamos, balancers, booster, and switchboard. |
| Elec. Tramway & Carriage Works | Cars. |
| Askham Bros. and Wilson | Cast-steel points and crossings. |
| Blake and Knowles | Feed pumps. |
| Wheeler Condenser & Eng. Co. | Cooling tower. |
| Albion Clay Co. | Cable conduits. |
| Mr. Boby | Heater detartariser. |
| Johnson and Phillips | Arc lamps. |

In conclusion we must express our thanks to Mr. Ullmann for the information from which this article is compiled, and to Messrs. Dick, Kerr & Co. for the photographs from which our illustrations are taken.

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## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 483.*)

§ 9. Ruston, Proctor & Co.'s Steam Dynamo Set.—This set, shown in Fig. 9, was entirely manufactured by Messrs. Ruston, Proctor & Co., of Lincoln. It consists of an enclosed vertical compound double-acting steam engine direct-coupled to a continuous current multipolar dynamo. The engine is rated at 100 B.H.P., running at 450 revs., and the dynamo at 80kw., delivering 300 amperes at 250 volts. The cylinders are 9½in. and 15in. by 8in. stroke, from which it will be seen that the piston speed is about 600ft. per min. There are piston valves on both cylinders, with an automatic crank governor on the high-pressure valves. The cut-off of the low-pressure cylinder is fixed at 55 per cent. A vertical section of the engine is shown in Fig. 10. The dynamo is of the six-pole type, with drum-wound armature and compound-wound field magnets. As shown in the illustration, it is of solid construction, with ample provision for collection from the commutator. There is a massive flywheel between the engine and the dynamo.

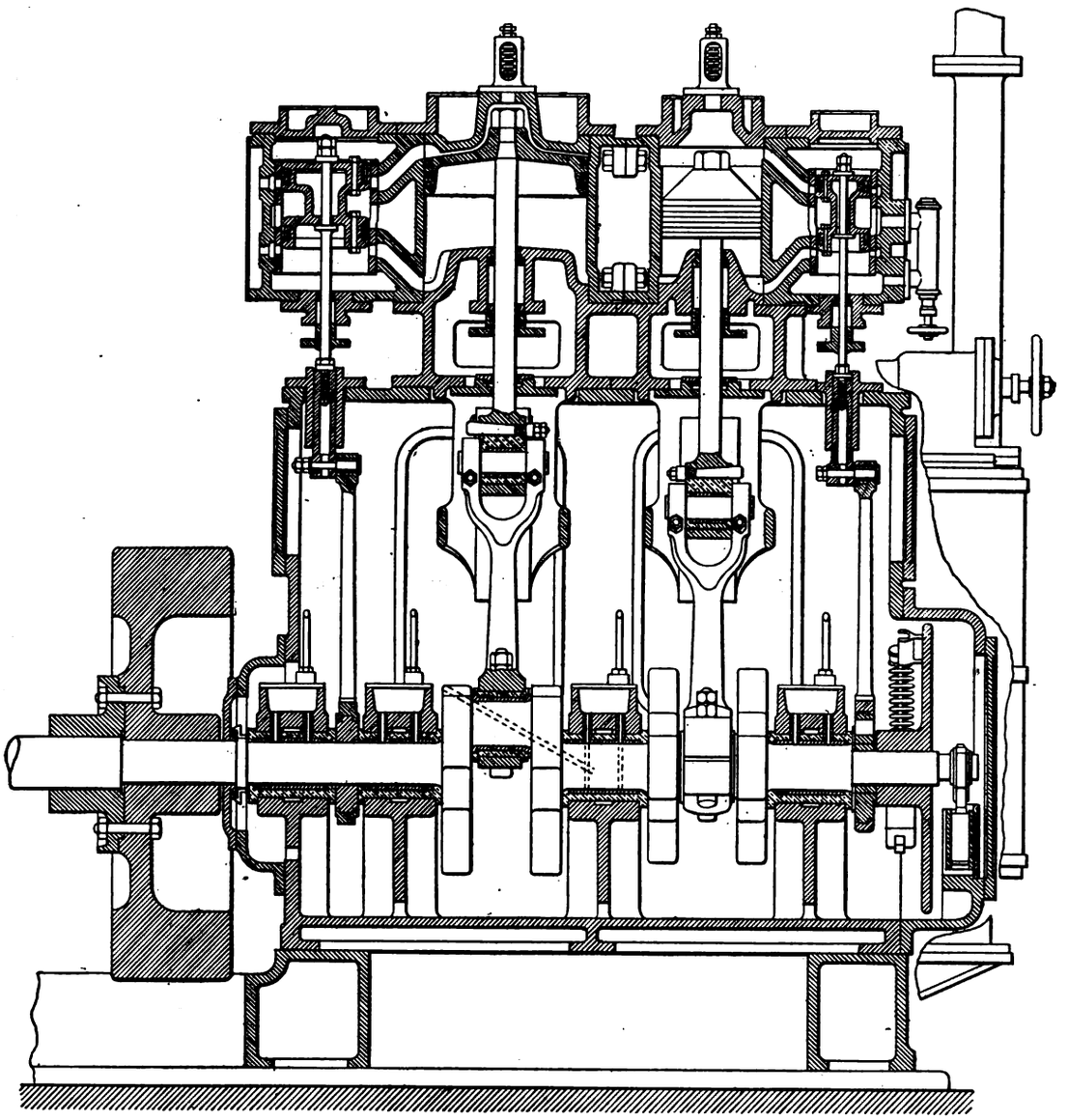

FIG. 10.—VERTICAL SECTION OF RUSTON PROCTOR STEAM ENGINE.

§ 10. Browett, Lindley—"Ediswan" Steam Dynamo Set.—This set is shown in Fig. 11. It consists of one of Messrs. Browett, Lindley & Co.'s standard enclosed vertical two-crank compound engines direct-coupled to a four-pole "Ediswan" continuous-current dynamo. The set runs at 880 revs., and is rated at 180kw. on the dynamo, with 120lb. steam pressure non-condensing. The cylinders are 12½in. and 21in. diameter respectively with a 9in. stroke. The steam distribution is effected by means of piston valves on both cylinders, each valve spindle being actuated by an eccentric on the crank shaft. The governing is effected by an inertia shaft governor directly acting on the throttle valve. The "Ediswan" dynamo has an output of 520 amperes at 250 volts running at 380 revs. It is used as one of the balancers on the three-wire network. The magnets are of the four-pole type and are of special quality cast steel of high permeability. The armature is of the slotted drum pattern with cylindrical bar winding. The commutator is built up of hard drawn copper section of high conductivity insulated with mica. The brushes are of high conductivity carbon, carried in light and simple brush holders, which are easily removable while running. The machine is sparkless at all loads. The guaranteed efficiency is 94 per cent. at full load, and 91 per cent. at half load.

§ 11. Alley and MacLellan-Mavor and Coulson Steam Dynamo Set.—This joint exhibit consists of an Alley and MacLellan three-crank compound engine direct-coupled to a Mavor and Coulson six-pole dynamo. The dynamo, which is similar in design to the machine described in § 7, gives an output of 680 amperes at 265 volts at a speed of 400 revs. The engine is one of Messrs. Alley and MacLellan's

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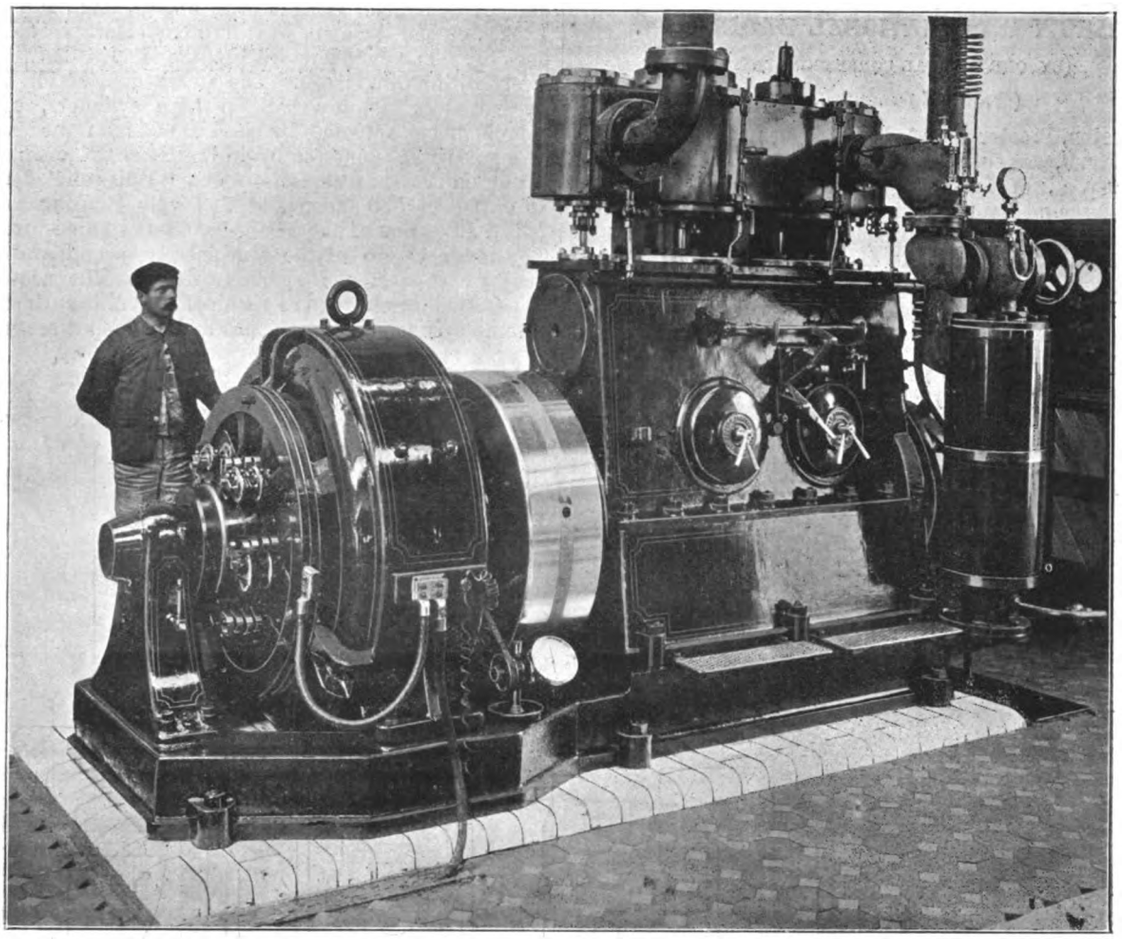

FIG. 9.—RUSTON PROCTOR & CO.'S STEAM DYNAMO SET.

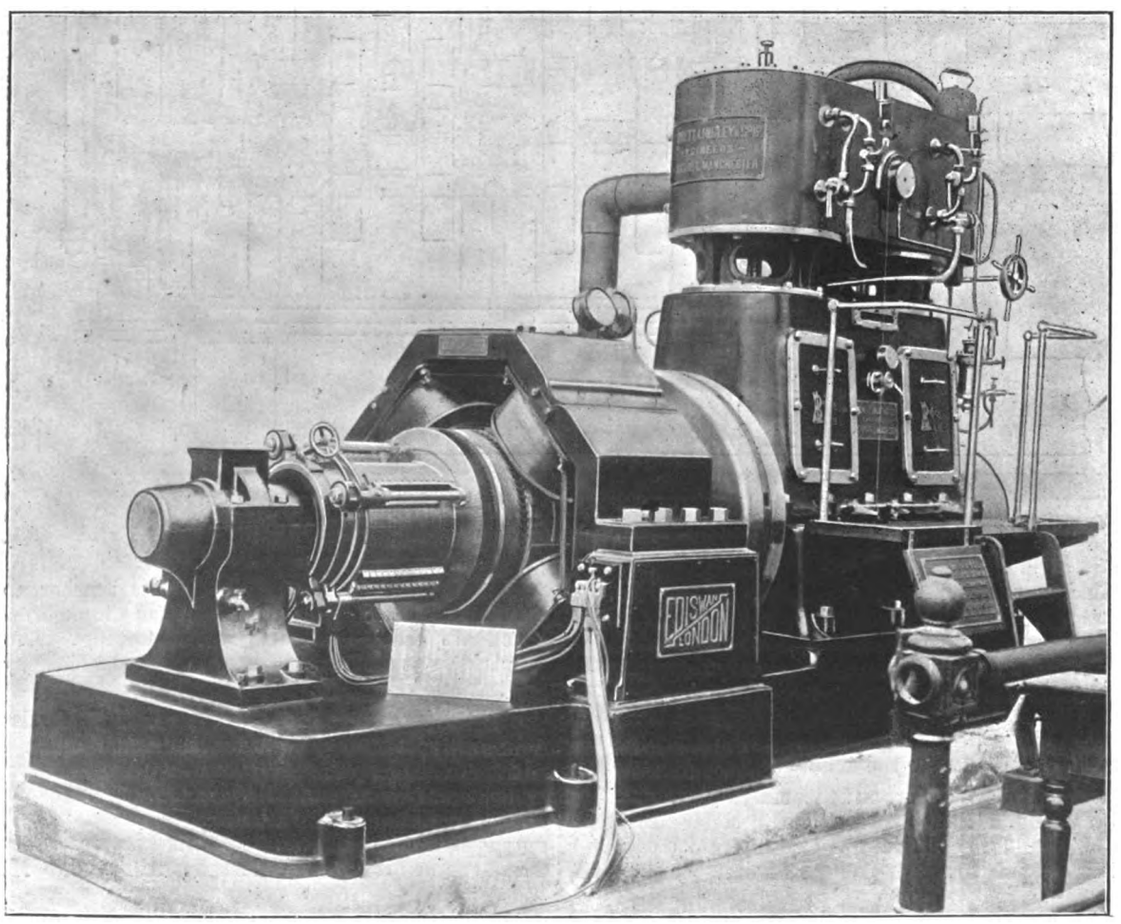


FIG. 11.—BROWETT LINDLEY-"EDISWAN" STEAM DYNAMO SET.

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"Sentinel" three-crank compound engines, capable of developing 300 H.P. at a speed of 400 revs. per min. It is of the single-acting self-lubricating type, and is designed to meet the requirements of such engines for central station or shipyard or factory work. The bearings are all of unusually large dimensions, and the engine is capable of making long continuous runs without stopping for adjustment of bearings or for lubrication. The cylinders are 10in. and 18in. diameter by 9in. stroke, and are arranged tandem-wise on each crank, the cranks being set at 120deg. apart. In mounting the dynamo with this engine the usual combination base-plate has been dispensed with, and in its place three cast-iron anchor plates are built into the foundations for carrying the magnets and the outer bearing of the dynamo. This arrangement affords more ready access to any part of the dynamo and also allows greater freedom of circulation of air, and in both these respects the arrangement is a decided advantage over the enclosing box bedplate commonly adopted.

§ 12. 25 H.P. Ship-Lighting Set.—This set consists of an open fronted double-acting compound engine by Messrs. Matthew Paul & Co., of Dumbarton, mounted on the same base-plate with and coupled direct to a Mavor and Coulson four-pole dynamo giving an output of 150 amperes at 180 volts at a speed of 500 revs. The engine is adapted to work with a steam pressure of 150lb. per square inch, and the cylinders are 5½in. and 10in. diameter by 6in. stroke. They are supported at the back on cast-iron columns which carry the guides, and at the front on two wrought-iron columns. Both cylinders have ordinary flat single-ported slide valves. The governor is of the crank shaft spring and ball type, and controls a balanced double-beat throttle value which, in conjunction with a heavy flywheel fitted on the end of the shaft next the dynamo, regulates the speed of the engine within very close limits.

*(To be continued.)*

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

*(Continued from page 477.)*

### THE BERLIN ELECTRICITY WORKS.

Unlike London, Berlin is supplied with electrical energy for light and power by a single company; and hence the undertaking of the Berliner Elektricitäts Werke is one of the largest (if not the largest) electricity supply system in the world. At present it possesses six generating stations, representing an engine power of nearly 150,000 H.P., and supplying 400,000 incandescent lamps, 16,000 arc lamps, and 8,000 motors, in addition to the current for the entire tramway system in Berlin. The adjoining municipal areas have independent electricity works, some of them municipally owned (as the Charlottenburg works which were erected by Messrs. Lahmeyer & Co.), but the whole of Berlin proper is supplied from these six stations, four of which are near the centre of the city, the fifth just outside the supply area, and the sixth further distant—viz., about 9 miles from the centre of the district. Current is distributed at 2 × 110 volts for lighting—which is rapidly being converted to double that pressure—and 500 volts for the tramways. The two outside stations generate at 6,000 volts three-phase, which is converted to the lower pressures in six sub-stations situated near the inner circumference of the supply area. Nearly all the lighting distributing network is a closed one, and the number of feeding points, particularly near the centre of the town, is exceptionally large.

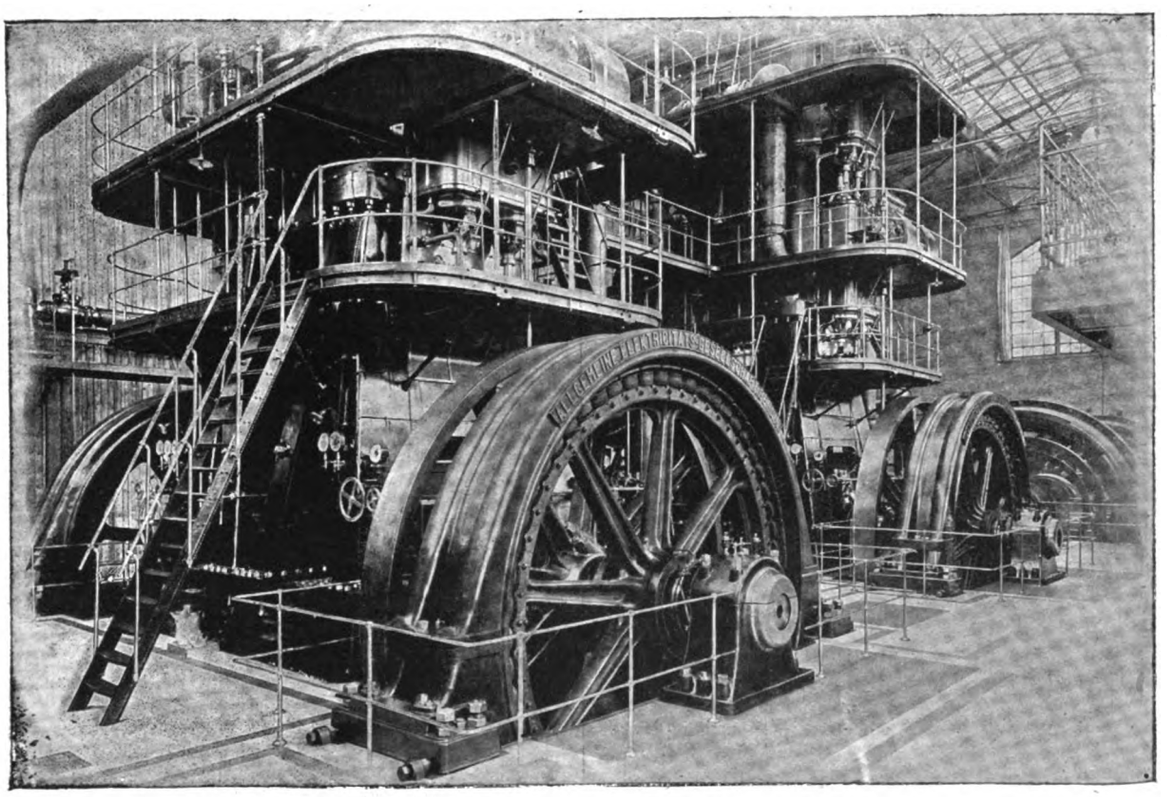

FIG. 7.—OBERSPREE STATION: 2,000 H.P. VERTICAL ENGINES, EACH WITH TWO 6,000 VOLT THREE-PHASE DYNAMOS.

The history of the undertaking dates back to 1881,* when Herr Emil Rathenau, the present managing director both of the A.E.G. and of the B.E.W. (Berliner Elektricitäts Werke), acquired the German rights of the Edison patents. He first formed a pioneer company which erected a few small self-

* *See* "Die Berliner Elektricitätswerke bis Ende, 1896," by Gustav Kemmann. (Berlin: Julius Springer. 1897).

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contained installations, and in 1883 this concern developed into the German Edison Co. with a capital of £250,000, the forerunner of the present company, whose capital (including both share and debenture capital) is ten times as large. After

use of the streets for its mains the company has to pay to the municipality 10 per cent. of its net receipts, and when the dividend exceeds 6 per cent. the town is to receive 25 per cent. of the surplus. These sums were intended to make

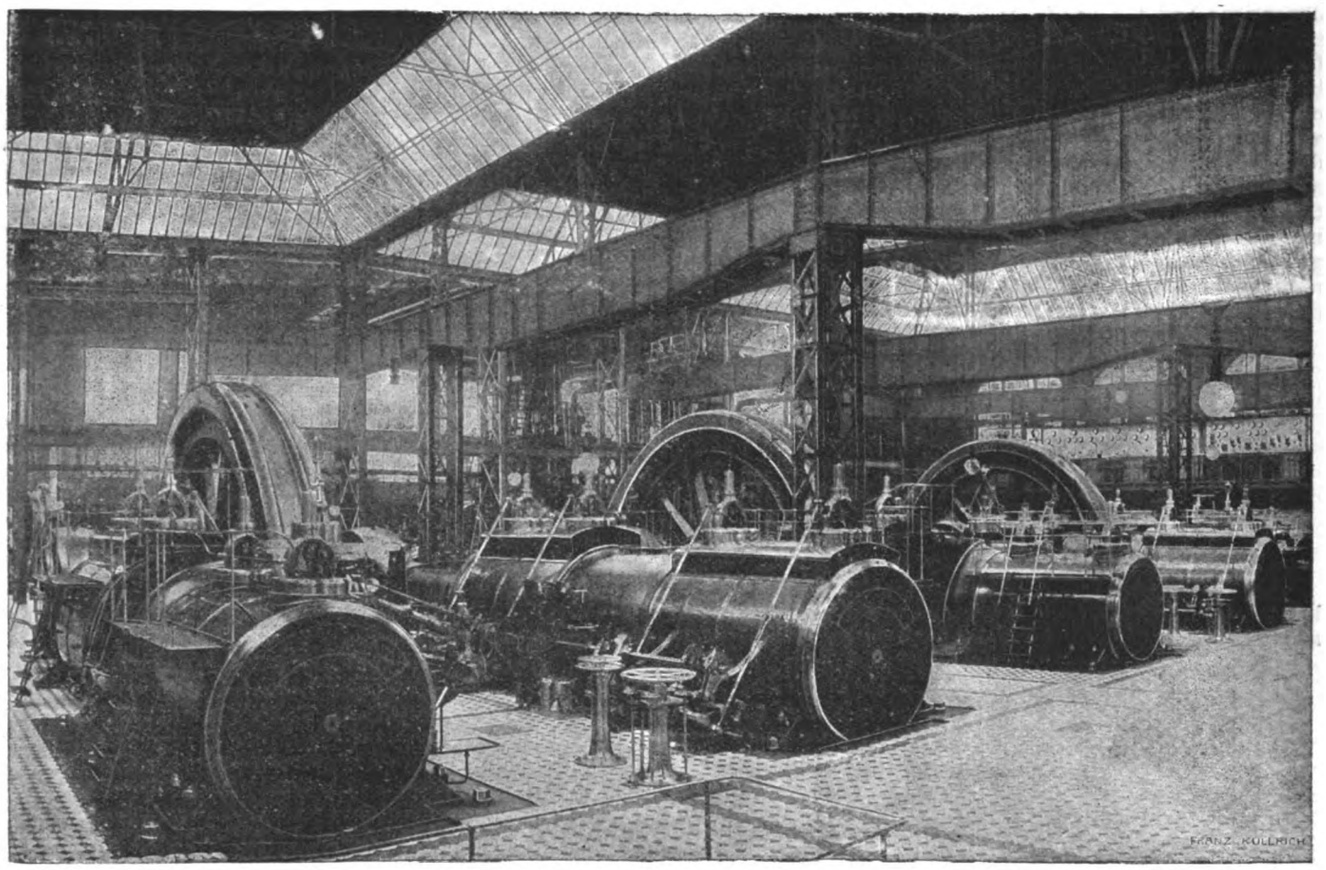

FIG. 8.—OBERSPREE STATION: HORIZONTAL 4,000 H.P. GÖRLITZ-A.E.G. SETS.

extending and joining together some of the single installations, the company sought to obtain from the municipal authority the power to supply consumers generally, and to lay mains

good to the municipality any falling off in the profits from its gas works. In 1894 the municipality had the power to purchase the undertaking at 166⅔ per cent. of its then value; in 1899 the purchase-price would have been 150 per cent. of

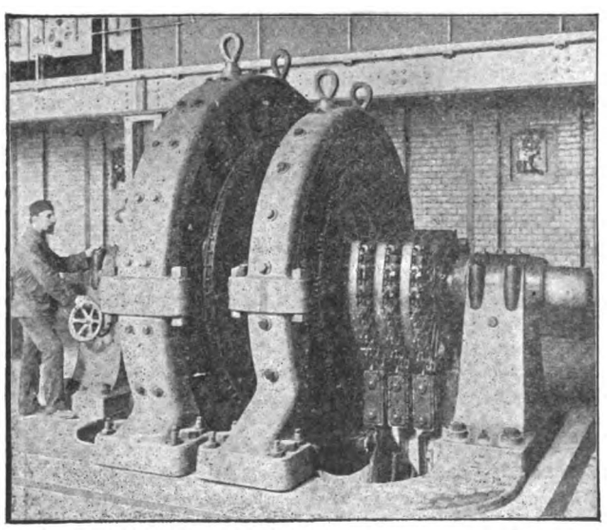

FIG. 9.—ROTATORY CONVERTER SET IN SUB-STATION. (THREE-PHASE SIDE.)

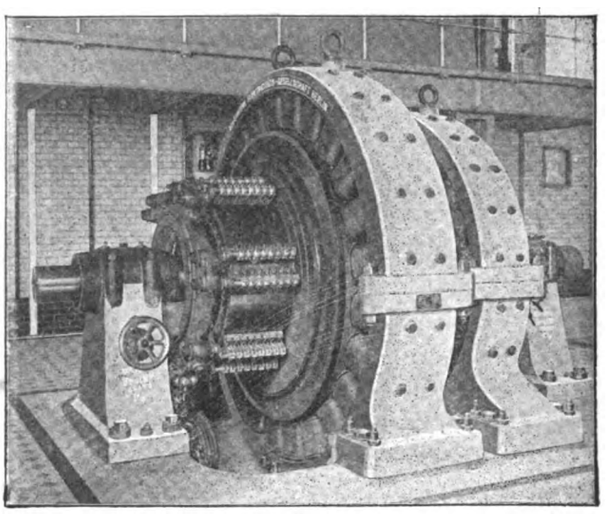

FIG. 10.—ROTATORY CONVERTER SET IN SUB-STATION. (CONTINUOUS-CURRENT SIDE.)

in the public streets, and an agreement was entered into in February, 1884, giving leave to the company to supply electricity for light and power in the central part of the town, within a radius of half a mile. For permission to make

the value at this later date; and future dates for compulsory purchase will be 1904, 1909 and 1914, when the price will be 133⅓ per cent., 116⅔ per cent. and 100 per cent. respectively. If the municipality purchases at the conclusion of any of

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these five-year periods the purchase-price is to be one of the above percentages of the value of the undertaking, to be settled on commercial principles by two arbitrators on the basis that it is a going concern, but without regard to the profits it is yielding at the time.

The first station to be completed was in Markgrafenstrasse, which was opened in August, 1885, and in May of the following year the Mauerstrasse station was opened; and in 1888 Unter den Linden and some of the other principal streets were lighted by arc lamps. The demand for private lighting increased rapidly, and in 1888 the agreement was altered to permit the company to operate in its present larger area, and forthwith new stations were erected. The capacity of the six stations is now as follows:—

| | | |
|---|---|---|
| Schiffbauerdamm-Luisenstrasse | 21,100 | H.P. |
| Spandauerstrasse-Rathausstrasse | 14,600 | ,, |
| Mauerstrasse | 14,500 | ,, |
| Markgrafenstrasse | 2,100 | ,, |
| Oberspree | 54,000 | ,, |
| Moabit | 36,000 | ,, |
| Total | 142,300 | H.P. |

The generating stations visited by the Institution party were those at Schiffbauerdamm - Luisenstrasse, Moabit and Oberspree, and the sub-station in the Königin Augusta Strasse. The first-mentioned of these is the largest of the earlier stations in Berlin, so that the machines in it are for the most part of obsolete design. Its most interesting feature is the arrangement of the buildings, for, as seen in Fig. 11, the boilers for the Luisenstrasse station are placed on the top floor above the switchboard gallery, the dynamos being on the ground floor, and the base of the chimney below the boiler house level contains offices. The Schiffbauerdamm portion is the older of the two combined stations, and supplies the lighting network. Its boiler house is on ground level, contains eleven Steinmüller water-tube boilers (six with 303 sq. metres heating surface each, and five with 452 sq. metres) and is provided with two chimneys. The engine room contains five direct-coupled sets, three of which are continuous-current machines with ring armatures, the outer bars of the ring serving at the same time as commutator, and the field-poles being stationary within the armature. This type of machine was at one time very popular in Germany, and its popularity was well deserved, as some of the machines have been running well for a large number of years. No doubt the machines were more costly than more modern ones, their efficiency is probably not so good, and their weight and size somewhat greater; but so satisfied have some dynamo users been with this old design that I was informed at one of the manufacturing works we visited that "repeat orders" for them are continually coming in—even in the power house for the new electric elevated and underground railway which Messrs. Siemens and Halske are building, a ring-armatured "internal pole" machine is being used, but in this case the commutator and armature are not one. The other two dynamos, more recently installed, are 3,000 volt three-phase machines, and the current which they generate is led to the Markgrafenstrasse station, where it is transformed to continuous current to supplement the current generated in that station for the tramways, as the load on the latter station had increased beyond expectation, and there was no room for further plant there.

The peculiar arrangement of the Luisenstrasse building, which adjoins the Schiffbauerdamm station has already been alluded to. On its top floor are eight boilers, placed in two rows, each with a heating surface of 303 sq. metres. They generate steam at a pressure of 14 atmospheres, and the steam passes through a superheater raising its temperature to 300°C. An electrically-driven coal conveyer brings the coal up from the basement. In the engine room are three fine vertical two-crank slow-speed triple-expansion 3,000 H.P. engines, each directly coupled to two 250–280 volt continuous-current dynamos. The dynamos are 16-pole drum-wound machines of the usual Continental type, and their speed is 85 revs. per min. These are now principally employed connected in series for the tramways, and occasionally only on the 2 × 110 volt lighting network. Two batteries, each consisting of 140 cells of 2,600 ampere-hours capacity on a three hour discharge are employed in parallel for regulating the pressure of the lighting network, and in addition the battery room contains a "buffer" battery for the tramways. The latter consists of 256 cells capable of delivering 1,400 amperes at 500 volts for one hour.

In the Moabit station are three 6,000 volt 3,000kw. three-phase dynamos, similar in all respects to the one shown at the Paris Exhibition (see *The Electrician*, Vol. XLV., p. 771), and at the Oberspree station there are also three of these directly coupled to horizontal slow-speed engines, but in the latter case of the Görlitz make illustrated in Fig. 8. At Oberspree there are also two horizontal 1,000kw. sets, and two 2,000 H.P. vertical engines with a three-phase dynamo on either side (Fig. 7). This station, the last one erected for the B.E.W., has Borsig water-tube boilers, and employs superheated steam and also economisers. The frequency of the three-phase machines is 50 ~ per sec., to allow of the transformed alternating current being employed for lighting, as well as the continuous current supplied through the rotatory converters.

At the Moabit station considerable interest was evinced in the exciting sets, which are combined rotatory converters and boosters, and are similar to those in the sub-stations (Figs. 9 and 10). Each machine consists of an ordinary multipolar six-phase rotatory converter, in series with whose armature are the six-armature coils of a second machine on the same shaft. The transformation ratio of the rotatory converter, is of course,

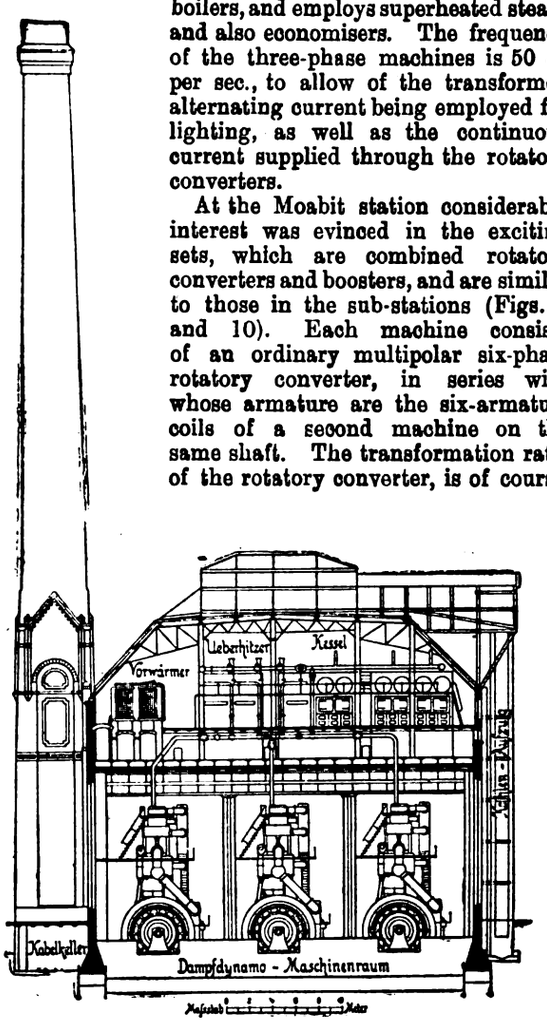


FIG. 11.—SECTION OF THE LUISENSTRASSE GENERATING STATION.

constant; but the E.M.F. generated in the armature of the smaller machine, which may be thought of as a three-phase synchronous motor or generator, can be varied by varying its field strength of this machine. Thus, the set is given a fairly wide range of E.M.F., and can be employed directly on the lighting or tramway mains or to charge the batteries. At the Königin Augusta Strasse sub-station visited were four of these machines, capable of converting the pressure from 390 volts to anything between 440 and 660 volts. The arrangement is found preferable to the induction regulator usually employed in American practice, and can cover economically a far wider range.

The stations described have been erected by the Allgemeine Elektricitäts Gesellschaft, who have kindly lent the blocks illustrating this article.

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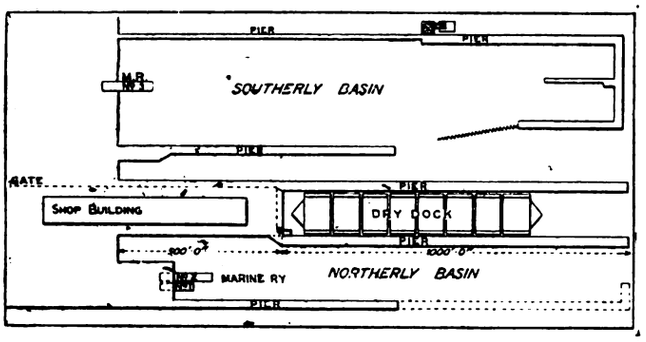
## AN ELECTRICALLY-OPERATED DRY DOCK.

The *Electrical World* of New York for June 22 describes the new dry dock for South Brooklyn, which they claim is the largest and most powerful floating dry dock in the world. It consists of five pontoons, each 80ft. in length, and has a total length of nearly 500ft., which includes the 4ft. spaces between the pontoons and the 36ft. extensions at each end. When completed, the dry dock will be between 700ft. and 800ft. in length, capable of accommodating with ease the largest ship afloat. The pontoons are 120ft. in width, and the combined lifting capacity of the pontoons at present installed is 15,000 tons. The power used is electricity, the motors being of the induction type, and the pumps are of the centrifugal pattern. An idea of the efficiency of the arrangement may be gathered from the fact that it is possible to dry dock an 8,000-ton ship in about 40 minutes' time. Recently the "Mt. Vernon," a 649-ton ship, was lifted in 25 minutes, and it took only 51 minutes to dock the "California," a 9,000-ton vessel.

Each pontoon or section has the shape of a V, and has a depth of 15½ft. at the centre. The two wings at each side measure 56ft. from the bottom of the pontoon to the top platform, on which the motors and handwheels for the inlet valves are located. The pumps have a capacity of 5,000 to 6,000 gallons of water per minute, and all suction pipes are 20in. in diameter. Each pump is connected by means of a vertical shaft to a 75 H.P. induction motor, which is carefully housed in at the top of the pontoon, more than 50ft. above the pump. Three-phase current at 6,600 volts and 25 cycles to operate these motors is supplied to the company by the Edison Electric Illuminating Co., of Brooklyn. It is led to three 300kw. air-blast transformers, connected up in delta, located in a transformer-house, where it is transformed down to 240 volts. A 2 H.P. induction motor is directly connected to a blower, which supplies the air for cooling the transformers. A duplicate set of three conductor cables has been installed to guard against a breakdown.




From the transformers the current is led to the switchboard, consisting of six panels, five of which are for the control of the motors. On one panel are mounted the polyphase wattmeters, one for the starting 'bus, at 140 volts, and one for the main 'bus, at 240 volts, as well as three 3,000 ampere single-pole quick-break knife switches for controlling the board. The voltmeter is mounted on a swinging bracket. On each of the five motor panels, each of which controls two 75 H.P. induction motors, are mounted two three-pole double-throw oil switches, and two Thomson alternating-current ammeters, reading from 0 to 350 amperes.

On the back of the board are two sets of 'bus bars, the lower ones being the starting and the upper ones the main 'busses. There are also two circuit breakers which control the starting 'busses. The transformers can carry a normal load of 2,300 amperes and an overload of 3,500 amperes for 30min., the ratio being 140 to 1. The transformers for the starting motors are designed for a normal load of 1,200 amperes and a 30min. overload of 2,000 amperes, the ratio being 80 to 1. The motors on the pontoons are controlled entirely from this board, and after the motors have attained their proper speed, which the operator judges from the noise in the transformers ceasing, he throws them from the starting 'busses on to the main 'busses. The motors drive the pumps at a speed of 250 revs. per min. The Edison Company also furnishes two-phase, 60-cycle, 2,500-volt current for the lighting of the dock, which is done by means of arc lamps located on the top platforms. The current is led to these lamps by means of flexible cables, supported in elevator loop fashion.

The mode of procedure followed in docking a vessel is as follows:—The inlet gates are opened and the pontoon sunk to a depth which will allow the vessel to be backed in between the wings, with the necessary clearance between her keel and the keel blocks. As soon as everything is in position, the pumps are started simultaneously, in case the vessel has no appreciable list, from the switchboard in the transformer house. As the water is pumped out the pontoons will rise, lifting the vessel clear out of the water. One advantage of this sectional building of a dock is that only so much of the dock need be used as is desired. For example, a vessel that is only 150ft. long would simply require the pumping out of the first two sections.

## ELECTRICITY WORKS ACCOUNTS.

### City of London Electric Lighting Co. (Ltd.).

In discussing the 1899 accounts of this company we had cause to note the great change wrought by competition in the financial results; the proximate cause of the diminished return being due chiefly to the reduced revenue. An unfortunate feature of those accounts was, however, the increase in the costs. This year, although the absence of an ordinary dividend and an inadequate allocation from revenue in respect of capital charges have to be recorded, the accounts show that a gratifying progress is being made along the path by which alone the business may hope to regain a measure of its former prosperity.

A reference to our analysis will show that with the perhaps natural exception of the fuel item, and, as a consequence, the total generating costs, all the items of expenditure have decreased, with the result that the aggregate costs at 3d. are, for a London concern, by no means abnormal considering the price paid for coal. To some extent the improvement in the costs must be attributed to the larger output and the higher load-factor. The former shows an increase of nearly 46 per cent., while the latter stood at 12·7 per cent., as compared with 10·8 per cent. in 1899. The following table indicates the growth of the lamp connections:—

| Dec. 31 | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|
| No. of consumers. | 242 | 1,080 | 2,740 | 4,230 | 4,303 | 6,320 | 7,414 | 8,737 | 9,855 |
| Eq. 8 c.p lamp con. | 20,241 | 65,341 | 135,460 | 195,317 | 247,785 | 296,012 | 355,82[illegible] | 437,612 | 519,113 |

The repairs and renewals, although debited in the official accounts to the depreciation fund, we have charged direct on revenue, and included in the costs as usual. The following are the details:—

| Year | Total. | Repairs and renewals at station. | | | | | | Maintenance, renewals, &c. of mains, posts and transformers. |
|---|---|---|---|---|---|---|---|---|
| | | Total at station. | Buildings. | Boilers, heaters, &c. | Engines and condensers. | Dynamos and exciters. | Instruments and tools, &c. | |
| 1899 | £19,120 | £14,729 | £1,995 | £5,200 | £2,037 | £981 | £4,516 | £4,391 |
| 1900 | 23,486 | 18,736 | 1,969 | 7,459 | 3,418 | 888 | 5,002* | 4,750 |

* Including £2,021 for coal conveyor, cranes, &c.

The balance existing to the credit of the reserve fund at the end of 1899, and amounting to £16,849, has now been included in the depreciation fund, which, however, has been charged with £29,237, being on account of various assets written off, loss on antiquated meters, alteration on consumers' premises on change of pressure, &c. Thus the depreciation fund stands at £97,560. The premium account has been reduced by £14,510—the expenditure on Wool Quay before abandonment as a generating site—leaving a balance of £47,361. Of the £25,000 set aside out of the revenue during the year ostensibly for depreciation, £23,486 was, as stated in the table above, expended on repairs and maintenance.

### Metropolitan Electric Supply Co. (Ltd.).

While the 1900 results of this company in the matter of costs of working are disappointing, it is to be admitted that the slight reduction in the expenses indicates a material improvement, considering the price of coal last year. It is satisfactory to find that the item of repairs at the station is being reduced, though the expenditure under this head is still much too high. By a reduction in the management costs they now present a most reasonable figure.

The company's receipts have decreased very nearly the same as have the costs, and the working profit was, therefore, practically the same as in 1899, compared with the capital involved. £14,000 was placed to reserve and depreciation, and £15,570 net paid in interest.

The principal portion of the £173,551 expended as capital during the year were for the works at Willesden and for the extension of the low-pressure system. A fourth steam generator of 1,500kw. capacity has been erected at Willesden, and a fifth machine of similar size was to have been installed during this summer.

The output for 1900 was 18·8 per cent. above that of 1899, and the lamp connections show an advance of 14 per cent.

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| | CITY OF LONDON. | | | | LONDON. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | The City of London Electric Lighting Co. (Ltd.) | | | | The Metropolitan Electric Supply Co. (Ltd.) | | | |
| *Date of Commencement of Supply* | Dec., 1891. | | | | 1890. | | | |
| *System of Supply* | [work; also con.-curr. 3-w. system. | | | | [distribution, con.-curr. 3-wire; also extra h.-p. 2-phase from Willesden with rotaries. | | | |
| *Chief Engineer* | Alt.-curr. trans. sub-station feeding 3-w. net-Frank Bailey. | | | | Alt.-curr. trans. in houses and sub-sta. with 3-wire R. R. Todd. | | | |
| **YEAR ENDED** | DEC. 31, **1899.** | | DEC. 31, **1900.** | | DEC. 31, **1899.** | | DEC. 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | — | | — | | 12,891,250 | | — | |
| „ **SOLD (TOTAL)** | 8,549,353 | | 12,472,900 | | 8,327,939 | | 9,855,175 | |
| „ sold to consumers | 7,446,703 | | 11,272,968 | | — | | — | |
| „ sold for public lighting, &c. | 1,102,650 | | 1,200,000[j] | | — | | — | |
| „ used on works | — | | — | | — | | — | |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 19·7 | | 26·6 | | — | | — | |
| Maximum supply demanded | 9,138 kilowatts | | 11,230 kilowatts | | 7,630 kilowatts | | 8,905 kilowatts | |
| Number of public lamps | 548 arc | | 508 arc | | 20 arc | | 25 arc | |
| Number of consumers | 8,737 | | 9,855 | | 7,900 | | 8,000 | |
| Connections to mains in 8-c.p. lamps | 437,612 | | 519,113[k] | | 500,036 | | 570,000 | |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 434,500 | | 469,000 | | — | | 336,000 | |
| **CAPACITY OF PLANT IN KILOWATTS** | 13,900 | | 15,000 | | — | | 10,750 | |
| **CAPITAL—** | **Total.** | **Per kilowatt capacity.** | **Total.** | **Per kilowatt capacity.** | **Total.** | **Per kilowatt capacity.** | **Total.** | **Per kilowatt capacity.** |
| **AUTHORISED (TOTAL)** | £1,600,000 | £115 | £2,000,000 | £133 | £1,850,000 | — | £2,000,000 | £186 |
| Share | 1,200,000 | 86·3 | 1,200,000 | 80·0 | 1,000,000 | — | 1,000,000 | 93 |
| Loan (including Debenture charges) | 400,000 | 28·8 | 800,000 | 53·3 | 850,000 | — | 1,000,000 | 93 |
| **RECEIVED (TOTAL)** | 1,400,000 | 101 | 1,693,909[o] | 113 | 1,225,276[a] | — | 1,419,056[b] | 132 |
| Share | 1,000,000 | 72·0 | 1,105,950 | 75·7 | 850,000 | — | 927,185 | 86·3 |
| Loan (including Debenture charges) | 400,000 | 28·8 | 560,503 | 37·4 | 345,000 | — | 470,000 | 43·7 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 200,000 | 14·4 | 333,547 | 22·2 | 655,000 | — | 602,815 | 56·1 |
| Share (unissued) | 200,000 | 14·4 | 94,050 | 6·27 | 150,000 | — | 12,310 | 1·15 |
| Share (uncalled) | nil | — | nil | — | nil | — | 60,505 | 5·63 |
| Loan (including Debentures) | nil | — | 239,497 | 16·0 | 505,000 | — | 530,000 | 49·3 |
| **REPAID (TOTAL)** | nil | — | 27,456 | 1·83 | — | — | — | — |
| **RESERVE OR SINKING FUND** | 16,349 | 1·18 | nil | — | } 64,361 | — | 78,422 | 7·30 |
| **DEPRECIATION FUND** | 108,934[a] | 7·84 | 97,560[m] | 6·50 | | | | |
| **EXPENDED (TOTAL)** | 1,513,456 | 110 | 1,756,431 | 117 | 1,244,254 | — | 1,417,805 | 132 |
| Lands and buildings | 336,174 | 24·2 | 382,832 | 25·5 | 285,702 | — | 334,257 | 31·1 |
| Plant | 615,696[b] | 44·3 | 744,984 | 49·6 | 517,666 | — | 596,504 | 55·5 |
| Mains | 443,174[c] | 31·9 | 577,040[n] | 38·5 | 371,320 | — | 431,629 | 40·1 |
| Miscellaneous | 118,413 | 8·49 | 51,575 | 3·44 | 69,566 | — | 55,416 | 5·15 |
| **BALANCE OF CAPITAL ACCOUNT** | −113,456[d] | −8·16 | −62,521[d] | −4·17 | −18,978[c] | — | 1,250 | 0·116 |
| **REVENUE—** | **Total.** | **Per unit sold.** | **Total.** | **Per unit sold.** | **Total.** | **Per unit sold.** | **Total.** | **Per unit sold.** |
| **TOTAL** | £179,843 | 5·050d. | £213,474 | 4·109d. | £179,190 | 5·163d. | £209,013 | 5·090d. |
| Revenue from supply | 159,739 | 4·448d. | 191,977 | 3·696d. | 173,374 | 4·998d. | 202,827 | 4·940d. |
| „ meters, &c. | 6,169 | 0·173d. | 7,394 | 0·142d. | 5,324 | 0·153d. | 6,144 | 0·150d. |
| „ public lighting | 13,088 | 0·368d. | 13,193 | 0 254d. | — | — | — | — |
| „ sale of lamps, &c. | 684 | 0·019d. | 380 | 0·007d. | 52 | 0·001d. | 42 | 0·001d. |
| „ miscellaneous sources | 162 | — | 530 | 0·010d. | 440 | 0·013d. | — | — |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| **TOTAL COSTS** | £113,351 | 3·183d. | £156,146 | 3 004d. | £112,797 | 3·250d. | £130,513 | 3·178d |
| **WORKS COSTS** | 88,599 | 2·487d. | 130,236 | 2·506d. | 92,351 | 2·660d. | 107,533 | 2·618d. |
| *Generation of electricity* | *77,319* | *2·170d.* | *119,149* | *2·291d.* | *90,419[d]* | *2·605d.* | *106,009[f]* | *2·581d.* |
| Fuel (including cartage, &c.) | 44,027 | 1·236d. | 78,128 | 1·503d. | 55,585 | 1·601d. | 69,065 | 1·681d. |
| Oil, waste, water, stores | 4,531 | 0·127d. | 5,520 | 0·106d. | 5,800 | 0·167d. | 6,172 | 0·151d. |
| Wages at station | 12,900 | 0·362d. | 15,844 | 0·305d. | 11,799 | 0 340d. | 15,275 | 0·372d. |
| Repairs and maintenance at station | 14,729 | 0·414d. | 18,736 | 0·361d. | 15,020 | 0·433d. | 15,472 | 0·377d. |
| *Distribution of electricity* | *9,127* | *0·256d.* | *10,057* | *0·194d.* | *1,932* | *0·056d.* | *1,524* | *0·037d.* |
| Wages, &c. | 4,470 | 0·126d. | 5,307 | 0·102d. | } 1,932 | 0·056d. | 1,524 | 0·037d. |
| Repairs, renewals of mains, &c. | 4,391[e] | 0·123d. | 4,750[e] | 0·091d. | | | | |
| *Public lighting* | *2,153* | *0·060d.* | — | — | — | — | — | — |
| Attendance | 1,351 | 0·038d. | — | — | — | — | — | — |
| Renewals | 802 | 0·023d. | 1,030 | 0·020d. | — | — | — | — |
| **MANAGEMENT AND PROPERTY CHARGES** | 24,752 | 0·695d. | 25,910 | 0·499d. | 20,446 | 0·589d. | 22,980 | 0·560d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *10,596[f]* | *0·298d.* | *10,727[f]* | *0·206d.* | *3,806* | *0·110d.* | *4,975* | *0·121d.* |
| *Management* | *14,156* | *0·398d.* | *15,183* | *0·292d.* | *16,640* | *0·480d.* | *18,005* | *0·438d.* |
| Salaries | 7,864 | 0·221d. | 8,306 | 0·160d. | 8,797 | 0·253d. | 12,143 | 0·296d. |
| Stationery, &c. | 907 | 0·025d. | 1,195 | 0·023d. | 920 | 0·027d. | 901 | 0·022d. |
| Establishment charges | 1,044 | 0·029d. | 1,311 | 0·025d. | 3,215 | 0·093d. | 3,129 | 0·076d. |
| Law charges, &c. | 4,341[g] | 0·122d. | 4,371[p] | 0·084d. | 3,708[e] | 0·107d. | 1,832[g] | 0·045d. |
| **FINANCIAL RESULTS—** | **Total.** | **% to mean cap. exp'nded** | **Total.** | **% to mean cap. exp'nded** | **Total.** | **% to mean cap. exp'nded** | **Total.** | **% to mean cap. exp'nded** |
| **WORKING PROFIT FOR YEAR** | £66,492 | 4·60% | £57,328 | 3·51% | £66,393 | 5·93% | £78,500 | 5·90% |
| Sum carried to Depreciation Fund | 1,879 | 0·130% | 1,514 | 0·093% | } 13,000 | 1·16% | 14,000 | 1·05% |
| Sum carried to Reserve or Sinking Fund | 2,349 | 0·163% | nil | — | | | | |
| Net interest on loans (incl. Debenture charges) | 17,621 | 1·22% | 23,192 | 1·42% | 9,575 | 0·855% | 15,570 | 1·17% |
| **BALANCE FROM LAST ACCOUNT** | 3,382 | 0·234% | 1,623 | 0·099% | 1,451 | 0·130% | 4,410 | 0·331% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 48,023 | 3·32% | 34,243 | 2·09% | 45,340 | 4·05% | 27,840 | 2·09% |
| *Deficit* | — | — | — | — | — | — | — | — |
| **ORDINARY DIVIDEND PAID** | 4% | — | nil | — | 5% | — | 6% | — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 63% | | 73·1% | | 63% | | 62·4% | |
| Expenditure per kilowatt capacity | £8. 3s. 0d. | | £10. 8s. 0d. | | — | | £12. 2s. 10d. | |
| **REVENUE PER KILOWATT CAPACITY** | £12. 18s. 7d. | | £14. 4s. 7d. | | — | | £19. 8s. 10d. | |
| Expenditure per 8-c.p. lamp capacity | 5s. 2½d. | | 6s. 8d. | | — | | 7s. 9d. | |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 8s. 3½d. | | 9s. 1½d. | | — | | 12s. 5d. | |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 8s. 2½d. | | 8s. 2⅞d. | | 7s. 2d. | | 7s. 4d. | |
| Price charged for lighting, per unit | 5d. to 4d. or 4½d.[h] | | 8d. to 2d.[l] | | 6d. to 5d. | | 6d. with discounts | |
| Price charged for power, per unit | 3d. to 2d. or 2½d.[i] | | 2½d. per unit | | 4d. | | 4d. | |
| Price charged for public lighting | £26 per lamp per ann. | | £26 per lamp per ann. | | — | | — | |

**CITY OF LONDON.**—REMARKS—*a* Being £71,826 in respect of generating machinery and £108,934 in respect of buildings, mains, lamp posts and transformers. *b* Includes £28,232 to lamp posts, lanterns, lamps and accessories. *c* Includes £21,078 cost of provisional order and expenditure on mains, meters, &c., Southwark lighting. *d* Over-expended. *e* Includes repairs and renewals of lamp posts *f* "Rents, rates, taxes and lighting." *g* £216 meter reading, £139 auditing, £913 collection charges, £1,707 insurance and £230 professional charges. *h* At option of consumer 5d. per unit for first 100 hours per quarter of maximum demand and 4d. after, or at uniform charge of 4½d. *i* At 3d. per unit for first 250 hours of maximum demand per quarter and 2d. after, or at uniform charge of 2½d. per unit. *j* Estimated *k* Assuming the 508 arcs as being equivalent to 8,000 8 c.p. lamps. *l* 8d. per unit for first six units per lamp in winter and for first three units in summer, 2d. per unit after. *m* Inclusive of £1,514 to credit of repairs and maintenance fund but exclusive of £47,361 balance of premiums. *n* Includes £24,106 on provisional order, mains and meters for Southwark lighting and £18,505 on conduits for telephonic purposes now largely used for lighting. *o* Including £27,456 out of premiums and reserve accounts. *p* £2,122 insurance, £691 fines, £554 law, £277 professional charges.

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## ELECTRO-CHEMICAL INDUSTRY OF TO-DAY.

The Society of Chemical Industry does not often choose an electrician for its president. It is fitting, therefore, that when such choice is made the presidential address should deal with the modern developments of electro-chemical industry. In this issue we present our readers with a lengthy abstract of the address delivered by Mr. J. W. Swan (one of the past presidents of our own Institute of Electrical Engineers) before the members of the Society of Chemical Industry, at Glasgow, on Wednesday. The address was both interesting and eloquent, and the information given by Mr. Swan relating to the number and importance of the electro-chemical industries of Europe must no doubt have surprised many of his hearers who had not followed closely the recent development of these new branches of manufacture. Readers of *The Electrician*, however, have been kept fully informed concerning the industrial utilisation of electro-chemical and electro-metallurgical processes (see *The Electrician*, January 4 and 11, 1901), and it is the third section of Mr. Swan's address, dealing with "the future," that will more especially repay their study and consideration.

Discussing the question of power costs, Mr. Swan admitted that at present many of the new processes of manufacture could only be carried on profitably in countries possessing water-falls suited for cheap development. He recognised a fact, however, that too many overlook, namely, that where the capital outlay upon engineering work is heavy, power derived from water may cost ultimately as much as, or more than, the power derived from coal. As an instance of the extremes of capital expenditure, he quoted £84 per H.P. at Lyons and £3. 9s. 3d. at Valorbe. Calculating interest at 5 per cent., here we have a difference of £4 per horse-power year in interest charges alone, and the final cost of the electrical horse-power year at Lyons must be absurdly high. With Mr. Swan's belief, that the cost of power generated from coal will gradually fall as a result of improvements in the thermal efficiency of steam and gas engines, we entirely agree, and we also share his opinion that in the near future the utilisation

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of blast furnace gases for power generation will be realised in this country. That nothing has yet been actually achieved in this direction up to the present is a striking illustration of the conservatism of the British ironmaster. On the Continent of Europe there are now a large number of such installations at work; and the recent visit of the electrical engineers to Körting's works at Hanover proved that the manufacture of large gas engines for power purposes is a growing and important branch of the engineering industry abroad. Our supineness in this respect is, therefore, to be regretted. We hope that Mr. SWAN'S remarks on this subject may be read by those responsible for the prosperity of our iron and steel industries, and that at an early date we shall have the pleasure of giving details of the first large gas engine driven by blast-furnace gases in this country.

Passing on to other forms of apparatus for producing electrical energy from coal, Mr. SWAN discussed the future of the carbon cell, and expressed the opinion that no form of cell, containing solid electrodes and a liquid electrolyte, could be considered a satisfactory solution of the problem. Here also, we are inclined to agree with his argument, that the cost of running and maintenance would be prohibitive. In Mr. SWAN'S opinion the only possible form of cell for producing electricity in large amounts by chemical action is a gas-cell; but we are immediately faced by a difficulty which he ignores, namely, that carbon can only be obtained in gaseous form (at workable temperatures), in combinations which represent a loss of thermal energy. A carbon gas cell at ordinary temperatures is therefore impracticable in the present state of scientific knowledge; while an oxygen or hydrogen gas cell would cost too much for its raw materials to be economically of any value. It is undeniable that gas engines are at the moment the most promising of all forms of apparatus for converting the thermal energy of coal into mechanical or electrical energy.

Having discussed the possibilities of our obtaining cheaper power in this country, Mr. SWAN next turned his attention to the future of the chemical industry, and was forced to admit that the present position is not reassuring. The spread of knowledge, the growth of electrolytic manufactures abroad, and the existence of hostile tariffs, had combined to undermine the position we once occupied in the heavy chemical trade. Mr. SWAN gave no figures, but it is undoubtedly true that the decline in British exports of alkali in recent years has been serious. As an additional cause of anxiety Mr. SWAN mentioned our defective educational system, and endorsed the opinions upon technical education to which we gave expression in our leader of July 5th. "We are giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science, of no great value, though probably good as far as it goes. We are neglecting to thoroughly educate those upon whose shoulders will soon rest the weight of the management of our great manufacturing industries. In the present state of things a competent knowledge of the science of the business a man is engaged in, as well as an active interest in it, whether it be chemical industry or any other, are essential conditions of any large degree of success, in meeting the emergencies of a highly competitive and progressive time. A scientific training of university standard, for our manufacturers and for our technical chiefs, is an absolute necessity." With this, and with the later remarks concerning the encouragement and endowment of scientific research, we heartily agree, and we are pleased that Mr. SWAN has had the courage to address them to a society which embraces all the leading chemical manufacturers of the country. But we certainly have no wish to intimate by this last remark that the chemical manufacturers of the United Kingdom are less inclined to accept the teachings of science than any other class of manufacturers in the country. Mr. SWAN'S remarks on education may be read with profit by all manufacturers in the United Kingdom—and they may convey some useful lessons even to the electrical profession. With this hint, that those who live in glass houses should not throw stones—we leave this most interesting and instructive address to the attention of our readers.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Earth's Uniform Magnetic Field.*—In connection with the problem of the physical decomposition of the earth's permanent magnetic field, L. A. Bauer attempts to answer the questions:—How is the uniform magnetic field itself composed? What physical basis have we for supposing that there actually exists a uniform magnetisation about a single inclined axis? And how do the coefficients of the first order harmonic vary if different portions of the earth are embraced in the calculations? Preliminary investigations show that there is no physical basis for supposing that the uniform magnetic field consists of one symmetrical about a single diameter, but that, owing to some cause, it is distorted and twisted out of its mean position from parallel to parallel. The inclination of the magnetic axis to the rotation axis is greater for parallels in the southern hemisphere than for corresponding parallels in the northern hemisphere. The meridional plane of the magnetic axis moves steadily from its mean position for the entire zone, in the northern hemisphere, in a direction contrary to that of the earth's rotation, and in the southern hemisphere in the same direction as the earth's rotation, as we go poleward.

[L. A. BAUER, *Terr. Magn.*, May, 1901.]

*Thermo-magnetic Effects in Tellurium.*—If a conducting plate carrying an electric current be placed in a magnetic field perpendicular to the lines of force, various galvano-magnetic effects may be observed:—1. A difference of electric potential is produced between the edges of the plate, perpendicular to the current and the field (Hall effect). 2. A difference of temperature is produced between the same points (Ettinghausen effect). 3. A change of resistance occurs (longitudinal Hall effect). 4. A difference of temperature is produced in the direction of the current. If the current is replaced by a flow of heat, four analogous thermo-magnetic effects are observed:—1. A difference of electric potential between the edges of the plate (Nernst effect). 2. A rotation of the isothermal lines or a difference of temperature between the same points (Leduc effect). 3. A change of conductivity for heat (Righi effect). 4. A difference of potential in the direction of the heat flow (longitudinal Nernst effect). All these effects have been observed in bismuth, and some of them only in bismuth. M. G. Lloyd has found all the transverse effects to exist in tellurium, and has determined their constants. They are 0·0002 for the Ettinghausen effect, 0·86 for the Nernst effect, 430 for the Hall effect, and 0·000004 for the Leduc effect. In tellurium, the transfer of electricity is always in the same direction as the transfer of heat; that is, the edge which is raised in potential is also raised in temperature. In bismuth, the reverse is the case, the heat and electricity being transferred in opposite directions. Thus, the edge which is warmed by the Leduc effect has its potential lowered by the simultaneous Nernst effect.

[M. G. LLOYD, *Am. Jour. Science*, July, 1901.]

*Aluminium Cell Rectifiers.*—C. Pollak has told us that it is not practicable to put aluminium cells in series when used as rectifiers of alternate currents, on account of unavoidable inequalities of the aluminium plates, which require different quantities of electricity for their preparation, and lose differently when in open circuit. This objection can be removed by

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connecting suitable resistances in parallel with the voltameters which lose least, so as to equalise the quantities of electricity required for each element.

[C. POLLAK, *Comptes Rendus*, July 8, 1901.]

*Spectrum of Induced Alternate-Current Discharge.*—The "flame discharge" produced by Spottiswcode by means of an alternate-current consuming 5 H.P., and transformed to some 120,000 volts, shows some peculiar spectroscopic properties which have recently been studied by A. W. Wright and E. S. Downs. The discharge consists of a light nebulous flame of a whitish colour, with a slight tinge of yellow or green, rising gradually from the horizontal terminals and meeting at the centre, where the colour changes to a reddish hue. Besides a number of lines extending from 6,127 to 6,269, photographed by means of plates stained with erythrosine, the authors observed some 60 lines comprised between wave lengths 3,063 and 3,134 in the ultra-violet. These lines are the same whether the electrodes are copper or platinum, and therefore they must belong to some gas or gaseous combination within the spark-gap. A jet of steam blown through the flame greatly enhances the brightness of the lines. The authors, however, consider that they are not solely due to water vapour, but rather to combinations of gases, such as oxides of nitrogen, facilitated by its presence.

[WRIGHT and DOWNS, *Am. Jour. Science*, July, 1901.]

*New Solution for the Copper Voltameter.*—The importance of the convenient and accurate method of measuring electric currents by the voltameter depends very largely upon the construction of a voltameter which admits of high current-densities. As ordinarily used, the copper voltameter is subject to irregularities due to the solvent effect of the solution in some cases and the oxidation of the copper in others. W. K. Shepard has found a voltameter solution which avoids these irregularities. It is prepared as follows:—A saturated solution of copper sulphate is boiled for a short time to expel the air, and then kept at 100°C. for about an hour in contact with metallic copper in order to neutralise the solution. The density is then about 1·20. A very small amount of $NH_4Cl$ is added, about 0·05 per cent. The weight of copper deposited is practically independent of the temperature between 20deg. and 40deg. The results are independent of the current density up to 0·07 amperes per square centimetre. The solution may be used a large number of times. The solution may be used with a current density two or three times as great as that permissible with others commonly in use, thus allowing the use of a smaller voltameter. Instruments may be calibrated to within 0·1 per cent.

[W. K. SHEPARD, *Am. Jour. Science*, July, 1901.]

## ELECTRO-CHEMICAL INDUSTRY.*

The nineteenth century will be for ever memorable for the great scientific discoveries it produced, and the wonderful development that took place during its progress in the applications of science to industrial uses in relation to chemistry and electricity.

Considering the importance of the subject, it seems to me a fitting occasion for passing in brief review the leading events of the century in connection with the rise and progress of electro-chemistry, and for considering its present position and prospects.

The birth of the century was heralded by signs and wonders; the whole horizon of chemical physics was aglow with the light of Volta's great discovery and the constellation of brilliant discoveries it gave rise to. It was in that outburst of new light that the history of electro-chemistry began.

The idea of the correlation of electricity and the energy that determines chemical action was then for the first time grasped; and the prescience of great minds, like that of Davy, led even to an anticipation of that then far-distant result, the utilisation of electricity as an operative force in chemical industry.†

But the light of that morning glory did not rapidly grow into noonday clearness. Much had to be done before industrial electro-chemistry was possible.

In the first decade the marvellous analytic power of electricity was fully realised, and the idea was generally accepted that electricity was probably of the nature of the force that controls chemical combination. We also then became familiar with those heat-producing effects of the electric current that have only within the lifetime of our society been turned to practical use. The three succeeding decades show no sensational discovery such as made the first decade conspicuous, but they yielded an immense product, not only of new knowledge, but many indispensable extensions and developments of what had already been partly attained; above all, they produced the work of Faraday, who mapped out and gave a code of laws to the new domain. So far all the work done was preparatory and scientific, and inspired by the pure and noble aim of the man of science who seeks truth and new knowledge for its own sake. But on the near approach of the fifth decade the eyes of men of different ideas—practical men—were opened to the advantages of employing the hitherto useless power, electricity, to reach new and useful ends. We all know that the first outcome of this recognition was the origin of that small department of electro-chemical industry to which Smee gave the apt name of electro-metallurgy. So long as this name applied only to the humble but beautiful art of electrotype, and electro-gilding and plating, it seemed pretentious. Smee felt the objection, answered it, and in doing so predicted with rare foresight the future expansion of this field. But, much as he foresaw, it was only the fringe of the wide territory that has since been added.

Faraday had lately discovered and laid down with great exactness most of the governing laws of electro-chemical action—a work of infinite value, essential to progress. But our debt to Faraday, measureless as it was from that great service alone, was further increased by his discovery of magneto electricity, whereby there was brought within reach a more economical means of generating electricity by the electro-magnetic transformation of motive power. By the employment of this fundamental principle, all the wonderful developments of the use of electricity that we see to-day have been rendered possible.

Historical relics are always interesting, and I feel sure many of you who may visit the exhibition, will look with interest on one of the exhibits of Messrs. Walker and Hall—an ancient magneto-electric machine used long ago for depositing silver. It is a progenitor of the dynamo, that to-day is an essential means of supplying all the great cities of the world with electric light, of working railways, propelling cars through the streets and under them, and of performing a great amount of electro-chemical work.

It is a singular coincidence that the discovery of the magneto-dynamic mode of generating electricity occurred almost at the very moment when several other discoveries and inventions were made which presently called for the assistance of cheaply produced electricity. One of these inventions was submarine telegraphy, with its requirement of large quantities of the purest copper. As I have said, it was in connection with electrotype and electro-plating that the first industrial application of power-generated electricity was made, and it is equally illustrative of the reciprocal action of demand and supply that the demand for pure copper, arising out of the use of copper wire for submarine telegraph lines, gave rise to the first large and improved mechanical generators, like those of Wilde. When other and yet larger uses for electricity developed, the electrical engineer discovered his vocation, and, by gradual steps, there was evolved that triumph of science, the modern dynamo.

But several striking events in the development of electro-chemical industry had taken place before that evolutionary process was fully accomplished. I go back to the time of our last meeting in this city 13 years ago; it is a most interesting point of departure. In that year, 1888, those responsible for the publication of the *Journal* of the Society first paid to electro-chemical industry the homage of sectional recognition; then, for the first time, there appeared in the *Journal*, under the heading, "Journal and Patent Literature, Section XI."—"Electro-Chemistry and Metallurgy." It is a tribute due to the editor and his colleagues to say that they hit the true psychological moment. Before that time electro-chemical industries certainly existed and flourished—notably electrolytic copper refining—but it is since then that they have grown in number and variety, to a degree of importance which now requires the most respectful consideration of all who are interested in chemical industrial progress.

Electro-chemical industry depends on the production of chemical effects in a new way; sometimes the effects themselves are new, and not otherwise producible, and in other cases the results are merely improvements on old chemical methods, either in respect of economy or superiority of the product, or both.

Electrotype and electro gilding belong to the first class; the results are unique, and constitute valuable additions to the resources of industry and art. Electrolytic copper refining is so great an improvement on the old method, both in point of economy and superiority of product, as to have largely supplanted it, and, incidentally, to have

* Abstract of the presidential address delivered by J. W. Swan, F.R.S., before the Society of Chemical Industry at Glasgow on July 24th.

† In the Bakerian lecture of 1806 Davy says:—"It is not improbable that the electric decomposition of netural salts, in different cases, may admit of economical uses."

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sensibly raised the value of commercial copper as an electrical conductor.

In another department of electro-chemical industry, the manufactures of calcium carbide, of carborundum, and artificial graphite (all new products) have attained large proportions. These depend, as industrial processes, wholly on the high-temperature effects economically obtainable only by means of the electric furnace.

The aluminium and sodium industries have developed into their present large dimensions, solely in consequence of the much greater economy of production of these metals by electrolysis than was ever attained by the old chemical processes. These are a few typical examples of electro-chemical industries, and illustrate the causes of their existence.

In reviewing the salient points of the different sections of electro-chemical industry, I propose first to speak of the electrolytic group of industries, and afterwards of that newer group in which, not electrolytic action, but the extremely high temperature obtained by the electric furnace is the operative agent. Outside these groups there is a miscellaneous group to which I must also briefly refer.

Prof. Chandler, in his most interesting and valuable presidential address of last year, gave a large amount of information relating to the progress of electro-chemical industries in America. I shall not repeat what he said, but confine my remarks almost entirely to the developments to be found on this side of the Atlantic.

I have attempted—with, I confess, imperfect success—to obtain authentic information concerning the present position of the electro-chemical and electro-metallurgical industries. I have been in communication with every firm I knew of in Europe applying electricity to the manufacture of chemical and metallurgical products. When I inform you that these firms now number over 150 you will recognise that this new field is being extensively cultivated. The information obtained in answer to a circular letter, issued through the medium of Mr. John B. C. Kershaw, whose valuable assistance I here desire to acknowledge, has been tabulated, and is presented as an appendix. I take this opportunity of also thanking those firms who have placed at my disposal all the information asked, and thus assisted me to the utmost. In many cases figures have been given with the understanding that they shall not be published; hence there are many gaps in my tables. In a number of instances, however, manufacturers have declined to give any information whatever. Of this reticence I make no complaint, for I recognise that is is only natural that those who have acted as pioneers in a new industry and worked out new processes should desire to reap to the full the fruits of their labour. At the same time I cannot but regret that, in consequence, the picture I have to present to you will here and there be wanting in some of the detail that otherwise I should have been glad to have been able to supply.

## The Present Developments.*

### *Copper Refining.*

The refining of copper is the most important electro-chemical industry. Over one-half of the copper output of the world is now refined by electrolytic methods, and in 1900 it has been estimated that America refined 172,000 tons and Europe 37,000 tons raw copper in this way. The European output of electrolytic copper, however, seems to be declining.

The advantages offered by the electrolytic method are many, and the power required is a comparatively unimportant item in the total cost of the process. Electrolytic copper refining is, therefore, an industry that can be carried on profitably in countries deficient in water power but rich in coal.

The saving effected by the substitution of electrolytic copper for the ordinary furnace product, and by the recovery of the gold and silver contained in the crude metal, is estimated to amount to £1,500,000 per annum on the present estimated consumption of 300,000 tons per annum for electrical purposes.

The Elmore, Dumoulin, and Cowper-Coles processes have been invented to avoid the losses due to casting and rolling electrolytic copper into sheet, tube or other form. The means taken to obtain smooth and dense deposits in these processes differ, but are all of them mechanical. Experiments made some years ago in my own laboratory prove that dense and smooth deposits can also be obtained by use of a minute amount of gelatine (1 part in 30,000,000 parts of the copper solution) in the electrolyte, and that the rate of deposition can be enormously increased without injury to the physical characteristics of the product by careful attention to the temperature, concentration and circulation of the electrolyte in the cell.

The details given in Table I. of the appendix show that nine European refineries in 1900 produced 18,962 tons copper.

### *Bullion Refining.*

Refineries for gold, silver, and platinum alloys, are in operation at Frankfort, Pforzheim, and Hamburg.

Table II. in the appendix shows that the Frankfort refinery produced 261,312oz. gold and 7,186,000oz. silver in 1900.

Figures have also been received for the output of the Hamburg refinery in 1900, but these may not be separately published.

### *Aluminium.*

The Hall and Héroult processes for extracting aluminium from its oxide are practically identical. Since their introduction in 1890 aluminium has been reduced in price from 16s. to 1s. 3d. per pound.

The chief outlet for the metal produced in Europe at present is in the iron and steel foundry. Other uses are, as a substitute for copper in electrical work, as a substitute for brass and similar alloys in the manufacture of scientific instruments and ornamental articles of various kinds, and its employment for production of high temperatures and for reduction of refractory oxides by the Goldschmidt-Vautin process. Table III. in the appendix shows that the six European aluminium works have 33,500 H.P. available for the manufacture of the metal, and that their output in 1900 was estimated at 4,000 tons.

### *Zinc, Copper and Nickel Extraction Processes.*

Zinc ores have been the subject of numberless experiments in the past, but commercially most of these have ended in failure. The Hoepfner zinc extraction process is, however, operating at Winnington, while the Swinburne-Ashcroft process is still in the experimental stage of its development.

As regards nickel, the Hoepfner process is in industrial use at Papenburg, and in 1900 was producing nickel at the rate of 1 ton per day.

### *Electrolytic Alkali and Chlorine Industry.*

The processes for decomposing common salt by electrolysis are theoretically "beautifully simple and complete," but are beset with difficulties when worked upon an industrial scale. The fusion processes have not yet overcome the obstacles to successful working, though two of these have been tried on an industrial scale—namely, those of Hulin and Ackers.

Greater success has attended the use of aqueous solutions, and the electrolysis of brine has attained the rank of a stable and successful industry. The Castner-Kellner and the Solvay are the two most satisfactory forms of mercury cell, while the Hargreaves-Bird, Outhenin Chalandre, and Le Sueur, are types of diaphragm cell in actual industrial use.

At Weston Point 4,000 H.P. is utilised in this industry without causing any nuisance by smoke or escaped gases. A recent visit to Middlewich showed that two sets of Hargreaves-Bird cells were in operation, and were utilising 220kw. to 240kw. electrical energy.

The information contained in Table V. of the appendix shows that six electrolytic alkali works in 1900 produced 12,000 tons caustic soda and 26,000 tons bleaching powder.

### *Organic Products.*

The following is a list of organic chemicals that have been made by electrolytic methods in the laboratory:—Iodoform, vanillin, chloral, azo and hydrazo compounds, oxidation products of fusel oil, dyes of triphenylmethane type, aniline blue and aniline black, Hofmann violet, alizarine, Congo red, oxidation products of the alcohols, sulphonic acids, piperidine, dihydrochinoline, benzidine, amidophenol.

The first five of these have been produced commercially in this way. Four of the leading firms in Germany manufacturing organic products are using electrolytic methods. A process for renewing exhausted chromic acid solutions by electrolysis, has been introduced at the works of Meister, Lucius and Brüning.

### *The Fixation of Atmospheric Nitrogen.*

The calculations published by Sir William Crookes in his 1898 British Association address, show that the direct production of nitric acid and of nitrates in the electric arc, may in time become industrially possible.

Recent experimental work by McDougal and Howles shows that Lord Rayleigh's earlier results can be improved upon, and that an increased yield of 34 per cent. is attainable under certain conditions. The subject is therefore worthy the serious attention of chemists.

### *Electric Furnace Products.*

Calcium carbide, carborundum, and artificial graphite are more or less accidental products of the electric furnace.

The manufacture of calcium carbide ranks, after copper refining, as the largest electro-chemical industry. The European output in 1900 is estimated to have been 60,000 tons, while plant exists equal to producing three times this amount. The recent over-production has, however, caused a fall in values, and a large number of carbide works are now shut down. Table VII. in the appendix shows that 13 carbide works in 1900 produced 17,000 tons carbide. The production of new electro-metallurgical products—such as chrome-iron, ferro-silicon, and ferro-titanium, may provide these idle works with a profitable outlet for their power. Chromium and chrome-iron are being made at Essen by the Goldschmidt process, by the Wilson Company in America, and by several of the French electro-metallurgical companies. Ferro-silicon is being produced at Meran in the Austrian Tyrol, and also at a few of the carbide works in France.

* This section of the address has been greatly condensed, as it practically covers the same ground as Mr. Kershaw's articles of January 4 and 11, 1901.

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Scrap iron, quartz, and coke are used as raw materials of the manufacture. The daily yield of each furnace is 1,200kg. The product contains 77·5 per cent. Fe and 21·5 per cent. Si, and costs at Meran £8 per ton. The yield in the electric furnace is 1 ton per 5,000kw. hours.

Ferro-titanium is produced by heating together scrap iron, titaniferous ore, and aluminium in an electric furnace. The latest proposal of this kind is to use the electric arc furnace for production of steel. The Stassano process for direct reduction of iron ores is about to be tried upon an extended scale at Darfo, in northern Italy, and both in Switzerland and Sweden similar processes are shortly to be exploited. Where coal and coke are cheap, these processes are unlikely to prove of economic value. Table VIII. in the appendix shows that over 30,000 H.P. is available, in the works already manufacturing these new alloys.

Phosphorus is another electric furnace product, and as in the case of sodium, it is probable that in a few years the older chemical methods of manufacture will have been supplanted. Phosphorus works operated by electricity exist at Wedne-field, Niagara, Paris, Vernier, and Griesheim.

*Miscellaneous.*

Miscellaneous uses of electricity for chemical purposes are its employment for generating oxygen and hydrogen, for tanning, and for analytical work in the chemical laboratory. The last-named use is extending, and no laboratory can be considered fully equipped until provided with the apparatus and fittings for electrolytic work.

*The Future.*

So far I have spoken of the past and present; allow me now for a few moments to direct your thoughts to the future. We have seen that electricity has revolutionised the process of copper refining, made aluminium one of the common metals, and so far reduced the cost of sodium that new and large uses have been found for it, and dependent industries created. Electricity has successfully invaded the domain of the alkali and chlorine manufacture, and now threatens to encroach on the province of the blast furnace and the Bessemer converter, and to become an increasingly important factor in the reduction and treatment of metals in general. Are these achievements of the last decade of the nineteenth century but the prelude to still greater developments in the century upon which we have just entered, and will electricity become a yet greater power in the chemical and metallurgical processes of the future? This question requires earnest consideration; it involves interests of national importance, for chemical manufactures occupy, and have always occupied, a leading place among the industries of our country.

One of the larger questions brought into view by the prospect of a more extended use of electro-chemical processes, with their immediate dependence on power for the generation of electricity, is that of the position of those countries which possess coal, but do not possess waterfalls. Unfortunately, though we have an abundance of coal, we have very little water in the form available for the economical generation of motive power. Therefore, the question comes home to us whether with coal only we can carry on electro-chemical industries with profit, in competition with the countries which possess a large supply of easily engineered water power.

The question is complicated in many ways. In the first place it is necessary to find what is the cost of power developed by coal, and what the cost of power developed by water. The cost in neither case is uniform; the cost of water power and the cost of power generated by coal both vary exceedingly under different conditions. It is even a fact that water power in some cases (no doubt exceptional cases) is more expensive than the power obtained from gas or steam.

The difference in cost in different circumstances is extremely great. From data gathered from many sources I find that there is one place (it is in Norway) where power is generated at a cost of 20s. per horse-power-year. This cost is chiefly interest on capital expenditure on the works. But, on the other hand, there are cases where water-power costs 10 times, or more than 10 times, this amount. The capital outlay at Lyons has been £84 per H.P. developed, as compared with £3. 9s. 3d. at Vallorbe, in Switzerland. Niagara power is a mean between high and low water-power costs; there the charge to large consumers is at the rate of £1 per electrical horse-power-year.

Difference of cost is equally wide in the case of coal-produced power. I am informed on good authority that there are steam-power plants in operation in the United Kingdom which yield the power at a cost equivalent to £5 per electrical horse-power-year; and certainly there are many where the cost will be twice and even four times that amount.

Such figures are for power generation on a large scale (not less than 1,000 H.P. units), and also, of course, continuously and uniformly delivered. One other essential condition for obtaining a low cost for steam-power is, obviously, low-priced fuel. In the case where the electrical horse-power-year is said not to exceed £5, fuel cost only 4s. 10d. per ton delivered at the boilers.

But, notwithstanding the fact that under extremely favourable conditions electrical energy can be generated from coal at a comparatively low cost, the fact remains that the greater number of electro-chemical and electro-metallurgical plants are operated by water-power, and in Table IX. in the appendix you will find the results of my own inquiries on this point. Summarised, the returns sent to me show that 50 works in Europe have 149,000 H.P. available from water, 16,700 H.P. available from steam, and 250 H.P. from gas.

In considering the bearing of these facts upon the actual position, it is to be borne in mind that the last word has not yet been spoken as to the cost of power developed by coal. Great advances have in recent years been made in the direction of reduction of cost, by improvements in the steam engine, the gas producer, and the gas engine. In the best modern steam engines a heat efficiency of 15 per cent. is obtained. There is great reason for hope that help in the more economical generation of power for electro-chemical work may come from the further development of the gas engine. Already much has been done, both in the improvement of the gas engine and also in providing it with cheap gas. Our honoured past president, Dr. Mond, has made a valuable contribution in this direction.

One of the drawbacks to the employment of gas engines for large operations has been that they were not adapted for large units of power, but now engines of 500 H.P. and even 1,000 H.P. are manufactured, and work with successful results.

Perhaps it is not wholly futile to inquire whether there is any other way of generating the electricity required for electro-chemical operations. The perfection to which dynamo-electric generators have been brought, both mechanically and electrically, is now so high that almost the utmost possible limit of economy in the transformation of power to electricity has been reached. When there is put in comparison with this most convenient and effective means of generating electricity mechanically, the cost of obtaining the same results by the best chemical means now known, the question of displacing the mechanical method of generation by the voltaic method seems almost useless.

The difference is extreme. In comparing the cost of electricity produced by mechanical and chemical means it has been usual to emphasise the difference between the cost of coal and of zinc. But even if the high price of zinc were not a hindrance, and if zinc were as cheap as coal, or if it could be had for nothing, it would still be practically impossible to carry on the electro-chemical industries of the world by means of the voltaic cell as it exists to-day. The cost of the labour and the complication of handling the gigantic cells, and keeping them in operation, would so far exceed the cost of producing electricity as we now produce it, that we should still continue to use the far more convenient water turbine, and steam engine, and dynamo, which yield us such great effects, with comparatively small apparatus, and with very little manual labour.

But that somewhat sweeping statement does not wholly dispose of the question, so far as it applies to the case in which cheap water-power is unobtainable.

We know that the best of our heat engines utilises but a small proportion of the potential energy resident in the fuel it consumes. Hence there is the possibility of a more economical way being found of transforming the heat energy of the fuel into electric energy, possibly even on the voltaic principle. But in order to obtain what is required that principle must be employed in a manner widely different from that hitherto attempted in the so-called carbon-consuming cells, or in any of the forms of cell where the electrolyte is a liquid and the elements are plates that require renewal. I do not pretend to say how it can be done, or that it can be done in any way, but it seems to me that if there is a way in any direction, it is in the direction of a gas-consuming cell. A bold attempt at the solution of the problem in that way was made some years ago by Mond and Langer, when they produced a gas battery, on the principle of Grove's gas battery, that yielded a considerable current in proportion to its size, and consumed nothing but hydrogen and atmospheric oxygen. Unfortunately, since one of the essential materials in its construction was platinum, the apparatus, whatever its other merits, was too costly to be of practical use. There is one other attempt of the kind, which deserves to be remembered in this connection; I refer to the experiments of Kendall and his very ingenious gas cell, with fused glass as the electrolyte and hydrogen and atmospheric oxygen as the source of energy. Here, too, the high price of platinum was an insurmountable bar to its practical utility.

For the present, it is to be feared and realised that electricity cannot be generated in the British Islands by means of coal as cheaply as in those countries where abundant, accessible, and easily engineered water power is available, and hence it is necessary to consider what is best worth doing with the little water power, and the more costly steam power or gas power, at our disposal. Some of the new industries I have been discussing cannot be carried on with profit in our almost water-powerless island. Those industries, I mean, which use a great quantity of power in proportion to the value of the product. An extreme example would be the electric-furnace production of iron and steel, and the alloys of the more refractory metals. Such uses of electricity in this country are, in the present state of things, nearly out of the question. But I trust

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that gas engines in conjunction with cheap gas may ameliorate the situation, and that at no very distant date blast-furnace gases may be generally utilised for power production, in conjunction with some complementary or auxiliary electro-chemical manufacture. We cannot do everything, but it is certain that within the limits of our capacity there is yet ample scope for the profitable exercise of our energies. There are many electro-chemical industries in which the ratio of cost of power to value of product is such that the cost of power, at a rate which we know to be attainable in many of our manufacturing centres, is not prohibitive. We must concentrate our attention on these.

The alkali manufacture is in a state of unstable equilibrium. The electrolysis of brine from a commercial point of view must, under existing circumstances, be considered as a process for the production of chlorine rather than as a process for the production of alkali, because it is only to the extent equivalent to the chlorine required in commerce, either directly or incidentally to chemical operations, that soda can be manufactured by electrolysis as economically as by other means. Electrolytic soda must, therefore, be treated as the by-product, and chlorine as the principal product, of the electrolysis of chloride of sodium.

It is with the Le Blanc process chiefly that it comes into competition, to the extent to which the muriatic acid is used for chlorine generation, and that, of course, is to a very great extent, The scope of the one process is limited by the same disability as the other—viz., the demand for chlorine in some form : and that demand is, according to Dr. Lunge, only about one-eighth part of the demand for the equivalent of soda. But yet that one-eighth is a very large quantity, and within that limit electrolytic production appears to have a fair prospect of commercial success under favourable conditions.

Chemical industry is, almost beyond any other industry, liable to change. Twenty-five years ago we possessed well-nigh a monopoly of the manufacture and export of alkali. The Clyde, the Mersey, and the Tyne were the supply markets of the world for this typical and indispensable chemical product. We well know that that state of things no longer exists. The causes of the transformation are many, and most of them in the natural order of things. Taking a large and liberal view of the subject, they seem to be in the direction of progress, and for the general good ; and yet it is a kind of progress in some respects detrimental to our interests, and not to be contemplated with perfect equanimity. Among what I term natural causes is the spread of knowledge, and especially such knowledge as we are so effectively helping to diffuse, a knowledge how to build, equip, and manage, chemical works. Then, too, there is general increase of wealth abroad, and great development of commercial enterprise. But one of the less satisfactory of the causes of change, from the point of view of the British manufacturer, is that non-natural, that quite artificial, cause—prohibitive tariffs, the force of the principle of boycott. But that is a difficult and many-sided question, which cannot be discussed on this occasion. I mention it because it is necessary to explain, or partly explain, the falling off of our exports in heavy chemicals. And I suggest that probably the want of the open door has been one of the contributing causes.

Then there is the great question of education, in its bearing on the future prosperity of chemical industry, and industry in general. It was refreshing to hear from our late president how thoroughly the advantages of technological teaching, and education of the highest kind, are appreciated in America, and how generously educational institutions are supported.

Speaking in one of the lecture theatres of this great university, which has lately reverberated with the acclamations of the world in honour of its long and splendid services to education, I cannot but congratulate Scotland and the Scottish section of the society on the very advantageous position it occupies in this respect. In England and Ireland we are suffering acutely from dire educational neglect and destitution, and that worst kind of poverty, *insensibility to our deficiencies.*

Our English system of scientific and technical education is not equal to the present needs of the country, seeing how severely we are pressed on every side by the most energetic and intelligent competition. We are giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science, of no great value, though probably good so far as it goes, while we are neglecting to thoroughly educate those upon whose shoulders will soon rest the weight of the management of our great manufacturing industries. In the present state of things a competent knowledge of the science of the business a man is engaged in, as well as an active interest in it, whether it be chemical industry or any other, are essential conditions of any large degree of success in meeting the emergencies of a highly competitive and progressive time. A scientific training of university standard, for our manufacturers and for our technical chiefs, is an absolute necessity. Surely public money cannot be better spent than in providing adequate facilities for the educational equipment of the men of the future, with this essential means of national defence. Our country possesses great stores of mineral wealth, a precious heritage that we are lavishly spending. That gift of nature will certainly not avert, and cannot go far to compensate for, the consequences of neglect of the scientific training necessary to turn our fast-diminishing mineral wealth to the best advantage.

One of the most pressing requirements of the moment, demanded not only in the interest of chemical industry, but in that of our manufacturing industries generally, is *adequate endowment and encouragement of research.* Original scientific research is the fountain head of new knowledge, the vital stimulus of industrial growth, the originator of new industries and sustainer of old. Yet, nationally, in the organisation of our educational and industrial system, we give to scientific research no hospitality—we barely pay it the respect of recognition.

The advances in knowledge, and the consequent revolutionary changes that have taken place in almost every branch of chemical industry during the last hundred years, are probably not greater than those further changes that will be seen at the end of the present century ; for change brought about by scientific discovery grows ever swifter and more sweeping.

But change is in the natural order of things, and so long as it is in harmony with progress and improvement it is to be welcomed—it cannot be resisted. We must prepare to meet it, and we had better meet it on the threshold. But to benefit by it, and to take complete advantage of it, demands the fullest measure of assistance that education, energy and enterprise can unitedly give.

The chief object of our society, when it was founded, was to help the progress of the chemical industries of the country by means of the interchange of technical information, through association of its members and the publication of its journal. It was an educational object, and it has in a large measure been realised. But now, after 20 years, at the beginning of a new decade and a new century, we see that the need of such assistance is no less urgent than at the outset, though happily the means and opportunities of help are greater than ever before. It rests with us to avail ourselves of them.

If, as we enter the darkness of the future, we firmly grasp the guiding hand of science, and with full faith in her leading, follow her with an alert step, we may go on with the full assurance that we shall be lead in the way of prosperity.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Concluded from page 496.*)

A large number of different methods have been employed for determining the electrical refractive index of dielectrics. One of the most simple of these is to employ a Hertz resonator of rectangular form, having spark balls at the centre of one side and a wire attached to the centre of the opposite side, this wire being connected to the secondary terminal of an induction coil. When the coil is set in operation, no sparks would then be found to occur at the spark balls of the resonator, because the electrical oscillations, starting from the point of origin, arrive at the spark balls by two different routes of equal length. If, however, one side of the rectangle is immersed in paraffin, sulphur, or any other dielectric, the equality is broken down and sparking would occur. This sparking can only be stopped by lengthening the opposite side of the rectangle, so as to increase its inductance, and when this is the case the product of inductance and capacity of each side must be equal. Hence, we can deduce the dielectric constant and, therefore, the refractive index of the material in which one side of the rectangle is immersed.

Experiments of this kind made by Prof. J. J. Thomson, to determine the electrical index of refraction of paraffin and sulphur, gave values respectively of 1·35 and 1·7, indicating dielectric constants equal to 1·8 and 2·9. By a similar and more sensitive arrangement Arons and Rubens found the electrical refractive indices of certain substances to be as follows :—

| | | | |
|---|---|---|---|
| Castor oil ..... ..... | 2·05 | Xylol ..... | 1·50 |
| Olive oil ..... | 1·71 | Petroleum ..... | 1·40 |

The values for the electrical refractive index were found to be in fair agreement with the dielectric constants of the same substances, as determined by slow alternations of electric force.

Similar measurements have been made by A. D. Cole, by determining the reduction in wave-length which occurs when the parallel wires of a Lecher arrangement are passed through a trough containing liquid. Cole has measured in this way the electrical refractive index of water and alcohol (*Wied. Ann.* 57, p. 290, 1896). In the first experiment, waves having a wave-length of 300cm. to 600cm. length in air were used. The wave-length in water for the same frequency was about one-ninth part of the above length, the exact ratio being 8·9, which is therefore the exact refractive index of water. This number agrees very well with similar measurements by Drude, using waves of 60cm. in length, which gave the value 8·7 for the electrical refractive index of water. The square of 8·9 is 79·21, which is almost identical with the value of the dielectric constant of water as determined by electrostatic methods, such as that employed

* Cantor Lecture delivered before the Society of Arts, Dec. 17, 1900.



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by Heerwagen. Electrical waves having wave-lengths 209cm. in air have been found to give for alcohol an electrical refractive index of 5·24, and the square of this last number agrees very well with the electrostatic or low frequency determinations of the dielectric constant of alcohol. By employing short electric waves, 5cm. or so in wave-length, Cole was able to measure the electrical refractive indices of water and alcohol by an indirect method. A sheet of zinc, 1mm. thick, is found to reflect the electric ray practically without loss at 45deg, when the electric component is perpendicular to the plane of incidence. Measurements of the reflective power of a water surface at the same incidence (45deg.) show that the reflective power is 71·8 per cent. when the electric component is perpendicular to the plane of incidence, and 52·7 per cent. when the electric component is parallel to the plane of incidence. In this latter case the zinc surface would reflect 92 per cent.

By applying two formulæ due to Fresnel, the index of refraction can be determined from these data. For water, the value deduced was 8·85, for alcohol the electrical refractive index lies between 3·15 and 3·25. Hence, it appears that in the case of alcohol there is a rapid diminution in the refractive index as the wave-length is shortened for 300cm. to 600cm. to 5cm., but for wave-lengths within the above-named range little or no such diminution occurs in the case of water.

The above facts, however, show that in the case of both these fluids there must be considerable anomalous dispersion. It is well known that within the limits of the ordinary visible spectrum a decrease in the wave-length of the refracted light is accompanied by an increase in refractive index in the case of most transparent bodies. For instance, when light passes though water, alcohol, or bisulphide of carbon, the waves which produce the sensation of violet light are shorter in wave-length and have a larger refractive index, and are, therefore, more refracted than those which produce the sensation of red light. But this is not universally the case. Many substances are known, such, for instance, as an alcoholic solution of fuchsine, which possesses anomalous dispersion, and for these substances the red rays are not less refracted than the violet, but the order of the colours in the spectrum is entirely changed. If light is passed through a thin prism formed with the above solution the violet rays are found to be less refracted than the red. This anomalous dispersion always accompanies great local absorption in the spectrum; and, as Kundt has pointed out, wherever there is a strong absorption band in the spectrum the refractive index is abnormally increased below the band and abnormally diminished above the band in going up the spectrum from the red to the violet.

In the case of water the optical refractive index for waves having a wave-length within the limits of the visible spectrum is a number lying between 1·4 and 1·3, a decrease in the refractive index within these limits corresponding to an increase in wave-length. If, however, the incident wave-length is increased in length up to 5cm. or upwards, by employing electrical waves the refractive index rises to a number not far from 8·9, and all experiments show that when using electric waves having wave-lengths between the limits of 6 metres and 6mm., the electrical refractive index of water is a number not far from 8·9. Hence there must be a large fall in refractive index in passing from the frequency $6 \times 10^{10}$, corresponding to waves of 5mm. in length to the frequency of $400 \times 10^{12}$, corresponding to the waves which give rise to red light which have a wave-length of about $\frac{1}{1500}$th of a millimetre. Accordingly it is clear that, in the case of water, there must be a marked anomalous dispersion. This may be connected with the strong absorption band which is known to exist in the case of water in the ultra red spectrum.

For alcohol it has been found that in passing from electric waves having a wave-length of 8 or 9 metres to waves having a wave-length of about 8mm., the electrical refractive index drops from a value of 5 or thereabouts to a value of 2·5. In other words, the refractive index diminishes with the wave-length, hence it is clear that here also there must be anomalous dispersion.

One of the results which has emerged from these investigations is the proof that is afforded by them of the fact that a change in frequency has a very much greater effect upon the electrical refractive index of some substances than others. Thus, as regards ice, it has been shown by M. E. Bouty* that when using low frequency alternations of electric force, the dielectric constant of ice at $-23°$C. and upwards has a value 78·8. Dr. J. Hopkinson and Prof. E. Wilson also made determinations of the same constant, and found that for alternations lying between 10 and 100 a second, the dielectric constant of ice is a number of the order of 80. M. Blondlot (*Comptes Rendus*, Vol. CXIX., 1894, p. 595), using electric waves, has measured the electrical refractive index of ice and found a value of 1·41 for it, corresponding to a dielectric constant 2. The experiments of Dr. Hopkinson and Prof. Wilson showed that the dielectric constant of ice measured with a frequency of a million is a number less than 3·0. Blondlot's value for the electrical refractive index of ice has been confirmed by A. Perrott (*Comptes Rendus*, Vol. CXIX., p. 601, 1894), who found the value of 1·43 of the electrical refractive index. We see, therefore, that for even, comparatively speaking, very moderate frequencies the electrical refractive index of ice falls to a value not far from that of its optical refractive index, whereas over the same range of frequency the electrical refractive index of water still maintains a value 8·9, which is far above the value of its optical refractive index. This and many other similar facts appear to show that when liquid dielectrics of high dielectric constant pass into the solid state these abnormally large values of electrical refractive indices are more easily reduced to an approximation in value to the optical refractive indices by increased frequency than are those of the corresponding liquids.*

As regards glass, Bose has measured the index of refraction of glass for electric waves by a method resembling the optical method of total reflection due to Terquem and Trannin, using electric waves having a frequency of $10^{10}$ or a wave-length of 3cm. By four different methods he found a value for the electrical refractive index of glass close to 2·04; the value of the optical refractive index for the D rays for the same glass was 1·53. The dielectric constant of this glass when determined by static methods would probably have yielded a number not far from 6; the square root of its dielectric constant would probably have been a number lying between 2·5 and 3. Hence the electrical refractive index has a number approximating more closely to the optical refractive index than does the square root of the static dielectric constant.

Leaving out of account questions of the absorption of energy, the facts show then that electric waves travel very much more slowly through dielectrics than through empty space. In the case of water, the velocities in space and water are in the ratio of 9 to 1 for any electric wave-lengths yet produced; whilst for visible light waves the ratio is more nearly 1·3 to 1. We find that for alcohol the wave velocity ratio is 5 to 1 for long electric waves and 2·5 to 1 for the shortest electric waves yet produced; whereas for visible light waves the ratio is only about 1·3 to 1. When, however, we select such substances as paraffin oil, turpentine, many hydrocarbons, liquid oxygen or bodies of simple chemical constitution, we find no such great difference between the velocities of the electrical and light waves of very different wave-length. Then again, it has been shown that very low temperature annuls this difference in the velocity ratios for electric and eye affecting radiation.

An interesting question then presents itself for solution: We ask, why is it that water retards the velocity of non-visible electric waves so much more relatively than it does the velocity of visible light waves if light waves are only electric waves of very high frequency? The answer to this question is found in the variation of dielectric constant with frequency. There are a large number of substances of simple symmetrical chemical constitution such as the liquid gases, paraffins, saturated hydrocarbons, &c., which have all dielectric constants lying in value between 2 and 3, and optical and electrical refractive indices, lying between 1·4, and 1·7, and these values are but little disturbed by any change in frequency varying between zero and billions per second. It would seem as if the *matter* of which these bodies consist merely had the power of about doubling the dielectric constant of empty space or ether without much changing the qualitative characteristics of the dielectric constant of the ether. We have seen that according to Thwing's law the dielectric constant of these bodies is always 2·6 times their density. On the other hand, all bodies, the molecules of which contain those little groups of easily removed atoms which chemists call radicles, such, for instance, as hydroxyl, nitryl, &c., have dielectric constants more or less sensitive to change in frequency according to their temperature. An increase in the frequency generally, but not always, decreases the dielectric constant. Hence, as a rule in these cases, the electric displacement is larger for a given electric force the longer the time during which the force is applied. To elucidate these anomalies I venture to propound the following theory:—

For the sake of argument and brevity let me assume the electronic theory. Start, then, with Dr. Larmor's fundamental conception of the electron as a strain centre in the ether, electrons being either positive or negative. Assume, with him, that atoms are collocations of electrons in stable orbital motion. In a saturated chemical molecule or atom we must then postulate that the positive and negative electrons are equal in number. We may take this to be the case in those chemically inert substances the paraffins and saturated hydrocarbons and other symmetrical atoms or molecules not containing chemical radicles. We must assume that whatever may be the nature of the ether strain which results from an application of electric force it is of such kind that it causes, or tends to cause, a displacement of positive and negative electrons in opposite directions. This displacement is instantaneous and of a purely elastic type, so that whether the force is reversed slowly or rapidly the ratio of the whole electric strain to the electric stress—*i.e.*, the dielectric constant, remains the same. Accordingly, the existence of electric force in a dielectric creates an ether strain and slightly distorts the configuration of the electronic groups which form the material atoms of a dielectric. The elastic reaction to the stress is the same or nearly the same

* *Journ. de Physique*, Vol. I., 1892.

* See Fleming and Dewar, "Note on the Dielectric Constant of Ice and Alcohol at Very Low Temperatures," *Proc.* Roy. Soc., Vol. LXI., pp. 2 and 316.

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whether it is reversed billions per second, as in the case of a ray of light passing through the dielectric, or very slowly, say 100 times per second. For these substances, then, Maxwell's law is fulfilled.

Consider next a substance such as *water*. Chemical arguments lead us to regard the molecule of water as capable of fission or partition into two non-identical masses—viz., H and (HO), which are respectively the semi-molecules of hydrogen and hydroxyl. These masses, when free, constitute the ions of water, and when free carry electric charges. Hence, on the electronic theory they must each be regarded as collocations of electrons, but the H groups or masses contain more positive electrons than negative and the (HO) groups more negative than positive. When united to form the water molecule, the collective mass H (HO) possesses an *electric moment*—that is to say, it is equivalent to a mass having a positive charge on one part and a negative on another. All chemical facts lead us to believe that the union between the O and the H in the semi-molecule of hydroxyl (HO) is far more intimate than the union between the H and the (HO) in water. Accordingly, under the action of electric force the water molecule will be *oriented* in space like a small magnet in a magnetic field. This orientation is equivalent to an additional electric displacement over and above that due to mere strain of the electrons in the molecule or of the ether in the same place. According to the theory here suggested it is this orientation of the molecules which bestows the abnormal value upon the dielectric constant. We have next to explain on this theory why these abnormal values of dielectric constant become normal on lowering the temperature sufficiently. Thermo-dynamic theory seems to indicate that sensible heat is the result of mass movements of molecules. Hence, as the temperature is lowered, the molecular agitation is quieted down and the molecules may unite into larger groups or aggregations. It is then easy to see that these larger groups of molecules will cease to possess an electric moment, just as groups of equal small magnets united pole to pole so as to form closed magnetic circuits cease to possess a magnetic moment as a whole. Accordingly, external electric force can no longer orient these molecular groups; and their power to contribute to augment the normal dielectric constant disappears. Hence, at very low temperatures, if ice consists of molecular aggregates of water molecules, it should have, as in fact it has, a dielectric constant not very different from that value due to a very rapidly reversed electric force when at 0°C., viz., a value lying between 2 and 3. Also, it is easy to see why on this theory high frequency in the electric force reversals leads to the same result as very low temperature.

In the case of the extra high-frequency alternating electric force (billions per second) the inertia of the water or ice molecule prevents it from orienting. The only effect of the electric force is to produce ether strain and strain of the electrons forming the molecule. At very low temperatures the molecules do not orient because they are bound up in groups and have no resultant electric moment. We also find experimentally that for such bodies as water, alcohol, &c., there is a temperature at which the large or abnormal dielectric constant has a maximum value. The decrease of dielectric constant at and above a certain temperature may be explained by the gradual breaking up of water molecules having an electric moment, and therefore capable of being oriented into ions having no electric moment. The gradual increase of conductivity in ice accompanying this dielectric change as it is heated is easily explained in the above theory, because the ions at once move under the electric force, and moving ions constitute electrolytic conduction.

I must not occupy more time in developing this theory at any length, but it seems to me to fit in fairly well with most of the observed facts as regards the influence of temperature and frequency upon the values of the dielectric constants of insulators and electrolytes, and to obtain support from the results of the dielectric measurements at low and increasing temperatures, to which allusion has already been made in a previous lecture. It is a curious fact that the more complicated and heavier molecules, such as those of the alcohols and glycerine, have their normal dielectric constants reduced to smaller and normal values by an increase in the frequency of the alternating impressed electric force not at all sufficient to similarly affect the abnormal dielectric constant of a lighter molecule such as that of water.

To these and many other interesting questions in molecular mechanics we are led by the study of electric waves and their propagation through dielectric materials. In this short course of lectures I have only been able to touch in the most superficial manner upon some of the chief results of scientific investigation in the last 13 years on the properties and production of electric waves. Time has not been found even for mention of the application of these electric waves in space telegraphy without continuous wires. As this latter subject has, however, been so fully expounded by the various discoverers and inventors to whom our advances in it are due, I have preferred rather to turn your thoughts to general principles. If the imperfect explanations to which you have granted your indulgent attention have rendered these underlying scientific principles in any degree to you less obscure, you will find their application to the interpretation of recent practical advances a comparatively simple matter to achieve.

# PARLIAMENTARY INTELLIGENCE.

## LONDON COUNTY COUNCIL TRAMWAY EXTENSIONS.

On July 15, Lord Hatherton's Committee of the House of Lords commenced consideration of the London County Council (Tramways and Street Widenings) Bill. (The proceedings before the House of Commons Committee were given in *The Electrician* for May 10 and 24.)

Mr. FREEMAN (for the bill), explained that the existing tramways of the metropolis had all been planned by different companies, and therefore had not been constructed in the best possible way, and there were a number of gaps between them. It was part of the object of the present bill to authorise the construction of lines to fill in these gaps. The first tram proposed was a short length of double line from the Archway Tavern, Highgate, to the boundary of the County of London, where it would be connected with the extensive system of tramways which were being constructed in Middlesex. Another line was from York-road, Wandsworth, to High-street, Tooting. This piece would connect the whole of the district served with the very heart of the existing tramway system. Other sections would run from a junction with the last-named line to the southern county boundary, where it would join with another line which it was proposed should run towards London from Wimbledon; from Battersea Park-road to the foot of the Albert Bridge, a length of about half a mile; and from Stamford-street to Southwark-street. Against the latter a petition was presented by the South Eastern and Chatham Railway Co., who alleged that the line would interfere with the traffic to and from their goods depot at Blackfriars. One of the principal sections would be 3½ miles long, and, starting from Camberwell Green, by a junction with the existing lines, would run along Denmark-hill, Champion-park, Grove-lane, Dog and Kennel-hill, and Lordship-lane, terminating near Forest Hill railway station. The remaining line of importance commenced by a junction with the last line, and, passing across Peckham Rye, ended at Stewart-road, a length of about a mile. The petitioners against the line were some frontagers, a derelict tramway company (the London, Camberwell and Dulwich Tramways Co.), whose lines had been allowed to get into a very bad state of repair, and who for a lengthy period did not work their lines, and, finally, the borough of Battersea, who required special powers in order to regulate the breaking up of streets, &c. At a recent conference of London local authorities ample protection was given.

Mr. BENN, chairman of the Highways Committee of the London County Council, repeated his evidence before the House of Commons Committee, adding that, in his view, the only way to relieve the congestion of population of London was to let the tramways precede the population rather than follow it.

Mr. BALFOUR BROWNE, K.C.: But if the population does not follow the trams you will have made a bad "spec"?—Our experience is that the population is glad to follow our tramways.

By Mr. HUTCHINSON (for the London, Camberwell, and Dulwich Tramway Co.): This company had certain rights of laying a tramway down Rye-lane, Peckham, but the cost of widening that thoroughfare would prohibit the company laying a line there. The present bill would not take away that right. The company's undertaking had been derelict for 15 months, and was, therefore, a public nuisance. It might be made of public utility if properly worked. Under proper notice by the Borough Council that company could now be removed as a trespasser. By failing to carry out their duties they had seriously damaged the district in the matter of communication. The running of a few trams by the company in the past fortnight had been merely for the purpose of obtaining from the London County Council some concessions which in the public interest could not be conceded.

The CHAIRMAN: What system of electric traction do you propose?—The conduit system.

Sir A. BINNIE repeated the evidence given before the previous committee, adding that in the case of the Camberwell Green-Forest Hill line, it would be impracticable to construct an underground railway because of the nature of the strata.

Mr. ALFRED BAKER, manager of the tramways undertaking of the London County Council, also gave evidence in support of the bill. He denied that the Council's cars would seriously interfere with the traffic entering and leaving Blackfriars goods stations of the South-Eastern and Chatham Railway Co.

By Mr. LAWRENCE (for frontagers): Is the service to be an all-night service?—It is possible, but that is not settled.

Mr. ANDREW YOUNG, valuer to the London County Council, said the net estimate of the cost of street widenings proposed in the bill was £384,900, and the gross estimate £414,130.

Mr. H. L. CRIPPS, parliamentary agent to the London County Council, said if Battersea made a point of having the whole law altered in their favour, because half a mile of tramway was made in their district, he did not know if the London County Council would proceed with the line. With regard to the suggestion of Battersea that the trams could interfere by electrolytic action with their electric lighting mains, he said the whole question of electrolytic action was raised when the clauses of the London County Council bill were discussed in 1900. Those clauses were included also in the present bill.

This closed the case for the bill.

Mr. BALFOUR BROWNE having called evidence for the frontagers,

Mr. MAYER (for Battersea) then handed in clauses which he desired should be inserted in the bill. These clauses embodied proposals regulating the notice to be given by the London County Council to any metropolitan borough council before any interference with a roadway for tramway construction could be proceeded with, or imposing penalties on the London



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County Council for default of giving such notice. On the subject of electrolytic action" the following clause was proposed :—

If it be proved that any injury or damage to any sewer pipe or other metallic pipes, structures, or substances of the council of a metropolitan borough shall have resulted from fusion or electrolytic action caused by any currents generated or used by the London County Council for the purpose of electric traction, nothing in this act or in the London County Tramways (Electrical Power) Act, 1900, shall relieve the council from any liability to make compensation for any such injury or damage which would have existed but for the passing of those acts.

Mr. Mayer said Battersea only asked that they should have the same powers as regards their electric wires as a company would have under the bill with regard to its electric wires. The protective clause of the act of 1870 was incorporated in the present bill, but that only gave power to borough councils to break up the roads for the purposes for which they were then constituted, and did not refer to electric wires. If a person wanted electricity from the Battersea Council, and the Council had to take their wires across the tramway main to supply it, they would not be able to do so. If, however, the supplier of electricity were a company, they would possess that power, and Battersea asked that they should be placed in a similar position. Under clause 15 of the bill, where tramways were altered or constructed, or where roadways were widened, the Battersea Council had the power that they sought, but that power was not given where a new tramway was made.

Mr. CAUDWELL, solicitor and parliamentary agent to Battersea, said the Borough Council would soon be in a position to supply electricity throughout the borough. With regard to the proposed new clauses desired by his Council, it was true sections 4 and 5 between them constituted the code as fixed last year for the protection both of gas and water companies, and also of electrical undertakings. but the protection was not asked for electric lighting undertakings and for sewer authorities, and therefore he thought, as it had not been asked for last year, it was time it was asked for this year.

By Mr. TALBOT (for the London County Council) : But you know the act of last year and of this year covered the whole tramway system of the London County Council with regard to their tramways ?—Yes.

Including in the two both companies and borough councils ?—But I can refer you to things in this act which are not provided for—things of general application which had to be provided for by the act that followed—the act we are now considering.

What you propose is to incorporate the whole of this act in order to give to your borough council, and them alone of all the electrical undertakers in London, the same protection as the gas and water companies had under section 5 ?—No, I propose to give it to all the councils.

Can you explain why you are the only body that comes to ask for some protection under this bill ?—Simply because Battersea looks more carefully into these things than some of the other authorities. In the electric lighting provisional order of Battersea the Council, as electric undertakers, could only break up tramways specified in the order. The tramways now proposed were not specified in that order, and therefore power was sought by the new clauses to break them up where necessary.

Evidence was then called as to the interference with traffic likely to be caused by the proposed line along the Waterloo-road, and some interesting figures as to the immense vehicular traffic in and out of Waterloo Station were produced by Mr. Owens, general manager of the London and South Western Railway.

Mr. PEMBER (for the London and South Western Railway Co.) said the proposal was merely to advance the present terminus of the tramway by 270yds. nearer to Waterloo Bridge, and that the railway company had on three occasions successfully opposed.

After further evidence in opposition to the proposals of the bill had been given,

The CHAIRMAN intimated that the Committee would not sanction the line between Camberwell and Dulwich, the line running along Stamford-street and Southwark-street, or the extension of line in Waterloo-road. They sanctioned the piece of line from the Archway Tavern at Highgate to the county boundary on condition that the Middlesex light railways to meet this line at the county boundary were also authorised.

Mr. TALBOT then urged the Committee not to order the insertion in the bill of the new clauses proposed by Battersea.

The CHAIRMAN (to Mr. Mayer, for Battersea) : Your point is that you want to protect the property you already have.

Mr. MAYER : Unless we have the power, by our inspector, to go underneath their wire (for that is what it comes to), and, further, to supervise when they are constructing. In one moment the whole town of Battersea may be in darkness owing to a crossing of the wires or a connection through the direction of a London County Council official who does not know where our wires are. If the work is done under their orders, subject to our supervision, this cannot occur.

The CHAIRMAN : You should try to agree upon a clause which would avoid what is evidently inconvenient—namely, importing into a tramway bill an electric lighting section.

Mr. MAYER : This is an electric tramway, and there is no distinction between an electric tramway and electric lighting.

Later Mr. FREEMAN (for the promoters) said it had been agreed to modify clause 16 of the bill as follows :—

The Council of the Metropolitan Borough of Battersea, and also any company having power to lay electric lines in any street in which a tramway is to be laid or reconstructed under this Act shall, notwithstanding anything contained in any Act or order relating to such borough or company, be deemed for the purposes of this Act to be a road authority or company respectively to whom section 32 of the Tramways Act, 1870, applies.

That gave Battersea the same powers as the companies had, and it overcame the great difficulty which the County Council foresaw if they accepted anything further, namely, of having different powers for one small length of line as compared to other portions of their system.

The COMMITTEE then sanctioned the line running from the existing trams at Battersea Park-road to the Albert Bridge, and the lines from Lower Tooting along Garratt-lane to Wandsworth.

The bill was then reported for third reading.

## MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

Sir Lewis McIver's Committee resumed, on Friday last, the consideration of Mr. Behr's scheme for an electric railway between Manchester and Liverpool on the monorail system.

Mr. FRANCIS FOX, whose examination was commenced the previous day, said, in his opinion, the proposed Manchester and Liverpool railway would be a sort of glorified Ballybunnion line, which was an engineering as well as a financial failure, and really detrimental to the locality. It was not only noisy but exceedingly uncomfortable and unsafe. He believed the defects of the Ballybunnion line would be repeated. He thought, in fact, that the whole thing would go to pieces. To his mind electric traction could not be applied in the monorail system so as to assist the advance of electrical traction in this country as a scientific principle. He submitted that platelayers would never be able to "pack" under the sleepers of the mono-railway. He did not think it was all-important that there should be a correct centre of gravity in the cars in the proposed railway. The difficulty, rather, was as to the possibility of derailment. He considered that under certain conditions the guide rails would fail to act, and it would be a dangerous thing to depend upon them. There must be perfect adjustment of the guide wheels, and this could not be secured with any certainty. No matter how well the line was made the evils of sinuosity could not be overcome.

Mr. W. P. O'NEILL, C.E., chief engineer to the Midland Great Western Railway of Ireland, said he had first made the acquaintance of the monorail line in 1898 in connection with the Listowel and Ballybunnion railway. He investigated the merits of that system, and came to the conclusion that it was impracticable. The oscillation and noise in the cars was enormous, but the main difficulty was due to subsidence of the permanent way, which would lead to "kinking" of the monorail. The "kinks" would become permanent, and of course it would be impossible to run over the line at high speed. He did not believe that the mono-railway could ever run at 110 miles an hour. There was no doubt in his mind that a very much higher speed could be attained on the bi-rail than on the monorail system if a sufficient amount of money were expended on the permanent way and the rolling stock. The Ballybunnion railway spent 90 per cent. of its receipts in working expenses.

By the CHAIRMAN : The train would be safer with no flanges to the mono-wheel than with flanges, and more comfortable with springs than without them, although more dangerous.

Then to your mind the passengers' choice is between death and discomfort ?—Yes.

Mr. J. BARTON, C.E., said he had laid down many hundred miles of railway in Ireland, and had studied the proposed monorail system. There were half-a-dozen dangers which could be explained in a simple way, though he was sure there were a great many more. [Witness, by means of plans and sketches, described the dangers he anticipated.] The dangers were the action of centrifugal and storm pressure, the bolts oxidising under tension of the trestles and leaving the sleepers, faulty design of the trestles, and expansion and contraction of the rails—a considerable source of danger on all railways. The fifth cause of danger would be the tendency for the rails when expanded to be pushed through the chairs on the top of the trestle. The rigidity of the structure would be interfered with and the trestle forced out of the perpendicular. The sixth danger was that of the breaking of one of the eight chains which it was proposed to use for the transmission of power to the driving wheel. The mono-railway should not be sanctioned until it was proved by experience that it could be worked with safety.

By Mr. FITZGERALD, K.C. : Your name, Mr. Barton, I believe, is associated with the scheme for a channel tunnel between England and Ireland. On what experience will you proceed ?—In that case you must work out your own experience.

Mr. FITZGERALD said, inasmuch as the dangers put forward by Mr. Barton was new evidence, as it was supposed to be demonstrated from plans and diagrams, it was impossible for him to cross-examine upon it. He therefore asked that Mr. Cooper, the promoter's engineer, be called.

The Committe agreed to this course.

On Monday, Mr. R. E. COOPER, joint engineer with Mr. Behr for the promoters, was re-called and examined regarding the alleged dangers of the monorail to which reference had been made by Mr. J. Barton. As to the suggestion that the car might turn over on its axis, he held that even in the extreme case of the centrifugal and wind forces both acting on one side of the car, there would only be a sliding, and not an overturning pressure on the car. There would be no possibility of derailment through the guide-wheels being provided with springs. The effect of the centrifugal force would be eliminated to a very considerable extent, wherever there were curves in the line, by the tilting of the sleepers, which would facilitate the passage round the curve of the car, conduce to the convenience of passengers, and save the pull upon the bolts of the guide rail. The strain upon the trestles would never cause danger ; and he had made such allowances for the expansion or contraction of the rails owing to temperature as would obviate danger. With reference to the possibility of the chain breaking, he agreed that if a break occurred the chain would fly, but no danger would result, because the chain would fall into the case, and so be inoperative.

On the subject of maintenance, the CHAIRMAN said the Committee were aware that there were special circumstances which made the work of

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maintenance impossible while trains were running on this line, and no further evidence on this subject need be given.

Mr. J. A. ROSS, chief engineer of the Great Northern Railway, in answer to the Chairman, said: As the promoters would only be able to repair the line between midnight and 6 a.m., there would be considerable risk of the work not being done effectively. There was danger on the curves that the sleepers might sink; that would involve risk to the train.

Mr. CHARLES ROWLANDSON, engineer of the Great Central Railway Co., said maintenance work could not be efficiently executed between midnight and 6 a.m. Platelayers patrolled ordinary railway lines and frequently discovered broken rails; on this line, while such breakages would be most difficult to discover, if they remained undiscovered there would be great danger. The structure of the mono-railway was inconvenient for replacing a rail; and on such a line there would be much more wear and tear of nuts and bolts than on an ordinary railway. Malicious placing of obstacles on railways was common, and if a piece of iron, say, were placed on the proposed line it might wreck the train.

Sir DOUGLAS FOX said as to the competition which might be anticipated by the Cheshire Lines Committee if the proposed railway were established, to his knowledge no railway which had received Parliamentary sanction ran for 13 miles alongside another railway for purposes of competition. The Cheshire Lines Committee's railway would be most seriously interfered with by the new railway, especially at the Liverpool end. The mono-railway would be constructed over certain mosses, or peat land, which would be a matter of great difficulty. If a person could travel to London from Manchester in two hours, the experiment might be worth trying; but considering the time saved between Manchester and Liverpool would be so little, the scheme would not be worth undertaking. He could not conceive wherein lay the advantage of raising the rail some feet above mother earth, the best support such a line could have. The machinery was much too complicated for practical purposes. He could speak from long experience as to the possibility of the breakage of the chain, which he considered a most dangerous factor. In the old days, people sitting over the wheel were frequently killed when the tyre of the wheel broke. He believed the casing could not be made strong enough to restrain the chain, if it broke, from getting loose and flying about.

Prof. CARUS WILSON considered that the curves were too short for the high speed proposed. A car would not be able to stop in a shorter distance than a mile, and the rapid retardation which would be necessary to bring about a stoppage would occasion great discomfort to the passengers.

Prof. S. H. SHORT referred to the danger which would occur through the possible kinking of the line, and the consequent liability to derailment. Mr. Behr had mentioned that in order to obtain certain results the cars were to be constructed of aluminium, and Mr. Behr had indicated the name of the firm from which the metal was to be obtained. Witness had secured a specimen of this metal, which he found consisted of aluminium and magnesium. It was an exceedingly brittle substance. [Witness illustrated this by producing a bar of it and snapping it in two across his knee]. He had described the scheme as visionary and impracticable. He considered Mr. Parshall's motor was not large enough. It was badly designed, and it had faults which were now abandoned by every manufacturer. It would not do the work it was intended to do. He did not know that Mr. Parshall had designed the motors of the Central London Railway.

By the CHAIRMAN: His contention was that on neither of the cars could a sufficient motor be fitted.

By Mr. FITZGERALD: For the purpose of suggesting that Mr. Parshall's motor is not sufficient you have taken a different motor and put it, not on Mr. Parshall's car, but on another car?—I put it on to Mr. Behr's last car, which was submitted here as his final 39-ton car.

What horse-power have you taken for the motor as large enough to do the work?—250 H.P., railway rating.

That is nominal?—Well, nominal is a term which can hardly be applied. Some engineers call it nominal, some do not. A motor which would give 140 H.P. all day without heating would be sufficient for the work required of it on this line, but with railway rating the horse-power must be double that mentioned. The car was badly designed, and when running at 110 miles an hour round a 30-chain curve, even with a body weighing not more than 1 ton, it would not last. It would be stronger and lighter if made of wood than if made of aluminium. If the car was made of the aluminium Mr. Behr had produced it would bend over and take a permanent set on one side which would be worse than breaking. The weight on each pair of tressels of the monorail would be 20 tons, not 4½ tons as was suggested. The hammer blow at the end of the rail as the train travelled would increase the pressure on the rail to 300 tons, which would be sufficient to cause depression in the rail. The motor shown by Mr. Parshall in a drawing would give 125 H.P., motor rating, or 62 H.P., continuous rating. That would be very much smaller than would be necessary to attain the acceleration on the line which must be attained if the journey was to be performed in the time stated. Mr. Behr had shown another drawing of a motor the capacity of which would be 130 H.P. or 140 H.P., motor rating. That also would not be sufficient to give the requisite acceleration. A motor which would be sufficient to give the necessary acceleration could not be fitted on the latest car suggested by the promoters. The hammer action of the wheels of an ordinary train was the common cause of trouble with the rails of an ordinary railway, and it would also operate on the monorail, the same result occurring in each case—viz., that the rail on which the car ran would not retain its position.

By the COMMITTEE: In the car proposed it would not be possible to place a motor which would develop 140 H.P. continuously, and without heating.

Mr. STEEL, Manager of the Great Northern Railway Co. said there was no indication of any requirement which would justify the construction of another line of railway between Manchester and Liverpool. Even if the monorail fulfilled every claim made on its behalf it would not be the means of revolutionising the railway system between the two cities. The line could not be made a commercial success even if it carried many more passengers than were at present carried between Liverpool and Manchester by the three railways at present engaged in the service. He did not like Mr. Behr's system, and his company would not adopt it. He agreed that there was a feeling in some quarters in favour of a higher speed than was attained at present, but he was not in sympathy with it. There was no movement in favour of high speed.

Yesterday Mr. SHAW (for the Lancashire and Yorkshire Railway Co.) said his clients had spent large sums of money for working and developing the traffic between Liverpool and Manchester. Electric traction had nothing specially to do with the proposed new line. Electric traction had been discussed all over the world, and whether it was applied to this system or to the bi-rail lines there was no doubt that it was coming. The adoption of the suggested system would introduce new elements of danger which were not connected with the double-rail lines. The only reason for the use of the trestle was to get round curves, and, therefore, the question reduced itself to getting round certain curves at certain speeds with safety. But apparently even the promoters had not much confidence in their system in this respect, because their greatest curve was 30 chains, which was a curve often safely negotiated by trains on the ordinary railway lines at a high speed. As to speed, they had it in evidence that the maximum speed on ordinary railways was by no means 60 or 65 miles an hour.

Mr. LITTLER, (for the London and North Western Railway Co. and the Cheshire Lines Committee) said this monorail system did not commend itself because it was complicated, depending on eight connections, three for the electricity and five for the carrying of the line. Mr. Behr years ago set up a railway on this system on some vacant land in Westminster, but after exhibiting it for a year there was not an engineer who saw it who did not ridicule it as cumbrous, impracticable and retrograde. This system was 70 years old, yet it was as helpless a babe as when it was six months old. Surely that was sufficient to make them pause. The line was to be placed in a locality where there was the best railway service, not only in Great Britain but in the whole world, there being 180 trains daily between the two places, each of which was only about one-third full. This was not the right way of applying electricity. It was not a hopeful method, and it was a method which would not ensure the same speed as would be obtained if electricity were applied to an ordinary railway.

Mr. BALFOUR BROWNE, replying on the whole case, said that no train could be run on the monorail until the Board of Trade had certified its safety. Everybody agreed that high-speed railways were required, that electricity was essential for them, and that high speed could not be obtained on curves or the ordinary bi-rail. Straight lines were not possible in English electricity schemes, and the monorail was the only system that could be employed for such high speeds on curves. As to the danger in connection with the brakes, everything could be done on the monorail that could be done on the bi-rail. The monorail system was eminently simple, one element of safety being that on it there would be no intermixing of fast and slow trains and no shunting. He was prepared to provide that there should be at least 30in. between two passing trains. The inspection of the line would be more simple than in the case of a bi-rail line. Replying to the Chairman the learned counsel said he had always held that it should be a feature of the scheme that the centre of gravity should be below the line, and he would pledge the promoters that the centre should be at least 12in. below.

On the conclusion of counsel's speech the Committee adjourned.

## LOWESTOFT CORPORATION TRAMWAYS BILL.

On Tuesday the Special Committee of the House of Commons presided over by Sir Frederick Goodson considered this bill, which seeks powers to construct tramways, make street improvements, for the provision of electric lighting and other purposes.

Mr. FREEMAN, K.C. (for the bill), said there was only one opponent to the measure, and that related to the tramways. Lowestoft a town of 30,000 inhabitants, was incorporated as a borough in 1885, and had taken over the electric lighting of the borough. The only means of communication between the two ends of the town was by what were locally known as "jingles,"—a small vehicle—an inconvenient mode of progression. This, and the requirements of the Corporation's electricity undertaking for a day load had led to a desire for electric tramways. In 1899 a company applied for powers to construct a tramway from Yarmouth to Kessingland, Lowestoft being in the middle of the route. That was opposed by the Great Eastern Railway Co. on the ground of competition, and a part of the scheme was disallowed and a part sanctioned. Negotiations took place between the Corporation and the company, and an arrangement was come to by which the company agreed to withdraw their application for the confirmation of a light railway order, and enabling the Corporation to apply to Parliament for power to construct a tramway between the borough boundaries. The estimated cost was £60,000. He contended that the tramways were required, and that they would prove remunerative.

Mr. R. B. NICHOLSON, town clerk, said the arrangement the Corporation had come to was to lease the tramways to a company, the latter to take electric current from the Corporation. A ratepayers' meeting had given the Corporation power to promote this bill. There was no opposition at the meeting to the tramways, but a number of people objected to the Corporation leasing the tramways to a company instead of working them themselves. The debt of the borough was £106,000, and of that £35,000 was for the electric lighting undertaking. For a long time there had been a great need for an improved vehicular service along by the sea. He could not say what was the capital of the company to whom the Corporation proposed to lease the tramways.

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Mr. W. BEER, C.E., engineer for the bill, said the proposed tramways would be 7¼ miles in length. The gauge would be the same as that of the East Anglian Light Railway Co., so that there might be a continuous run from one to the other. It would be a single line, with frequent passing places.

Mr. J. E. WALLER, C.E., said, in his opinion, Lowestoft was a town which would prove remunerative for tramways. He did not know of any electric tramway that had not been a success. The working expenses at Lowestoft he put at 5½d. per mile.

Other evidence for and against the bill having been presented,

The Committee found the preamble proved, and ordered the bill to be reported for second reading.

## LOCH LEVEN WATER POWER BILL.

Sir J. Kitson presided on July 17 over a Select Committee of the House of Commons to consider the bill promoted by the British Aluminium Co. (representing the North British Water Power Co.) seeking the right to take power from the waters of Loch Eilde Mor and Blackwater, near Loch Leven, Ballachulish, for the generation of electric current.

Mr. LITTLER, K.C. (for the promoters), said a good deal of industry had left this country, and would probably continue to do so unless some cheaper power than steam was discovered. The difference between water power and steam power was that some products could be manufactured by means of the former, at prices from £20 to £5 a ton less than by the latter. The public advantage of this scheme was the establishment of a great industry at the foot of the hill at the eastern side of Loch Leven. So long ago as 1894 those who were mainly interested in the British Aluminium Co. had their eyes on this particular source of supply. They had been the pioneers in this matter in Scotland. A great deal of opposition and a great deal of newspaper abuse was showered on the promoters of the Falls of Foyers scheme because it was said that they were interfering with the beauties of Nature. But when industries which might have been developed in this country had been developed in connection with the Niagara Falls, and endangered the beauty of Niagara, it was reasonable that they should have some regard for the prosperity of the country. The experiment at the Falls of Foyers had been eminently successful. The British Aluminium Co. had a capital of £700,000 and it had established a very important industry. They were not taking any of the water from the eastern watershed, and indeed, the water they proposed to use ran to waste at present. The bill was supported by every public interest, and the objections of petitioners were covered by the Land Clauses Act. The land proposed to be taken was 170 acres out of a total area of 40,000 acres, and the electric power it was intended to generate was 18,000 H.P., compared with 40,000 H P. under the bill which Parliament rejected two years ago.

Mr. ROGER WALLACE, K.C., witness for the promoters, said he was chairman of the British Aluminium Co., and this scheme had been before them since 1894. At Foyers the power they utilised was 7,000 H.P. out of a possible 12,000 H.P. The company were making carbide of calcium, and were also carrying on experiments in other directions for the use of electrical power for making chemicals and certain metals. The monthly wages bill at Foyers was £1,000. The company were experimenting in the manufacture of iodine, an industry that might be revived in the Highlands with very great benefit to that part of the country. Soda and sodium and such like chemicals were already being made, but the great use of the water power would be for making metals such as magnesium and silica for use in the steel trade. Finally, iron itself would be smelted by electric power. This was not merely a commercial speculation. It was a good thing for the country at large, and he did not think Lord Kelvin would have been connected with it if it were simply a commercial speculation. It was not the case that the unexhausted 5,000 H.P. at Foyers was due to lack of demand. It was intended to raise a new company. The British Aluminium Co. were the backers of this scheme, and had powers for raising capital.

Mr. F. G. WORTH, managing director of the Acetylene Illuminating Co., said carbide of calcium was practically not a commercial article before water-power was available to generate electric power for its manufacture. The carbide that was made abroad and imported into this country might easily be made here, but if they could not get additional water power in the United Kingdom they would have to go abroad. They could take 5,000 H.P. out of the 18,000 H P. provided for at Loch Leven under the bill.

Mr. ALBRIGHT (Messrs. Albright and Wilson) said the manufacture of chlorate of potash was an example of the industries that had left this country because of the want of cheap electric power. When the Highland Power Bill was being promoted the negotiations his firm had with the company showed that the price of electric power under that bill would work out at about 15d. per unit.

Lord KELVIN said great efforts had been made to find water power in this country, but no great amount was available in this country or in Ireland. The advantage of the Loch Leven scheme was the ready access that could be obtained to the sea. In this respect the site was preferable to that at Foyers. Cheap water carriage was very important to industries in which electric power was employed, both in respect of bringing material and carrying away products. The aluminium industry had been injuriously affected by competition abroad, but the metal produced in Switzerland was no cheaper than that produced at Foyers. Before the development of water-power at Niagara and the supply of electric energy, a great number of electrical and chemical industries which had now sprung up were altogether in the air. At Foyers the British Aluminium Co. wished to expend all their energy on making aluminium.

Mr. W. V. GRAHAM, joint engineer of the scheme with Mr. G. Anderson, said he was engineer of the Foyers scheme, and resident engineer at Foyers. The estimated expenditure on these works was made up of:—Reservoirs and dams £212,500, aqueducts £76,500, bridges £9,380, pipe lines £37,500, tail race £2,000, turbines and spare turbines £13,500, buildings £10,000, roads £1,000, pier and dredging £6,000, contingencies (10 per cent.) £36,838—total £405,218, and for lands £81,000, making a total cost in connection with the hydraulic works of £486,218. The electric plant would cost £79,500, making £565,718, to which would be added £9,882 for expenses in obtaining the act, &c.

After the opponents to the bill had been heard,

The Committee declared the preamble of the bill proved.

## FACTORIES AND WORKSHOPS BILL.

Before the Grand Committee on Trade, which is considering the Factories and Workshops Acts Amendment Bill, a proposal was made to include in the bill premises in the occupation of the Postmaster-General.

Mr. C. T. RITCHIE (Home Secretary) opposed the motion on the ground of its far-reaching character and the great inconvenience which would be caused if such a proposal were adopted. At the same time the Postmaster-General would do all possible to bring all the premises in the occupation of the department into good sanitary condition, and otherwise as far as possible on a line with the provisions of the bill.

The proposal was rejected, and the Committee adjourned.

## CAPE-AUSTRALIA CABLE.

In the House of Commons on Friday, Sir EDWARD SASSOON asked the Secretary of State for India whether, in view of the establishment of the Capetown to Australia cable, he had under consideration the desirability of a spur line from Cocos to Ceylon in association with the Imperial Government as a practically all-British route from the United Kingdom to India.

Lord GEORGE HAMILTON said an Inter-departmental committee was now sitting to consider and report upon the subject of submarine telegraph communication generally. He had reason to believe that the Committee's attention has been called to the matter.

## POST OFFICE AND TELEPHONE OPERATORS.

In the House of Commons on Tuesday, in answer to Mr. Schwann, Mr. A. CHAMBERLAIN said the Postmaster-General, with the concurrence of the Treasury, had sanctioned a scheme for placing on the establishment of the Post Office efficient telephone operators employed by the department, and steps were being taken to carry out the scheme at an early date.

# LEGAL INTELLIGENCE.

## Taff Vale Railway Co. v. Amalgamated Society of Railway Servants and Others.

In the House of Lords on Monday judgment was given by the Lord Chancellor and Lords Macnaghten, Shand, Brampton, and Lindley in the appeal against the decision of Mr. Justice Farwell in the original action and the reversal of this decision by the Court of Appeal. It will be remembered that the society was sued, in conjuction with its general and organising secretaries (Messrs. Richard Bell and James Holmes), for having on Aug. 20, 1900, written to the general manager of the appellant company supporting the action of the company's servants in ceasing to work, and stating that all further negotiations were to be conducted through them. The appellants thereupon made arrangements for the engagement of fresh servants, and large numbers of men arrived at Cardiff These men were watched and beset, and, the appellants contended, illegally prevented from entering their service. The appellants on Aug. 23 began an action for injunction, and on Sept. 5 Mr. Justice Farwell granted the injunction, ordering that

> "The defendants, the Amalgamated Society of Railway Servants, their servants, agents, and others acting by their authority, be restrained until the trial of this action or until further order, from watching or besetting, or causing to be watched or beset, the Great Western Railway station at Cardiff, or the works of the plaintiffs, or any of them, or the approaches thereto, or the places of residence, or any place where they may happen to be, of any workman employed by or proposing to work for the plaintiffs, for the purpose of persuading or otherwise preventing persons from working for the plaintiffs, or for any purpose except merely to obtain or communicate information, and from procuring any persons who have or may enter into contracts with the plaintiffs to commit a breach of such contracts."

The society appealed to the Court of Appeal, which, in November, reversed the decision of Mr. Justice Farwell, and dissolved the injunction. The Railway Company now sought the final arbitrament of the House of Lords.

The LORD CHANCELLOR said: I am content to adopt the judgment of Mr. Justice Farwell, with which I entirely concur, and I cannot find any satisfactory answer to that judgment in the judgment of the Court of Appeal which overruled it. If the Legislature has created a thing which can own property, which can employ servants, which can inflict injury, it must, I think, be taken to have given power to make it sueable in a court of law for injuries purposely done by its authority. I, therefore, move that the judgment of the Court of Appeal be reversed, and that of Mr. Justice Farwell be restored.

Lord MACNAGHTEN: I am of the same opinion. Parliament has legalised trade unions, whether registered or not. Registered bodies enjoy certain advantages. The respondent society is a registered trade union. Practically the government of the society is in the hands of its executive committee, a body with vast powers, including complete power of disposition of the funds of the union. All the funds of the society, for whatever purposes they may be collected, form a common fund. The main question, therefore, as Mr. Justice Farwell set out, is—Has the Legislature authorised the creation of bodies of men capable of owning great wealth and of acting by agents with absolutely no responsibility for the wrongs

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they may do to other persons by the use of that wealth and the employment of those agents? I hold not. Therefore, if trade unions are not above the law, the only remaining question is one of form—How are these bodies to be sued? I hold that a trade union, whether registered or not, may be sued in a representative action if the persons selected as defendants be persons who, from their position, may be taken fairly to represent the union as a body. A further point is—May a registered trade union be sued in and by its registered name? I cannot see any difficulty in the way of such a suit. I therefore find that the Act of Parliament actually provides for a registered trade union being sued in certain cases by its registered name as a trade union, and does not say that the cases specified are the only cases in which it may be so sued. I can see nothing contrary to principle or contrary to the provisions of the Trade Union Acts in holding that a trade union may be sued by its registered name. I, therefore, agree that the appeal should be allowed and the judgment of Mr. Justice Farwell be restored.

Lord SHAND and Lord BRAMPTON also agreed.

Lord LINDLEY, in concurring, said: I have no doubt whatever that if the trade union could not be sued in this case in its registered name some of its members—viz., its executive committee—could be sued on behalf of themselves and other members of the society, and an injunction and judgment for damages could be obtained in a proper case in an action so framed. I also hold that if the trustees in whom the property of the society is legally vested were added as parties an order could be made in the same action for the payment by them out of the funds of the society of all damages and costs for which the plaintiffs might obtain judgment against the trade union. I entirely repudiate the notion that the effect of the Trade Union Act of 1871 is to legalise trade unions and confer on them rights to acquire and hold property, and at the same time to protect the union from legal proceedings if their managers or agents, acting for the whole body, violate the rights of other people. Further, I hold that a mandamus could go against a trade union to compel it to perform the duties cast upon it by statute; and here, again, the obvious course would be to proceed against the union by its registered name, unless there is something in the statute to prevent it. A careful study of the act leads me to the conclusion that the Court of Appeal held, and rightly held, that trade unions are not corporations; but the Court held, further, that, not being corporations, power to sue and be sued in their registered names must be conferred upon them, and that the language of the statutes was not sufficient for that purpose. Upon this last point I differ from the Court of Appeal. I do not say that the use of the name is compulsory, but it is, at least, permissive. We have not now to consider how a judgment or order against a trade union, in its registered name, can be enforced. I see no difficulty as to this, but if a judgment or order in that form is for the payment of money, it can, in my opinion, be enforced only against the property of the trade union, and that to reach such property it may be found necessary to sue the trustees. I am in agreement that the orders of Mr. Justice Farwell were right and should be restored.

The appeal was therefore allowed, with costs against the respondents in both actions.

## Ferranti's Patent.

In the Judicial Committee of the Privy Council, before the Lord Chancellor, Lord Hobhouse, Lord Macnaghten, Lord Davey, Lord Robertson, and Lord Lindley, was heard on Tuesday the petition by Mr. Sebastian Ziani de Ferranti for the prolongation of letters patent granted to himself in September, 1887, for a term of 14 years, for an invention for improvements in electric railways.

Mr. FLETCHER MOULTON, K.C., said the petition had reference to letters patent granted to Mr. Ferranti for an invention of "Improvements in Electric Railways," bearing date September 13, 1887, and numbered 12,419. The petitioner sought an extension of the term of the said letters patent. The petition was opposed by Messrs. Ganz & Co., of Buda-Pestb, by the British Thomson-Houston Co., and by Messrs. Siemens Bros. & Co.

Mr. HENRY SUTTON (interposing) said he desired to take a preliminary objection, which, if allowed, would be fatal to the application, and he thought it would be convenient if he stated his objection at once. In paragraph 4 of the petition appeared the following statement: "The said letters patent have, during the whole term, been vested in and still remain the property of the said Sebastian Ziani de Ferranti." That was a statement which was untrue, in fact, and the law was well established that a petition to succeed must state all material facts, in order that their lordships might not be led into giving an erroneous decision. Shortly, Mr. Ferranti had turned himself into a limited company, which might be described as "Ferrantis Limited," and had conveyed to that company all his equitable or beneficial interest in the patent. That company, when formed, was duly incorporated. It was only necessary for him to remind their lordships of the definition of the term "patentee" given in sec. 46 of the Letters Patent Act, 1883, for their lordships to see that Mr. Ferranti could not successfully petition for a prolongation of the patent to him. The word "patenetee" in the section "means the person for the time being entitled to the benefit of a patent." Counsel then referred to the agreement by which Mr. Ferranti had assigned the equitable rights over to the limited company, by which the company was to acquire and obtain from him all present and future beneficial rights in the said patent. No money appeared to have passed, but in clause 2 the consideration was stated to be £99,930, made up in various ways and represented by shares. Of these Mr. Ferranti practically took 70 per cent. himself, his father-in-law, Mr. Francis Ince, 20 per cent., and Mr. C. P. Sparkes the rest. There was an important provision in the agreement that in the event of the limited company being wound up from any cause whatever the beneficial interest in the patent, whatever it might then be, was to revert to the grantor himself. The learned counsel said another point to which he wished to call attention was that the nominal capital of the company had from time to time been increased. These particulars bore out his proposition that all material facts were not stated in the petition and, therefore, the petition ought to be dismissed.

Mr. FLETCHER MOULTON said there was not the slightest doubt that the petition has been put forward in its present form in perfect good faith by Mr. Ferranti and his advisers. The possibility of the objection being raised never struck anybody until a day or two ago, when it was too late to amend. He could rest content that certainly in form, and to a certain extent in substance, it was wrong. But he submitted that it was only substantially bad in form, and that in substance all that was necessary for the decision of the question was before the board. On the facts, as he hoped to show conclusively, it was a merely technical objection that had been taken, and not one of real subetance. Mr. Ferranti was unquestionably the absolute owner of the patent, and he had no idea that having parted with the equitable title he thereby put himself out of court. The statement in paragraph 4 that the letters patent had during the whole term been vested in and were still his property was not made to mislead. He had never parted with the legal title. Being the legal owner he believed himself to be the beneficial owner in the sense, at any rate, that he was the person who, as "patentee," should present the petition for prolongation of his own invention. In 1887 S. Z de Ferranti, Limited was formed and preference shares were then issued. The whole of the ordinary shares belonged still to Mr. Ferranti. About two years ago a certain portion of the preference shares were sold, but they were not assigned as any consideration of the company. If the company, from any cause whatever, was wound up under the agreement the patent rights were to revert to the granter. Mr. Ferranti was the company in fact, and always considered himself and acted as being the company. He owned the whole of the ordinary shares, and no profits from the patent could ever have gone to anybody else. He always considered himself the sole owner, and, as such, the person to present the petition. Perhaps he might be allowed to call Mr. Ferranti?

The LORD CHANCELLOR: I do not see why you want to call him. A fact, which must have been known to the petitioner, is not stated in the petition, and as stated is not true. That seems to me to end the matter. The petition is dismissed, with one set of costs between the three petitioners.

## Howell's Simplex Anti-Inductive Telephone Syndicate (Ltd.)

This matter was again before Mr. Justice Wright in the Chancery Division on Wednesday on a summons by the liquidator dealing with the claim of Mr. T. J. Howell, who alleges that his patents were sold or transferred to the syndicate and that he had had no adequate consideration for them. He sought to recover in the liquidation, and the liquidator asked for instructions as to dealing with this claim.

Mr. BLACK, who appeared for Mr. Howell, said the latter had no capital to exploit his telephone patents, but he was introduced to a Mr. James Gordon McIntosh, and he agreed to receive £600 in cash and one-third of the shares in a syndicate which McIntosh was about to form. McIntosh then entered into a fresh agreement with the syndicate to sell to it the patents he had obtained from Mr. Howell for £2,500 in cash and 5,450 ordinary shares. The syndicate got Mr. Howell's patent rights for Great Britain and abroad, and its capital was £12,000. The syndicate was now being voluntarily wound up, and Mr. Howell having failed to get the price agreed upon from McIntosh, now sought to prove in the liquidation. His lordship, said counsel, on the last occasion on which the matter was before him, said that Mr. Howell had been badly treated, and that there might possibly be grounds for formulating charges of fraud and conspiracy against McIntosh and the syndicate. Since that time evidence had been obtained which, to his mind, greatly strengthened Mr. Howell's claim, and he put in affidavits which he said made the matter clearer, and an agreement which established the connection between Mr. Howell and the syndicate, and the assignment to the syndicate of his patents.

Mr. CASSELLS said that, on the last hearing, the liquidator of the syndicate agreed to let Mr. Howell have his patents back for £270, the price which they had paid for them, but the liquidator had since found that Mr. Howell had attempted to sell the articles and patents which were still in the hands of the company.

Mr. BLACK denied that that was the case.

His LORDSHIP said there was no new material before him to enable him to come to a different conclusion. The assignment was by McIntosh to the syndicate, and there had been no consideration as between Howell and the syndicate. He thought that Mr. Howell had been a great sufferer by somebody's dishonesty, but his application had not been strengthened, and, therefore, he must decide against him. The claim would be dismissed with costs.

Mr. CASSELLS remarked that misfeasance proceedings had been commenced by the liquidator against some of the directors of the syndicate.

## C. Bright & Co. (Ltd.) v. River Plate Construction Co. (Ltd)

On Wednesday, in the Court of Appeal, this case came before Lords Justices Rigby, Collins and Romer on two appeals by the plaintiffs from an order of Mr. Justice Farwell dismissing actions brought by plaintiffs against the defendant company as frivolous and vexatious and as disclosing no reasonable cause of action. After lengthy legal arguments their lordships dismissed both applications, with costs.

An application by Mr. C. Bright for leave to appeal from an order of Mr. Justice Farwell in an action brought by plaintiff against the London and Brazilian Bank and others was also refused with costs.

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The position of senior demonstrator in electrical engineering and applied physics at the City and Guilds Technical College, Finsbury, will be vacant at the close of the present session. An instructor in electrical engineering, with experience in polyphase and high-voltage work, is also required. Applications to Prof. S. P. Thompson, F.R.S., Technical College, Finsbury, E.C.

Finchley Urban District Council require a resident electrical engineer and manager at a commencing salary of £300 per annum. Applications to Mr. Charles Roberts, Council Offices, Ribbsworth House, Church End, Finchley, by noon, Aug. 19. See advertisement.

The governing body of the South-Western Polytechnic, Chelsea, London, S.W., invite applications for the position of demonstrator in electrical engineering. Applications to secretary by Aug. 6. See advertisement.

The post of assistant lecturer and demonstrator in the department of physics and electrical engineering at Hartley College, Southampton, is vacant. Salary £130 per annum, rising annually by £10 to £150. Applications to the principal. See advertisement.

A teacher of engineering workshop book-keeping and accounts is required at the City and Guilds Central Technical College, Exhibition-road, London, S.W. See advertisement.

There are vacancies in the teaching staff (including the lecturership on electrical engineering) of the University of Glasgow. Particulars from Prof. Barr. See advertisement.

Battersea Borough Council require a shift engineer for their central electric generating station. Commencing salary, £104 per annum. An advertisement gives some further particulars, and applications have to be sent in to Mr. W. Marcus Wilkins, town clerk, Municipal-buildings, Lavender-hill, London, S.W., by noon of Sept. 3.

An electrical engineer is required, thoroughly trained, for a large electrical power scheme. See advertisement.

A large firm of engineers, manufacturing motors and dynamos, requires agents in the United Kingdom. See advertisement.

A foreman glass-blower is required in a glow lamp factory. Permanency for the right man. See advertisement.

Applications for three assistant superintendentships in the Telegraph Department of the Goverment of India will be received by the Secretary, Public Works Department, India Office, Whitehall, London, S.W., until July 31.

The Bombay, Baroda and Central India Railway Co. require an assistant telegraph superintendent. Applications to secretary, Gloucester House, Bishopsgate-street, London, E.C., by Aug. 7.

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Mr. Alfred Schwartz, of the South-Western Polytechnic, Chelsea, has been appointed head of and professor in the physics and electrical engineering department of the Manchester Municipal School of Technology at £500 per annum.

Mr. H. Pomeroy has been appointed superintendent engineer of the Midland District, Ireland, Postal Telegraphs, in succession to Mr. W. W. Louth, retired.

Mr. G. W. Cripps, of the Islington (London) electricity works, has been appointed shift engineer at Bedford.

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**Barrow-in-Furness.**—The General Purposes committee have arranged for the British Electric Traction Co. to take a lease of the local tramways for 26 years, subject to confirmation by the Council.

**Bethnal Green (London).**—Acting on the advice of their consulting engineer (Mr. Robert Hammond) the Borough Council have rejected the offer of the Charing Cross and Strand Electricity Supply Corporation to supply electricity in bulk in the district for 42 years.

**Bexhill.**—The Electric Light committee reports that the equivalent of about 9,000 8 c.p. lamps are connected to the mains.

**Bournemouth.**—The Bournemouth and Poole Electricity Co. have withdrawn from the negotiations concerning the purchase of their undertaking by the Council.

The consulting engineers (Messrs. Lacey, Clirehugh and Sillar), in conjunction with the borough surveyor (Mr. F. W. Lacey), recently presented a report on the proposal to construct electric tramways in the borough, and particularly dealing with the recommendations made by the deputation sent by the Council to Brussels and Paris, as to the most suitable form of traction. The report states that the Corporation may safely adopt the conduit system in the main thoroughfare. The engineers had considered the question of cost, and they had obtained the cost of the Paris conduits. They estimated that in Bournemouth the extra cost per mile of single track would be approximately £6,000 over the trolley system. If, therefore, the whole of the main route between the County Gates and Boscombe were so equipped, the extra cost would be approximately £50,000. They would, however, only recommend the conduit system between the Pembroke Hotel and the Metropole Hotel, and the extra cost of this length of tramway would not exceed £15,000. For the remaining routes the overhead trolley system could be erected in such a manner as not to prove unsightly, and as it would represent a saving of £35,000 in capital expenditure, they recommended its adoption. They estimated the additional cost of constructing the proposed tramways as between the Pembroke Hotel and the Lansdowne junction to be approximately £20,350, and with regard to maintenance, the additional cost would be about £300 per annum. The Council have adopted the report and the conduit system will be adopted as advised.

**Buxton.**—An inquiry has been held into the application of the Council to borrow £25,000 for electric lighting extensions. The electrical engineer (Mr. E. Calvert) said last season, with the equivalent of 4,500 8 c.p. lamps connected, they had a load of 126kw., being approximately 3,500 lamps alight, or four-fifths of the total lamps connected. They had now 10,000 lamps on the books, which, at the same ratio, would give them a load of 8,000 lamps alight, equal to 285kw. They were not in a position to deal with such a load with their present plant. It was proposed to expend £16,520 at once, and the balance of £8,440 would be required at an early date. There was no opposition.

**Chartered Institute of Patent Agents.**—The qualifying examination of this institute will be held in November next. Full particulars can be obtained of the secretary, 19, Southampton-buildings, London, W.C.

**Companies Struck Off Register.**—The undermentioned companies have been struck off the register of joint-stock companies, and are dissolved :—

Acetylene Gas Corporation.
Anglo-Continental Motor Syndicate.
Bagshawes.
Blackburn Corporation Tramways Co.
British Electro-Chemical Agency.
British Engineering Co.
Central Engineering Works Co.
Electric Hansom Cab & Carriage Co.
Electric Light and Power Co.
Electric.
Electric Metal Working Syndicate.
Electric Night Advertising Co.
Elieson's Electrical Switch.
Elsner & Co.
Engineers Syndicate.
General Electrical Co. of Roumania.
High Power Electrolyte Syndicate.
Johnson Miners' Safety Lamp Co.
Maxim Autocar Syndicate.
Maxim Carbide Process and Acetylene Gas Syndicate.
Penarth Tramways Syndicate.
Peterborough Electric Light and Power Co.
Pioneer Electric Carriage Co.
Pure Acetylene Gas and Carbide Co.
Safety Motor Syndicate.
Sectional Standards.
Steady Arc Lamp Co.
Telegraph Improvement Co.
Telephone Construction Co.
Traction Syndicate.
Trehearne Electrical Engineering Co.
Wenlock Electrolytic Co.
Werner-Cadmium Electric Accumulator Syndicate.

**Customs Duties.**—Recent decisions of the Swiss Customs authorities have fixed the import duty on electric incandescent lamps at 10s. 2d. per cwt. ; on metal lamp-holders for electric incandescent lamps, imported separately, if of brass, 4s. 1d. per cwt, of zinc, 6s. 1d. ; roughly shaped bulbs for incandescent lamps 7½d. per cwt. Arc lamps and all parts thereof, commutators, resistances, cutouts, regulators, incandescent lamp fittings, recording instruments, indicators, &c., are included under the heading "electric lamps," and are subject to a duty of 6fr. per 100 kgs.

**Electric Driving.**—The Ashbury Railway Carriage and Iron Co. (Ltd.), which has extensive works at Openshaw, Manchester, and are busy on a contract for six complete trains, each comprising nine coaches, for the Metropolitan and Metropolitan District Railways, are extending their works by the erection of a large new shop. This shop is to be electrically lighted, and equipped with special tools and overhead cranes, all electrically driven.

**Electrical Developments in Norway.**—The extension of the Aktieselskabet Hafslund's electric power station at Sarpsborg is making steady progress, and will, when finished, provide the company with 16,000 H.P. of electric power. Room is left for an addition of 7,000 H.P. to 8,000 H.P. should the demand for power require this addition to be made. The several calcium carbide factories erected in this town in 1899 have proved complete failures, the demand for this article having entirely collapsed.

An installation of public electric lighting for the town of Fredikstadt by the Aktieselskabet Hafslund has been completed, and current is available also for private supply.

At Flekkefjord municipal electricity works are being erected and equipped for 1,000 H.P. The plant is water driven from a waterfall distant about 7 miles from the town. The average price charged to private consumers for lighting is said to be 10s. per annum per 16 c.p. lamp, and for power at £2. 15s. to £3. 18s. per H.P. per annum.

At Kragero a scheme for lighting the town by electricity has been approved. Water power is available, as there are several large waterfalls from 10 to 12 miles from the town. The company erecting the electricity works has recently been formed, with a capital of £35,000. An electric railway is also contemplated in this district, for which the company will provide power.

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The Skienfjord district includes the county of Bratsberg, where nearly 30,000 H P. is generated and utilised in driving machinery for a number of large works which are established in the neighbourhood. There are still large waterfalls in this district unutilised, it is estimated to the extent of 40,000 H P. The Skien Electric Light and Power Works supply current for lighting the town of Skien, and electricity works are being erected at Porsgrund. The extensive Lundetangen brewery, which is owned by a company, is worked and lighted entirely by electricity, and is a great commercial success. At Ulefoss the mines and foundries, which have now recovered from a past period of inactivity and loss, are working on up-to-date plans, the machinery and appliances being wholly electrically driven. 280 men are employed at these works.

During 1901 the electricity works at Trondhjem will be completed. The lighting of the town and the running of the tramways by electricity is proceeding, the contractors being Messrs. Siemens and Halske and Messrs. Schukert & Co.

**Guatemala.**—M. Romiro Fernandez, representative of the Urban Railway Co. of Guatemala, is said to have secured a concession for a tramway from Guatemala City to Guado Viejo. The construction material for the line will be allowed in free of duty.

**Hastings.**—An inquiry has been held into the Council's application to borrow £14,272 for electric lighting. £1,285 is required for new mains, £9,500 for plant, £3,289 for house cables, and £94 for three arc lamps in Norman-road.

**Italy.**—The project to construct an electric railway between Rome and Naples has been officially approved. The journey between the two cities is to be made in three hours.

**Java.**—The electric railway at Batavia is now in full working order along its entire length.

A tramway line has been constructed from Sourabaya to Babat on the Solo river, and is to ultimately join the Samarang-Soerakala railway.

A concession was recently granted to a syndicate to construct an electric tramway for Buitenzorg and the surrounding district, but the capital has not yet been fully subscribed.

**Leicester.**—The Tramways committee recommend the Corporation to purchase the local tramways for £134,000. It is proposed to equip the lines electrically and to construct extensions at a total estimated cost of £350,000. The overhead trolley system will be adopted.

**Light Railways.**—At Hounslow, on Monday, the Light Railway Commissioners opened an inquiry into the applications of the Middlesex County Council and the London United Tramways (Ltd.) for powers to construct light (electric) railways :—

Mr. ASQUITH, K.C., opened the County Council case, and stated that the proposed lines ran almost along the same roads as the projected lines of the London United Tramways. The first line ran from Staines to Hampton, and would serve Staines, Sunbury and Hampton. The second was from Staines to Hounslow, where it would join the terminus of the Metropolitan District Railway, to which it would act as a feeder, and give direct access from the extreme west of Middlesex to London. The third opened in Hounslow, and at Colnbrook crossed the Great Western line, which it would help to feed. No. 4 ran from Hounslow north to Southall for 3 miles. No. 5 was a short branch to Cranford to connect the foregoing with the generating station. No. 6 started at Twickenham and went to Sunbury. No. 7 line was from Isleworth to Hanworth. There were 30 miles of double track, which would cost £450,000. The population of the district was 101,000. No goods would be carried on the proposed tramways, and the lines would serve as feeders and not competitors of the existing railways. The London United Tramways held some lines already laid, and had others sactioned, and they were in accord with the Council in thinking that new lines could be profitably worked, since they proposed to utilise practically the same route. The London United Tramways had a line to Kew and through Brentford, and there were constant accidents, through the narrow streets, and the Council believed that no line could be worked with safety in such streets, which they proposed to widen to 50ft. The County Council proposed to lease the working of the lines to a company, but there was no agreement in force yet with any company.

After Mr. JAMES BIGWOOD, M.P., had given evidence in support of the scheme,

Mr. V. B. D. COOPER said he had prepared the plans and sections. He had advised the Council as to all the extensions, and the result was the present scheme. He was examined at some length. He said he thought the Council tramways would pay even without a through connection with the London United lines. They could not connect with the Staines and Egham scheme, as the gauges were not the same. His idea was for the lines to act as a feeder to the District Railway.

Mr. C. T. YERKES said he had acquired a controlling interest in the District Railway, and was prepared to financially assist the scheme, and had the capital ready. The lines would be valuable to the District Railway.

A long discussion arose as to the estimates prepared by the Middlesex County Council as to the cost of the tramways proposed, and finally

The PRESIDENT said there was no doubt the estimates presented were very insufficient. He did not think that it would be possible to make the road in the way in which Mr. Cooper proposed. He thought the parties concerned should consider the position with regard to those estimates.

Mr. ASQUITH said the estimate did not appear to be as full or as satisfactory as it ought to be. The reason for it not being so was not any intentional desire to evade the requirements of the act, which was the last thing the County Council would desire to do. He would suggest that their lordships should give the promoters power to amend the estimates by supplemental information.

The PRESIDENT said there were very large omissions. The estimate of the Middlesex County Council was for £497,000, which amount obviously would not nearly cover many of the works referred to.

Mr. COWARD, K.C. (for the London United Tramways), referred to the meeting of the County Council on May 23, when the Council considered the cost of the lines. The ratepayers had a right to know what the cost would be. Why should they depart from the usual rules meted out to promoters who came into court with an ill-defined, crude and ill-considered scheme?

The PRESIDENT said the Commission considered that such very inaccurate estimates must be fatal to a scheme like this. They certainly would not be justified in creating a precedent which they had been asked to do by allowing estimates which are confessedly inadequate to count as being substantially accurate. Therefore it was no use continuing this scheme.

Mr. BALFOUR BROWNE, K.C., then outlined the case of the London United Tramways, for whom the first witness was Mr. J. CLIFTON ROBINSON, who said that his company were now operating 16 miles of tramways. The first extension they now asked for was the Bath-road line, which had been eliminated by Sir John Kennaway's Committee from the present bill in order that it might be considered by the Commissioners, and the Committee stipulated that the promoters should not be prejudiced before the Commissioners by that rejection. The next line, in Hampton, commenced with a junction with the authorised line in Church-road, Hampton, and proceeded on to Thames-street and other roads to Hanworth, terminating in the junction the Staines-road of with the Hanworth-road. The next line passed from Staines-road through Hanworth and Twickenham to Twickenham Green. The company were supported by eight district councils out of nine affected. The total mileage was over 15¼ miles. There were also lines 5 and 6 from Lampton-road, Hounslow, to Southall, on which they proposed to spend about £10,000 in widening. It would give them the advantage of a circular route between Shepherd's Bush, Ealing, Southall, Hounslow, Brentford, Chiswick and Hammersmith. The maximum fare for the single journey would be 5d. The whole of the proposed and existing lines could be worked from their power-house at Chiswick. Should Parliament pass the present bill, the total of their mileage, with that included in the present application would be 70 miles. In addition, he was now under arrangement to meet and discuss with the Surrey County Council a comprehensive system of light railways for Surrey.

After this evidence, the inquiry was adjourned until Monday.

The Amesbury and Military Camp Light Railway (Amendment) and the Wigan Light Railway orders have been submitted to the Board of Trade for confirmation. Objections to latter order by Aug. 14, and to the former by Aug. 17.

The Board of Trade have confirmed the Lizard Light Railway (extension of time) order.

The Stroud District Council have unanimously approved Mr. T. Nevins' scheme for a light railway in the district.

**London County Council.**—At Tuesday's meeting electricity loans were advanced to Hackney £34,200 (£21,300 for electric lighting and £12,900 for dust destructor); Hammersmith £1,900 (for meters); Woolwich, £20,000 and £27,805; Hampstead, £9,623; Islington, £2,500 and £2,018 (for meters).

It was agreed to make application to Parliament for power to acquire lands compulsorily at Greenwich for an electricity generating station for the working of the tramways in lieu of the station previously agreed upon at Camberwell. It is expected that a saving of £50,000 will be effected by this change.

It was agreed to serve notices on the South London Tramways Co. and the Woolwich and South-East London Tramways Co. for the purchase of their respective undertakings.

The Highways committee reported on the practicability of constructing a shallow underground electric tramway from Westminster (via Parliament-street, Strand, Fleet-street, and Cheapside) to the Bank, and on to Finsbury-pavement on a similar principle to those laid down in Buda Pesth and in Boston, U.S.A. The committee recommended that the electrical engineer and the tramways manager be authorised to visit America to obtain the latest information with regard to the system of shallow underground tramways, and also as to the latest developments in the application of electrical and other forms of mechanical power for tramway traction, and that £250 be allowed for travelling expenses. This was agreed to.

Further proposals for new tramways were brought up by the Highways committee and will be discussed next Tuesday. They are about 5¼ miles in length and the estimated cost is £175,400, with £87,800 for street widenings. One of the proposals is for a tramway along Victoria Embankment from Westminster Bridge to Blackfriars.

The Woolwich Borough Council have lodged an objection with the London County Council as to the works now being carried out by the Blackheath and Greenwich District Electric Lighting Co., which works have been approved by the County Council. Woolwich pointed out that the Blackheath Company are incurring large expenditure on capital account, which is not justified, and which would not be incurred but for the fact that there is a prospect of the expenditure being recouped with 33 per cent. interest when the Woolwich Council take over the company's undertaking in accordance with a notice served on the company on June 11. The Council decided to formally disapprove the company's plans.

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**Merthyr.**—Public electric lighting is under consideration by the Council, who have received a report from their surveyor (Mr. T. F. Harvey). Certain proposals have also been submitted by the Merthyr Electric Lighting and Traction Co.

**Northallerton.**—The contract for the public electric lighting has been renewed for 12 months. Current is supplied by the Northallerton Electric Light Co.

**Norwich.**—The Executive committee are asking for power to employ an expert to report upon the value of the undertaking of the Norwich Electricity Co.

**Oldham.**—The Copster Hill-road and Hollins road electric tramway routes have been opened for traffic.

**Poole.**—The Board of Trade have declined to revoke the Poole and Branksome provisional order on the request of the Town Council.

**Scarborough.**—The Streets and Buildings committee are considering proposals submitted by Mr. A. A. Campbell Swinton for the construction of tramways. Mr. Swinton offers to form a company for carrying out the scheme. The company would agree to the Corporation taking over the lines in 1915, subject to the repayment of all expenses, and making up the dividend for the years prior to purchase to 5 per cent. in case such a percentage was not earned by the company. If a higher dividend should be paid, then the company would require reasonable compensation. The company would obtain current from the Scarborough Electric Supply Co.

**Tonbridge.**—Sanction to a loan for electric lighting has been received by the Council. Tenders for plant have been accepted.

**Trade Depression in Germany.**—The Berlin correspondent of the *Morning Leader* states that Messrs. Schuckert & Co., of Nurnberg, have decided to dismiss 2,000 workmen and 500 officials in the autumn.

**West Bromwich.**—A deputation from the local tradesmen's association recently urged upon the Electric Lighting committee the necessity of making a reduction in the charge for electric current, and a reduction to 4d. per unit is now advised.

**Woking.**—A curious state of affairs has arisen in connection with the council's lighting arrangements. After much discussion it was recently decided to discontinue electric lighting and to enter into a seven year's contract with the gas company, to date from next month. It now appears that the necessary notice to discontinue electric lighting has not been given to the Woking Company and the latter claim that they are entitled to continue the lighting of the streets up to Oct. 7, 1902. A compromise is suggested.

**Workhouse Lighting.**—Electric lighting has been decided upon for the new Hammersmith workhouse and infirmary, and current will be taken from the mains of the Borough Council.

**Cricket.**—The cricket clubs of the staffs of the Chloride Electrical Storage Syndicate and the Tudor Accumulator Co. played a match at Dukinfield on Saturday, when the home team were beaten by the Chlorides by 57 to 33.

**Outing.**—On Saturday the staff of the British Thomson-Houston Co. held their annual outing on the Thames from Maidenhead to Henley, the largest launch on the river being required to accommodate the gathering.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Dundee* Gas Commissioners require surface condensers, electrically-driven air and circulating pumps, cooling towers, &c.; electrically and steam-driven feed pumps and feed-water heaters and fittings. Specifications from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders to the clerk to the Commissioners (Sir Thomas Thornton, LL.D.), City-chambers, Dundee, by Aug. 5. An advertisement gives additional particulars.

*Bradford* Corporation invite tenders for the supply and delivery of 100 electric tramcars. Specification from the tramways manager (Mr. C. J. Spencer), 5, Forster-square, Bradford, and tenders to the town clerk (Mr. Frederick Stevens) by 31st inst. An advertisement gives further particulars.

*Farnham* Urban District Council are open to contract with a responsible firm for the supply of electricity under their electric lighting order, 1900. An advertisement gives some further particulars, and proposals have to be lodged with Mr. Richard Mason, clerk to the Council, Farnham, by noon of Aug. 27.

*Worcester* Corporation invite tenders for the supply and erection of the plant set out in an advertisement elsewhere. Specification, &c., can be obtained of Mr. C. J. Sutherland (city electrical engineer), Guildhall, Worcester, and tenders must be sent to Mr. S. Southall, town clerk, Guildhall, Worcester, by noon of Aug. 23.

*Wigan* Corporation invite tenders for the supply of enclosed electrical motors and starters as required during 12 months. Particulars from the borough electrical engineer (Mr. H. Collings Bishop), to whom tenders by Aug. 10. See advertisement.

*Gravesend* Town Council invite tenders for boiler-house plant, steam and exhaust pipes, engine-house plant, switchboard, underground mains, lamp posts, accumulators, meters, cranes, dust destructor, and well and water-lifting apparatus. Tenders to town clerk by 10 a.m. July 30.

*Rochdale* Corporation invite tenders for steel poles, bases, section boxes, overhead line, and accessories for, approximately, 5 miles of tramway, and also for feeder cables and pilots. Tenders to town clerk, Town Hall, Rochdale, by Aug. 1.

*Partick* Town Council invite tenders for wiring the electricity supply station. Tenders to Mr. Jas. Donaldson, 97, West Regent-street, Glasgow, by noon Aug. 6.

*Kearsley* District Council require tenders for steel tramway poles, bases, section boxes, overhead line material and accessories for the equipment of 1¾ miles of tramway. Tenders to clerk by Aug. 1.

*Manchester* Electricity committee require tenders for 70 feeder and section pillars for tramway routes. Tenders to town clerk by Aug. 7.

*Manchester* Electricity committee also require switchboards at Stuart-street station and sub-stations. Tenders to chairman by noon Aug. 14.

*Glamorgan* County Asylums committee invite tenders for the electric lighting of the Parc Gwyllt Asylum, near Bridgend. Tenders by 29th inst.

South Lancashire Electric Traction and Power Co., 12, St. John's-lane, *Liverpool*, require tenders until Aug. 2 for permanent-way construction of about 30 miles of tramways.

*Cardiff* Corporation invites tenders for single-deck and double-deck bogie cars and double-deck four-wheeled cars; also main switchboards, with instruments complete. Tenders by Aug. 6.

*Stockport* Tramways committee invite tenders for wiring their car sheds. Tenders by noon Aug. 1.

*East Indian Railway Co.* (Nicholas-lane, E.C.) invite tenders for an electrical installation and stores. Tenders by Aug. 7.

The *French* Post and Telegraph Authorities invite tenders until Aug. 12 for a quantity of lead-covered telephone cable (21 conductors). Tenders to Le Sous-Secretariat d'Etat des Postes et des Télégraphes, 103, Rue de Grenelle, Paris.

### TENDERS RECEIVED AND ACCEPTED.

*Correction.*—We, in our last issue (p. 500) credited the accepted tender by the St. Pancras Borough Council for three-phase plant to the Electrical Company. We are asked to state that the accepted tender was that of the Allgemeine Electric Co., 25, Victoria-street, Westminster, S.W.

Battersea Borough Council recently invited tenders for works and plant for obtaining water for condensing purposes from the Thames. No tenders were received for the execution of the river portion of the work, but Messrs. Fraser and Fraser offered to do the work for £7,000 if they were allowed to make certain deviations from the specification, and this offer has now been accepted. Messrs. Mather and Platt's tender for electric pumps and pipe work in connection with the scheme for £2,163 has also been accepted. Four schemes were received for the wiring and fitting up of consumers' premises free of initial cost, but the Council have not accepted any of them, and the further consideration of the question has been adjourned in view of the application to Parliament, proposed by the London County Council.

Tonbridge Council, at their meeting on Tuesday, accepted the following tenders:—

| | | | |
|---|---|---|---|
| Houldsworth & Sons (boiler-house plant) | £1,120 | 0 | 0 |
| Johnson and Phillips (engine-house plant, Alley and Maclellan engines) | 1,871 | 0 | 0 |
| Ditto (condensing apparatus and pipework) | 1,136 | 0 | 0 |
| Herbert Morris and Bastert (overhead crane) | 111 | 11 | 2 |
| Veritys Limited (switchboard) | 921 | 2 | 0 |
| Ditto (accumulators) | 1,539 | 16 | 0 |
| Western Electric Co. (mains) | 4,002 | 17 | 0 |
| Improved Electric Glow Lamp Co. (public arc lighting) | 444 | 6 | 0 |
| Ditto (public incandescent lighting) | 331 | 9 | 6 |
| Chamberlain and Hookham (house meters) | 162 | 0 | 0 |

Mr. H. D. Munro, borough electrical engineer, Exeter, has submitted a report to the Electric Lighting committee on the tenders received for generating plant for the new electricity works. The Council are recommended by the committee to submit Mr. Munro's scheme, with the plans and tenders, to an expert for advice as to whether sectional tenders or a complete tender shall be accepted for the work. The committee decided to ask the president of the Institution of Electrical Engineers to submit the names of three consultants to advise the Council in the matter. The tenders received for the station buildings ranged from £13,903 to £27,096. Following are the tenders received for the whole of the plant and equip-

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ment :—Ferranti Limited, £26,461, £24,657 and £26,300; British Westinghouse Co., £28,989 ; Brush Company, £28,625 and £28,715.

Southwark (London) Borough Council have received the following tenders for two additional panels to the main switchboard :—

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|---|---|---|---|
| Geipel & Lange (*accepted*).. | £129 0 | J. G. Statter & Co. ..... | £262 0 |
| Mechan & Sons ..... | 357 0 | Veritys Limited ..... | 241 0 |
| General Electric Co. ..... | 301 10 | Clayton & Co. (incomplete) | 152 10 |
| Williamson and Joseph ... | 283 0 | | |

Dublin Corporation on Monday accepted the final batch of tenders for plant, &c., for the Pigeon House power station. These appeare d in our issue of June 21 (p. 350), but the tender of Ferranti Limited was accepted for main switchboards (in place of the General Electric Co. at £3,814) and for sub-station switch gear (in place of the Brush Co. at £5,880), the total amount being £10,304.

West Ham Town Council have accepted the tender of Ferranti Limited for the supply of three 500kw. continuous current tramway generators for £14,248. The dynamos will be supplied by Messrs. D. Bruce Peebles & Co.

Long Eaton District Council received 38 tenders for electric lighting plant, and these have been referred to the consulting engineer, Mr. J. H. Crowther, of Wallasey.

Farnworth District Council have accepted the tender of the British Insulated Wire Co. for the overhead equipment of the tramway extensions. Messrs. Lacey, Clirehugh and Sillar are the consulting engineers.

Rochdale Corporation have ordered three specimen electric tramcars from Messrs. Dick, Kerr & Co. and three from the British Thomson-Houston Co.

Portsmouth Corporation have accepted the tender of Mr. W. W. Evans for the erection of tramcar sheds, &c., for £17,980, and that of Mr. T. W. Quick for extending the electricity station buildings at £4,715.

The contract for the electrical equipment of the Mersey Railway has been let to the British Westinghouse Co.

## BUSINESS NOTICES.

Messrs. Warren, Beattie & Co., Lower Commercial-street, Middlesbrough-on-Tees, have taken into partnership Mr. Charles Bertram, of Newcastle-on-Tyne (formerly manager to Messrs. D. Selby, Bigge & Co.), and the company has been registered as Warren, Beattie & Co. (Ltd.). Messrs. J. W. F. Warren and Bertram will act as managing directors, and Mr. Beattie as director and secretary. The chairman of the company is Mr. John Beattie, J.P., Mayor of Newcastle-on-Tyne, and Mr. S. N. Warren, who has taken an active part in the business, has been elected a director.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Joseph Taylor, electric light fittings maker, &c. (trading as J. Taylor & Co.), 24, Pyrland-road, Canonbury, N., and 1A, Dyott-street, Shaftesbury-avenue, W.C., London, has been adjudicated bankrupt.

Claims against the Electrical Inventions and Manufacturing Co. (Ltd.) must be sent by Aug. 15 to Mr. C. W. Provis, jun., 3, Mount-street, Manchester.

Claims against the Electric Street Car Manufacturing Syndicate (Ltd.) must be sent to Mr. M. Fletcher, 47, Lichfield-street, Wolverhampton, by Aug. 31.

A meeting of the World, Gas and Electric Syndicate (Ltd.) will be held at 27 and 28, Broad-street-avenue, London, E.C., on Aug. 30 to receive an account of the winding-up.

A meeting of the Electric Light Insurance and Maintenance Co. (Ltd.) will be held at 100, St. Martin's-lane, London, W.C., on Aug. 27 to receive an account of the winding-up.

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**Sale by Tender.**—The Electric Supply and Tramways committee of St. Helens Corporation are open to receive tenders for the purchase of plant set out in an advertisement. The plant was new in 1896, and is in first-class condition.

The committee of management of the District Asylum, Mullingar, Ireland, have for sale by tender the plant and apparatus set out in an advertisement elsewhere. Tenders have to be sent to the committee not later than Aug. 2.

**For Sale.**—The liquidator of the Morecambe Electric Launch and Power Syndicate (Ltd.) has electric launches for sale which are now running on the bay.

**Business for Disposal.**—The well-established business of an electrical engineer at Halifax is to be disposed of. See advertisement.

**Royal Warrant.**—The Electrical Power Storage Co. have been appointed by His Majesty the King makers of electrical secondary cells to His Majesty. The E.P.S. Co. had the honour of holding a similar warrant from Her late Majesty Queen Victoria. This is the first royal warrant ever granted for any electrical appliances.

**"Pirelli" Cables.**—Messrs. Pirelli & Co., of Milan, Naples, and Turin, a very old-established firm of electric cable makers, have just issued a pamphlet calling attention to their special manufactures in this branch.

**"Geeko" Telephones.**—A second edition of the price list of these telephones has just been issued by the General Electric Co., and shows illustrations of a large number of sets for domestic use.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 17 to July 23, with the ports of destination :—

*Africa*—Alexandria, £30 ; Cape Town, £195 ; Chinde, £122 (telegraph material) ; Durban, £62 ; East London, £145 ; Port Elizabeth, £680. *Argentina*—Buenos Ayres, £650. *Australasia*—Brisbane, £52 ; Christchurch, £20 ; Fremantle, £60 ; Melbourne, £520 ; Perth, £325 ; Sydney, £377. *Belgium*—Ostend, £100. *British Guiana*—Denmark, £182 (telegraph material). *Canada*—Quebec, £29. *Ceylon*—Colombo, £60. *China*—Chefoo, £37 (telegraph material) ; Shanghai, £166. *Cochin China*—Saigon, £61. *Denmark*—Copenhagen, £68 (including £50 telegraph material). *Germany*—Hamburg, £228 (telegraph material). *Gibraltar*, £20. *Holland*—Amsterdam, £75 ; Flushing, £116 ; Rotterdam, £224 (including £164 telegraph material). *Hong Kong*, £73 (telegraph material and apparatus). *India*—Bombay, £400 (including £329 telegraph material) ; Calcutta, £1,130 (including £87 telegraph wire) ; Madras, £128. *Italy*—Genoa, £15 (telegraph wire). *Japan*—Tokyo, £18 ; Yokohama, £126. *Malta*, £246. *Norway*—Christiania, £10 (telegraph wire). *Portugal*—Lisbon, £116. *Spain*—Barcelona, £73. *Straits Settlements*—Singapore, £189 (including £99 telegraph paper). *Sweden*—Gothenburg, £12 ; Stockholm, £50 (telegraph wire). *Turkey*—Constantinople, £603 (telegraph cable). *United States*—San Francisco, £42. Total, £7,835, against £11,622 in the corresponding week last year (July 18 to 24).

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# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 19, 1901.

5,766. SIEMENS BROS. & CO. (LTD.), A. SIEMENS, and A. M. DUKE. London. Improvements in the working and controlling of electrically driven cars.

5,778. J. B. POWELL. London. Improvements in repeating mechanism for phonographs and the like.*

5,784. J. B. POWELL. London. Improvements in automatic stop mechanism for phonographs and the like.*

5,808. T. J. PHIPPS. Watford. An improved single or duplex electric clockwork switch for turning on and off electric light every half minute, or for longer or shorter period, for illumination or advertising purposes.

March 20, 1901.

5,889. H. H. LAKE. London. Improvements in sound-recording and reproducing apparatus. (J. E. Alexander and C. H. Pell, United States.)

5,906. R. W. BOYD. London. Improvements in electrical heating apparatus.*

March 21, 1901.

5,921. D. NEWTON. Liverpool. Improvements in life guards for electric tramcars or the like.

5,952. H. HIRST and T. H. BACON. London. An improved watertight cover for electric cutouts, switches, joint boxes and the like.

5,954. J. MATTHEWS and W. DAVIES. Birmingham. Improvements in armatures for dynamo electric machines and the like and in the manufacture of the same.

5,964. A. J. BOULT. London. Improvements in or relating to electric railway signals. (J. D. Price and W. H. Council, United States.*)

5,975. C. COLSMAN and A. COLSMAN. London. Improvements in carriers for glow lamps.*

5,982. A. W. SHARMAN. London. Improvements in and relating to etheric signalling.

5,985. A. REINECKE and A. JOST. London. Improvements in and relating to current collectors for electric railways on the overhead system.*

5,986. G. KOPPELMANN. London. Improved armature core for electric generators.*

5,987. A. W. BENNIS. Manchester. Improvements in carrying telephone and telegraph wires across streets and protecting the trolley wires or overhead wires of electrical tramways therefrom in case of breakaga.

6,004. F. J. BEAUMONT and W. M. STILL. London. Improvements in means or apparatus for driving dynamos on railway and other vehicles from the axles thereof and for connecting such dynamos and batteries to lighting, heating, or other circuits, or such vehicles.

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March 22, 1901.

6,010. E. P. Appleyard. Manchester. An automatic electric cut-off.
6,013. F. Pegler and J. J. Warry. Liverpool. An improved insulated glove.
6,041. W. Brown. London. Improved contrivance for concealing slack wires on lifts, arc lamps, wall plugs, ceiling pendants and the like.
6,042. L. Kamm. London. Improvements in printing telegraphs.
6,043. F. G. Kleinsteuber. London. Trolley conductor insulated fitting for electric tramways and railways.
6,070. F. E. Elmore. London. Improvements in apparatus for the generation and electrolytic application of electric currents. (Partly by J. O. S. Elmore, India.)
6,085. E. D. Billing and A. Dunhill. London. Improved terminal for electric wires.

March 23, 1901.

6,096. L. B. Codd. Nottingham. Improvements in and relating to electric arc lamps.
6,097. T. Greenwood. Halifax. Improvements in storing up waste power, by balance weight, for enabling electric and other tramcars or vehicles to travel up and down very steep inclines with perfect safety.
6,102. A. F. Harris. Birmingham. Improvements in anodes.
6,104. R. L. Ross and R. Bridge. Manchester. Improvements in or connected with the trolley wheels used in overhead electrical traction.
6,107. A. C. Heap and W. O. Smith. London. Improvements in electrical measuring instruments.
6,125. G. H. Parr. London. Improvements in incandescent electric lamp holders.
6,137. W. S. Boult. London. Improvements in or relating to starting and controlling electro motors.
6,161. Siemens Bros. & Co. (Ltd.) and F. Lydall. London. Method of and apparatus for controlling single-phase alternate current motors.
6,164. E. Franke. London. Improvements in and relating to accumulator plates.

March 25, 1901.

6,191. R. L. Wood. Cheltenham. Improvements in electric light and power appliances.
6,207. R. Swales, F. Stamford and R. A. Swales. London. Improved method of and means for automatically switching off the current in trolley wires used for electric traction in case of a breakage or other accident.
6,242. W. Cowderoy. London. Improvements in or connected with electric demand indicators.
6,258. J. J. Glass. London. Improvements in electrical switches and like contact devices.
6,271. A. J. Boult. London. Improvements in or relating to telegraphic or telautographic apparatus. (E. K. Gruhn, Germany.)*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1901.

3,397. Siemens Bros. & Co. (Ltd.), Dumas and Palairet. Commutator brushes.
3,491. Rignon, Carbone and Moreno. Arc lamps.
3,493. Jahr. Method for obtaining electric currents from the earth.
3,494. Couch. Electrical glow lamps.
3,526. Manger. Electrically-lit watch or clock case.
3,576. Spies and Norden. Electric switches or couplings.
4,007. Abel (Siemens and Halske Aktiengesellschaft). Telephonic apparatus for central stations.
4,098. Hume. Railway electric signalling apparatus.
4,149. Spangler. Electrically-operated railway and tramway switches.
4,388. Courtier. Devices for producing by the electric volatilisation of metal wires flashes for use in photography.
4,508. Pickard and Evans. Electric accumulator plates.
4,509. Pickard and Evans. Composition of paste for filling the cells of reticulated accumulator plates.
4,695. Strickland. Regulation of dynamos.
4,767. Meissner. Cable for supplying the electric current to electrically driven ploughs and for like purposes.
4,768. Meissner. Electric bell circuit for mechanically-driven ploughs.
4,870. Abel (Siemens and Halske, Actiengesellschaft). Electric couplings for railway cars.
5,026. Claremont and Hyde. Machine or apparatus for measuring the lengths of electric cables or wires, rope and the like.
5,077. De Mare. Devices for X-rays.
5,098. Nisbett. Multiple conductor cable terminal or analogous fittings.
5,121. Justice (Erie Exploration Co.). Insulating strips or cores for rheostats, electric heaters and similar devices.
5,194. Sansome. Gramophones, graphophones, phonographs, and the like.
5,220. Mosher. Electric surgical dilators. (Date applied for under International Convention, Aug. 25, 1900.)
5,227. Hultman. Arrangement of electric cables or groups of conductors.
5,247. Bloxam (Helios Electricitäts Aktiengesellschaft). Switch for controlling electric motors.
5,303. Volkers. Micro-telephones.
5,332. Courtney. Electro-therapeutic apparatus.
5,411. Ziegenberg. Electric measuring apparatus.
5,510. Lundell. Commutator brushes and brush holders for electric motors or dynamo-electric machines.
5,560. Dorman and Smith. Electrical switches.
5,700. Poschl and Gaütsch. Electric clocks.
5,786. Eichwede. Telephonic apparatus, comprising conversation counters or meters.
5,906. Boyd. Electrical heating apparatus.
5,975. Colsman and Colsman. Carriers for glow lamps.
5,985. Reinecke and Jost. Current collectors for electric railways on the overhead system.
5,986. Koppelmann. Armature core for electric generators.
6,271. Boult (Gruhn). Telegraphic or telautographic apparatus.
7,113. British Thomson-Houston Co. (Ltd.) (Green). Apparatus for rectifying alternating electric currents.
7,114. British Thomson-Houston Co. (Ltd.) (Everest). Electric regulators.
7,135. Bliss and Holland. Telephone metering system.
7,150. Engelhardt, McNelly and Gallert. Electro-magnet motor.
7,224. Claremont and Stratton. Apparatus employed for covering telegraph cables and wires with lead or other metallic substance for electric purposes, or for manufacturing metallic pipes or tubes or like uses.
7,338. Schneider. Electric furnaces.
7,492. Wait. Winding for electromagnetic inductive apparatus. (Date applied for under International Convention, Jan. 12, 1901.)
7,497. Cruvellier. Contact boxes for the distribution of electricity. (Date applied for under International Convention, Nov. 21, 1900.)
7,547. Lake (Smithers). Incandescence electric lamps.
7,783. British Thomson-Houston Co. (Ltd.) (Potter.) Controllers for electric motors.
7,834. Bennet and Johansson. Insulators for electric conductors.
8,102. Cerebotani and Moradelli. Switch systems for telephone circuits.
8,162. Feeny (Allgemeine Elektricitäts Gesellschaft). Electrical lamps.
8,195. Uytenbogaart. Sockets or holders for incandescent electric lamps.
8,518. Vittorio Alessandro Arcioni. Electric meters.
8,720. Mathieson. Differential alternating current arc lamps.
8,964. Parker. Means for use in operating from a car or train switches employed with a surface contact system of electric traction.

# COMPANIES' MEETINGS AND REPORTS.

## Edison and Swan United Electric Light Co. (Ltd.).

The eighteenth annual report of the directors for the year to June 30 states that the profit and loss account shows that £19,514. 4s. 1d. has been carried to net revenue, £18,242. 15s. of which has been absorbed in payment of interest on debenture stock.

Competition in every branch of the business has been very keen, lamps especially being sold at very diminished prices. The price of materials has considerably increased, hence the cost of production has been higher, and as the sales have been smaller, the business has suffered seriously.

At the last shareholders' meeting the chairman announced that a new manager of the fittings department had been appointed. On his getting to work, everything in that department was thoroughly overhauled and examined. During this investigation it was discovered that, in the past, work which had been completed at a loss was reported as "work in hand," and carried forward as a good asset. This led to further changes, amongst others the general manager was removed from that office, and the directors set on foot a special inquiry into the value of the whole of the stock belonging to the company; and they regret to say that they have found it necessary to write off therefrom the large sum of £31,048. 5s.

When this company absorbed the Manchester Edison-Swan Co. it took over their Broadheath factory, and, as it was found impossible to work it at a profit, it has been closed. Such plant as could be beneficially utilised has been removed to Ponder's End, and the rest has been sold. The Walsall and Kalk factories have also been closed, and the loss on the closing of these factories has been provided for in the accounts.

The sums of £31,048. 5s. depreciation of stock, £19,075. 14s. 4d. special outlays written off, £9,069. 7s. 9d. loss on closing factories, and £4,578 provision for bad and doubtful debts, together with the interim dividend, paid March 1, of 2½ per cent., amounting to £9,596. 19s., have absorbed the whole of the reserve. £784 is carried forward as against £6,199. 18s. 5d. last year.

The fall in the market quotation of the shares, the changes which were known to have been made in the staff, and other reasons, led to the formation of a committee, which consisted of shareholders holding more than one-fourth part of the "A" shares of the company. A deputation from this committee has had several interviews with the directors, has visited Ponder's End, and has made an examination into the affairs of the company. As the result of these meetings an arrangement has been arrived at between the directors and the committee, by which two seats at the board have been placed at the disposal of the committee, and, in accordance with this arrangement, Mr. E. B. Ellice-Clark and Mr. H. Wolfenden have been nominated for election as directors at the ensuing meeting of shareholders.

Mr. J. S. Forbes, who has been chairman of the company from its commencement, resigned his seat on the board on the 19th of the present month, stating that he was compelled to reduce his engagements owing to domestic bereavement and from considerations of health. Major Flood Page retires in rotation, and offers himself for re-election. Mr. E. Villiers retires in rotation, and does not offer himself for re-election. Mr. E. B. Ellice-Clark and Mr. H. Wolfenden have been duly nominated to serve as directors and offer themselves for election accordingly.

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The directors have in this report placed before the shareholders, fully and unreservedly, the result of the special examination which has occupied them for several months. In expressing their sincere regret at these unexpected results, they desire to say that they are of opinion that the business, if properly conducted, is good, and that there is reason for believing that with certain changes in organisation and in policy, which have been already under consideration, and which will have to be decided when the board is re-constituted, the company can once again be placed in a satisfactory commercial position.

## General Electric Co. (1900) (Ltd.).

The directors' report for the first year of the company's working to March 31 sets out the net trading profits and income from investments, &c., at £75,766. 8s. 6d. After deducting interest on balance of purchase money up to date of payment thereof, and on payments in advance of calls on preference shares, income tax, depreciation and debenture interest, amounting to £21,347. 13s. 10d., there remains an available balance of £54,418. 14s. 8d. The directors therefore recommend the payment of the dividend on the 5 per cent. preference shares requiring £5,778. 3s. 5d., managing directors' and employés' bonus £4,864. 1s. 1d., and a dividend on the ordinary shares at 10 per cent. requiring £25,692, leaving to be placed to reserve £18,084. 10s. 2d.

Since the formation of the company the directors have acquired an additional 63 acres of land at Witton and Erdington, adjoining the property previously bought for the purpose of erecting modern engineering, electro-chemical, and other works. The completion of the new works at Witton is being pushed forward, so as to be able to start manufacturing there before the end of the present year.

During the past year Mr. Max Railing, manager of an important department, has been appointed as an additional director. The board also recommend the election of two additional directors (Mr. Henry Bevis, manager in the firm since 1889, and Mr. Tom Hawkins, the present chief engineer at Manchester).

The 692 ordinary shares issued since the formation of the company have all been allotted at par—as to seven of such shares to the subscribers of the memorandum of association, and as to the remaining 685 to members of the staff.

## Crompton & Co. (Ltd.).

The report of the directors for the year to March 31 gives the net profit at £27,100. 12s. 7d. After providing interest, interim dividend, &c., there is £17,926. 9s. 1d. available for distribution. Of this £2,500 is provided for doubtful debts, £5,000 is placed to reserve, a final dividend of 9 per cent. per annum for the past half-year (tax free) is recommended, making 8 per cent. for the year, and £3,143. 18s. 1d. is carried forward. The reserve is now £17,906. 6s. 6d., and the directors propose to write off from this £5,648. 6s. 10d. from patents account, which will then stand at £10.

46,000 shares in the company were offered for subscription in March at 5s. premium, and 31,000 shares were applied for. The premiums, less cost of issue, have been placed to reserve and invested outside the business.

The order book continues very full, and the prospects for the future are satisfactory. Consequent upon the growth of business the registered offices of the company have been removed to larger premises at Salisbury House, London Wall. The building of the new arc lamp, instrument and switchboard shops is well advanced, and the extensions to the works offices are approaching completion.

A new generating station and offices have been erected for the Chelmsford Electric Lighting Co., and the whole of the plant and machinery has been overhauled, and, where necessary, renewed. The cost of these repairs and renewals has been charged to the Lighting Company's revenue. The profits of that company show a satisfactory increase.

## Dublin United Tramways Co. (1896) (Ltd.).

The report of the directors for the half-year ended June 30 states that a dividend has been declared at the rate of 6 per cent. per annum on the preference, and at the rate of 4 per cent. per annum (tax free) on the ordinary shares, of which £85,500 did not rank for dividend this time last year. These dividends absorb £29,028. 6s. 5d., leaving £3,372. 11s. to be carried forward. The results of the half-year's working have been adversely affected by the exceptional charges which the company had to meet under the head of compensations for accidents and legal expenses connected therewith, amounting to the sum of £6,337. 13s. 6d., representing more than 2 per cent. dividend on the ordinary share capital. These accidents occurred over a period of three previous half-years. The directors have effected a third party insurance policy for one year from March 5 last, covering all claims for accidents up to £7,500 in the aggregate, or £1,500 in the case of any one accident, except for claims arising from horses slipping on the pavement, the company's liability for which is now the subject of an appeal to the higher Courts. The premium payable in respect of this increase is £3,050 for the year. Contracts for a year's supply of coals have recently been made at 9s. 9d. per ton, delivered at Ringsend, against an average cost of 15s. 10d. per ton during the past half-year.

## Direct United States Cable Co. (Ltd.).

The report of the directors of this company for the six months ended June 30 states that the half-year's revenue, after deducting out-payments, amounted to £50,649. 19s. 10d., compared with £52,204. 8s. 7d. for the corresponding period of 1900, a decrease of £1,554. 8s. 9d. The working and other expenses, including income tax but exclusive of cost of cable repairs, amounted to £21,124. 17s. 4d., leaving £29,525. 2s. 6d. as the net profit, making, with £5,255. 13s. 2d., brought forward, a total of £34,780. 15s. 8d. For the corresponding period of 1900 the working expenses and other payments amounted to £20,506. 8s. 10d. Three quarterly interim dividends of 3s. each per share, amounting to £27,319. 10s. have been declared and paid during the financial year, and a final dividend of 3s. per share is now proposed, together with a bonus of 1s. per share, making, together, 3¼ per cent. for the year (absorbing £39,461. 10s.). After transferring £10,000 to reserve the balance of £3,532. 5s. 8d. on revenue account is proposed to be carried forward.

Reserve has been debited with £19,414. 13s. 5d. for cost of cable repairs, and, after being credited with interest on investments and amount transferred from revenue, now amounts to £430,996. 18s. 7d., taking the investments at cost price.

Sir Spencer Walpole, K.C.B., has found it necessary to resign his seat on the board of the company, and the vacancy thus created has been filled by the appointment of the Hon. Thos. H. A. E. Cochrane, M.P.

**ANGLO-AMERICAN TELEGRAPH CO. (LTD.)**—The report of the directors for the half-year to June 30 give the receipts, including £1,156. 1s. 5d. brought forward, at £188,357. 16s. 11d. The traffic receipts show a decrease of £3,954 when compared with the half-year to June 30, 1900. The total expenses, including repair of cables, &c., amounted to £64,979.3s., an increase of £4,195. 1s. 8d. compared with the corresponding period of 1900. The directors have set apart £12,000 to renewal fund, leaving £111,378. 13s. 11d. One quarterly interim dividend of 15s. per cent. on the ordinary and of £1. 10s. per cent. on the preferred stock was paid on May 1, absorbing £52,500, and a second quarterly dividend of similar amount on each stock will be paid on Aug. 1. The balance of £6,378. 13s. 11d. will be carried forward. All the main cables and landlines of the company are in good working order.

**GLOBE TELEGRAPH AND TRUST CO. (LTD.)**—The directors' report for the year ended July 18 gives the net revenue for the year, after deduction of expenses, as £197,136. 12s. 6d., making, with £982. 14s. 11d. brought forward, £198,119. 7s. 5d. From this there has been distributed £131,035. 10s. 8d. in interim dividends, leaving £67,083. 16s. 9d. A final dividend of 3s. on the 6 per cent. preference and 4s. 6d. on the ordinary shares is recommended, making 5¼ per cent. net for the year, and leaving £1,101. 16s. 7d. to be carried forward. Owing to his official duties, the Right Hon. St. John Brodrick, M.P., has resigned his position as director, the vacancy being filled up by the appointment of Sir John Wolfe Barry, K.C.B.

**GREAT NORTHERN AND CITY RAILWAY CO.**—The directors report for the half-year ended June 30 states that at Drayton Park 1,200 lineal yds. of tunnel had been driven, and only 536yds. remain to connect with Essex-road. At Essex-road the station tunnels and connecting passages for the shafts are completed, and the cross passages between the platforms are in hand. At Regent's Canal the up and down line tunnels have been driven southwards to a point within 69yds. of the north end of Old-street station, where the station tunnels are in course of construction. At Finsbury-pavement terminus the connecting passages are approaching completion, and the driving of the station tunnel is being rapidly proceeded with. 400 lineal yds. of double tunnel remain to be driven between the terminus and Old-street. Generally, the progress made is satisfactory, and it is anticipated that the whole of the tunnelling will be completed by the end of the current year. A contract for the electrical plant and equipment will shortly be placed.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BIRMINGHAM MOTOR MANUFACTURING AND SUPPLY CO. (LTD.)**—Reg. July 17, capital £5,000 in £1 shares, to manufacture, sell or let on hire motors, cars, carriages, waggons, vans and vehicles of all kinds, and accessories thereto, and to carry on the business of electricians, engineers, wire drawers, tool makers, &c.

**COVENTRY LIGHTING AND ENGINEERING CO. (LTD.)**—Reg. July 20, capital £15,000 in £1 shares, to acquire the business of the Coventry Gas Fitting, Electrical and Engineering Co. (Ltd.), and to carry on business as electrical, pneumatic, hydraulic, gas and general engineers, bellhangers, tool makers, makers of electric, gas, and other lamps, &c.

**FOLKESTONE MOTORS (LTD.)**—Reg. July 19, capital £5,000 in £1 shares, to manufacture and deal in automotor cars, carriages, cabs, omnibuses, tramcars, railway coaches and trucks, waggons, &c.

**NORTON AND WHITE (LTD.)**—Reg. July 10, capital £10,000 in £1 shares, to acquire the business of Norton and White, Birmingham, and to carry on the business of metal spinners, manufacturers of electrical apparatus and materials, gilders, &c.

**METROPOLITAN DISTRICT ELECTRIC TRACTION CO. (LTD.)**—Reg. in London July 15 by Fowler, Perks & Co., capital £1,000,000 in £20 shares, to adopt and carry into effect certain agreements with the Metropolitan District Railway Co. for the electrical equipment and working of the railways of the latter company, or any railways of which the company is part or joint owner, or over which it has running powers or in which it is interested; to enter into agreements with the Metropolitan District Railway Co. and the Brompton and Piccadilly Circus Railway Co., for the erection of a generating station, to construct subways and ducts, to lay cables and rails, to build sub-stations, to alter existing stations, to execute all necessary works for the conversion of railways and tramways using steam or other form of tractive power into railways or tramways worked by electric power, to acquire from the Metropolitan District Railway Co. or any other persons land and premises at Chelsea or elsewhere for the erection of, and to equip and maintain generating stations or power houses,

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to manufacture rolling stock, engines, trolleys, trucks, electric motors and machinery, and to carry on the business of electricians, engineers, producers and suppliers of electricity, contractors, financiers, &c. The subscribers are :—

| | Shares. |
|---|---|
| Charles T. Yerkes, 54, Wall-street, New York City | 16,800 |
| John J. Mitchell, Chicago | 1,000 |
| Maryland Trust Co., Baltimore, Maryland | 4,000 |
| George R. Webb and H. A. Parr, Baltimore, Maryland | 500 |
| P. Calbena, 30, Broad-street, New York | 2 500 |
| Brown Brothers & Co., 59, Wall-street, New York | 2,500 |
| Simon Borg & Co., 20, Nassau-street, New York | 1,000 |
| Pemberton and M'Cados, 15, Wall-street, New York | 1,000 |
| J. G. White & Co., 29, Broadway, New York, contractors | 2,000 |
| S. W. Marckinald, 27, William-street, New York | 500 |
| Alex. Brown & Sons, Baltimore, Maryland | 1,000 |
| Henry H. Roque, 26, Broadway, New York | 2,500 |
| H. I. Harrison, 26, Broadway, New York | 100 |
| John H. Parsons, Union Traction Co., Philadelphia | 250 |
| J. W. Brown, President Maryland Trust Co., Baltimore, Maryland | 2,500 |
| Gorett, Sons & Co., 4, Throgmorton-avenue, London, stockbrokers | 3,150 |
| James Phillips, junr., Hotel Lorraine, Boston, Mass. | 500 |
| T. Jefferson, Cooledge, Boston | 2,250 |
| Frederick Ayer, Boston, Mass | 2,500 |
| Charles F. Ayer, Ames Building, Boston, Mass. | 400 |
| Lee, Higginson & Co., 44, State-street, Boston | 1,000 |
| F. H. Prince, 14, State-street, Boston | 500 |
| Charles G. Weld, 81, Mason-building, Boston, Mass. | 1,000 |
| Charles F. Adams, 23, Court-street, Boston | 100 |
| Alexander Cochrane, 55, Kilby-street, Boston, Mass | 250 |
| Arthur T. Lyman, P.O., Box 1,717, Boston, Mass. | 100 |
| George P. Gardner, 22, Congress-street, Boston, Mass. | 100 |

No initial public issue. The number of directors is not to be less than three nor more than five, and the subscribers are to appoint the first.

**POWER-GAS CORPORATION (LTD.)**—Reg. July 16, capital £350,000 in £1 shares (100,000 deferred), to acquire patents and rights relating to the production of fuel-gas, sulphate of ammonia and other by-products, to adopt agreements with Dr. L. Mond and with E. J. Duff and the United Alkali Co. (Ltd.), to manufacture, produce and recover from coal, slack, dross and fuel of all kinds and to deal in gas, ammonia, sulphate of ammonia and other by-products, and to carry on the business of chemical manufacturers, electricians, engineers, suppliers of electricity and gas for light, heat and power, &c. During the current week the company has invited subscriptions for 183,538 ordinary shares of £1 each, entitled to a preferential dividend of 6 per cent. per annum and other participation in the profits, out of which number of shares 60,000 has already been applied for. The company has a very strong board of directors, the chairman being Sir H. H. Fowler, M.P. The prospectus contains particulars of a number of Mond gas plants which have been installed at large engineering works, these installations having a capacity of about 250,000 tons of slack per annum. The company takes over the business and connection as from March 31 last of Messrs. Ashmore, Benson, Pease & Co. (Ltd.), at Stockton-on-Tees. These works cover an area of over 8 acres, and are well situated for railway and water siding accommodation. The technical advisers to the company include three of the directors—Dr. L. Mond, Mr. E. J. Duff and Mr. E. Schweich—all of whom have a full knowledge of the patented and other details of Mond gas plant. Mr. R. S. Benson, managing director of Ashmore, Benson, Pease & Co., retains that position in the new company. Excepting the moneys required for preliminary expenses, the whole of the share capital now issued is available as working capital. The vendors, as purchase consideration, receive 66,462 fully paid ordinary and 100,000 fully paid deferred shares. No part of the purchase money is in cash. The deferred shares are entitled to a dividend only after the ordinary shares have received a 6 per cent. preferential distribution. The subscription list closed yesterday (Thursday). [Some comments upon this issue will be found on a previous page.]

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27d. per oz. (July 25). Consols (2¾ per cent.) 92 13/16—92 15/16 for money, 92 13/16—92 15/16 for account; 2½ per cent. 93—93½ (July 25). Consols Pay Day Aug. 1; Stocks and Shares Continuation Days, July 29 and Aug. 13; Ticket Days, July 30 and Aug. 14; Pay Days, July 31 and Aug. 15; Mining Share Carry-over Days, July 26 and Aug. 15.

**ARON ELECTRICITY METER (LTD.)**—Subscriptions have been invited for £60,000 5 per cent. debentures of £100 each at 95, part of a total authorised issue of £75,000.

**BRITISH THOMSON-HOUSTON CO. (LTD.)**—At the meeting held on Monday, the chairman, Mr. E. A. Lazarus, said the directors' report was so complete that he had nothing further to say. The report and accounts were then adopted, and the retiring directors—Messrs. C. Burrell, J. Hamspohn, W. A. McArthur, M.P., and J. T. Merz—duly re-elected. Messrs. Price, Waterhouse & Co. were re-appointed auditors, and a vote of thanks to the chairman terminated the proceedings.

**CENTRAL LONDON RAILWAY CO.**—The directors recommend a dividend for the past half-year at the rate of 4 per cent. per annum, carrying forward £19,000.

**HUELVA GAS AND ELECTRICITY CO. (LTD.)**—At the meeting on Wednesday it was stated that the receipts from the sale of electric current showed an increase of 27·4 per cent. The net profit for the year was £1,217. 4s. 6d., compared with £1,590. 5s. 1d. last year. A dividend of 2½ per cent. was declared.

**LIVERPOOL OVERHEAD RAILWAY CO.**—The accounts for the past half-year show an available balance of £11,722, and the directors recommend the payment of the dividend on the 5 per cent. preference and 2 per cent. per annum on the ordinary shares (against 3 per cent. for the corresponding period last year), with a balance forward of £3,722.

**NATIONAL TELEPHONE CO. (LTD.)**—The directors have resolved, subject to final audit, to recommend the following dividends (less tax) for the half-year ended June 30, after charging £17,673 against revenue, being the special expenditure incurred in repairing the damage caused by the snow-storms in the early part of the year:—At the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. on the third preference shares, 5 per cent. per annum on the ordinary shares, carrying £65,000 to reserve and about £6,000 forward. The transfer books of the company will be closed from 2nd to 15th proximo. inclusive.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has been asked to allow the further issue of 8,000 7 per cent. cumulative preference £5 fully-paid shares (Nos. 50,001 to 58,000) of the *Brompton and Kensington Electricity Supply Co. (Ltd.)*, and the further issue of £100,000 4½ per cent. debenture stock of the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)* to be quoted in the official list.

**WATERLOO AND CITY RAILWAY CO.**—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended June 30 last, being at the same rate as last year.

**WESTERN UNION TELEGRAPH CO.**—The following statement of the finances of the company at the close of the quarter ended March 31, has been issued :—

| | | |
|---|---|---|
| Surplus Jan. 1 | | $8,964,710 46 |
| Net revenues, quarter ended March 31 | | 1,504,225 57 |
| From which appropriating for— | | $10,468,936 03 |
| Dividend of 1¼ per cent. paid April 15 | $1,217,001 25 | |
| Interest on bonded debt | 239,040 00 | |
| | | 1,456,041 25 |
| Surplus | | $9,012,894 78 |
| The net revenues of the quarter ending June 30, based upon nearly completed returns for April, partial returns for May, and estimating the business for June will be about | | 1,750,000 00 |
| From which appropriating for— | | $10,762,894 78 |
| Interest on bonded debt | | 239,040 00 |
| | | $10,523,854 78 |
| It requires for a dividend of 1¼ per cent. on capital stock issued, about | | 1,217,001 25 |
| Surplus, after paying dividend | | $9,306,853 53 |

A dividend is therefore recommended of 1¼ per cent. on the capital stock.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a). |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | July 20 | 1,011 | + 147 | 7 | 5,769 | + 592 |
| *Birmingham Tramways. | „ 20 | 4,902 | + 191 | 2 | 9,808 | + 421 |
| *Blackburn Corporation.. | „ 19 | 632 | + 92 | 29 | 13,795 | + 1,250 |
| Blackpool Corporation... | „ 18 | 1,768 | + 447 | †16 | 13,350 | + 3,198 |
| Blackpool and Fleetwood | „ 22 | 1,367 | - 124 | 3 | 3,193 | - 49 |
| Bolton Corporation ..... | „ 21 | 1,606 | + 72 | 16 | 24,489 | + 2,800 |
| Bradford Corporation... | „ 21 | 1,135 | + 599 | 16 | 16,725 | + 8,775 |
| Brisbane Trams ..... | June 5 | 2,004 | + 215 | 22 | 56,794 | + 6,952 |
| *Bristol Trams & Carriage | July 19 | 5,097 | +1,492 | 2 | 10,163 | + 2,954 |
| *Buenos Ayres & Belgrano | June 23 | 2,675 | + 513 | 24 | 49,271 | +12,785 |
| Calcutta Trams. Co. ... | July 20 | R19,951 | +R1,255 | 3 | R59,842 | + R1,966 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | „ 20 | 6,218 | ... | 3 | 18,442 | ... |
| City & South London Ry. | „ 21 | 1,800 | + 389 | 3 | 5,644 | + 1,350 |
| Cork Elec. Trams ..... | „ 18 | 614 | + 125 | 28 | 12,819 | + 1,731 |
| Dover Corporation ..... | „ 20 | 279 | - 3 | 16 | 3,664 | + 240 |
| Dublin & Lucan Rly. ... | „ 21 | 143 | + 17 | 3 | 444 | + 77 |
| Dublin United ..... | ‡ „ 19 | 4,208 | + 237 | ‡3 | 11,209 | + 843 |
| Dublin Southern Dist... | ‡ „ 19 | 1,336 | + 35 | ‡3 | 3,185 | |
| *Dundee Corporation ... | „ 17 | 736 | + 197 | 3 | 2,125 | + 761 |
| *Glasgow Corporation ... | „ 20 | 10,858 | +3,033 | 7 | 83,069 | +16,592 |
| Halifax Corporation..... | ¶ „ 21 | 2,844 | +1,096 | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 20 | 1,114 | + 384 | 16 | 14,776 | + 3,537 |
| Hull Corporation ..... | „ 20 | 1,787 | + 409 | 3 | 5,289 | + 1,242 |
| Liverpool Corporation... | „ 13 | 10,199 | +1,569 | 28 | 241,774 | +34,676 |
| *Liverpool Overhead Rly. | „ 21 | 1,801 | + 50 | 3 | 5,298 | + 105 |
| *Manchester Corporation | „ 20 | 2,438 | ... | §6 | 9,971 | - 83 |
| Perth (W.A.) Elec. Trams | ... | ... | ... | ... | ... | ... |
| Portsmouth Corporation | „ 20 | 1,026 | - 121 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 20 | 3,757 | + 693 | 3 | 11,260 | + 3,243 |
| Southampton Corporat'n | „ 11 | 956 | + 355 | 3 | 2,725 | + 955 |
| | „ 18 | 925 | + 323 | | | |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year
* Partly electrical † Minus 3 days ‡ Minus 2 days. § Plus 2 days. ¶ Fortnight.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 17: | | Price Wednesday, July 24. | | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending July 24. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Hi'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ⅝ | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) .. | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12 | 13 | 4 12 4 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ... | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 5/6 | Brompton & Kensington Elec. Supply Ord | 7⅝ | 8¼ | 7⅝ | 8¼ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9 | 8¾ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7½ | 8½ | 7½ | 8½ | 2 2 6 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp.... | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5½ | 5¾ | 3 18 3 | ,, ,, | 5⅝ | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) ... | 102 | 104 | 102 | 104 | ... | ... | 104 | 103½ |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5½ | 6 | 5½ | 6 | 4 11 3 | March | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) ... | 107 | 110 | 107 | 110 | 4 2 0 | June and December... | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8⅝ | 8⅜ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 12½ | 13½ | 4 12 2 | January and July ..... | 13⅜ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ... | 120 | 125 | 120 | 125 | 4 0 0 | June and December ... | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) ..... | 100 | 102 | 100 | 102 | 4 8 8 | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary..... | 8½ | 9⅛ | 8½ | 9⅛ | 4 4 8 | ... | 9⅛ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference..... | 12 | 13 | 12 | 13 | 4 13 4 | March and September | 12½ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ..... | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary ... | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary..... | 11⅛ | 12⅛ | 11 | 12 | 4 7 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅝ | 7 | 6⅝ | 7 | 4 2 7 | January and July ..... | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)..... [Deb. Stk. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 42,540 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £260,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ..... | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) ..... | 13 | 14 | 13 | 14 | 4 5 9 | April and October..... | 13⅜ | 13 1/16 |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13 | 14 | 13 | 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage .. | 108 | 111 | 108 | 111 | 4 1 0 | June and December ... | ... | ... |
| £250,000 | Stock | 3¾% | Do. 3¾ per Cent. Mort. Deb. Stock (red.) ..... | 94 | 97 | 94 | 97 | 3 12 0 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6⅛ | 5⅝ | 6⅛ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock ..... xd | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅞ | 1 1/16 | ⅞ | 1 1/16 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. ... | 65 | 75 | 65 | 75 | ... | January and July ..... | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October..... | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary ..... | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | 15 | 15⅜ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅝ | 9⅜ | 8⅝ | 9⅜ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) ..... | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 | | 2 | | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2⅛ | 2⅜ | 2⅛ | 2⅜ | ... | ... | ... | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary ..... | 11⅝ | 12⅝ | 11⅝ | 12 | 4 7 6 | March and September | 11⅞ | 11⅝ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... | 4 | 4½ | 4 | 4½ | 4 14 2 | April and October..... | 4⅜ | 4 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock..... | 124 | 129 | 124 | 129 | 4 13 6 | ... | 126 | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 10 | 2 0 0 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference .. | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 97 | 102 | 97 | 102 | 4 18 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 93 | 98 | 93 | 98 | 4 12 0 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways..... | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2⅛ | 2⅜ | 2⅛ | 2⅜ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. ..... | 4⅛ | 4⅜ | 4⅛ | 4⅜ | ... | ... | 4⅛ | 4 1/16 |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. ..... | 101 | 103 | 101 | 103 | 4 7 5 | ... | 101½ | 101⅛ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary ..... | 21½ | 22½ | 21¼ | 22½ | 3 15 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) ..... | 10⅜ | 11 | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... | 114 | 116 | 112 | 115 | 3 9 6 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary ..... | 6½ | 7 | 6½ | 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference ..... | 9½ | 9⅝ | 9½ | 9⅝ | 5 2 7 | May and November ... | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs..... | 100⅝ | 102⅞ | 100⅝ | 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary..... xd | 14 | 15 | 14 | 14½ | 6 4 2 | ... | 15⅜ | 14 |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref..... | 12 | 13 | 12 | 12½ | 4 16 0 | February and August | 13 1/16 | 12½ |
| £250,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... | 123 | 125 | 124 | 125 | 4 0 10 | ... | 1 24½ | 123 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅜ | 1⅞ | 1⅜ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 2/0 | Do. 6% "A" Cum. Pref. | 5⅜ | 5⅝ | 5⅜ | 5⅝ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5⅜ | 5⅝ | 5⅜ | 5⅝ | 2 3 6 | ... | 5⅝ | 5 1/16 |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 102 | 105 | 102 | 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) . | 96 | 99 | 96 | 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) ..... | 10⅛ | 11⅛ | 11 | 12 | 2 10 0 | ... | 11⅞ | 11⅛ |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) ..... | 103 | 105 | 103 | 105 | 4 5 9 | ... | ... | ... |
| 400,000 | 1 | 1/2½ | Cape Electric Tramways Shares ..... xd | 1⅜ | 1⅝ | 1⅜ | 1⅝ | 3 4 0 | ... | 1⅝ | 1⅜ |
| £1,909,800 | Stock | ... | Central London Ordinary Stock ..... | 90 | 93 | 90 | 93 | ... | June and December... | 93 | ... |
| £440,100 | Stock | ... | Do. 4% Preferred Stock ..... | 93 | 101 | 92 | 102 | ... | ... | 101 | 100½ |
| £440,100 | Stock | ... | Do. Deferred Stock ..... | 92 | 95 | 92 | 95 | ... | ... | ... | ... |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs ..... xd | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 101 | 104 | 100 | 103 | 3 17 8 | ... | 103⅛ | ... |
| £955,000 | Stock | 1¾% | City and South London Railway Con. Ordinary .. | 54 | 56 | 53 | 55 | 2 5 3 | February and August | 53 | ... |
| 47,500 | 10 | 2/0 1/10 | Do. Ordinary (Nos. 22,501 to 70,000) ..... | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) .. | 132 | 137 | 132 | 137 | 3 13 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 5% | Do. (1896) ..... | 124 | 128 | 124 | 128 | 3 18 0 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... | 112 | 117 | 112 | 117 | 3 8 6 | May and November ... | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Tramways (1896) Ltd., Ordinary ... | 11⅛ | 12⅛ | 11⅛ | 11⅞ | 5 4 0 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference ..... | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 2¼% | Do. 3½ per Cent. Mort. Debs. (red.) ..... | 98 | 102 | 98 | 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tract'n. Pref. | 5¼ | | 5¼ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4⅛ | 5 | 4⅛ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary..... | 22 | 22½ | 21½ | 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference..... | 14½ | 15½ | 14½ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... | 113 | 114 | 111 | 113 | 3 19 7 | January and July ..... | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary ..... | 8⅜ | 8½ | 7⅞ | 8 | 4 1 3 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ..... | 13 | 13½ | 13 | 13½ | 3 15 6 | ,, ,, | ... | ... |
| £135,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... | 100 | 102 | 100 | 102 | 3 18 3 | January and July ..... | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | xd | ... | 110 | 114 | 4 7 9 | ... | 3 111½ | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908) ... | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) ..... | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary ..... | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 5/0 | Do. 6 per Cent. Cumulative Preference ..... | 4½ | 5 | 4½ | 5 | 6 0 0 | May ..... | ... | ... |
| 12,334 | 10 | 4/0 | Potteries Electric Traction Ordinary ..... | 12 | 13 | 12 | 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference..... | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... | 105 | 108 | 105 | 108 | 4 3 4 | ... | 107 | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) ..... | ... | | ... | | ... | April and October..... | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) ..... | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) ..... | ... | | ... | | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary ..... | 91 | 94 | 90 | 93 | 3 5 3 | June and December ... | 93 | 90 |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 17. | | Price Wednesday, July 24. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending July 24. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | African Direct Telegraph 4% Mort. Deb. (red.) . ... | 93 | 101 | 98 | 101 | 3 19 0 | January and July ..... | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph ..... | 3⅛ | 4⅛ | 3⅛ | 4⅛ | ... | June and December . | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures ..... | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American..... | 53 | 56 | 53 | 56 | 5 12 7 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred ..... | 98 | 100 | 98 | 100 | 6 2 0 | ,, ,, | 100 | 99½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred ..... | 9⅜ | 10½ | 9⅜ | 10½ | 2 8 9 | ,, ,, | 10 | 9⅜ |
| 13,333,300 | $100 | $14 | Commercial Cable Capital Stock ..... | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,099 | Stock | 4% | * Do. 4 per Cent. Debenture Stock)..... | 100 | 102 | 101 | 103 | 3 17 9 | ,, ,, | 102 | 101 |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary ..... | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. ..... | 14½ | 15½ | 14½ | 15½ | 6 9 0 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary ..... | 3 | 4 | 3 | 4 | 5 0 0 | April and October..... | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference ... | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures..... | 99⅞ | 103⅞ | 99⅞ | 103⅞ | 4 7 6 | January and July ..... | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable ..... | 10⅜ | 11⅛ | 10⅛ | 11⅛ | 6 1 9 | Jan., Apr., July, Oct. | 1⅜ | 10⅞ |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. ) | 99 | 102 | 99 | 102 | 4 8 3 | June and December ... | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary ..... .. ..... [to 1,200) (red.)... | 143 | 148 | 143 | 148 | 4 15 10 | Jan., Apr., July, Oct. | 148 | 145 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock.....xd | 89 | 92 | 91 | 94 | 3 14 6 | ,, ,, | 93 | 90½ |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) ..... | 110 | 114 | 110 | 114 | 3 10 10 | May and November ... | 113 | 111¼ |
| 300,000 | 10 | 2/6 | Eastern Extension ..... xd | 13⅜ | 14⅛ | 13⅜ | 14⅛ | 3 15 0 | Jan., Apr., July, Oct. | 14⅛ | 13⅛ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock..... | 110 | 115 | 110 | 115 | 3 10 10 | February and August | 111 | ... |
| £200,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909..... | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) .. | 100⅞ | 103⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November ... | 101 | ... |
| 150,000 | 10 | 5 0 | Great Northern of Copenhagen ..... | 30 | 32 | 30 | 32 | 4 13 9 | January and July ..... | 31 | ... |
| £278,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos | 99 | 102 | 99 | 102 | 4 8 3 | June and December ... | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European ..... [1 to 1,200) (red. | 43 | 47 | 43 | 47 | 5 6 5 | May and November ... | 45 | 43½ |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 ... | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) .... | 99 | 102 | 99 | 102 | 3 18 6 | June and December... | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) ..... | 99 | 102 | 100 | 103 | 4 19 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America..... | ¼ | ⅜ | ¼ | ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures ..... | 99 | 102 | 99 | 102 | 3 18 6 | January and July ..... | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama ..... | ⅜ | ⅝ | ⅜ | ⅝ | ... | May and November ... | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference ..... | 5 | 6 | 5 | 6 | 10 0 0 | ,, ,, | 5⅜ | 5 |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference ..... | 3 | 5 | 3 | 5 | 12 0 0 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures ..... | 101 | 104 | 101 | 104 | 4 16 2 | January and July ..... | ... | ... |
| 207,920 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) ..... | 13⅜ | 14⅛ | 13⅜ | 14⅛ | 4 18 3 | Mar., June, Oct., Dec. | 14 7/16 | 13 15/16 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) ..... | 101 | 104 | 101 | 104 | 4 16 2 | June and December... | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) ..... | 100 | 103 | 100 | 103 | 3 17 8 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) ..... | 3⅜ | 4⅛ | 3⅜ | 4⅛ | 4 14 2 | August ..... | ... | ... |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. ..... | 3/0 | 3/6 | 1/6 | 2/6 | 12 0 0 | April and October..... | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary ..... | ½ | ¾ | ½ | ¾ | 5 0 0 | November ..... | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference ..... | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, ,, | ... | ... |
| 590,000 | 5 | 2/6 | National..... | 3⅜ | 3⅝ | 3¼ | 3⅜ | 7 17 2 | February and August | 3 13/16 | 3⅝ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference .. | 11 | 12 | 11 | 13 | 4 12 1 | ,, ,, | 11½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference ... | 11 | 12 | 11 | 13 | 4 12 4 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. .. | 4⅛ | 4⅜ | 4⅛ | 4⅜ | 5 14 3 | ,, ,, | 4 3/16 | ... |
| †£1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) ..... | 90 | 93 | 90 | 93 | 3 15 3 | June and December ... | 90 | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) ..... | 95 | 98 | 95 | 98 | 4 1 10 | ... | ... | ... |
| 171,504 | 1 | 0/8⅜ | Oriental ..... | ⅞ | 1 | ⅞ | 1 | 6 0 0 | April and October..... | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate ..... xd | 5 | 5½ | 5 | 5½ | 6 7 3 | July ..... | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. ..... | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December ... | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.)..... | 101 | 104 | 101 | 104 | 4 16 2 | June and December ... | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref..... | ⅜ | ½ | ⅜ | ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary ..... | 1/16 | 1/8 | 1/16 | 1/8 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference ..... | ⅜ | ½ | 7/16 | 1/2 | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary ..... ... | 10 | 11 | 10 | 11 | 6 16 4 | July and February ... | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference ..... xd | 6 | 6⅜ | 6 | 6⅜ | 4 12 4 | January and July ..... | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference..... | 4⅛ | 5 | 4⅜ | 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering ..... | 1⅛ | 1⅜ | 1⅛ | 1⅜ | 5 14 3 | September ..... | 1⅛ | ... |
| 15,731 | 2 | ... | Do. £1 paid ..... | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2⅜ | Do. 5 per Cent. Pref. Non-Cum. ..... | 2 | 2⅛ | 2 | 2⅛ | 5 6 8 | ,, | 2⅛ | 2 |
| 15,731 | 2 | ... | Do. £1 paid..... | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock ... | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock ..... | 99 | 102 | 99 | 102 | 4 8 3 | January and July ..... | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. ..... | 14 | 15 | 14 | 15 | 5 0 0 | ,, ,, | 14⅜ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference..... | 5½ | 6 | 5½ | 6 | 4 3 4 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.)..... | 107 | 111 | 107 | 111 | 4 1 0 | November and May ... | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid)..... | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) ..... | 93 | 97 | 93 | 97 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary ..... | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 15 7 | March ..... | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference ..... | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9⅜ | Crompton and Co. (Nos. 1 to 54,000) ..... | 3⅞ | 4 | 3⅞ | 4 | 5 12 7 | January and July ..... | 3⅞ | 3⅞ |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.) .. | 100 | 105 | 100 | 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref..... | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) .. | 1 | 1¼ | 1 | 1¼ | 10 12 0 | February and August | 1 | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid)..... | 2 | 3 | 2 | 3 | 8 16 6 | ,, ,, | ... | ... |
| †£344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb.Stock(red.) .. | 80 | 85 | 80 | 85 | 4 14 0 | June and December... | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 92 | 96 | 92 | 96 | 5 4 0 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord.....xd | 5½ | 6 | 5½ | 6 | 4 3 4 | Half-yearly ..... | 5 9/16 | 5 5/16 |
| 10,000 | 5 | 1/6⅛ | Do. 6% Cumulative Preference ..... | 5½ | 6 | 5½ | 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) . xd | 102 | 105 | 102 | 105 | 4 5 9 | ... | ... | ... |
| 112,100 | 5 | 1/4⅜ | Electric Construction Co..... xd | 1⅜ | 2⅛ | 1⅜ | 2⅛ | 5 6 8 | January and July ..... | 1⅜ | 1 13/16 |
| 25,000 | 2 | 2/9⅜ | Do. 7 per Cent. Cumulative Preference..... xd | 2⅛ | 3 | 2⅛ | 3 | 4 13 4 | July ..... | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.)...xd | 98 | 102 | 98 | 102 | 3 18 5 | January and July ..... | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. ..... | 9⅜ | 10⅛ | 9⅛ | 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures ..... | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary ..... ..... | 15⅞ | 16⅛ | 15⅞ | 16⅛ | 6 1 3 | February and August | 16⅛ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... ..... | 5⅞ | 6 | 5⅞ | 6 | 3 15 0 | ,, ,, | 5⅞ | 5⅝ |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb.Stock(red.) ... | 108 | 112 | 108 | 112 | 4 1 5 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works ..... | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | 21⅛ | 21⅛ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. .....xd | 36 | 40 | 37 | 41 | 5 2 5 | March and July ..... | 38 | 38 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 ..... | 101 | 104 | 101 | 104 | 3 17 0 | January and July ..... | 103⅜ | 102½ |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary ..... ..... | 10⅛ | 11⅛ | 10⅛ | 11⅛ | 5 4 4 | ... | 10⅜ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent.Cumulative Preference..... | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary ..... ..... | 10 | 11 | 10 | 11 | 5 9 0 | April and October..... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. . ..... ..... | 6½ | 7 | 6½ | 7 | 4 5 9 | ,, ,, | 6 15/16 | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures . | 105 | 107 | 105 | 107 | 4 0 2 | May and November ... | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | | | |
| 19,200 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. xd | 5 | 6 | 5 | 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust ..... | 9⅜ | 10½ | 10 | 10⅛ | 5 0 0 | Jan., Apr., July, Oct. | 10½ | 10 |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference ..... | 14⅜ | 15⅛ | 14⅜ | 15⅛ | 3 18 8 | ,, ,, | 15⅛ | 14⅝ |
| 11,839 | 8 | 4/0 | Reuter's..... | 7 | 8 | 7 | 8 | 5 0 0 | April and October..... | 7⅛ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust..... ... ..... | 125 | 130 | 125 | 130 | 4 12 10 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,211. [No. 15. Vol. XLVII.] FRIDAY, AUGUST 2, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 3d., or 15 cents, or 30c., or 70pf.


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## NOTES.

IT is with great satisfaction that we announce that the Manchester and Liverpool Electric Express Railway Bill has been passed by the Committees of both Houses of Parliament, and is, therefore, practically certain to be realised in the actual railway. There was ample justification for the decision of the Committees to pass this bill, notwithstanding the uncertainties and daring novelties of the scheme. Were every apparently daring novelty to be tabooed by Parliament, progress would be well-nigh impossible. And although there has been a large amount of railway expert official evidence hurled against the scheme, there has been, on the other hand, the expression of the serious conviction of a large number of leading electrical engineers that the scheme, as a whole, is feasible. Whether this particular high-speed railway will prove a financial success is not a question that need trouble the minds of engineers for the present. They should be grateful to Parliament for having granted permission for so important an experiment to be carried out on a commercial scale. A highly commendable feature of the changes in the bill made by the House of Commons Committee is that which provides for the supervision of all the plans and construction work by the Board of Trade, which is authorised to order any necessary experiments and trials to be carried out, at the expense of the railway company, during the construction of the line. We may expect, therefore, that all the moot points which have been raised as to brake power, windage, &c., will be experimentally settled on a working scale before the public is permitted to risk its precious life on this remarkable railway.

OUR "City Notes" this week give particulars of a significant promotion, entitled Electric Propulsion (Ltd.), with a capital of £100,000. This new company is formed for the purpose of manufacturing and supplying electric and other vehicles, together with the plant and accessories connected with this rapidly growing industry. The British patent rights of the Still system are to be acquired and should prove a valuable asset. For Mr. STILL has expended a large amount of time and inventive skill in developing the electric motor vehicle, with the result that a large business in the manufacture of Still motor cars has grown up in Canada. It is proposed to commence the erection of large works in England for the manufacture of these and other motor cars to supply the British market.

THE chief significance of this promotion lies in its being an indication of the rapid growth of one of the latest developments of electrical engineering. Amidst the crowd of motor cars now being hurried on to the market to meet the clamorous demand of society for the new pastime of motoring, and the not less important demand of the business public for light or heavy goods vehicles, there is plenty of room for the electrically-driven car. Doubtless, in the matter of long-distance travel the steam or oil-propelled car has the advantage over electricity; but for ordinary use within a radius of 30 or 40 miles, if not more, probably nothing is so convenient, serviceable and pleasant as an electric car. The readiness of control, smoothness of running, and absence of vapour or vibration are its great points, and in the matter of cost it should prove far cheaper than horseflesh. Electric motor cars in the streets of our larger cities are fast increasing in numbers, and the time is probably not far off when small towns and even villages will discover an advantage to themselves in being able to offer the electric "motorist" a convenient charge-up.

WE have received a copy of the revised rules lately issued by the combined fire insurance offices relating to electric motors in textile mills, wood-working factories and other premises where the use of open motors may be attended with fire risks. The principal difference between the new rules



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and those previously in force is that ventilating holes are now allowed in the outer metal case, provided the openings are protected by wire gauze. This concession to the electrical industry takes the form of a note, which reads as follows :—

NOTE.—Inspection holes fitted with plate glass are allowed. Motors and resistances must be suitably designed to withstand, without serious overheating, the effect of the absence of ventilation incidental to the use of a metal case. Ventilation, if any, must be only by direct communication with the outer air or by openings in the vertical portion of the metal case, protected by two thicknesses of wire gauze set at least ½in. apart permanently attached to the case.

We are glad to observe this recognition by the insurance companies of the fact that it is not dangerous *per se* to ventilate electrical machinery, and the concession should be a valuable one to the large number of manufacturers who have made a speciality of motors of the semi-enclosed type. These machines, as generally designed, will now fall within the rules, if the gauze protector is used, and consequently the whole cost of installation will be considerably reduced, and at the same time the weights of the motors will be diminished.

IT has become the recognised tradition of the majority of engineering associations to meet for a few days every summer in some manufacturing centre, where they can have every facility of studying the most recent progress of the special branch of engineering with which they are concerned. The interests being so varied, the meeting places are also many, but this year the great majority of engineering corporate bodies decided to visit Glasgow, with the result that an International Engineering Congress will be held in that city, at which no less than 27 British societies and institutions are to take part, whilst a large number of foreign countries and societies will be represented by delegates. The Congress provides for both entertainment and work. The latter can be gauged by the number of electrical Papers, a list of which we publish in another column; whilst special visits will be paid to 80 works, and members may visit many more if so inclined. The entertainment consists of excursions each day to almost every place of interest that could be managed in an interval of five hours, whilst in the evenings there is to be a banquet, a reception, and a ball.

WE reprint elsewhere two interesting American criticisms on the subject of electric traction—viz., "A Lesson in Advanced Electric Traction" and "The Electrical Equipment of the District and Metropolitan Railways." Of late the practice of the English electric tramway engineer has been more and more to follow American standards, so it is especially instructive to learn that the leading technical paper in the electrical industry of the United States considers that the American has ruminated a year or so too many, and that now is the time "when the new methods must be tried and worked out to their legitimate ends." These new methods are the three-phase system now being worked out on the continent of Europe. Mr. YERKES, on the other hand, looks at the question from the capitalist's point of view when he states—"To take a system which has not been thoroughly tested, not for a few, but for many months, and even years, is a species of business recklessness which I do not wish to try." The best method to adopt for the Metropolitan and the Metropolitan District Railways will, we hope, soon be threshed out before the Board of Trade, but we agree with Mr. YERKES that a greater profit could be gained by the two companies working under one official head than with the two companies separate, as at present.

University College, London.—The next session begins on October 2nd. Prospectuses may be obtained from the secretary, Mr. T. Gregory Foster.

Owens College, Manchester.—Some particulars of the course of instruction in electrical engineering are given in an advertisement elsewhere.

Cable Communications Committee.—This Committee met again last week, when evidence was tendered by Mr. W. H. Mercer, Crown Agent for the Colonies.

Visit of the Lord Mayor and Sheriffs of London to the British Westinghouse Co.'s Works.—In connection with the visit of the Lord Mayor and Sheriffs of London to Manchester, the Lord Mayor will to-morrow lay the corner stone of the British Westinghouse Electric and Manufacturing Co.'s Works at Trafford Park.

University Intelligence.—Among the successful candidates in the recent D.Sc. examination of the University of London were Messrs. C. V. Drysdale (of the Northampton Institute), W. H. Eccles (of the South-Western Polytechnic), and P. E. Shaw (of the University College, Nottingham). In each case the candidate's choice was experimental physics.

Cable Interruptions and Repairs :—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Cayenne—Pinheiros | April 21, 1901 | — |
| San Domingo—Curaçao | July 12, 1901 | July 31, 1901 |
| Anjer—Kalianda | July 30, 1901 | — |
| Trinidad—Demerara | July 30, 1901 | — |

Personal.—Mr. Walter J. Murphy has, with the consent of the directors of the Eastern Telegraph Co., resigned from the service in order to establish himself in private practice as a consulting engineer and electrician. Mr. Murphy's address is 25, Victoria-street, Westminster, London; the Royal Society's Club, St. James-street, London; or Horsenden Lodge, Harrow-on-the-Hill.

The National Antarctic Expedition.—*The Times* states that Mr. Louis Bernacchi accompanies the expedition as specialist in terrestrial magnetism. Ample arrangements have been made on board for special work in various departments of science; there is a magnetic observatory and biological, chemical, and physical laboratories, and an ample supply of instruments and apparatus of the latest and best forms has been provided for scientific research of all kinds.

Windmills for Electric Light on the ss. "Discovery."—It will be remembered that the ss. "Fram" was fitted with a windmill coupled to a dynamo for her Arctic voyage to be used for charging accumulators when her engines were not at work. The ss. "Discovery" has also been fitted in the same way for her Antarctic trip, and in this case Messrs. Bergtheil and Young, who have fitted up the installation, have used a windmill coupled to two dynamos which are connected to help each other when the wind is light, or to oppose each other when the wind is strong.

Breakdown of Insulation of High-Voltage Cables.—The *Electrical World* of New York, in a recent issue, records the breakdown of a cable rubber-covered to a depth of $\frac{9}{32}$in., and which stood the test of 50,000 volts for 10min. between wire and outer covering. It was thought that extreme precautions would not be necessary with a wire of such heavy insulation, and the wire was run through the brick wall in clay tubes, and carried in porcelain clamp insulators. After a week of continuous service at 22,000 volts the insulation broke down in three places.

An Electrical Hub Motor-driven Omnibus.—The *Western Electrician* of Chicago, for June 13th, describes the electrical omnibus that will probably be in active use in Chicago in a few weeks. The vehicle is designed to carry 20 passengers inside and 20 outside. It is driven by four four-pole motors built into the wheel hubs. Each motor is rated at 7 H.P.,

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requiring 38 amperes at 160 volts. At a test at Pittsburg, before shipment to Chicago, the vehicle ran at 6·8 miles an hour, with a dead weight of 8½ tons, the pressure being 63 volts and the current 80 to 85 amperes. The 'bus weighs 13,115lb. without battery.

Obituaries.—We regret to announce the death of Mr. Slater Lewis, who succumbed to paralysis on Saturday last. Mr. Lewis was a director of the Brush Electrical Engineering Co., of the Swansea Electric Tramway Co., and of the Merthyr Electric Tramway Co. He was for many years engaged in manufacturing pursuits, being closely identified with the Birmingham Telegraph Factory, the Fowler Lancaster Co., and in the early days with the Telegraph Manufacturing Co. He was also for some time general manager to Messrs. P. R. Jackson & Co. He was a writer on technical subjects, and a short time ago published a bulky volume on "Works Management."

The death took place yesterday (Thursday) morning of Mr. John Palfreman, chief engineer at the Houses of Parliament for about three years. Mr. Palfreman was previously chief engineer at the Law Courts.

A 90-Mile Run on an Electric Automobile.—On Monday last one of the new type of sporting dog carts being introduced by "Electric Propulsion (Ltd.)," started on a trial trip from Messrs. Morgan & Co.'s, the carriage builders, in Long Acre, en route to Bath. The roads being shockingly bad after the recent heavy rains, it did not reach Bath as intended, but succeeded in reaching Calne (Wilts.), a distance of over 90 miles from the London depôt, with one battery charge. An official observer of the Automobile Club accompanied the drive. The vehicle only weighed 31¼cwt., being the total weight of car with two passengers, the "Ideal" storage battery used for propelling this dog cart weighing 17cwt. We understand the company will shortly build another type of vehicle estimated to run from 140 to 150 miles on one charge, and when finished the company will invite all other makers of "electric vehicles" to join them in a friendly run of 120 to 150 miles on one charge.

Finsen Light Treatment of Lupus.—The opening of the department for the treatment of *lupus vulgaris* at the Manchester and Salford Hospital for Skin Diseases took place on the 26th ult. At present one arc lamp of about 30,000 nominal candle-power has been installed, but by an arrangement of collectors four patients can be treated at the same time. The collectors are made of siberian rock crystal filled with distilled water. The portion of the skin being treated is compressed with two pieces of glass set in a metal frame, between which a constant stream of cold water is kept running. The pressure is to remove the blood from the skin, whilst the flow of water helps to further keep the skin cool. About a quarter of a square inch is treated for about 50 minutes; antiseptic ointment is then put on, and in a few days the skin is completely healed. Twenty patients can be treated each day, and although the treatment has been in operation for only a month, 34 patients are waiting for a vacancy.

A Form of Artificial Submarine Cable.—Mr. Augustus Trowbridge, in the June number of the *Physical Review*, describes an electrolytic capacity for use in artificial submarine cables. It consists of short lengths of glass tubing, about 1cm. in diameter, with a platinum wire as an electrode sealed in to one end. The tube is filled nearly full of distilled water, and the other electrode, which is a piece of platinum foil about 3mm. wide, was corked in so as to dip about 5mm. into the water. In the cable made 39 such cells were used, arranged in 13 sets of 3 cells each. The 13 resistances aggregated about one million ohms. The galvanometer had a figure of merit of $10^{-8}$ amperes, which made a signal to consist of a small but very marked throw of the instrument. It was found convenient to mount the cells on a thin board, in which a triple row of holes were drilled just large enough to allow the wire electrodes to project a few millimetres from the under side, and to have this board rest on another, in which were three troughs filled with mercury to serve as an earth connection for all the wire electrodes. If the board carrying the cells are lifted, all the capacity is at once removed from the system, and a signal is sent along the conductor with no appreciable time-lag. The time-lag when the capacities were in was about 6 seconds. A single Daniell or Leclanché cell was used.

Special Report on Steam Engines and Boilers (Persons in Charge) Bill.—A Parliamentary paper has just been issued containing the special report on this bill. The Committee report that in their opinion there is no necessity for any system of certificates for persons in charge of land boilers and engines, seeing that the facts and figures brought to their knowledge indicate that great care appears to be taken in the selection of capable, trustworthy and qualified persons to take charge of engines and boilers, and that the owner of the engine or boiler, on whom the liability rests in case of accidents and explosion, is the person on whom the absolute responsibility of selection should continue to be placed. The committee consider that if a system limiting the charge and control of boilers and engines to certificated persons were established, it would unduly restrict the opportunities of selection, especially in outlying localities, and, while such certificates would offer some guarantee of technical knowledge, there would be a danger that less attention would be paid to the more important questions as to practical experience, moral character, nerve and common sense of an individual applicant. The Committee report that, having regard to the enormous number of boilers in use, the figures for recent years do not indicate that accidents arising from ignorance on the part of the persons in charge are numerous. The Committee are of opinion that the provisions of the Mines Regulation Act, 1887, the general rules incorporated with that act, and the special rules which are fully detailed in the evidence of Mr. Ellis are admirably adapted to secure the selection of competent persons for taking charge of engines and boilers, and for fixing the responsibility in the case of mines. The Committee consider that any proposal to place under the Board of Trade the men in charge of engines and boilers in factories or mines, at present subject to the inspection of the Home Office, would be objectionable, as it is undesirable and uneconomical to create dual control.

The New Lightning Arresters at Niagara Falls.—The *Electrical World* of New York, in describing the new lightning arresters for the 22,000 volt circuits, states that, after passing through a long 36in. fuse, which is of about No. 28 German silver wire enclosed in a hard fibre tube of about ⅞in. inside diameter, the circuit is led through an adjustable spark-gap between balls to a bank of 10 arresters, each of which has seven cylinders of non-arcing metal. There are, therefore, six gaps in series on each arrester and 10 arresters in series, making 60 gaps in series. The gaps are slightly less than $\frac{1}{32}$in. but are to be enlarged to $\frac{1}{32}$in. After passing through the first bank of 10 arresters, the circuit passes through a resistance of 380 ohms, and then through a resistance of 280 ohms to ground. In shunt with 380 ohms resistance is a bank of eight arresters or 48 gaps. The discharge first takes place over the adjustable gap of ⅜in. or ½in. between the balls and then over the 60 gaps and through the resistance to ground. The flow of current over the 380 ohms resistance is sufficient to create a potential which breaks over the 48 gaps. Each of the high-tension transmission lines has a set of three arresters mounted on marble boards on the three sides of a square frame. This frame is mounted on rollers so that in case a set of arresters is damaged it can be wheeled out and another set put in its place. Connection with the line is made through the fuses, which hook into flexible spring contacts at their upper ends. These springs permit of some variation in the location of the arresters. The fuses are detachable and interchangeable, and can be removed at any time by means of a wooden handle which is attached to the fibre tube. At the top these fuses are fastened into a terminal which ends in a hook which screws as a plug into the top of the tube. The bottom of the tube is open and the fuse wire passes to an outside terminal. There are six choke coils with 17 turns per coil in series with each arrester. On the 24 miles of 22,000 volt line there are three arrester stations, one at Niagara Falls power house, one at Tonawanda sub-station and one at the sub-station at Buffalo.

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**Electrical Transmission at Messrs. A. Ransome & Co.'s New Works.**—*Engineering* for July 19th gives a description of Messrs. A. Ransome & Co.'s new works at Newark, which they have just built, covering an area of 12 acres, and in which electrical transmission is used. In the generating station are two 100 H.P. Stockport gas engines, driving two Laurence Scott dynamos by rope gear. These two units supply all the power and light for the premises; the producers for making gas for the engines are by Messrs. Paisley and Welch. Anthracite is the fuel used, and it is found by experience that 1 B.H.P. at the switchboard is obtained at a cost of 1¼lb. of coal when running at full power. Every department in the works is driven by electricity. The motors are of the Norwich type, multipolar, 205 volts, each machine being of 65kw. There are underground conduits and lead-covered cables, with distributing fuse-boxes in each shop. The engines run at 180 revs., and the dynamo at 500 revs. There are main distribution boxes in each shop to the separate motors. It may be stated that the producers, of 200 H.P. each, are double the capacity at present worked, the additional power being given with a view to extension. The gases pass through what is termed a superheating tube. No sawdust scrubber is needed with this plant. The producers also supply gas for a muffle furnace in the tool-room, and a small gas engine for office lighting, when the main engines are not running. In the foundry the blowers, cranes, mixers, grinding machinery, &c., are all driven by electricity. In the main shop there are two lines of shafting, each 200ft. long, and each line is cut into two, but connected by a clutch. There is a separate motor to each length, or four motors in all, each of 20 H.P. In this way the whole length of one shaft can be driven by one or both of its motors. In the fitting shop small groups of tools are driven by separate motors, and the trial shop, which is an important feature in these works, is driven by another 20 H.P. motor furnished with an electric resistance, so that the speed of rotation can be varied instantly from 100 revs. to 500 revs. per min. This is a convenient arrangement for doing away with the use of change pulleys when testing. Here are provided ammeters and voltmeters, so that the power absorbed in working machinery under given conditions can be at once ascertained.

**International Engineering Congress at Glasgow.**—This congress will be held on September 3rd, 4th, 5th and 6th. Those to whom invitations have already been issued and members of societies specified by the Executive committee, are eligible for membership of the congress, and become members on payment of the subscription of 10s. 6d. to the general secretary. The billeting committee has secured a number of rooms in hotels in Glasgow and neighbourhood, which will be allotted by ballot among members who apply on special form before 10 a.m. on August 10th. Each member will be entitled to a volume of abstracts of the Papers read in all the sections, and this volume will be forwarded to him as soon as possible after the close of the congress. Lord Kelvin has been appointed honorary president, Mr. James Mansergh president and chairman of the General committee, and Mr. Robert Caird chairman of the reception committee. The electrical sub-committee for visits to works is composed of the following gentlemen:—Messrs. W. A. Chamen, M. B. Field, W. W. Lackie, Prof. Magnus Maclean, Messrs. W. B. Sayers, E. George Tidd and W. G. M'Millan, with Mr. H. A. Mavor as convener. The following is a list of Papers which will be of interest to electrical engineers:—

*Section I.*—Railways. Chairman: Sir Benjamin Baker. PAPERS: A. Timmis, "Modern Practice in Railway Signalling." Prof. C. A. Carus-Wilson, M.A., "The Economy of Electricity as a Motive Power on Railways at present driven by Steam."

*Section III.*—The Institution of Mechanical Engineers. Chairman: Mr. William H. Maw. PAPERS: Hon. C. A. Parsons and G. Gerald Stoney, "Trials of Steam Turbines for Driving Dynamos." James Rowan, "A Premium System of Remunerating Labour." Arthur Greenwood, "Application of Metric System to Workshops." James Crighton and W. G. Riddell, "Power Required to Drive Marine Engine Works and for Electric Lighting." William Weir and J. R. Richmond, "Workshop Methods." Gisbert Kapp, "Rating and Testing of Electrical Machinery." R. Lenke, "Some Experiences and Results Derived from the Use of Superheated Steam in Engines." A. Rateau, "A Regenerative Steam-Accumulator and its Application to the Utilisation of Exhaust Steam."

*Section VI.*—The Institution of Mining Engineers. Chairman: Mr. James S. Dixon. PAPER: Sydney F. Walker, "Alternating Currents and their Possible Application to Mining." Part 2.

*Section VII.*—The Incorporated Association of Municipal and County Engineers. Chairman: Mr. E. George Mawby. PAPER: James More, "Recent Tramway Practice."

*Section VIII.*—The Institution of Gas Engineers. Chairman: Mr. George Livesey. PAPER: Dr. Leyboldt (Hamburg), "Electrolysis of Gas Pipes, &c."

*Section IX.*—The Institution of Electrical Engineers. Chairman: Mr. W. G. Langdon. PAPERS: Chairman, Short Introductory Address. "Notes on the Electrical Exhibits in the Exhibition." J. R. Dick, "Electricity Supply Meters of the Electrolytic Type." M. B. Field, "The Relative Advantages of the Three, Two and Single-Phase Systems for Feeding Low-tension Networks." H. M. Hobart, "Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits." Prof. A. Jamieson, "The Protection of Trolley Wires." Prof. M. Maclean, "Kelvin's Electric Measuring Instruments." H. A. Mavor, "Continuous-Current Dynamo Design." A. R. Sennett, "The Use of Electricity in the Propulsion of Road Vehicles." Herr Lasche (Berlin), "High-speed Railways."

The programme, giving full particulars, and illustrated guide to excursions can be obtained from the general secretary, Mr. J. D. Cormack, 105, West George-street, Glasgow.

**Transformer Switching Arrangements in the Western States.**—The *Electrical World* of New York, in its second article on "Western Practice," mentions that one very good arrangement, with oil-cooled transformers, is to have each transformer connected on to the mains by double-pole switches on both primary and secondary. The transformers are then each mounted on a four-wheel truck, which runs on a track running the length of the transformer room, and there is a turntable in front of each transformer, so that each one can be cut out, run out on the main track and out of the station into the open air in case it should catch fire. In such case the leads would have to be disconnected before the transformer was rolled out, and a reserve transformer could then be rolled in and connected in its place. A still further refinement of this plan, where only one bank of transformers with one in reserve is used is to have a double-pole double-throw switch or its equivalent on both high and low-tension sides of a transformer. Throwing these switches one way connects in the transformer. Throwing them the other way connects in the reserve transformer in its place. With air-blast transformers the trucks cannot be used. The ideally flexible arrangement, where there are several banks of transformers and more than one high-tension line, is one that will permit any bank of transformers to be used on any line. If there are two lines, double-throw switches on the high-tension side of each bank of transformers will accomplish this, but if there are three lines or more the only scheme yet devised and put in use in the West is the plug board principle as installed at Snoqualmie Falls. In this each bank of transformers is connected through three long-break Westinghouse trigger switches to three 'bus bars running crossways of the transformer room. The four three-phase transmission lines are connected through similar switches to 12 'bus bars running lengthways of the transformer room and about 8ft. above the transformer 'bus bars. By plugging together at 'bus bars intersections any bank can be put on any line. As a rule, most of the Western transmission plants have a sufficiently steady load, so that both light and power can be operated from the same transmission line and transformers, and hence everything is operated in multiple. The transformer primaries switchboards in the generating station usually have double-throw switches for connecting each bank to either the upper or lower 'bus from the generator panels. One notable exception is the Independent Electric Light and Power Co.'s switchboard at San Francisco, where in ordinary operation each generator is operated as a unit with one bank of three transformers. The high-tension side of each generator-transformer unit can be connected to any one or all of three sets of high-tension 'bus bars. The generator panel is arranged with two single-pole switches, so that each generator can be thrown either on its bank of transformers or on a common 'bus bar. Ordinarily the generator is connected to its own bank of transformers. In case of emergency the bank of transformers belonging to one generator can be connected to another generator by raising the brushes on the first generator, closing the switches connecting it to its transformers, and also the switch connecting it to the 'bus bars, and also closing the switch connecting the second generator to the 'bus bars.

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## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Electrical Black Body.*—O. Lummer and F. Kurlbaum describe their electrically heated "ideal black body," with which they proved that the total radiation of such a body is proportional to the fourth power of the absolute temperature. It consists of a double cylinder, the outer one being of platinum, which is electrically heated, while the inner one is of porcelain lined with a mixture of chromium, nickel and cobalt oxides, which resists temperatures of over 1,500deg. A thermo-couple is introduced into the centre of the inner tube to determine its temperature. A series of diaphragms, getting narrower towards the end, lines the same tube. Thus the essential condition is fulfilled of having a hollow body with walls at a uniform temperature. If necessary, the inner tube is surrounded by two successive air chambers, the last being contained in an asbestos tube. Then a temperature of 1,560deg. may be obtained with a current of less than 100 amperes. At that point the porcelain used by the royal Prussian porcelain factory begins to soften and acquire a conductivity which interferes with the readings of the thermo-couple.

[LUMMER and KURLBAUM, *Ann. der Physik*, No. 8, 1901.]

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*Magnetic Action of Cathode Rays.*—Since the time of Hertz, it has been believed that though a magnet exerts a deflecting action upon a beam of cathode rays, the latter does not exert any corresponding action upon a magnet. There is an action, in fact, without a reaction. It has been explained by supposing that the return stream of cathode particles exactly neutralises the action exerted by the cathode beam. Even if, as in Hertz's experiment, the cathode beam filled practically the whole of the tube, the return stream might pass along the wall, and constitute an "inductionless winding." If, in such a case, a small magnet could be suspended in the cathode stream itself, it would probably show some deflection. That this is actually the case has been proved by J. von Geitler. He suspended a small magnet in a long and wide tube, in the centre of the stream, and found a deflection such as would have been produced by the current passing if an ordinary conductor had been substituted for the tube. On bringing the magnet near the wall of the tube, a contrary deflection was observed. This at once suggests the return stream, but the author wisely refrains from straightway adopting this obvious inference.

[J. VON GEITLER, *Ann. der Physik*, No. 8, 1901.]

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*Magnetic Elements at Geological Epochs.*—Our knowledge of the earth's magnetisation at remote periods is likely to experience an enormous expansion by the researches instituted by B. Brunhes and P. David. Encouraged by the success achieved by Folgheraiter in determining the magnetic dip of 3,000 years ago from Tuscan vases, the authors applied the same principle to geological deposits. It is known that clay at the time of baking is magnetised in the direction of the earth's field, and keeps that magnetisation for untold ages after cooling. An analogous case in nature occurs when a stream of lava traverses a bed of clay. A layer 2yds. or 3yds. thick is baked into a hard mass, which has the advantage over the Tuscan vases of retaining its orientation, so that not only the dip but the magnetic declination may be found. The authors actually found a well-defined magnetisation, different from the earth's field, in some cubes of such clay situated near the Puy-de-Dome. The dip was 56deg. 30min., and the declination 7deg. to the east of the present compass. It now remains to determine the age of the eruption. Incidentally, we obtain a test of the contemporary nature of two lava flows.

[B. BRUNHES and P. DAVID, *Comptes Rendus*, July 15, 1901.]

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*Analogy between Nernst Bodies and Gases.*—W. Kaufmann has shown that the electrodynamic behaviour of conducting gases may be deduced from an empirical curve $E = f(I)$, the so-called "characteristic," where E denotes the E.M.F. at the ends of the gaseous interval, and I the current intensity. For stability of equilibrium, the condition

$$W > -\frac{\delta E}{\delta I}$$

must be observed, W being the resistance of the remainder of the circuit. Since these results are obtained independently of the unknown mechanism of discharge, it follows that they must be applicable to any conductor whatever. Thus a solid body possessing a "characteristic" similar to that of a gas must show the same peculiarities, such as discharge potentials, minimum currents, and intermittent discharges. The author proves the existence of these peculiarities in a Nernst glow-body, and shows, incidentally, that the instability of the discharge at the point where the spark potential is reached is purely electrodynamic and has nothing to do with the inner mechanism of gaseous conduction. The "characteristic" of a Nernst body is

$$E/I = c\left(\frac{EI}{k} + T_0\right)^{-n}$$

where $\log c = 53{\cdot}18$, $k = 966$, and $n = 18{\cdot}2$. The resistance and temperature curve shows no singularities.

[W. KAUFMANN, *Ann. der Physik*, No. 8, 1901.]

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*Electric Suction.*—The blackening of a field of buckwheat blossoms by a thunderstorm is a well-known but hitherto unexplained phenomenon. The researches of Selim Lemström on the transport of water in capillary tubes under the influence of an electric current passing through the surrounding air shed a new light upon it. The author mounted a capillary tube in a beaker full of water, which was joined to earth. At a few centimetres above the capillary tube he fixed the pointed negative pole of an influence machine whose positive pole was put to earth. When the machine was worked water was sucked up along the walls of the tube, and formed drops near the top. The formation of drops is observed even when the distance between the pole and the level of the water is 75cm. The suction of water continues at even greater distances. The amount of water sucked up is proportional to the current intensity, and that, again, is inversely proportional to the square of the distance between the point and the meniscus. The amount is also, for the first three minutes or so, proportional to the duration of the current. Salt solutions act like water when dilute, but the amount sucked up is smaller. The connection with plant life is obvious, since all the vegetable humours rise through capillary tubes. The explanation must be connected with the transport of material particles in liquids described by Quincke.

[S. LEMSTRÖM, *Ann. der Physik*, No. 8, 1901.]

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*Induction Coils.*—The largely-increased demand for induction coils in consequence of the discovery of Röntgen rays has led to their more careful study by physicists and manufacturers. F. Klingelfuss has, as the result of such study, been enabled to produce considerably improved patterns. Two coils may be advantageously placed side by side, with their iron cores joined at one end and nearly joined at the other, leaving, however, an air space of 1cm. between, so as to obtain the maximum spark length. The latter, otherwise, increases directly as the number of windings. The insulation of the condenser sheets must be the better the smaller the number of windings of the secondary coil with which a given spark length is to be obtained, since the primary extra-current with the same magnetising current and the same capacity in the condenser assumes a higher E.M.F. the smaller the number of secondary windings. There is no direct ratio between the length of a spark and its E.M.F., since much depends upon the form of discharge and the resistance of the gas. It is even possible for sparks of the same length and the same apparent thickness to have different E.M.F.'s.

[F. KLINGELFUSS, *Ann. der Physik*, No. 8, 1901.]

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## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 523.*)

### MESSRS. SIEMENS AND HALSKE'S CABLE WORKS.

Messrs. Siemens and Halske's cable works, which were put into operation in August, 1899, are at Nonnendamm, on the northern side of the Spree, a little distance below Berlin, between Charlottenburg and Spandau. A general view of the works is given in Fig. 12, in which the extremely good transport facilities are made evident. A canal cut at right angles to the river leads past the longer side of the works, and affords a private harbour for barges bringing material to and from the factory, and, in addition, a direct connection is to be made with the main railway. Until the latter is accomplished a steam ferry is made use of, which conveys, if necessary, two

FIG. 12.—GENERAL VIEW OF SIEMENS AND HALSKE'S CABLE WORKS.

FIG. 13.—WIRE WINDING SHOP.

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railway trucks at a time to the other side of the river, where access is obtained to a siding of the Westend goods station.

The works have been erected on piles, and they consist of a three-sided block of four-floor buildings surrounding the main shops, where all the heavy work is done. There being no floor above these shops, they have a glass roof over them and are extremely well lighted. As has been mentioned in a previous article, what attracted immediate attention in the works was the extreme order and cleanliness throughout. Not only were the floors of the shops, the machines themselves,

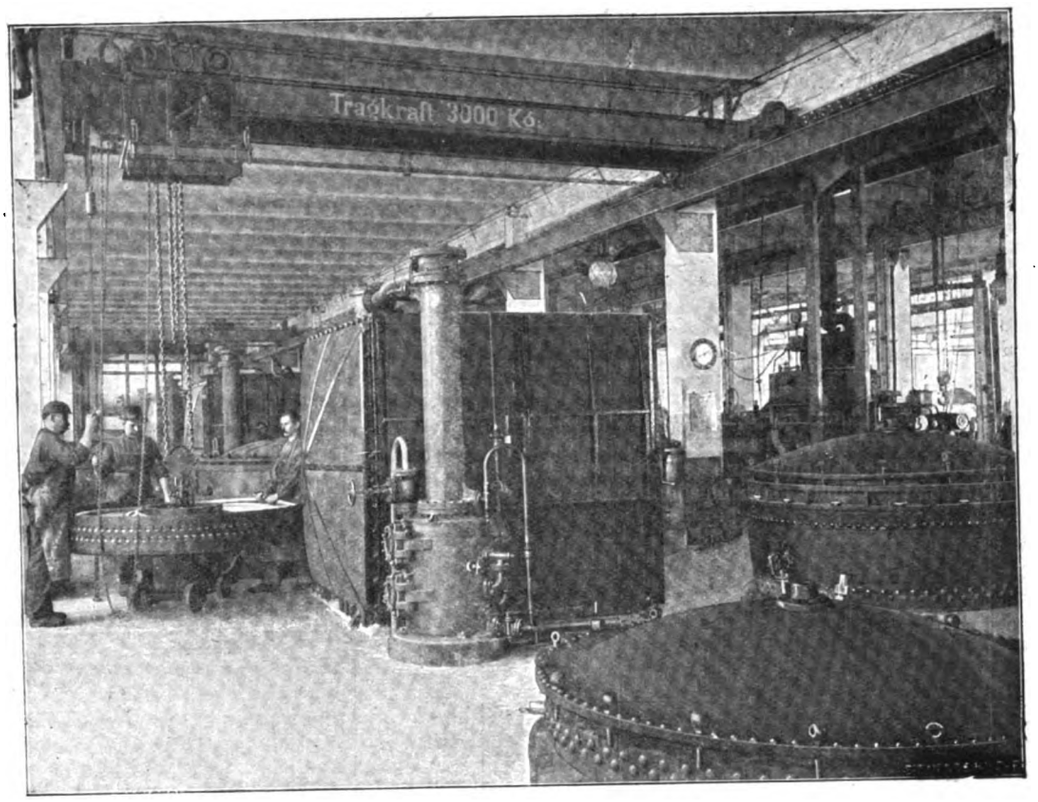


FIG. 14.—VACUUM DRYING AND IMPREGNATING TANKS.

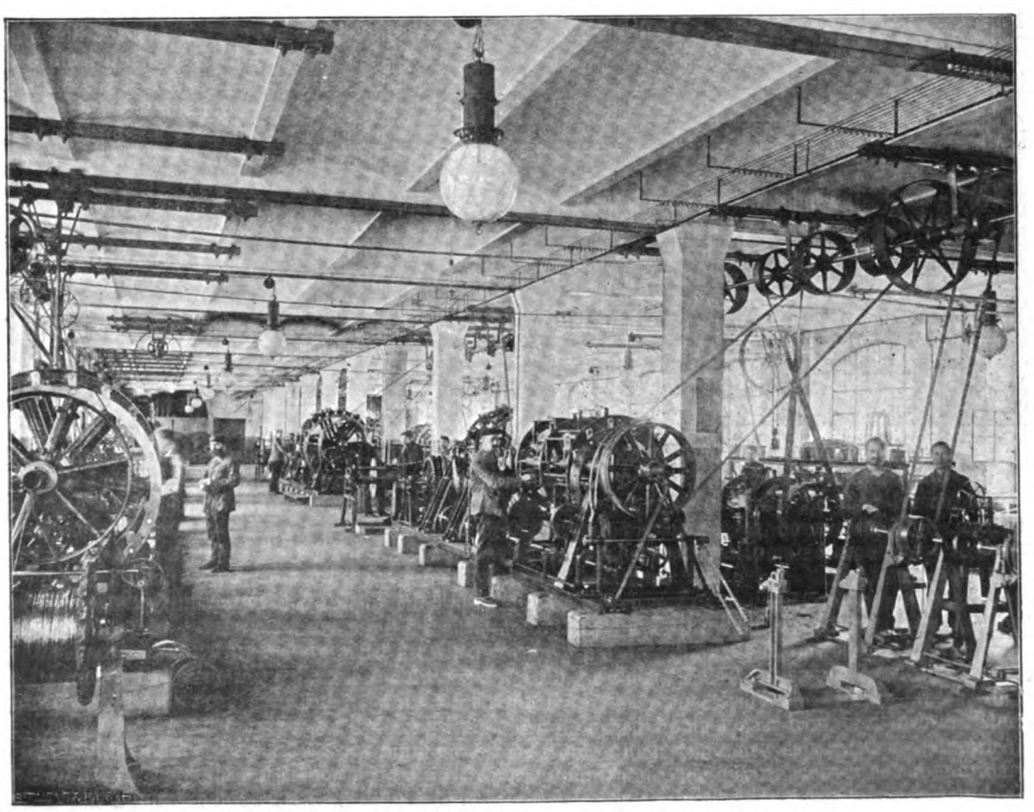

FIG. 16.—STRANDING SHOP FOR LIGHT CABLE.

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and the drums much cleaner than what is customary in the older-established works in England, but the tidiness of everything was remarkable. The arrangements are such that the drums of cable and reels of wire have but a short distance to travel between each of the processes, and, as a result, drums of finished and half-finished cable are always waiting in their proper places, and the "yard gang" is little in evidence. This general tidiness was, perhaps, more apparent than at ordinary times, owing to the fact that although there was an enormous amount of cable in its early stages of manufacture at the time of the visit, there was not so much completed and nearly completed cable being handled.

All the machinery is driven by electric motors, the usual system being followed of providing a motor for each of the larger machines and driving the lighter ones in groups. Continuous current at 2 × 110 volts is employed, and is supplied from a power-station equipped with two 600 H.P. sets, and with plenty of room for extensions.

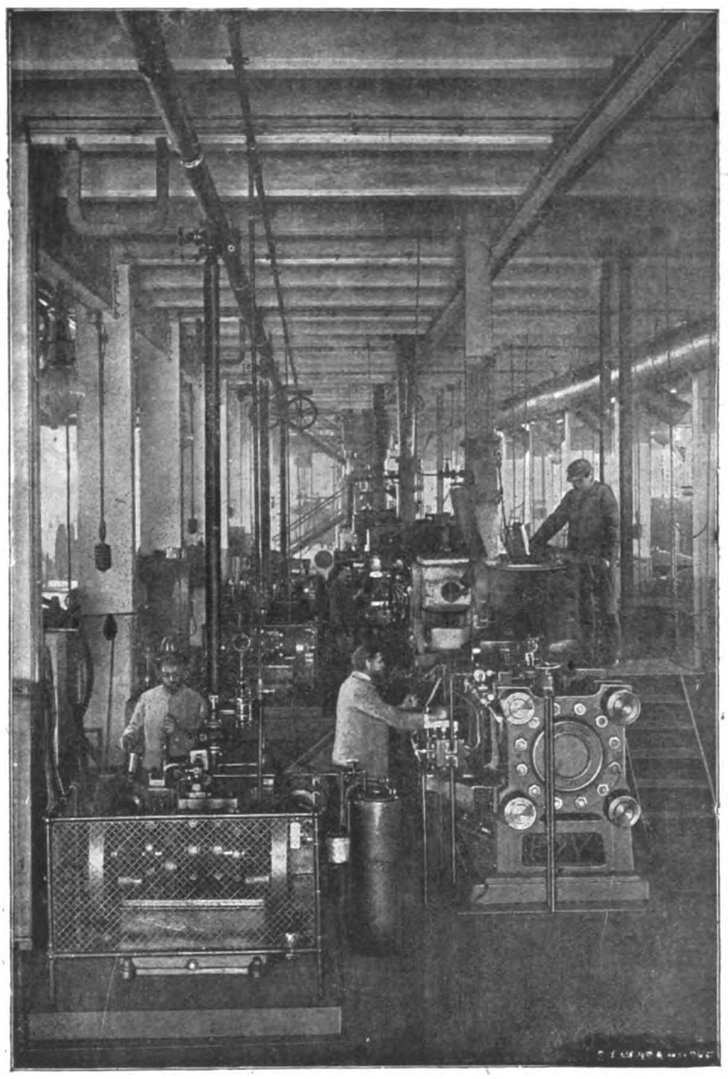

FIG. 15.—LEAD PRESSES.

In general, the methods of manufacture are much the same as are followed in England, as will be recognised in the illustrations of the various shops. One of the types of cable seen, which is not made much in this country, was the stranded steel wire for military purposes, which is stranded on small fast-speed machines in which the wire-bobbins are stationary and the cable is rotated. In passing through the works the plentiful employment of measuring machines was noticeable, and another of the controlling and checking apparatus was the time checker shown in Fig. 19, one of which is fixed at the door of each shop. The workman has merely to turn the handle to his number on a dial and press the handle, when the time is printed against his number on the recording paper. These time-registering apparatus serve also as watchmen's tell-tales.

A large amount of cotton-covering of small wires was being carried on, and the factory possesses numbers of the light machines for this class of work, so that it has facilities for turning it out rapidly. On some of the rows of small horizontal cotton-covering machines, one girl could attend to as many as 12 cotton-covering heads. The pure rubber covering, on the other hand, seemed to be slower, but this may only have been in comparison with the cotton-lapping near it. In this case there are four machines attended to by one girl, and they are so driven that all must be stopped in order to renew the supply of tape on one of the machines. For pairing telephone wires, small horizontal machines were mostly employed.

The braiding, especially on the smaller cables, seemed generally of rather looser texture than is customary in this country. Most of the braiding machines were of the same type as is used here, but there was one horizontal braiding machine for heavy work running very slowly. Two large vertical machines—one braiding wire for flexible cable used for mining drills and similar purposes, and the other braiding several-ply threads—had pendant weights on the thread or wire from each bobbin to equalise the tension during the motion of the bobbin towards and away from the cable.

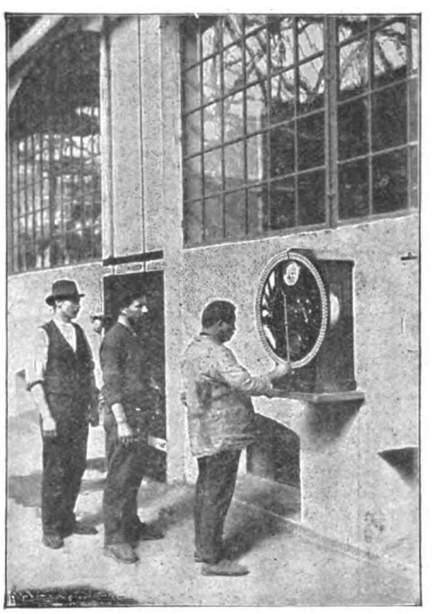

FIG. 19.—WORKMEN'S TIME CHECKER.

The amount of vulcanising rubber-covering done seemed small in proportion to the amount of other work. In this, again, the practice seemed to be much the same as here, with longitudinal machines for the smaller wires, and occasionally taping the rubber on the larger sizes. Fig. 18 is a view of the gutta-percha covering shop; the machine is of the "sausage machine" type, and the length of the cooling trough, through which the core passes several times, is about 35yds.

Modern vacuum drying and impregnating apparatus (Fig. 14) is employed* in place of the older drying-room method. Against the great saving of time and the cleaner and more scientific method, however, must be set the fact that coiling the cable in the trays and manipulating them apparently

* A description of some forms of these drying chambers appeared in *The Electrician*, Vol. XLI., pp. 385 and 661.

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required more hands than does the ordinary winding on to skeleton drums and conveying to the drying room and impregnating tanks on the old system; and this charging operation takes a longer time also, although the drying and impregnating

projects just sufficiently from beneath the floor to engage the flange of the drum and turn it by friction. The trouble occasioned by this is evidently due to the necessity of using exactly standardised sizes of drums for this purpose, and the inequality

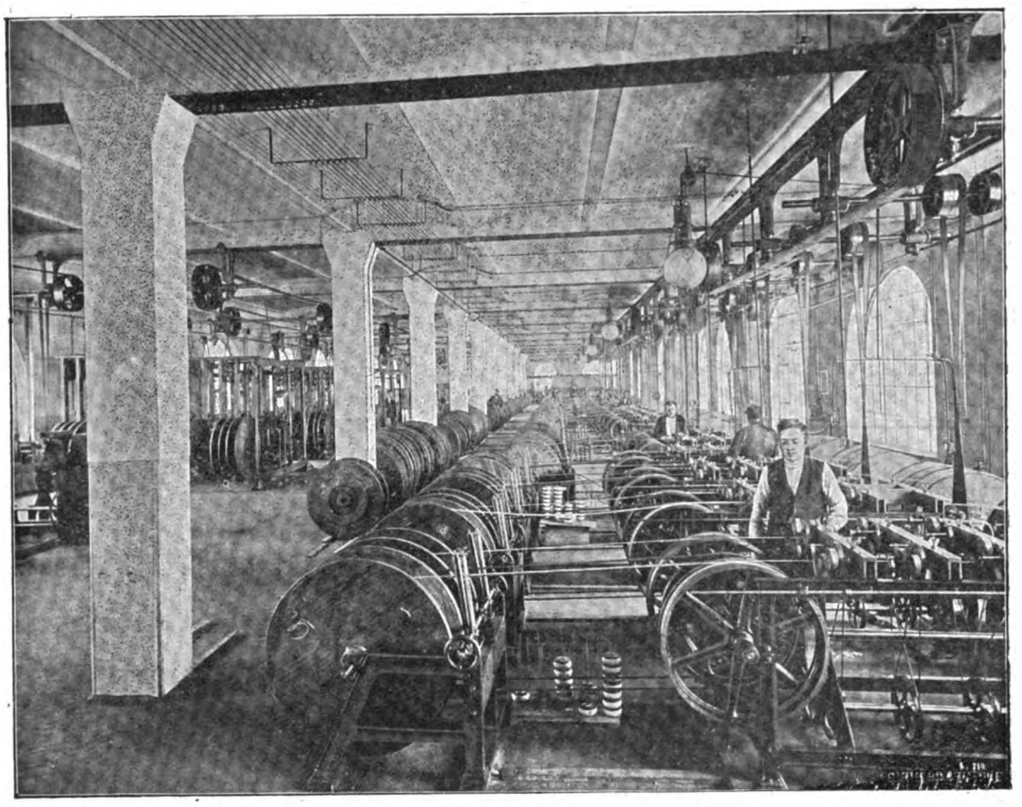

FIG. 17.—COTTON-COVERING SHOP.

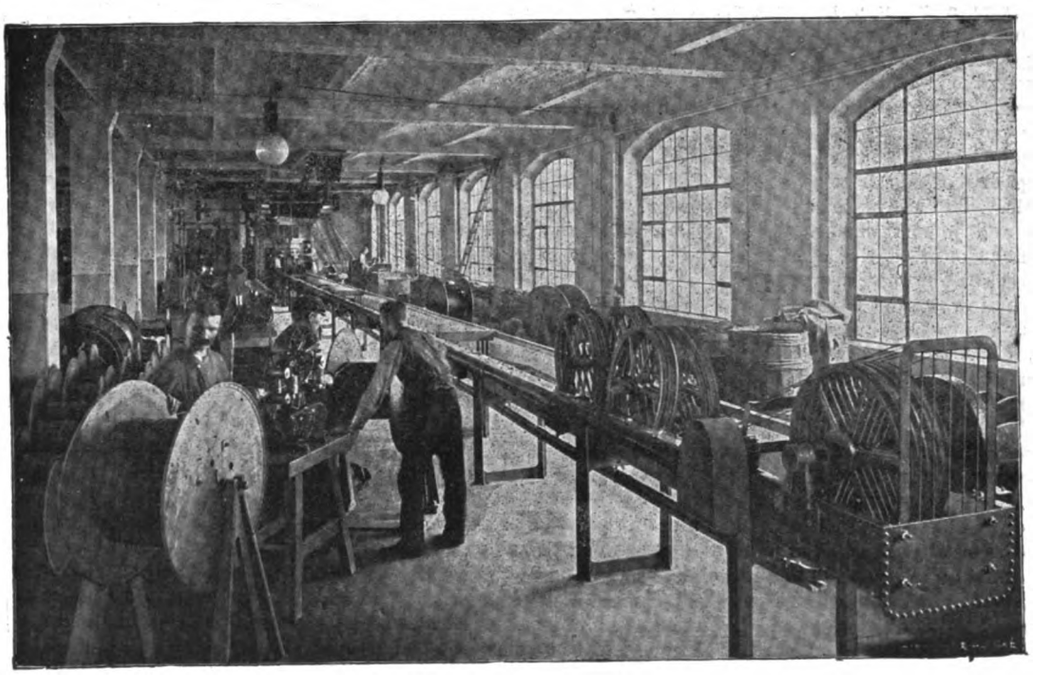

FIG. 18.—GUTTA PERCHA COVERING.

is done more quickly. Another innovation, which I believe has been tried and found troublesome in some English works, is the driving of the hauling-off drum of serving machines, stranding machines, &c., by a rotating roller, whose top surface

of motion if (as will occur in the best conducted works), the flanges of the drums have got battered. This hauling-off drive is only adopted on one or two machines at Messrs. Siemens and Halske's works, however.

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Immediately behind the drying and impregnating apparatus are the lead presses, which are mostly of the Huber pattern, with two horizontal rams.

The works have a brass foundry, and manufacture the various cable accessories. Among these were some practical and evidently not costly cable-heads for smaller telephone cables. For cables containing up to 14 wires, the cable head consisted simply of a cast-iron pipe, conical at the end, which is passed over the cable and provided with an ebonite top. The pipe is filled up with compound to keep the end watertight. Heads and junction boxes for larger cables were, of course, not of such simple design. A sample of 1,027-pair paper-insulated telephone cable was also exhibited in connection with larger types of junction boxes. This cable had 0·8mm. copper wire, and its diameter over-all was 80mm. On inquiry I learned, however, that this was merely an exhibition sample, and that the firm have only made cables up to about 250 pair. The brass foundry is of considerable size, as, in addition to the castings for cable junction boxes, &c., it also supplies the Berlin and Charlottenburg works of Messrs. Siemens and Halske with brass castings.

## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 521.*)

§ 13. Small Ship-Lighting Set.—One of Messrs. Drysdale's "Bon Accord," open type doubling-acting engines mounted on the same bed-plate with and coupled to a four-pole Mavor and Coulson dynamo, giving an output of 100 amperes at 100 volts, is exhibited on Messrs. Drysdale's stand. The engine is designed to develop 16 B.H.P. at a speed of 250 revs. with a steam pressure of 100lb. The cylinder is 7½in. diameter by 7in. stroke. This set is fitted with a short cast-iron base, and the outer bearing of the dynamo is carried by a bracket supported from the magnet casting.

§ 14. Electric Construction Company's Polyphase Induction Motors.—The two motors exhibited are a 5 H.P. motor of standard type and a 2½ H.P. motor erected on a portable truck, the former representative of a series up to about 100 H.P. The following description is applicable to all sizes:—The form of the motor is reduced to the simplest possible elements, *i.e.*, a stationary part permanently connected to the main circuits, and a rotating part having no electrical connection with any other, and absolutely no electrical contacts or adjustments; in fact, no sliding or working friction except that of the shaft in the journals. The only parts that can wear, therefore, are the shaft and journal boxes. The friction in these is very slight, on account of the light weight of the rotating part. Ample self-oiling bearings provide for liberal lubrication. The hollow cylindrical cast-iron frame in which the primary is mounted forms a base for the machine, and also supports the two end brackets carrying the self-oiling bearings. Perforated iron plates fitted into these brackets both protect the rotating elements and permit of excellent ventilation. They are replaced by solid plates when it is desired to make the motor absolutely dust-proof. The housing completely encloses the primary and secondary elements and protects them from any external damage. The primary element consists of a hollow cylinder built up of laminated sheet-iron rings, slotted on the inside to receive the conductors. These rings are rigidly supported by the cast-iron housing which encloses the primary. The conductors are machine-wound coils, which are thoroughly insulated before being placed on the core. The terminal blocks, which are located on top of the machine, are connected to the primary windings by leads which pass through the housing. The secondary part is built up of laminated steel discs, of a high grade of metal, mounted upon an open spider, and carrying in slots around the periphery the rectangular copper bars of the winding. The construction is such that the conductors cannot be thrown out by centrifugal force, the whole secondary being extremely simple, rigid and durable. The conductors of the secondary are all purposely short-circuited, so that no accidental short circuit can possibly cause injury to the winding, and the danger of interruption to service from this cause—always a menace in direct-current apparatus—is eliminated.

§ 15. Robey-Scott and Mountain Steam Dynamo Set (Open Type).—This neat little set is shown in Fig. 12. It consists of a Robey vertical compound open type steam engine, capable of developing 100 H.P. at 250 revs., direct-coupled to a shunt-wound multipolar dynamo, built by Messrs. E. Scott and Mountain, of Newcastle. The dynamo has an output of 200 amperes at 250 volts. This is used as one of the balancing sets on the supply system. The engine cylinders, which are steam jacketted, are 10½in. and 18½in. diameter with 11in. stroke. The engine is equipped with a continuous self-lubricating apparatus, and, inasmuch as all the working parts are balanced and the engine itself is governed by the Richardson automatic link-expansion gear, the running is very regular. The working range of cut-off is from 0 to three-quarter stroke. Piston valves are fitted to the high-pressure cylinder, while on the low-pressure cylinder there is an ordinary slide valve. A heavy flywheel of the disc pattern is, as shown in the illustration, bolted to the armature. The field magnets are carried on an extended base-plate attached to the engine.

§ 16. Robey-Scott and Mountain Steam Dynamo Set (Closed Type).—This is a 150 H.P. set, consisting of a Robey enclosed vertical side-by-side compound steam engine, direct-coupled to an inverted two-pole continuous-current shunt dynamo built

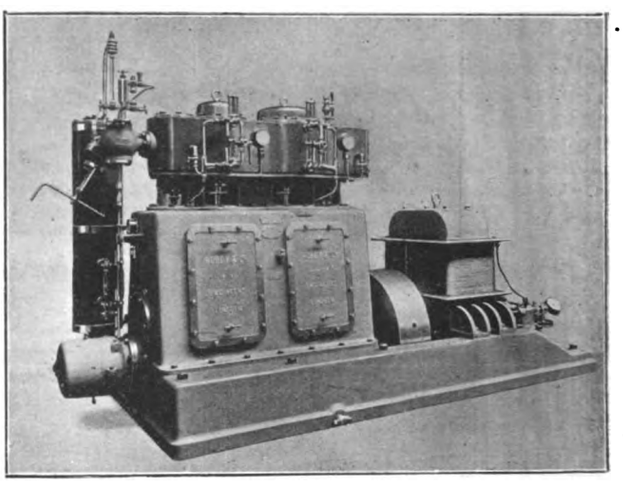

FIG. 13.—ROBEY-SCOTT AND MOUNTAIN CLOSED-TYPE STEAM DYNAMO SET.

by Messrs. E. Scott and Mountain. The set runs at 550 revs. per min. The cylinders are 8½in. by 14½in. diameter, with a 6in. stroke. The governor is of the throttle type, but the high-pressure cut-off can be adjusted by hand to suit any particular load. Piston valves are fitted to the high-pressure cylinder and a slide valve to the low-pressure cylinder. The dynamo is capable of giving 200 amperes at 250 volts, and, like the set described in the previous paragraph, is used as a balancer on the three-wire supply system. A view of this set is shown in Fig. 18.

§ 17. Scott and Mountain Steam Dynamo Set.—Beside the two dynamos mentioned in the preceding paragraphs and illustrated in Figs. 12 and 13, Messrs. E. Scott and Mountain exhibit a combined set of their own, consisting of a high-speed engine direct-coupled to a multipolar continuous-current dynamo. This set is illustrated in Fig. 14. The engine is of the enclosed compound vertical side-by-side type, specially built for direct coupling, and provided with forced lubrication to all the working parts. The rated power at 860 revs., with steam at 10lb. pressure, is 240 B.H.P. The cylinders are 14¼in. and 20in. diameter respectively, the stroke being 10in. The cylinders are mounted upon a cast-iron box forming the crank chamber, from which they are separated by distance pieces with large hand-holes for giving access to the glands. The steam distribution is controlled by a central piston valve distributing steam to both cylinders. Oil is prevented from

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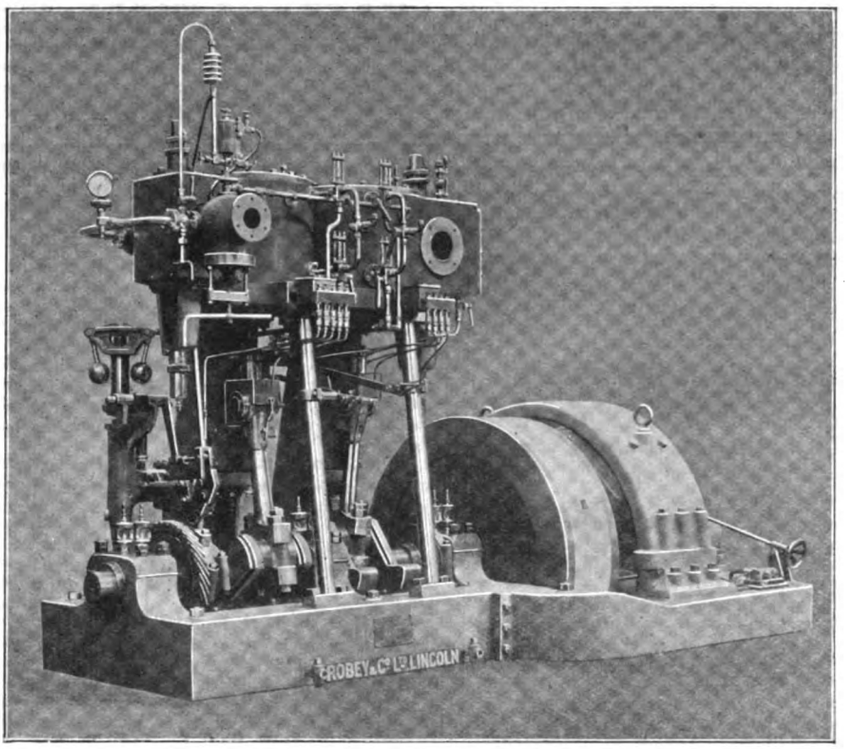


FIG. 12.—ROBEY-SCOTT AND MOUNTAIN OPEN-TYPE STEAM DYNAMO SET.

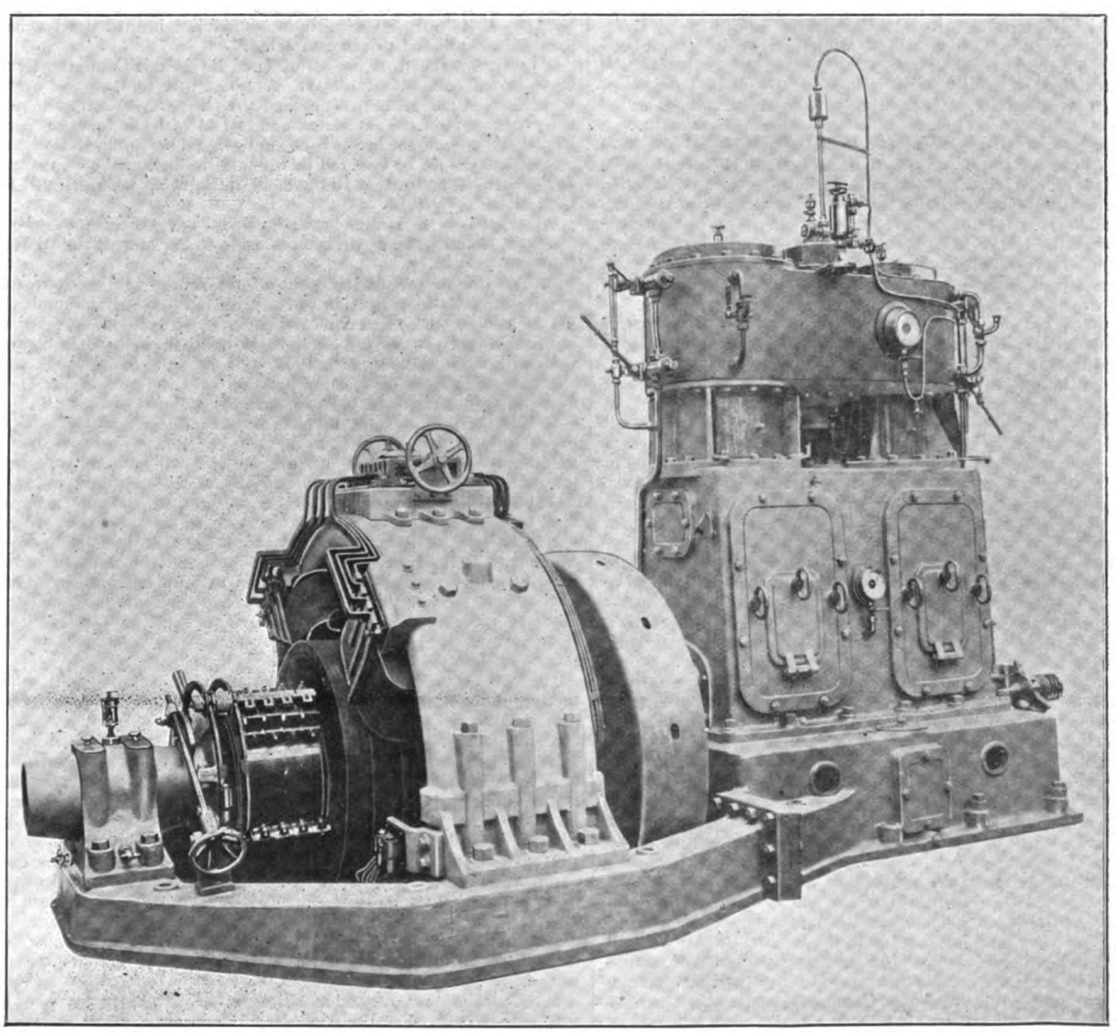

FIG. 14.—SCOTT AND MOUNTAIN STEAM DYNAMO SET.

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travelling along the crank shaft, either to the governor or to the dynamo, by means of special oil throwers secured to the crank shaft at either end, the oil flying to a drip ring, which returns it to the crank chamber. The dynamo is of Scott and Mountain's four-pole continuous-current type, to give 640 amperes at 250 volts. The magnet ring is of circular pattern, made in halves, and the bobbins for each magnet are wound separately upon insulated formers. The armature is of the slotted drum type with embedded conductors, the core being mounted upon a cast-iron sleeve fitted over the dynamo spindle, and strongly bolted to the half coupling on engine crank shaft. The outer bearing of the dynamo is of extra length, and is of the self-oiling self-aligning type.

*(To be continued.)*

## UNDERGROUND RAILWAYS IN LONDON.

The report of the Joint Select Committee of the House of Lords and the House of Commons on London underground railways was issued on Friday last week as a Parliamentary paper, and is reprinted below :—

1. The Committee have met and considered the matters referred to them, and have taken evidence in respect of the lines of route for underground railways which have been proposed by bills introduced during this session. The order of reference is as follows :—

(1) Whether the lines of route for underground railways in and near London, proposed by bills which have been or may be introduced during the present session, are best calculated to afford facilities for present and probable future traffic ; and, if not, what modification of those lines of route are desirable ;

(2) What special provisions (if any) should be made for the protection of the owners, lessees, and occupiers of properties adjacent to underground railways from possible damage and annoyance ;

(3) What special terms and conditions (if any) as to construction and working should be imposed upon the promoters ;

(4) Whether any, and which, of the schemes proposed by the said bills should not be proceeded with during the present Session.

2. Looking to the general terms of reference it appeared to the Committee that these bills were not to be considered and dealt with by them as by ordinary Private Bills Committees to whom they might have been referred ; that the Committee had not, for example, to deal with the financial questions that ordinarily arise, nor with any special engineering details, and only partially and indirectly to consider questions of competition. They, therefore, called for no evidence upon these points.

3. For the purposes of this report the Committee adopted the map handed in by Sir Alexander Binnie, on behalf of the London County Council, of the London Tube Railways, 1901, showing all lines open to traffic, in progress, authorised and proposed, from which it will be seen that the needs of considerable areas are unprovided for, specially north of the river in the neighbourhood of East and West Ham, and south of the river between Greenwich and Dulwich. This is possibly accounted for by the fact that the subsoil is of such a character as to make the construction of underground railways very costly.

4. The Committee have had before them 10 bills proposing lines of routes for underground railways in and near London, or extensions of already authorised lines.

5. The difficulty in dealing with the question of the best routes is greatly increased by the fact that a considerable number of underground railways have already been authorised by Parliament ; some of these have not been commenced, while others have been only partially constructed. It is obvious that any conclusions as to the best lines of route, or modification of the schemes now before Parliament, must be materially influenced by this fact.

6. The Committee think it may be useful to state, in the first instance, some general points which they suggest should be borne in mind when dealing with this question of routes.

(*a*) Underground railways or underground tramways in London and its immediate suburbs, which can be hereafter extended if required, above or below ground, into the country, but from the termini of which passengers could, for the present, proceed by electric surface tramways, omnibuses, and so forth, appear to be the best mode of dealing with the present traffic, and the probable requirements of an increasing population.

(*b*) These underground railways or tramways should run from well-recognised centres of traffic to other like centres of traffic, or from centres of traffic to districts whence large numbers of people have to be carried daily to and from their work in London or the suburbs.

(*c*) It is desirable that Parliament should carefully investigate the circumstances under which authorised lines apply for an extension of time. The result of many of the authorised railways having remained in abeyance for a considerable number of years has been in some cases to prevent other companies coming forward to make lines along the same route. The renewal, therefore, of lapsing powers should not be granted without the most careful consideration as to the probability of a company which has already failed to carry out its obligations to the public being able by an extension of time to fulfil those obligations within a reasonable period.

(*d*) The Committee have been informed that the London County Council have had difficulty in getting a *locus standi* to oppose the renewal of powers before Parliament because they have not opposed the original scheme. The Committee are of opinion that the County Councils and the City Corporation should be granted a *locus standi* in all such cases where they are concerned.

(*e*) The underground lines may be worked at the termini on the shuttle system, or by means of terminal loops. Which system should be adopted in each case is a question for the Parliamentary Committee to which the bill is referred. But while the advantages to the working of the line by loops are obvious, and in outside districts there can be no objection to them, the Committee think that very great caution should be exercised by a Committee in sanctioning them in the heart of the city on the ground of the large amount of space occupied to the possible exclusion of future railways. They have the less hesitation in making this recommendation as the multiple motor system, by which much time is saved in shunting at terminal stations, appear likely to be adopted in future.

(*f*) Confluent junctions inside tubes should be avoided, nor are they desirable in the open where the service of trains at the converging point is very frequent, since slight detentions on one line impair the service on both.

(*g*) We concur in the recommendations of the Joint Parliamentary Committee of 1892 as to the acquisition of wayleaves in the case of private property, and in the case of passing under the streets.

(*h*) One of the main objects of underground railways being to relieve traffic in congested places, it is desirable that stations should be so constructed as to avoid, as far as possible, the discharge of passengers into crowded streets. Interchange stations should, where practicable, be placed at all points where underground lines cross one another, and should be connected by subways so as to facilitate the passing from one system to another underground.

7. Damage and annoyance to the owners, lessees, and occupiers of properties adjacent to underground railways may occur through one or other of the following causes :—

1. Subsidence due to construction, especially to the construction of a station.
2. Vibration due to the working of the railway.

(1) The Committee did not think it desirable to receive evidence on the general question of underground railways causing subsidence ; they considered that each case of probable or alleged subsidence must be judged by the circumstances of the particular case.

(2) The Committee found that a special Committee (known as Lord Rayleigh's Committee) was examining fully into the question of vibration, and it was decided, therefore, not to enter upon this part of the reference.

It was, however, thought desirable to have some short statement as to the proceedings of Lord Rayleigh's Committee, and at the second sitting a memorandum was handed in by the late Sir Courtenay Boyle. It concluded with the following statement :—

"The Committee may, in the meantime, say that from the information already obtained they believe that on new tubular railways, under proper conditions, no objectionable amount of vibration need be apprehended, but they abstain from a definite recommendation until the further experiments above alluded to are completed."

To wait for the final report of Lord Rayleigh's Committee would have necessitated considerable delay. As soon, therefore, as the evidence and arguments of counsel were concluded the Committee decided to report upon the other parts of the reference, and to deal with the future report of Lord Rayleigh's Committee by the following general recommendation, namely :—

A clause should be inserted in every bill binding the company to adopt and give effect to the recommendations, &c., which Lord Rayleigh's Committee may make.

As regards a line already authorised such a clause can be properly imposed, if and when application is made to Parliament for an extension of time or of works.

8. The Committee find a want of uniformity in the clauses imposing upon companies an obligation to run trains in the early hours of the morning for the accommodation of workmen at specified fares ; but every act should contain clauses imposing these obligations, and the clauses in the Central London Railway Act, 1900, with some modifications suggested by the representatives of the Corporation of London and London County Council, appear well adapted to secure the desired object.

9. The Committee have taken a considerable amount of evidence as to through fares for the various systems of railway proposed, and as to uniformity of fares. While there would be obvious advantages to the travelling public in both these proposals, and they would commend them to the consideration of the various companies, they cannot make any practical suggestion for their adoption so long as the interests involved are in various hands, but they recommend that the Board of Trade should make a report to Parliament every five or 10 years on the working of these railways, of their relations to one another, and on the reasonableness of the fares charged thereon. They consider that such a report, while giving no absolute power regulating the conduct of the railways, would have a very strong moral effect in inducing the companies to take a reasonable view of their duties to the public.

10. The Committee proceed to report upon the several schemes for underground railways proposed by bills introduced during the present Session from the route point of view, leaving, as above stated, ordinary financial questions and other details to Parliamentary Committees.

The bills that have been referred are as follows :—Central London ; Charing-cross, Euston and Hampstead, No. 1 and No. 2 ; Islington and Euston ; King's-road ; West and South London Junction ; City and North-East Suburban ; North-East London ; Brompton and Piccadilly-circus ; Charing-cross, Hammersmith and District ; Piccadilly and City.

11. The Central London Railway apply for power to make loops at each end of their line, so as to enable them to increase the number of trains and thus facilitate traffic. It appears to the Committee that there can be no objection to the proposed loop at the western end of the line. There is more difficulty with respect to the proposed loop at the east end of the line. This bill may be referred to a Parliamentary Committee in the ordinary course, subject to the remarks contained in paragraph 6, sub-section (*e*).

12. Charing-cross, Euston and Hampstead, No. 1 and No. 2.—These bills may be referred to a Parliamentary Committee in the ordinary course. The Committee think there should be no confluent junction on the autho-

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rised line. One of the branches should join end on and the other should be connected by an interchange station. There should be no difficulty in securing this as the works of the authorised line have not been commenced.

13. Islington and Euston.—This bill may be referred to a Parliamentary Committee in the ordinary course.

14. King's-road.—This bill may also be referred in the ordinary course if interchange stations are provided at Victoria. An extension to Putney Bridge would be desirable.

15. West and South London Junction.—This bill may also be referred in the ordinary course.

The question has been raised whether there should not be an end-on junction with the North-West London, which might involve the abandonment of the line between the Marble Arch and Paddington station. On the whole the Committee think that the proposed scheme is the best, as securing the direct through route between Paddington and Victoria stations.

16. It will be convenient to consider the City and North-East Suburban and the North-East London together.

(*a*) An extension further north of the North-East London would be very desirable, especially in view of the area of land taken by the County Council for building purposes. The Committee are of opinion that the Chingford branch is not wanted if the City and North-East Suburban is sanctioned.

(*b*) The Committee consider that that portion of the City and North-East Suburban route from the centre of the City along Bishopsgate, and thence turning to the east to Victoria Park is not desirable, and they suggest that (unless engineering difficulties prevent it) a better route would be eastward from the centre of the City, along Leadenhall-street, or other streets in like direction, and thence in a north-easterly direction to Victoria Park. This would prevent the overcrowding of Bishopsgate with tubes, and would also bring communication to an overcrowded district of Whitechapel, which otherwise would remain without these facilities of rapid transit.

(*c*) Subject to the above remarks, it appears to the Committee that both these schemes may be referred in the ordinary course, as they both afford great facilities to crowded districts, and to districts where building is increasing and likely to increase.

17. Brompton and Piccadilly-circus, Charing-cross, Hammersmith and District, and Piccadilly and City.

The Committee are of opinion that there ought to be one through line from Hammersmith along Piccadilly to Piccadilly-circus and the City. They consider it most desirable that there should be an end-on junction between the Hammersmith line and the City and Piccadilly at or near Piccadilly-circus. Failing that, the alternative junction at Charing-cross should be adopted so as to secure a through route.

18. The Committee, under the circumstances, do not approve the proposed extension of the Brompton and Piccadilly-circus line to Bloomsbury-square, but if the through line from Hammersmith to the City can be secured, an extension to the "Angel," Islington, from Piccadilly-circus, with an interchange station at the latter place, would be a useful route and should receive favourable consideration.

19. In the course of their deliberations the Committee have had brought under their notice several matters which do not appear to lie distinctly within the terms of their reference. Of these the most important was the proposal that all these underground railways should be subject within certain limits to the control of a central authority. On this the Committee desire to make the following observations:—

The question of underground railways in London and the suburbs and of their working is so complicated, and of such importance, from a financial as well as traffic point of view, that the Committee are disposed to agree with the views of the Corporation of London and the London County Council—that in some way there should be a more direct control and supervision of all projects for such underground railways. Whether this should be effected by the supervision of some public department as the Board of Trade, or by some body like the Light Railways Commission, or by a joint committee of members of both Houses of Parliament, appointed at the beginning of each session, to consider all projects affecting the relief and distribution of traffic in or near London, is a question which appears to them to deserve serious consideration.

20. The railways should be constructed on sound economical principles and without undue inflation of capital. It is obvious that if dividends are to be paid on inflated capital, fares to produce such dividends must be on a scale higher than would be required to pay a fair remunerative interest on the money expended on the works. The Light Railways Act gives power to the local authority to construct or to assist in the construction of light railways, and the Committee are of opinion that some such power given to the City Corporation and the County Councils concerned in respect to London underground railways would be of the greatest advantage. They therefore recommend that the Board of Trade should insert in each bill a model clause based upon that in the Light Railways Act, with such modifications as may be necessary, giving powers to the City Corporation or the County Councils in the counties in which the railways would be constructed, either to construct or to aid in the construction of the lines.

21. Such powers would enable the councils to encourage, by subsidy or otherwise, the prolongation of railways into districts thinly populated, and, therefore, suitable for the relief of congested districts, whereas, in many cases at any rate, a public company would not feel justified in extending their line till the population became greater.

22. It has indirectly been brought to the notice of the Committee that another system of underground locomotion—namely, that of subways or shallow tunnels immediately under the surface of the roadways—has been successfully developed, and is in process of further extension, both on the Continent and in America.

The Committee have heard no evidence with regard to this system; but in view of the large amount of capital involved in the schemes now before Parliament, and the importance of utilising it to the best public advantage, the Committee recommend that an early inquiry should be held by the Board of Trade upon this system.

## STORAGE BATTERIES IN ELECTRIC POWER STATIONS CONTROLLED BY REVERSIBLE BOOSTERS.

**The following is an abstract of the discussion which took place in connection with Mr. J. S. Highfield's Paper on the above subject before the Institution of Electrical Engineers, on May 9 last. The Paper was reprinted in our issues of June 14 and 21, and July 5 and 12:—**

Mr. J. N. SHOOLBRED said the subject matter of the Paper was of considerable interest, and especially to those who for many years past had advocated the use of batteries in stations. Ten years ago their use was very much disputed; indeed, it was considered that they were so expensive that no economy could result from their use. Now scarcely a station was without its battery—for lighting purposes, at all events; and their use in tramway stations was likely to lead to still further important results. This booster method was one way of treating the subject, but it was a matter which he personally preferred to treat in another way, and in which he had looked more into the question of the economy and simplicity of the machinery. The booster, as it had been explained by Mr. Highfield, consisted of several moving parts—viz., the booster, the exciter and the motor. Thus, there were three moving parts which had to be regulated. He himself had found great advantage in using simple machines to work at the half-pressure, which could be used on either side. They could be used for a variety of purposes, and have very good results. Although favourably inclined towards this booster, he could not altogether ignore the advantages which he had derived for several years by treating the matter differently. The author stated that he had endeavoured to obtain a return of the batteries from various stations, in order to try and form a ratio between the batteries and the generating plant, and that he found a difficulty in understanding exactly what was taking place. He (Mr. Shoolbred) had also looked somewhat carefully into this matter, and although the returns he had studied included two stations which he had personally laid down, he had found great difficulty in understanding them. In the first place, not sufficient distinction was made between the application of batteries to lighting and their application to traction. In his opinion, the two ought to be kept perfectly distinct from one another, if only for the reason that the economic use of batteries in lighting was just at the point of commencement. The value of the batteries diminished as the load increased. In many cases in Table II. the ratio given between the batteries and the plant was such that the value of the former was very far from useful, and in some cases it had almost died out owing to the fact that the generator capacity of the station had increased. According as the load increased in a tramway station, the extra proportion of the battery reserved to take the peak likewise increased; and in this way it was a totally different requirement from that of lighting. It appeared to him that this was one of the things which rendered Mr. Highfield's Table II difficult to understand. With regard to what the author spoke of as the grading of generating plant, this had been a most important question for the last 10 years. It was in that very room that the late Mr. Willans impressed, when discussing the Bradford installation, the advisability of not having too large units to begin with and also of keeping the size of the units afterwards within as small limits as possible. He quite agreed with the author as to the immense importance of simplicity in the selection of what he had termed grading generators, but the importance of the part played by batteries in assisting that grading and in bringing up the generators so that they could always be worked at as nearly as possible full load could not be appreciated unless one had carefully followed up the working of continuous-current stations. Reverting again to the question of tramway work, he said that, great as had been the economy in regard to lighting, a still larger and more advantageous future was opening up in relating to traction, and the author was deserving of their best thanks.

Mr. G. A. GRINDLE thought everyone would agree that the only means which had hitherto been at our disposal for the regulation of batteries—viz, regulating cells—had been extremely unsatisfactory, and at the same time very much to the detriment of the battery. Speaking from experience, he was able to say that in the system introduced by Mr. Highfield nearly all these defects had vanished, and it was one of the most perfect means for employing a battery for either lighting or traction that had yet been designed. It had been employed in several places, and he himself had had it under actual trial with very satisfactory results. This system would assist the maintenance more than in any other direction, as working with a booster in this way put the cells in a most advantageous position. Nothing was more detrimental to a battery than to run it down, and in the usual methods of working this unfortunately occurred often. By employing a booster this difficulty was overcome, and the battery was almost always kept on the top of the curve. The moment a heavy discharge was given out it was almost immediately replaced, and the result was most satisfactory working.

Mr. W. H. PATCHELL had been working with a booster for the last five or six years. When arranging to increase the plant it was a good plan to work the booster with a reversed field, and in this way one got practically the same results as Mr. Highfield did. In the early days he had worked with a double-wound armature, but this had not proved convenient, so he had given it up and used a motor generator, a method which had given the greatest success for three years. His boosters were for 1,000 amperes, and were hand-regulated. He also had some motors driven off the 1,000 volts high pressure, but this could only be done when the plant outside the district which supplied the high tension into the district was actually running. The regulating cells always gave him trouble, and he



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quite appreciated that Mr. Grindle, as a maker, would be very glad if they could be done away with altogether. The main trouble was between the charge and the discharge stops on the regulator switch. Another thing which had led him to do away with regulating cells was the very small amount of work got out of them compared with the rest of the battery. Sixty cells were necessary to run a 100 volt circuit, but 50 would do if used in conjunction with a booster, and in big cells the cost of the extra 10, with their leads, very far outweighed the booster and the switch necessary to work it. The maintenance was only on 50 cells instead of 60, so that the saving was an accumulative one. He could not say much as to efficiency, because he had only had the Paper put into his hands just before the meeting. But he thought Mr. Highfield had rather overstated this. Whether this was 70 per cent. or 75 per cent. did not very much matter so long as a saving was made on the coal bill, which could be done by getting a steady load. In one case he had in mind 26 per cent. of the plant ran for six hours a day, and only earned 4 per cent. on the capital outlay, which was very bad, because for the other 18 hours there was the standby loss on the same plant, which would be done away with if one used batteries. With regard to the stations mentioned in Table II. he thought some of these were rather prejudiced by not being able to purchase good batteries 10 years ago. They would now be ashamed to put such cells on the market as was done at that period. The Chelsea station, which was supposed to be the station to show everyone how batteries should be used, was about the bottom on the list. But if that started again with about half an inch between the plates, they would level their curve and get decent results.

Mr. C. H. WORDINGHAM said it appeared to him that this invention would have very far reaching influences on the industry, especially for traction work. Personally he had always thought that one of the greatest difficulties in using a battery was to know when to charge it, because it was always so very useful. Generally it was wanted in use for 24 hours a day, and this was practically what Mr. Highfield managed to do, just squeezing in the charges at odd moments.

Mr. H. M. SAYERS was attracted by the Paper because during the last two or three years he had given considerable attention to this problem, and although he believed he had found Paper solutions, he had not found a working solution which was exactly what Mr. Highfield *had* done. However, he could not quite understand the author's booster and exciter diagram, but he would like to suggest that probably a series-wound machine as the generator side of the booster might simplify matters a little. The particular problem which he had in mind was to supply lighting from batteries in combined stations for lighting and traction purposes, and he had particularly wished to be able to charge his lighting batteries from the traction sides, during the time when the load permitted it. As regards charging, he had succeeded in doing this without regulating cells, and the result as regards load-factor and cost had been exceedingly satisfactory. In fact, the costs per unit generated in the station had been knocked down by a full half-penny. For tramway purposes many people had thought that the battery had not much application except in sub-stations, but in his opinion in many cases tramway plant would be greatly benefited by a battery and the method shown in the Paper, by which the polarity of the regulating booster was varied in accordance with the load and the regulating cells entirely done away with, seemed to make this a practical thing on tramways where only a small number of cars were in operation. It was well known that the variations in the load were very large and very sudden. In one case with which he was personally acquainted, they got peaks of 380 amperes, with an average load of 90 amperes, so that whilst 100kw. was underloaded on the average, it was necessary to have two 100kw. machines for a half-section at a time. They did not have this, however, and the voltage and the speed dropped, which was an unsatisfactory state of things, and a battery of Mr. Highfield's plant would help this station immensely. In another case an average load of 70 amperes had peaks of 240 amperes. The curious thing about these lines with a small number of cars was that the peaks are quite periodical. But when one came to consider it out the connection between the periodicity of the peaks and the time-table was a perfectly simple one. On lines laid with single tracks and turn-outs the multiplication of the number of cars could never bring the peaks down to any great extent, because this method of working involved the simultaneous starting of two cars on each starting place, and the simultaneous starting of a considerable number of cars at a considerable number of passing places. Under these conditions, every other passing place had a pair of cars on it starting at a particular moment; consequently the multiplication of the number of cars did not cut down the peaks to a very large extent, unless there were also a number of branch lines at work with different services on them. Therefore, for small stations, and even for stations of pretty fair size, it would appear that this battery arrangement had a large field of use. While wishing for a few figures as to the efficiency of working and economy (which could only be supplied from experience) he could not help thinking it was a very promising method. As to first cost, they had been told in the Paper that for traction conditions the batteries did not cost very much more than steam plant for the same output. He could not quite say this, but perhaps it was a question of the way it was calculated. With regard to the efficiency, 84 per cent. was very much more than had ever been experienced from batteries under lighting conditions, and it appeared to show that the extra voltage due to polarisation had been utilised to considerable advantage. Would Mr. Highfield be good enough to state whether his 84 per cent. included the power taken to run the booster? Mr. Highfield spoke about load factor and asked for some assistance in obtaining a good definition of load factor. He had found that the most useful load factor for the station engineer was the running plant load factor—*i.e.*, the relation between the actual output of the station and the output which might have been given by the plant which was actually running during the time it was working at full load. That figure and the cost of generation followed each other inversely in a very close way, and when he had been in charge of stations he had directed his energies to keeping that running plant load factor high with very satisfactory results.

Prof. ERNEST WILSON said Mr. Highfield had shown that on small traction schemes his booster could effect a very great economy. He believed there had been several similar systems devised, but he did not know whether they had been put into actual operation. One of these systems, shown in the illustration (Fig. A) was invented by Messrs. Siemens and Halske, of Berlin, and was arranged as follows: The exciting coil of the booster B is connected to the terminals of a small exciter D and the excitation of this small exciter was the difference of the current terms between the two coils, one of which is placed in parallel with the battery and the other in series with the conductor going to the line; or, of course, a shunt could be used. Whether this system had ever been put into practical use he did not know, but it interested him because it was analagous to Mr. Highfield's. The great difference between the two was that in the exciter D the potential difference was reversed as well as the potential difference of the booster, so that if the ampere-turns on the small exciter became positive or negative the two commutators were reversed. With Mr. Highfield's arrangement this was not done; what was done was to reverse the potential difference of the booster B, but the exciter D maintained constant potential and was not varied. There was this radical difference between the two systems, and he thought it a great advantage in Mr. Highfield's system that there was only the reversal of the booster B, whereas the other one reversed the two commutators. When one started designing a booster for this purpose, one naturally picked upon the differentially wound machine, and the amount of copper required to be put upon a booster where the reversing was all done on the booster was prohibitive. Whether the Siemens and Halske arrangement of using a small exciter and differential coils upon it still led to any economical working he did not know. In America there were one or two systems working with reversible boosters, but the great point that Mr. Highfield had brought out was the practical use of it, and he was not aware that there was any other automatic reversible booster that had been demonstrated to be a practical success.

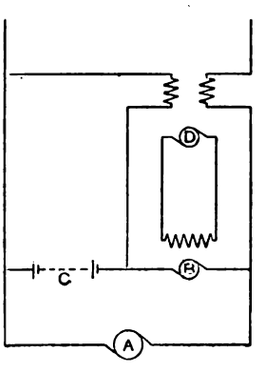

FIG. A.

Col. R. E. CROMPTON, referring to Prof. Wilson's remark that these systems had been worked in America, said that unless he was very much mistaken Mr. Chamen, when he was with Crompton & Co., worked out to his (Col. Crompton's) order this very arrangement that had been so ably put before them by Mr. Highfield, and what was more, it had been patented. They had held the patent and sold it well in America; but this did not for one moment detract from the admiration he felt for Mr. Highfield's skill and ingenuity in adapting practically the same invention at his station. He had had nearly 20 years' experience in accumulators, and still he was alive. There was no doubt that Mr. Highfield was right, and the whole reason why batteries had not been used to a far greater extent than they were was because the men who managed them differed so completely amongst themselves. There were many fellows who were splendid men in managing their station mains, but they could never "cotton" to the batteries, and in all those stations the batteries had either been a failure in breaking down and giving trouble, or a financial failure, *i.e.*, the repairs and maintenance had been so heavy as not to warrant their further use. On the other hand, there were men, like Mr. Highfield, who had seen the weak points and used their brains with the results shown that evening. He thought Mr. Patchell was a little hard when he spoke of the accumulators of 10 years ago not being properly spaced. It was nearly 15 years ago that he introduced ⅜in. spacing, and that, no doubt, was one of the great reasons why the maintenance of accumulators costs was very much less than it used to be. However, he quite agreed that the wear and tear was mainly to be attributed to the regulating cells, and it was that which made him call upon Mr. Chamen to invent to order a reversible booster to take the place of the regulating cells. He agreed with Mr. Highfield that a very fair mean cost of installing accumulators at a three-hour rate would be £35 per kilowatt, and he thought that it would be found to pay to instal a much larger proportion of batteries at that cost than was generally the case. He also agreed with him even if the rate of depreciation was 1d. higher than was given. For many years he had insisted upon the rate of depreciation being charged against the batteries of the Kensington Company at 14 per cent. per annum, *i.e.*, whatever they cost was deducted from the sum yielded to 14 per cent. on their first cost, and the balance was carried forward to a battery fund. For many years there were accumulations in that fund, but afterwards, when the station got

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larger, the batteries got overloaded and overworked in the manner Mr. Highfield has stated. Then the repairs became higher and that 14 per cent. figure was justified. Some speakers had doubted that such a figure as 84 per cent. could be obtained. Although speaking from memory, he believed that in the station engineer's books of the company mentioned above, for many years the efficiencies, which were got out every month, varied between 81 per cent. and 84 per cent.

Mr. A. P. TROTTER said Mr. Highfield was the engineer to one of those towns in which the Corporation did the lighting and supplied current to a company who ran the tramways, and this was one of the very few places where there was a destructor which was likely to earn its food. He had several times watched this booster running, and of all the switchboards he had ever seen there was nothing more interesting than those at St. Helens and Birkenhead. The battery room, also, was a real treat after some that he had seen. Simply a row of batteries and a main conductor going out at one end and a main conductor coming in at the other with none of the usual forest of connections. There was a great deal in the suggestion to work between 2·2 and 2·8 volts, which meant so much for the efficiency. One rarely has a chance of seeing, without roundabout calculation from a meter, what the average amperes were, but in Figs. 11 and 12 this opportunity was afforded, and they seemed to be extraordinarily low. The dotted line appeared to give about 240 amperes for 20 cars. On the other would be seen about 300 amperes for 25 cars, which worked out at 12 amperes per car. The cars at St. Helens were not so large as at some places, but the load was uncommonly steady. In ordinary practice it was usual to try and keep to one unit per mile per car, but Mr. Highfield had obtained 15 amperes for from 15 to 20 cars, and in some cases it had come down to as low as 12. In view of this he would like to ask if there were any special features in his line which brought about this remarkably low figure?

Mr. W. B. ESSON said the proportion of battery power to the generator power and the relative cost had often been referred to in the discussion, but there did not appear to be a very clear understanding on the point. In Table II. the author had arranged the stations in a somewhat higgledy-piggledy fashion, and from the figures there would not appear to be any particular law which determined the proportion of battery power to the generator power. But if the stations were arranged according to size, there was indicated the very clear principle that the smaller the station the larger the battery power comparatively. When they came to big stations the battery power was very small. For stations up to 500kw. it was 0·25; from 500kw. to 1,500kw. the proportion was 0·125; above 1,500kw. and up to 5,000kw. it was 0·1; and above 5,000kw. it was 0·04. Of course, there was considerable variation in the figures for various stations, but the above gave a good average, and clearly indicated the law he had referred to. In opposition to Col. Crompton, he was of the opinion that Mr. Siemens had been the truer prophet, for some years ago this latter gentleman had said that accumulators were only used for toy stations, and that with large stations it was very much cheaper to run the generating plant instead. In a small station, the accumulator formed a very important and essential part of the supply plant, inasmuch as it enabled the shutting down of the generating plant for one or two shifts, but a time came when the station became of such a magnitude that it was very much cheaper to run the steam plant than to use batteries. With all due deference to Mr. Highfield, he thought there was a very good reason for a discrepancy in his figures: it was simply furnished by the natural development of the stations. In the initial stages of an undertaking a battery was of great service, but, as time went on and large sets were added, it became of less importance. Referring to the cost of generation, he asked if Mr. Highfield's efficiency of 75 per cent. was the efficiency of the battery? Frequent references were made to wonderful economies when working at half or three-quarter load, and so on, but engineers as a class seemed to have very different ideas of what the difference would be in steam consumption.

Mr. E. K. SCOTT pointed out the advantage of using batteries in connection with a plant driving an electric crane. If accumulators were used with cranes it was necessary to use these reversible boosters, a thing which had been done on the Continent in several places, and was being done by Messrs. Johnson and Phillips. These reversible boosters had also been used by the Union Company in Berlin for working tramways, and in two or three other towns in Germany.

Mr. SYDNEY WALKER remarked that not only did this system get rid of the regulating cells, but it got rid of a large amount of work on the plates of the accumulators themselves, and by this means enabled a higher efficiency to be obtained as well as longer life.

Mr. J. S. HIGHFIELD replied that he had gained from the discussion what he had hoped—viz., a very greatly extended knowledge of the subject. Taking the speakers in their order, he said he objected to Mr. Shoolbred's statement that as the station grew larger the use for accumulators practically vanished. It was this very idea that batteries were useful in small stations, and not at all useful in larger stations against which he had directed his Paper. He quite admitted that in a large station three shifts under all conditions would be necessary, but that batteries were no use in large stations he could not admit at all, because although in a large station, through having a large number of units—or what he called graded units—it was perfectly simple to keep the load on the generators constant, at the same time there was the difficulty of keeping the load on the boilers constant. He was now speaking of lighting stations only. It was equally important to keep the load on the boilers and steam pipes constant as to keep the load on the generators constant, and it was because of this that accumulators were necessary. There was one objection to accumulators which had not been noticed. In certain towns which were benefited by heavy fogs—and he believed Glasgow was one—the engineers asked what good was an accumulator when there was an all-day fog on, because it would be wanted to give a 12-hour discharge. But as a matter of fact it was not wanted to do anything of the sort. In the Paper he had given a case of a station designed with four units, one of which was represented by a battery, and as long as the battery was big enough to take a peak of one-quarter or one-sixth of the top load the spare plant could be run, using the accumulator as a spare. Nobody in his senses would try to discharge this accumulator on a load beginning at six o'clock in the morning, and keep it up all day. Mr. Shoolbred and Mr. Esson both complained a little as to his figures. He was quite willing to admit that the arrangement of his Table II. had no law whatever, and he was much obliged to Mr. Esson for pointing out the relation there was between these figures. But this seemed to him to prove what he had said in the beginning of the Paper—viz., that the practice had been to start a station with a very good and useful battery, and use it properly for about 12 months, say on a night shift. But after a time this night load became a little too large for the capacity of the battery, with the inevitable result that it broke down and cost a lot of money for repairs, and when the question of extensions was approached more generators were installed, and increased battery capacity left alone. Mr. Sayers had proposed a series-wound booster for the purpose of an automatic reversible booster, but this class of machine would only partially work because a reversible booster must take account of the variations in the battery pressure, and unless it did this in a perfect way they were not perfect boosters. No series-wound booster could take any account whatever of the variations in the battery pressure, which depended simply on the inherent qualities of the battery and not at all on the current going in or coming out. It was very satisfactory to hear that Mr. Sayers had benefited from charging a lighting battery from the traction 'bus bars, and this had been one of the chief points of the Paper, viz., that in using batteries for combined stations, if regulating cells were not used, and if there was a high voltage tramway system, it was possible to use identically the same battery for either lighting or traction. The high efficiency of the battery used on the tramway load did not depend on the use of the reversible booster. This latter simply enabled the battery to be worked at a one-hour rate of discharge and did not have any effect on the efficiency. The higher efficiency was due to the fact that the discharge immediately followed the charge, and so on. The figure of 84 per cent. given in his Paper did not include any loss in the booster; it was the battery efficiency. Referring to Prof. Wilson's description of the Siemens and Halske machine, he said he was afraid his Paper had given the impression that his was the *only* reversible booster. Naturally, he thought it was the *best*, but that it was the only one he did not for a moment think. As had been explained, the German system depended upon the action of two windings, one against the other, and the magnetising force in the booster fields simply depended upon the difference between the ampere turns of the two coils. It was therefore necessary to have a very much greater weight of copper in such a machine than in one that did not depend on the differential principle, and probably the reason why the exciter was added was that without it the machine would have looked exceedingly cumbersome and it was much better to put eight times the amount of winding on a little machine than on the big one. One very serious defect of this pattern machine was that one of the coils was excited by the battery pressure, so that when the battery pressure was high, this had a greater effect than when it was low. To some extent, of course, this took account of the variation in the battery pressure, but it did not take account of the full variation. If, when one did not want to boost, the current could be prevented from going through that coil, and then as the battery pressure rose one could get the right boost, it would be all very well, but this could not be done. Col. Crompton had mentioned the fact that this booster of his (Mr. Highfield's) was old and that Mr. Chamen had invented and patented a similar one in the United States. All he could say was that this was an injustice on the part of the United States, because they had, in spite of their careful search, granted him a patent for his booster. He was very pleased that this same speaker had corroborated his figures as to the cost of accumulators. He was also glad to have the additional information from Mr. Esson as to the connection between cost of working and load-factor, and he would embody these figures in the shape of a curve to see if it compared in shape with his Fig. 18. In conclusion, he remarked that this particular curve was very approximately a hyperbolic curve.

Mr. Highfield was accorded a hearty vote of thanks at the conclusion of his reply.

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**Municipal Telephones at Tunbridge Wells.**—According to *The Times* the Lord Mayor of London, accompanied by the Lady Mayoress, visited Tunbridge Wells on Saturday and inaugurated the system of municipal telephones established there. The event was characterised by much local demonstration, and the town was brilliantly decorated. Tunbridge Wells is the first town in England to complete a municipal system in competition with the National Telephone Co. The company, after unsuccessfully attempting to purchase the licence, have resorted to cutting rates and are now offering a practically unlimited service for £4—exactly half its former charge. The Corporation's system has cost about £10,000, and the service covers an area of 240 square miles, nearly all the villages in a 10-miles radius being connected with Tunbridge Wells. At the present time there are over 500 subscribers. The Corporation's charge is £5. 17s. 6d. for unlimited service, and there are two toll-rates for small users, namely, £3. 10s. and ½d. per call, and £2. 10s. and 1d. per call.



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The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,
1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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## THE PLANNING OF UNDERGROUND RAILWAYS.

We reprint this week the important report of the Joint Select Committee of the Houses of Parliament on London Underground Railways. The proceedings of this Committee have been placed before our readers in our "Parliamentary Intelligence" columns from week to week, and have afforded a clue to the general tenor of the report issued last Friday. It is unnecessary here to reiterate the full text of the somewhat complex and disjointed reference to this Committee, for this is embodied in the report itself. Suffice it to say that its ramifications comprised such questions as (1) the suitability of 10 schemes then before Parliament; (2) the general or conjoint planning of London underground railways, with a view to public facilities; (3) the provisions to be enforced as regards vibration and other nuisance; and (4) the conditions to be imposed, financially, &c., upon the promoters of new railways of this class. There is small cause for surprise, therefore, that the recommendations made in the report are of a discursive and disconnected nature, or that in some respects the report itself is couched in such vague and general terms as to become mere platitude. For instance, it needed no Special Committee of Parliament to discover the truth embodied in the statement that "the railways should be constructed on sound economical principles and without undue inflation of capital." Or, again, with regard to such a stupendous problem as the enunciation of a species of general principle on which these railways in future should be mapped out, how could Parliament expect anything more sublime and comprehensive than the information embodied in clause 6? Not that this information is not, in the main, useful; but it is doubtful if any Special Committee was really needed to discover and enunciate it. Probably the bulk of it would occur to any intelligent promoter of a genuinely honest scheme, and would be embodied forthwith; the residuum would most likely have been introduced by any ordinary committee during the ordinary committee stage. As a single instance we may cite the provision of interchange stations at points where two lines cross. Would not every sane promoter seek powers for such a provision, if in any way it would be likely to promote an increase of traffic?

It must not be supposed, however, that this report does not embody a mass of useful inquiry, or that it contains none but trite and obvious recommendations. On the contrary, time

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will probably show that more than one of the Committee's suggestions are worthy of being incorporated in the majority of underground railway schemes that may in future come before the Legislature. But whether this yield of useful result is at all commensurate with the heavy price paid, in the shape of a year's delay in the progress of the London underground railway system, is a matter open to doubt. We should have preferred, at any rate, that the 10 existing schemes had been pushed on irrespective of the theoretical investigations of this Special Committee. London is starved of means of passenger traffic; and a starving man does not need to be kept waiting while critics debate on the literary style of the menu.

Coming more closely to the details of the report, we may notice, in the first place, that the Committee recommends that a sharper watch should be made upon dilatory schemes lest there should be a stumbling block to real progress. It is suggested that the County Council should have a *locus standi* to oppose extension of time to a dilatory scheme, even where it had not originally opposed the scheme. But surely the time has fully come when the London County Council should be looked at askance in regard to its attitude towards underground or other methods of metropolitan travel promoted by companies; for the Council is building up a more and more extensive system of tramways of its own, and therefore cannot be expected to view impartially the growth of competitive undertakings. This consideration also affects the proposal to create a central authority having control of all projects for underground railways in London, and it should constitute an insuperable barrier to the London County Council being ever created such an authority. Provided, however, that a strong and impartial authority were to be constituted, the proposal is one that might be adopted with advantage. Another recommendation that merits careful consideration by Parliament is the proposal that a county authority should be authorised to subsidise any scheme for carrying an underground railway beyond its ordinary paying area into a region that would thereby receive a public benefit. It is to be feared, however, that considerable difficulty would be experienced in carrying this out in practice, especially if the undertaking were also to be kept clear of anything like joint working or municipal control. As a general principle, it does not appear judicious to allow local authorities to become railway mortgagees. From an engineering point of view many of the recommendations are remarkable, the reasons advanced in their favour being singularly inadequate or mistaken. Thus the Committee states that its objection to looped termini arises from "the large amount of space occupied to the possible exclusion of future railways." Evidently the Committee can think only in two dimensions of space, and has not perceived that "future railways" can easily pass either over or under the loop. It would be a great pity if Parliament were to veto so useful an appendage as a terminal loop on the basis of so flimsy an objection. Finally, we may observe that, as regards the vital question of nuisance from vibration, the Committee adheres to the decision of Lord Rayleigh's Committee, notwithstanding that it is obliged to admit its ignorance of what that decision—as yet unrevealed—may be. There is something not a little startling, therefore, in the simplicity of the proposal that "a clause should be inserted in every bill binding the company to adopt and give effect to the recommendations, &c., which Lord Rayleigh's Committee may make." Such faith in a sister committee is really touching. But we opine that a railway company will not so easily be persuaded to "close its eyes and open its mouth, &c."

A glance at the recommendations concerning the individual schemes will suffice, as these are categorically set forth in the report. As regards the Central London Railway, we trust it will be allowed to have both of the proposed terminal loops, for the Committee's objections, as already stated, are not valid. The affection for "end-on" junctions displayed by the Committee in connection with the Piccadilly Circus and some other of the 10 schemes, needs further elucidation. It is not clear whether by "end-on" is meant a through service of trains or merely a continuity of track. If the former, the two railways would no longer remain independent undertakings; but if the latter is intended, and a train arriving at one end of the platform is to discharge into another company's train "end-on" at the other end of the platform, there is great danger of rear collision. Probably, however, the Committee really intends an interchange station and not an end on station at all.

## THE ELECTRICAL EQUIPMENT OF THE DISTRICT AND METROPOLITAN RAILWAYS.

Under the heading "The Electrification of the Underground Railways," Mr. Chas. T. Yerkes writes to *The Times* of July 31st as follows:—

It has not been my intention to enter into any public controversy in regard to the electrification of the Metropolitan Railway and the Metropolitan District Railway, for several reasons, mainly because, so far as I can see, the Metropolitan Company has in years past not improved the position of its stockholders by the controversies in which it has engaged. But after reading the report of the former company as made by the vice-chairman, where I am placed in a false position, and also seeing the notes of the shorthand writer, and particularly as I concur in the desire expressed by that company that all our affairs relating to such electrification shall be made public, I have concluded to write this letter and respectfully request its publication so that our position might be better understood than by the statements made in the Metropolitan report.

As to the merits of the electrical systems I will not argue, but merely say what I think of adopting a new system on general principles, and if my refusal to adopt such system makes me "look absurd," I am perfectly willing to labour under that condition. I told the gentlemen connected with the Metropolitan Railway, whom we met in regard to the matter, that if the system which they seemed to adhere to had been tried on a railway like the Metropolitan for a period of three years and had worked successfully I would most willingly adopt it on any work that I had to do with.

To the charge that I am concerned in properties where the general system of electric equipment is being used, and that to adopt a better would cause a great loss by virtue of being compelled to abandon those systems and adopt another radically opposed in principle to it, I will say that we have never been afraid of the scrap-heap when we found we had made a mistake, but we do not court it. It is full of wrecks of failures, and it is just here that I would remark that we do not wish to add to that heap a plant that would cost in the neighbourhood of half a-million pounds sterling, apart from the expenditure on the power-house. I will also say that, as to systems or works or anything applying to electrical traction, I have no financial interest whatever, and my whole object is to see that whatever plan is adopted on any property with which I may be connected is the best. To take a system which has not been thoroughly tested, not for a few but for many months and even years, is a species of business recklessness which I do not wish to try. I also desire it understood that I am entirely free from prejudice, and desire only what is the best. To attempt to experiment now or to be guided by the experience of the little mountain roads in Switzerland, or the road which is being installed in Italy, which is not yet working, would be foolish, and even if it were in operation its success would be no indication of its adaptability to the Metropolitan Railway. If the managers of the Metropolitan Company had commenced this experiment years ago, when the Central London was begun, I am satisfied they would have lost some time, but they might have corrected their plant so as not to have been in the humiliating position we find them to-day. They cannot make the excuse that their credit was poor and they were unable to raise money. They have simply waited until the wolf was at their door, and long afterwards.

Another matter I would like to have understood. The system so called which we propose to use is not the "Yerkes system." There is no such thing. I never invented anything pertaining to electricity. It is a system universally used the world over by all modern-built railways, and I am only one of the scores of people who are doing this. It is used extensively in England, and only lately Glasgow has adopted it in the important plant which they have recently made and which is the largest in Great Britain.

In regard to the proposition that was really made to the Metropolitan Company, I will now give it and leave it for others to say whether it was fair.

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At the present time I am chairman of the Metropolitan District Electric Traction Co., and we have a subscribed capital of £1,000,000. The subscribers are all gentlemen of means and, I may say, affluence. Our propositions were:—

1. That we would electrify the Metropolitan Railway, furnish all the rolling stock, also a power-house and sub-stations, and do everything and furnish everything necessary to change and operate their road by electricity, charging therefor the sum of ¾d. for each passenger they might carry. There were some things, such as keeping their buildings in order, that they were to provide for. But I cannot see any way that they would make such a statement as they made in their report—that we would charge them £291,000 for what cost them £101,000.

2. The second and most important proposal was that we would work or lease the whole of the railways and general undertaking of the Metropolitan Company, subject to the statutory obligations of that company, guaranteeing to the Metropolitan Company a net yearly revenue sufficient to pay the whole of its debenture and other fixed charges and its guaranteed and preference interest.

As to a yearly dividend upon the ordinary share capital, we found that the average dividend for a period of seven years terminating on June 30, 1900—that is to say, prior to the competition which the company has had to meet with the Central London Railway—was £3. 6s. 11d. per annum. We offered to pay on the aforesaid capital stock yearly dividends in perpetuity at the rate of 3½ per cent. The dividend this half-year is at the rate of 2¼ per cent. per annum.

In regard to the surplus land stock, the dividend upon that would be provided, as heretofore, out of the revenues of land especially set apart for payment of interest on the surplus stock, and our proposition did not affect this stock.

For securing the dividend on the ordinary shares the Traction Company proposed at its own expense and cost of not less than £700,000 to convert the railways mentioned in the scheme from steam to electric traction, build all necessary sub-stations (the Metropolitan Railway Company to supply the land for the same), and supply the rolling stock.

We propose to increase the capital of the Traction Company from £1,000,000 to £2,000,000, or more if necessary; also to give to the proprietors of the Metropolitan Railway Co. the right to take £500,000 of the increased stock. We also proposed that the whole of the capital or the property of all kinds whatsoever belonging to the Metropolitan District Electric Traction Co. should be placed in the hands of trustees, who should hold the same for the benefit of the contract to be made with the Metropolitan Railway Co. In case we desire to sell or change any securities belonging to the Traction Company, we should do so only with the consent of the Metropolitan Company.

The security of the Traction Company has been sneered at by the Metropolitan Company, but it seems to me that with £2,000,000 of hard cash well invested, a portion of it in the property of the Metropolitan Company, this security is such as would not be offered by any other company. The terms that we offered—namely, placing all our property in the hands of the Metropolitan Company—were for the purpose of reconciling our differences and endeavouring to join the two companies—the Metropolitan and Metropolitan District—together in such a manner that they could be worked by one official head. It is my belief that if so worked a fair profit could be gained by our company—much greater than can be done if the two companies are separate.

The tender having been rejected, I wish to say that it is the desire of the managers of the Metropolitan District Electric Traction Co. to proceed to carry into effect at the earliest moment possible the electrification of the District Railway; and, as the officers of the Metropolitan Company have also expressed the same desire, there is no reason why the latter should hold to the text of the bill which has been passed—namely, that one month should elapse before we can go to the Board of Trade. The losses to both companies at the present time are very great, and I believe there is nothing that will stop the continuance of these losses but the running of the roads by electricity. Therefore every day means money, and it is for that reason that I am extremely anxious that not a moment should be lost.

## A COLONIAL ELECTRICITY WORKS ACCOUNTS.

### Launceston (Tasmania) Corporation Electric Supply Works.

Although Launceston (Tasmania) is not under British Board of Trade regulations, the Corporation engineer (Mr. Wm. Corin) has worked up the accounts in his report to the council into a form which enabled us to analyse them. Unfortunately for comparison with British works acccounts this is a water-power station, and the total costs thus work out very low—1·16d. per unit—and the ratio of total costs to revenue at only 40·2 per cent. But owing to the heavy capital outlay in hydraulic work and in the two mile overhead line, as well as to the general increased cost of materials in Australia, the profit is largely swallowed up in interest. Nevertheless a net profit of £525 is shown in the fourth year, and £1,700 is estimated for this figure for the current year.

Special efforts are being made to push the motor load and consumption of energy for heating, the charge for these purposes being only 2d. and 1d. per unit on the maximum demand system. On December 31st last 34 induction motors were in service, with a total capacity of 100 H.P. These ran for an average of 766 hours per annum, taking 770 units per H.P. and yielding a revenue of 1·7d. per unit, or £5. 10s. 7d. per H.P. For cooking and heating 13 consumers had heaters of a total capacity of 7·8kw. and consumed 580 units per kilowatt yielding a revenue of 1·6d. per unit, or £8. 17s. per kilowatt. An interesting comparison is made between the earlier consumers, who pay by contract at the rate of 11s. per lamp per annum with discounts, and those who have been connected more recently, who pay by meter on the maximum demand system at rates of 6d. and 8d. per unit:—

| For 1900. | By contract. | By meter. |
|---|---|---|
| Number of consumers | 386 | 758 |
| Ditto 8 c.p. lamps | 4,946 | 11,708 |
| Revenue, total | £2,427 | £2,998 |
| Ditto per lamp | 9s. 9d. | 5s. 1¼d. |
| Units sold | 300,810 | 121,643 |
| Price obtained per unit | 1·94d. | 5·92d. |
| Units used per 8 c.p. lamp | 60·8 | 10·4 |
| Average hours of burning per night | 5·55 | 0·95 |

The change over from contract to meter will thus probably largely reduce the load on the station without very much altering the revenue.

## LAUNCESTON, TASMANIA

*Undertaking Worked by*—Corporation of Launceston.
*Date of Commencement of Supply*—1896.
*System of Supply*—Alternate-current, 2,000 volts.
*Chief Engineer*—Wm. Corin.

| | 1899. | | 1900. | |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 749,261 | | 932,095 | |
| „ SOLD (TOTAL) | 576,243 | | 698,700 | |
| „ sold to consumers | 369,406 | | 483,873 | |
| „ sold for public lighting, &c. | 206,837 | | 212,827 | |
| „ used on works | 9,616 | | 13,216 | |
| UNITS SOLD per 8 c.p. LAMP CAPACITY | 33·1 | | 40·4 | |
| Maximum supply demanded | 365 | | 440 | |
| Number of public lamps | — | | 117 arc, 300 incan. | |
| Number of consumers | 806 | | 1,136 | |
| Connections to mains in 8-c.p. lamps | 19,419 | | 24,626 | |
| CAPACITY OF PLANT IN 8-c.p. LAMPS | 17,400 | | 17,400 | |
| CAPACITY OF PLANT IN KILOWATTS | 560 | | 560 | |
| **CAPITAL—** | Total. | Per kw. capacity. | Total. | Per kw. capacity. |
| RESERVE OR SINKING FUND | £3,487 | £6·23 | £4,541 | £8·11 |
| DEPRECIATION FUND | — | — | — | — |
| EXPENDED (TOTAL) | 91,639 | 163·6 | 98,794 | 176·4 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £6,414 | 2·67d. | £8,305 | 2·86d. |
| Revenue from supply | 4,423 | 1·84d. | 5,734 | 1·97d. |
| „ meters, &c. | — | — | 545 | 0·19d. |
| „ public lighting | 1,991[b] | 0·83d. | 2,026[b] | 0·70d. |
| „ sale of lamps, &c. | — | — | — | — |
| „ miscellaneous sources | — | — | — | — |
| **EXPENDITURE—** | | | | |
| TOTAL COSTS | £2,889 | 1·203d. | £3,339 | 1·150d. |
| WORKS COSTS | 1,829 | 0·762d. | 2,244 | 0·773d. |
| *Generation of Electricity*— | | | | |
| Oil, waste, water, stores | — | — | 68 | 0·023d. |
| Wages at station | — | — | 923 | 0·318d. |
| Repairs & maintenance at Station | — | — | 1,253 | 0·432d. |
| *Distribution of Electricity* | —[a] | — | —[a] | — |
| *Public Lighting* | —[a] | — | —[a] | — |
| MANAGEMENT CHARGES, &c. | 1,060 | 0·441d. | 1,095 | 0·377d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'd. | Total. | % to mean cap. exp'd. |
| WORKING PROFIT FOR YEAR | £3,525 | 3·86% | £4,968 | 5·01% |
| Carried to Depreciation Fund | — | — | — | — |
| Carried to Res. or Sinking Fund | 908 | 1·02% | 964 | 1·01% |
| Net int. on loans | 3,274 | 3·58% | 3,477 | 3·51% |
| BALANCE FROM LAST ACCOUNT | — | — | — | — |
| Do. AVAILABLE for DISTRIBUTION, &c | — | — | 525 | 0·53% |
| *Deficit* | 656 | 0·72% | — | — |
| % of TOTAL COSTS to GROSS REVENUE | 45·0% | | 40·3% | |
| Expenditure per kilowatt capacity | £5. 3s. 3d. | | £5. 19s. 5d. | |
| REVENUE PER KILOWATT CAPACITY | £11. 9s. 5d. | | £14. 16s. 2d. | |
| Expenditure per 8-c.p. lamp capacity | 3s. 4d. | | 3s. 10d. | |
| REVENUE PER 8-C.P. CAPACITY | 7s. 4¼d. | | 9s. 6½d. | |
| REVENUE PER 8-C.P. CONNECTED | 6s. 7¼d. | | 6s. 9d. | |
| Price charged for lighting, per unit | 6d. and 3d.[c] | | 6d. and 3[c] | |
| „ for power, per unit | 2d. and 1d. | | 2d. and 1d. | |
| „ for public lighting | —[b] | | —[b] | |

REMARKS.—*a* Included in generating expenses. *b* Covered by a lighting rate. *c* Also by contract at 11s. per 8 c.p. lamp per annum.

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## A LESSON IN ADVANCED ELECTRIC TRACTION.*

We have sometimes had occasion to remark on the erratic growth of American electrical engineering. The art has advanced not by a steady and dignified progression, but by a series of unequal zigzag leaps. Truth to tell, such is frequently Nature's method of planning growth. The practical result has been that we have not infrequently found ourselves busily pushing some branch of electrical engineering to the front and barely holding our own, or even falling behind, in others. At the present moment America is easily the leader in telephony and in electrical power transmission, so far as the engineering side is concerned. On the other hand, the really revolutionary work in electric traction is being done on the Continent. To be sure, we build nearly 10 miles of electric road to the Continent's one, but the one seems to represent advance in the art, while the 10 mark little but capital invested.

We are moved to these remarks by the receipt of a little brochure from Vienna giving some account of the striking railway enterprises under way in the Italian Lake district—a region already conspicuous from the installation a few years since of the first three-phase electric road at Lugano. Now a mere matter of 60 miles of line and a speed of 35 or 40 miles an hour is not much of a problem from the American standpoint. We can see just how it would be done—a third-rail construction, with plenty of supplementary copper in 500,000cm. cables, a central station at the water-power with large slow-speed generators, a handsome bank of raising transformers, four or five reducing stations with more transformers and large slow-speed rotaries, plenty of motors on the cars—one per axle, if possible, so as to get the rapid acceleration so dear to the engineer and so cursed by the passengers—and the whole interesting system linked together by a transmission system at, say, 15,000 volts. And if the results of the leakage on the third-rail system could be kept out of the papers the system would prove thoroughly successful, except when the rotaries hunted and went out of step, or some such slight accident marred the serenity of the general manager.

Now, just consider how these wretched peace-of-mind-destroying foreigners have tackled the job. To begin with, they have outraged all our holiest traditions by using three-phase motors on the locomotive and thereby putting the beautiful and efficient rotary converters out of service; and, as if that were not bad enough, have dared to replace the third rail, with its inches of mildewed wooden insulation, by a combined transmission and trolley system adequately insulated for a working pressure of 3,000 volts. More than this, they have capped these enormities by feeding the static transformers along the line from a 20,000 volt transmission line taking current directly from the generator armatures. Of minor offences against propriety, such as using two or four motors per train when they might have used a dozen, they have committed many, and, besides, they are hopelessly old fogey in using a locomotive when everybody knows that a mere steam locomotive can make all the speed that anybody has yet been willing to pay for.

Now, joking aside, when we consider that some of the earliest propositions for high-speed electric roads, for high-pressure trolley wires and for polyphase motors on the cars, came from American engineers, and that some of them have been steadily preaching such methods for a long time past, it is a shade annoying to find the achievement due to other hands and in a foreign land. It is now more than a decade since high-speed electric traction on a large scale, using motors wound for more than double the voltages now used, was worked out to a point where success was certain if once the project were developed; and yet it is quite certain that the first high-speed road will be a monument to European skill. We recognise fully that in every art a period of standardisation, or rumination, as it were, is necessary to the perfection and fullness of growth, but in electric traction that time has already lasted a year or two too long. The day is now here when the new methods must be tried and worked out to their legitimate ends. They may or may not prove their right to a place in the world's economics, but in any event the time for trial has come, and it behoves American engineers to be ready and alert.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Electricity in Mining." By H. Louis. (London: The Mining Journal.) 3s.

"Galvanoplastic et Galvanostégie." By Ad. Minet. (Paris: Gauthier-Villars.) 2f. 50c.

"Science Abstracts." July. (London: E. and F. N. Spon.) 2s.

"L'Electricité à l'Exposition de 1900." By E. Hospitalier and J. A. Montpellier. No. 7. (Paris: Vve. Ch. Dunod.)

"An Introduction to the Practical Use of Logarithms." By F. G. Taylor. (London: Longmans, Green & Co.) 1s. 6d.

* Reprinted from the *Electrical World* of New York.

## THE EQUITABLE ALLOCATION OF COSTS IN COMBINED LIGHTING AND TRACTION STATIONS.

**The following is an abstract of the discussion on Mr. W. H. Tittensor's Paper, with the above title, read at the Annual Convention of the Incorporated Municipal Electrical Association. The Paper itself appeared in our issue of July 19th:—**

The PRESIDENT (Mr. W. A. Chamen) said the Paper introduced a subject of the greatest interest to town councils as well as to engineers.

Mr. J. F. C. SNELL (Sunderland) said he was glad that Mr. Tittensor had brought this important subject before the Association, because it was one which, at the present moment, a great many must seriously consider. There was much in the Paper with which he agreed, and there was also much with which he entirely disagreed. In the first place, Mr. Tittensor was unduly hard upon the outside expert. A higher system of commercial morality existed among professional gentlemen experts than he gives them credit for. It would be a most deplorable matter to the industry at large if separate stations for lighting and tramways were allowed to be erected. Of course, in a big city like Glasgow, the question was different to what most have to deal with in smaller towns, but even there a great mistake was made in permitting so large a plant in a separate tramway station to be put down, rather than using some portion of the plant in the two magnificent stations which Mr. Chamen has erected in Glasgow. It is being stated that Liverpool is supplying current to its tramways committee at the price of 0·9d., if not less, per unit. He knew also of another city in the Midlands which was supplying electricity to its tramways committee at the low price of 1d. per unit all round. As many engineers know, circular letters were sent to them some months ago asking for details as to how they made up their prices, and he had good reason to know that in this instance the price has been raised to 1d., showing that the initial cost that this Corporation charged to its tramways committee was much too low. Mr. Tittensor says, "In a given station the total standing charges will be the same, whatever the number of consumers connected may be," and so on, and that it is unnecessary to take into consideration the maximum kilowatt demand in determining the cost per unit generated. He always understood it was one of the most important factors to take into consideration. The best way of replying to this Paper was by taking the history of the problem in Sunderland. Before doing that, however, there was another contradiction to point out. "The author had always held that supplies of a purely public nature should be given at cost price," and he went on to add, in the same paragraph, that on no account should public works be run as philanthropic institutions. Surely these two premises were entirely contradictory. Of course, he may mean that if you are to run as a philanthropic institution you are to supply at less than cost price; but surely there was no committee in this kingdom which would agree to supply current to another department of the Corporation—another department which makes far handsomer profits than the electric lighting will do—at less than cost price. Coming to the particular question of price, he agreed that the interest in sinking fund should be charged on the full value of plant used for tramway purposes alone—that is, for the plant and the proportion of buildings and other etcetera which necessarily go with that plant. In Sunderland we have 13 engines at the present moment, and one engine which would be mutually convertible for tramway and electric lighting purposes. Are we simply to rely on that one engine as stand-by plant for either lighting or tramways? Surely not. We must at least have one stand-by set for tramway purposes and one stand-by set for electric lighting. Suppose a breakdown occurs on the traction side and the electric lighting side simultaneously, where are we going to be? Tramway plant must be more economical to run than the lighting plant. It would be unfair to the tramway authority if you took the average price of the coal per unit generally, and spread over lighting and tramways, and charge that rate to the tramway authorities. When you come to the question of plant for tramway purposes £15. 6s. per kilowatt is a ridiculous figure. From figures I have got from other towns it is more nearly £35 and £40 than £15. 6s. Does Mr. Tittensor include not only the tramway steam generators, but also the boilers, the steam piping, the condensing plant and the details which follow from the plant in that cost per kilowatt, and so on? This question had forced itself upon them naturally at Sunderland, and the lighting committee were going to take good care that they did not supply their current at a loss to themselves, and very rightly. The tramways committee were very anxious to get the best terms, also very rightly. The question is how to decide. The total costs, including interest and sinking fund, both of which are very much higher figures per unit generated than Mr. Tittensor gave, and yet Sunderland occupies a very favourable place among the stations that now exist. The total cost per unit generated was 2·7d., of which more than a third was for capital charges. That was for a total of 1,300,000 units. If one turned to the tramway plant alone and allocated the cost in the way Mr. Tittensor had done one found there was a reduction. Last year there was no reduction, because while they had plant standing ready to supply the tramways for close upon 12 months, owing to the Board of Trade inspection not having taken place, the tramways were unable to run, the result being that the standing charges were going on, and spread over the units thus amounted to 2d. per unit, and of course the lighting committee last year lost on the units which they sold to the tramway authority. The capital costs instead of being only £15. 6s. per kilowatt for tramway purposes was about £38. This year it will turn out 1,200,000 units for tramway purposes, and taking the interest on sinking fund, wages, rates and taxes the total standing charges are as near as possible four-fifths of a penny.

Mr. S. E. FEDDEN (Sheffield) said that after carefully reading over this Paper he came to the conclusion that it was trying to complicate

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accounts that were already considerably complicated. If they asked a chartered accountant he will probably give them an opinion, but it appeared to him that this Paper, if carried into effect in many stations, would result in increasing the account ½d. per unit for clerical charges. The question in the second paragraph in the Paper, as to whether power for traction should be generated by combined lighting and power plant, or in a station specially erected or fitted up, is a problem almost all right-thinking men have settled. In Mr. Wordingham they had a man who thoroughly grasped how all power supply should be carried out in the future. There was no doubt that polyphase power stations would be the stations of the future. It seemed to him that all small stations that have been erected now will, in the course of a very short time simply become sub-stations. They seemed to think that is impossible. There was no doubt that with combined sub-stations, either with roadways for tramways and motors and lighting circuits, there would be no trouble in getting the proper voltage. They would then get the benefit of a large power station under one management, and all the necessary economies. The question of the size of power station, of course, was another point. A large number of professors in late days talked about 5,000kw. and 10,000kw., and they gradually mounted up and kept putting a different limit; but if they looked at places on the Continent and America, they could safely say that 100,000kw. is about the right limit. Mr. Tittensor, in one part of his Paper, said that the tramway department should be considered as the customer of the general lighting department. Later on he said he would like to divide up all the boilers and everything in the station. That is just the same as starting two stations.

Mr. C. H. WORDINGHAM (Manchester) thought the Paper was of vital importance, and congratulated the author particularly for having pointed out the right way of charging for energy supplied for tramway purposes, as for all others—namely, on the basis for the maximum demand. In a report which he had to make about two years ago he came exactly to the same conclusion—namely, that the only way in which you can charge equitably for tramway working on a combined system was upon the maximum demand. Before going into that, however, he would like to refer to two general subjects which Mr. Tittensor introduced—namely, the question whether municipalities ought to make profit or not, and also the question of combined stations. It did seem to him that every department of the Corporation ought to be treated in the same way as ordinary consumers, that you should charge them the proportion of what they cost you, and that you should make some profit besides. As to the question of the wisdom of combining two stations, it must be an extraordinary case in which it would not do to combine. The only case conceivable was where either the lighting or the tramway station, was chosen in such a position that it would be uneconomical to transmit from it to the other. These cases are very rare. The station ought to be so designed, at all events, that the generators are interchangeable for the two purposes. As to the way in which Mr. Tittensor divides the charges, he joined issue with him. It is common practice to regard all the coal as a running charge. It seemed to him that that was absolutely wrong, as a very large proportion of your coal is a standing charge, because whatever the demand on the plant may be the boilers and steam pipes must be kept heated, and the coal burnt in 24 hours in order to do that amounts to a figure they would not like to know. It was a very heavy charge indeed, and absolutely a standing charge, and he therefore thought a larger portion of the fuel ought to be made a standing charge. Then again Mr. Tittensor regarded all the wages as a standing charge. There again he was wrong, because even if a station is never running, but simply prepared to run, a certain staff is required whose wages are standing charges, but if that station is called upon to run it will require more men. He could not understand the distinction which Mr. Tittensor draws between the cost of generation and the cost of supply. The only meaning he could conceive with regard to it is that the cost of generation does not include the cost of mains, and also the cost of connecting currents, motor and so on.

Mr. J. A. BELL (Aberdeen) said the Paper was of considerable interest to folk in Aberdeen, as they were very near neighbours, and he had repeatedly had pointed out to him the excellent way in which Dundee can supply their tramways at 1½d. per unit, which includes interest on sinking fund and also repairs to cables and line wages. This had often been thrown at them as something they should do in Aberdeen, where they had an arrangement that they should supply at cost price. It all depended upon the arrangement between the electricity and tramway committees as to how that price is to be calculated. In a station of the size Mr. Tittensor quoted, with an output of 500,000 units for traction and 800,000 for lighting, and if the plant for lighting and traction purposes was kept separate and distinct the way he arrived at them was fairly equitable. At present they only ran some eight to 12 hours, and the output for tramway purposes would only be one-seventh of the whole. On Sundays they did not run at all. He would like Mr. Tittensor, in his reply, to give the basis on which he supplies current in Dundee at 1½d. per unit and what he allows for repairs on line and cable work. They were all very anxious to do it as cheaply as possible, and it would be of considerable interest in Aberdeen, where the tramway committee think they have got hold of a gold mine.

Mr. G. H. CORRINGHAM (Brighton) said that the equitable allocation of costs was the basis of all remunerative business. With regard to combined stations his own opinion, until he heard Mr. Wordingham speak, was, that there was no doubt about the advantage in any but the largest towns. There was no doubt whatever that combined stations can generate and supply at a less rate than separate stations, and the establishment of separate stations was wrong especially. But if the lighting station is originally put down on a bad site with regard to working efficiency, it may be excusable to put down a separate station for tramway purposes. With regard to the standing charges, a saving in a combined station may be made on interest, sinking fund, management expenses, insurance, rents, rates and wages, which, of course, will vary with the load-factor. In a combined station there is a saving of fuel used in the stand-by steam plant. He did not agree with the idea of having separate boilers for the traction plant, for the simple reason that the advantage was at once lost. Repairs in a combined station will cost less, especially in small stations, because the rate at which they are done will be less. A small separate station cannot afford to keep such a good staff for doing repairs as a combined station will be able to do. Of course, that does not count for so much on a very large station.

Mr. J. CHRISTIE (Brighton) said that it might be interesting to the members to hear how this problem has been met and satisfactorily solved in Brighton, where they are about to run a system of some 25 cars to start with. Mr. Wright, the first president of this Association, was at present designing a large station which will ultimately supply all the electric energy for Brighton. As the tramways had to start in a very short time, it became necessary to settle what method to adopt for supplying them until a three-phase station was ready. They had a system of motor transformers and batteries for the ordinary lighting department in the first instance, but, for reasons which it is unnecessary to discuss, it was thrown out, and the Tramway committee insisted on having separate plant for their own purpose. The tramways have an engineer of their own, who is responsible for the track, rolling stock and overhead equipment, and also the cables to the switchboard, at which his responsibility ends.

Councillor TREWHITT (Sunderland) said the Paper was of great assistance to him as chairman of the Sunderland Tramways committee. Mr. Snell had told them that he was sometimes between the devil and the deep sea, but his two chairmen dealt very leniently with him, and the two committees had absolute confidence in his judgment. As chairman of the Tramways committee, he could hardly influence that committee or the council to adopt opposite views to those held by Mr. Snell. Mr. Snell had already told them that they were using about 1,200,000 units per annum for tramway purposes. Up to the present time they had been paying 2½d. and 2¼., and 2d. at present. He had been told by outside experts that he ought not to pay so much, and naturally he wished to have the current supplied at cost price. If municipalisation is right in principle, it follows that he ought to have it supplied at cost price, and to municipalise the station for tramway purposes. The present station which is now used for electric traction and lighting purposes will presently be used for traction purposes only, as the Corporation propose to erect a large new station. From the author's paper he saw that the Dundee Corporation committee only pay 1½d. per unit for 500,000 units, and in that case he ought in Sunderland to have it at considerably less, if not at cost price. The Sunderland Corporation had had the electric lighting running now for about six years, and they had not to buy out any private companies. For five years' electric lighting, after paying sinking fund and interest, has been a charge on the rates. During the last 12 months the committee had produced an estimate in which they say they have realised a profit of £1,200. He would like to know whence that profit comes? Of course, there is the personal element. The engineer is desirous of seeing his station pay on its electric lighting. The profit is coming from the tramways department of course. The engineers will be very likely able to refute that, but to the layman that is the impression created.

Ald. BRUCE (Sunderland) said he presumed that what takes place in Sunderland will take place in other towns. When they first commenced to deal with the price of the current they were met by Liverpool being able to supply current at 0·9d. per unit. It naturally became his business to try to find out how it was possible that that could be done. It will be admitted on all hands that the chairman of any committee must necessarily be dependent on his engineer for the facts and figures in order to enable him to come to a right conclusion. We could not have an electrical engineer who was better qualified to give any committee advice upon such a subject than Mr. Snell. There were several factors that go to enable committees to provide cheaply. If they ignored interest and sinking fund then, of course, they could produce very cheaply. Then, again, in a large city like Liverpool or Glasgow, where the units are turned out by the million, of necessity they can produce more cheaply than in a smaller municipality where, perhaps, the maximum is a million to a million and a half. But the various committees need have no difficulty in facing this question. Underlying the whole there are principles that may be ascertained to guide committees upon this question. First of all, in the town councils of the various municipalities, whatever their committees may be, and however many there may be, whether it is a joint committee or two committees—one representing lighting and the other tramways—they both represent the same constituents, and therefore it was the duty of both committees to produce as cheaply as possible that which their constituents demand. They demand, first of all, light, and then they demand tramways. He did not agree with those who want the Corporations to produce either of those commodities and sell them at cost price. Now, Councillor Trewhitt said that they had during the past 12 months made a profit, and the other five years they had been a charge on the rates. It was only during the initiatory years that there was a small charge on the rates, but that which was taken out of the rates was really needed to pay into the sinking fund. If it had not been for the sinking fund there would have been no charge on the rates. He agreed with the writer of the Paper that stations ought to be combined, because both committees ought to join together to produce as cheaply as possible for the benefit of the whole community. He also agreed that they ought not to change the tramways at the same rate as other consumers. In fact the maximum charge that any lighting committee ought to make on any tramways ought not to exceed what it would cost the tramways committee to provide for themselves. But care must be taken that proper changes are taken into account in making up the proposed charge to the tramways committee before the amount is settled upon.

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Mr. R. A. CHATTOCK (Bradford) had inquired last year as to how the charges made for tramway supply were arrived at, and from the answers he got he found they were made up in very different manners. Some engineers simply charged the cost of the current at the switchboard. Others had the cost of the tramway feeders to provide for. Others had the cost of the overhead equipment to provide for in their charge per unit, and naturally the figures differed considerably. At Bradford they had the tramway cables under their charge, and had to pay interest and sinking fund and depreciation on the cost of these. They did not touch the overhead gear at all. When he went to Bradford he found there was a charge of 1d. per unit made to cover everything in traction supply. He saw he could not possibly make any profit out of this. In fact there was no doubt they were making a loss. He brought the matter before the committee. The committee decided not to do anything until the costs up to last March were got at, on account of the increase of the lines, &c., and the Tramway committee agreed to pay cost price for current. He worked it out on very much the same lines as Mr. Tittensor had done in his Paper.

Mr. R. C. QUIN (Blackpool) did not agree with Mr. Tittensor's figures, but with his method generally. He was faced by the same difficulty in the latter part of 1896. Blackpool had decided to have a combined station. He was the engineer to both, and had to solve the problem of the equitable allocation of costs as between the two departments. He had no precedent to go upon in those days, for the simple reason there was no combined station. But as a devotee of the demand indicator he adopted that system. He took some of the fuel as a standing charge, and did not agree with Mr. Chattock that that is by any means difficult to do. The result for a minimum of 250,000 units was a 2d. per unit rate, and above that they could do it at 1¾d.

Mr. TITTENSOR, in reply, said it would be a Herculean task to reply on all the points that had been raised, and he would do so in writing. A gentleman he showed his Paper to said, "I see you give figures here. You know that old saying that figures cannot lie, but liars can figure."

# PARLIAMENTARY INTELLIGENCE.

## MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

On Friday last, after the Committee had deliberated,

The CHAIRMAN said: The Committee have arrived at a conclusion by a majority in this matter. The Committee regard the proposal contained in this bill as being rather in the nature of an experiment on a practical scale of a novel system of locomotion and traction than as an ordinary railway bill. Therefore, as the questions before them are conditioned by new factors and new considerations, they are necessarily constrained to modify the application of some of those principles which ordinarily govern the decision of railway bills. For instance, the competition question practically disappears; indeed, and very properly, it has hardly been pressed. There is no competition. If the monorail be started and succeeds up to, or nearly up to, the point claimed for it by the promoters, it will, of course, annex a good deal of the express passenger traffic of the existing lines in its neighbourhood, just as the railway absorbed the express coach traffic; and if it succeeds it will deserve to do this, and in the doing it will benefit the public. If it does not succeed it will not annex the traffic, and it will not injure the Cheshire Lines. Similarly, in the case of an important experiment, which may result in great advantage to the public, the Committee is disposed to some extent to relax the severity with which it would ordinarily examine the financial prospects of a railway scheme. The money for making this experiment appears to be forthcoming, but having regard to the sums that will inevitably be invested in similar works, should this one prove a success, the amount does not seem disproportionately large, and the Committee are not inclined to accept the responsibility involved in stifling a promising new departure merely on the ground of possibly poor returns to the future shareholders. In the present galloping evolution of locomotion, new developments of which present themselves every month, that would be a reactionary policy. Much money will inevitably be expended on experiments before the ultimate solutions are arrived at; but having said so much in these directions, there are on the other side very grave considerations which arise from the novel and experimental character of this proposal. For the purposes of this bill, the existing Board of Trade railway practice would be of little or no service. The Board of Trade has no established doctrine in relation to such a method as this line foreshadows. In an ordinary railway the Board of Trade inspector intervenes only after construction. Now, clearly in the case of an entirely novel system, devoid perhaps of some familiar dangers, but beyond question fraught with large potentialities of new and perhaps very serious dangers, the ordinary powers of the department are inadequate. As to the danger of the new system, while the promoters scout the very idea of such danger, the advisers of the petitioners have succeeded in producing, during the last few days, a positive inferno of dangers, scientific and blood-curdling, which have greatly comforted the Committee. But taken all together, the Committee feel satisfied there is a case, in the interest of public safety, demanding special care and special treatment, and the Committee are clearly of opinion that an experiment of this sort, if made at all, ought to be hedged by every reasonable precaution and safeguard available, and ought, in certain respects, to be subject to conditions analagous to light railways. The point I have, therefore, to put to Mr. Balfour Browne, for the promoters, is this: In the event of the Committee being disposed to pass the preamble of this bill, are the promoters prepared to accept the position of light railway and tramway projecters? Are they prepared to insert clauses, before constructing, to submit for the approval of the Board of Trade, plans and other details of construction and material in respect of permanent way, rolling stock, mode of working, electrical installation, system of signalling, system of braking, and also to satisfy the Board of Trade as to their scheme for the effectual maintenance of the permanent way and the exclusion of the public from trespassing on the permanent way? Further, are they prepared to consent that the Board of Trade should be able to call upon the company to conduct, or that the Board of Trade should conduct, under such conditions as the Board of Trade might prescribe, and at the company's expense, experiments which the Board of Trade might desire to have made with a view to determining whether such approval might properly be given in any of those cases? Lastly, clause 59 of the bill should be extended in relation to the question of electrical power as the Board of Trade might prescribe to ensure the safety of the public and of the company's servants in relation to electricity.

Mr. BALFOUR BROWNE: Yes. As regards everything you have asked, I give at once, without consulting my clients, a categorical answer that we will submit to these conditions without hesitation.

The CHAIRMAN: Then, by a majority we find the preamble of this bill proved.

On July 30 the clauses of the bill were considered.

Mr. BLENNERHASSET submitted the following clause, framed to carry out what the promoters understood to be the decision of the Committee:—

For further securing to the public and to passengers on the railway and to the servants of the company all reasonable protection against danger arising from the use of the railway under the provisions of this act, the following provisions shall have effect—that is to say:—

1. Three months before commencing the construction of the railway the company shall submit for the approval of the Board of Trade plans, sections and other details of their proposal with respect to (*a*) the construction and materials of the permanent way and proposed mode of maintenance thereof; (*b*) rolling stock; (*c*) mode of working, including system of signalling; (*d*) electric installation; (*e*) system of braking; and (*f*) mode of fencing and prevention of trespass.

2. The Board of Trade may require the company at any time during the construction of the railway to conduct at their own expense such experiments as the Board may desire to have made with a view to determining whether the arrangements of the company in respect of any matters referred to in this section are satisfactory, and the company shall comply with any such requirements before opening the railway for the public conveyance of passengers.

3. The Board of Trade may make regulations for giving effect to all or any of the foregoing provisions of this section, and also for securing to the puplic and to passengers and to the servants of the company all reasonable protection against danger arising from the use, under this act, of electrical power on the railway, and for regulating the use of electrical power.

4. The company, or any other company or person using any electrical power on the railway contrary to the provisions of this act, or of any regulations made by the Board of Trade under this section, shall for every such offence be liable to a penalty not exceeding £10, and also in the case of a continuing offence, to a further penalty not exceeding £5 for every day during which such offence is continued after conviction thereof.

5. The provisions of this section shall be in addition to and not in substitution for any provisions for the protection of the public and of passengers and of the servants of the company contained in any general act relating to railways which are applicable to the railway and the company.

Mr. RUSSELL, K.C., for opposing railway companies, said there was nothing in the clause to enable the Board of Trade to say what was intended to be the use of the railway. The promoters meant by the use of the railway the running of a passenger service thereon between Manchester and Liverpool in 20min, and as the Board of Trade were to see whether the construction was proper, they must know the speed for which the permanent way and other appurtenances were intended. It was essential, therefore, that there should be embodied a statement of the use which was to be made of the railway. Obviously it was not intended for use of low-speed trains. Then it was provided that three months before commencing the construction of the railroad the company should submit for the approval of the Board plans, sections and details of their proposals. So that if it at the end of three months the Board had not pronounced on the plans, sections and details so deposited the company would be at liberty to commence the construction of the railway. He ventured to say that was not the intention of the Committee. He suggested that the provision as to three months ought to be struck out, and that the clause should state that before commencing the construction of the railway the company should submit for the approval of the Board plans, sections, and other details of their proposal with regard to (*a*), (*b*), (*c*), (*d*), (*e*) and (*f*), and that the company should not commence the works until such plans, sections and other details had been approved by the Board; after such approval the works should be executed in accordance with such approved plans, sections, and details. The order of events should be: Submission of plans, approval, and if the Board required it before approving, conduct of experiments, and then commencement of construction. He suggested the provision should read: "For the purpose of determining whether such approval can properly be given the Board of Trade may require the company at any time to conduct at their own expense such experiments as the Board may determine."

The CHAIRMAN: I do not see the difference. The Committee do not propose to make any reference in the bill as to the rate of speed or use of the railway; and with regard to the three months' point they thought Mr. Russell right.

Mr. RUSSELL then urged that the clause should clearly show that the Board of Trade were to have power to call for experiments before giving their approval, as well as power to call for experiments to see whether the construction had been properly carried out.



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The CHAIRMAN said that was the intention of the Committee, and he therefore suggested that sub-sec. 2 should read—"The Board of Trade may require the company at any time before or during the construction of the railway," &c.

Mr. BALFOUR BROWNE, with regard to the question of "before or during," said that if the Committee inserted the word "before" they might put upon the promoters the obligation to make an experimental railway—which they had no power to do.

The CHAIRMAN said the promoters had no power, and the Board of Trade could not require them, to make such a railway.

Eventually it was decided to insert the words "before and," so that the clause would read: "The Board of Trade may require the company at any time before and during the constructian of the railway," &c. It was also agreed to leave out the words at the commence of sec. 1 down to "the company," so that it would read: "The railway shall submit for the approval of the Board of Trade plans, sections and other details of their proposal with respect," &c., and then at the end add "and the railway shall only be constructed in accordance with such plans, sections and other details, as approved by the Board of Trade."

Other slight adjustments having been made, the bill was ordered to be reported.

## LONDON UNITED TRAMWAYS BILL.

This bill, which seeks powers to extend the tramway system of the London United Tramways (Ltd.) to Barnes and Richmond, and to Malden and Coombe, Surbiton and East Molesey came last week before a House of Lords Committee presided over by the Duke of Northumberland.

Mr. BALFOUR BROWNE (for the bill) said the whole length of tramways belonging to the promoters or already authorised was 40 miles, and 16 or 17 miles of line were at present worked by electric traction. Last week they carried 1,000,000 passengers over these lines. The lines now being promoted were almost entirely in the county of Surrey, one from the terminus of the line in Hammersmith, running south over Hammersmith Bridge into Barnes, which would be coupled up with Richmond. Another line was from Kew to Richmond, a line at present worked by horses. The Chelsea Water Co. were opposing on the ground of electrolytic action. But this company were amply protected by the regulations of the Board of Trade. The water company wanted something more than the protection given in the bill, but the promoters objected to give it. It was true that in a Sheffield bill, owing to things not having been made sufficiently clear to a Committee presided over by Lord Newton, special protection had been given to a water company, and this protection had also been given in another case, but it had been refused in all others, and in the Bexley tramway case this year the protection was distinctly disallowed. Referring to the other opponents, it was absurd to suppose that a few frontagers and the Richmond Corporation could prevail to prevent the company from giving the increased travelling facilities which they proposed.

Mr. BAGGALLAY (for the Chelsea Waterworks Co.) said Mr. Balfour Browne was not accurate in stating that it was left to the Board of Trade to decide whether or not the promoting company should use insulated or uninsulated returns, and he also denied that if the Board made further regulations they would operate retrospectively. If insulated returns had to be substituted for uninsulated returns it would mean that the whole system would have to be altered, and the original capital expenditure would be wasted. It was no doubt provided in the bill that the company should take all reasonable precautions in constructing and maintaining their electric lines and in working their undertaking so as not to injuriously affect by fusion or electrolytic action pipes, mains, &c. But assuming that they did take all reasonable precautions, the case for the petitioners was that unless they had insulated returns sooner or later there must be electrolytic action, which meant the eating through of the pipes. He joined issue with Mr. Balfour Browne as to the power of the Board of Trade to put insulated returns upon the company. When the present bill was before the House of Commons the parties went fully into the question, and in replying on the case Mr. Balfour Browne taking, as he thought, a wrong view on the question of law, really led the Committee to decide against the water companies, for he said that the Board of Trade had absolute power to compel the tramway company to adopt insulated returns at a future date even if they had started with uninsulated returns. If the promoters were prepared to insert words in the clause which should make it clear that the Board of Trade had power to insist on the use of insulated return he would say no more.

Mr. BALFOUR BROWNE said he did not think it necessary. He was sure their lordships would not give a direction to the Board of Trade. He would leave the clause as it stood. This would leave the Board full power to alter.

Mr. J. CLIFTON ROBINSON, managing director and engineer to the London United Tramways, said the company were carrying on their lines nearly a million passengers per week at an average of something less than 1d. a passenger. The estimated cost of the widenings involved in the present scheme was £91,700. The estimate of the permanent way construction was £169,900, making a total of £260,000, exclusive of electrical equipment. The whole of the lines would be worked electrically from one generating station at Chiswick. The cars on the new lines would be similar to those now running, each of which cost £1,000, the cost of an ordinary horse car being only about £200. When the company's scheme was complete and in full operation he believed they would carry from 150,000,000 to 200,000,000 passengers a year. With the present extensions the company's system would be nearly 55 miles in length.

A mass of evidence in favour of the bill was given by local witnesses, which concluded the promoters' case.

The CHAIRMAN intimated that the Committee did not think the Hammersmith line had been proved, therefore they did not propose to hear the opposition against it. They would hear the opposition for the other sections.

Evidence was then taken on behalf of the Middlesex County Council and other opponents of the measure, which chiefly centred round the question of the widening and strengthening of the bridges across the Thames and the contribution which the promoting company should be called upon to make towards such widening and strengthening. In the course of the evidence,

Sir J. SZLUMPER, Mayor of Richmond, said the whole of the present horse tramway from Kew to Richmond was within the borough of Richmond, and, in accordance with their powers under the Tramways Act of 1870, they had passed a resolution to purchase the line in 1903. Richmond Corporation supported the proposal of the company to purchase the tramway when the bill was before the House of Commons, but that support was given only because it was then proposed to make extensions to Hammersmith and Putney. Under no circumstances would Richmond have ever consented to part with their rights in the existing tramway unless the system was to be extended. He did not think a case existed in which a company had been given power to acquire compulsorily a line entirely within the area of the borough.

Sir WHITTAKER ELLIS, M.P., said he had been interested in the tramway question in and around London for some years. The result of these electric trams he found to be this—they destroyed the use of the road so far as wheeled carriages were concerned. No one would ride in his carriage where there was a tramway if he could avoid it, and no one would keep a carriage where there were electric tramways. Tramways were constructed by Act of Parliament, and they assumed that they had the right to stop and interfere with all other traffic which came in the way. The result of constructing electric tramways was to reduce the value of property along the front of the road! He thought the promoters should either acquire a portion of Kew Gardens or buy the whole of the houses along the proposed route, and, having made use of so much of the front gardens as was required, re-sell the property. In that way they would find that the tramways would seriously decrease the value of property.

Further evidence against the bill having been given, Mr. Fitzgerald, K.C., rose to reply for the promoters.

The CHAIRMAN: What has become of the opposition of the Chelsea Water Company?

Mr. FITZGERALD said the Water Works case was settled. A clause had been agreed between the Chelsea Company and the promoters which would be submitted. Subject to the clause being inserted it must be taken the Water Works Company was no longer present. Terms had also been made with the Middlesex County Council, who were the only opponents to the tramway crossing the bridges. The Surrey County Council and all the local authorities were supporting the large group of tramways in Surrey. Therefore, on the question of their crossing the bridges, the only party outstanding was the Middlesex County Council, with whom terms had now been arranged. The only point left to be dealt with was the proposed electrification of the tramway from Kew to Richmond. At the last moment an opposition had been got up by a small number of frontagers. What they objeccted to was not to tramways but to electric tramways. This was a curious objection, because, since electric tramways had been introduced it had been taken as an axiom that even if you do not like tramways an electric tramway is better than a horse tramway. The position of the frontagers was inconsistent with that of the Richmond Corporation, who had stated that if the horse tramway passed into their hands they would make it an electric tramway. So that the frontagers would be in the same position whether the Committee passed the bill or not. If the bill passed, the company would proceed to electrify the line at once; if it did not pass in 1903 the tramway would pass into the hands of the Richmond Corporation, and they would proceed to electrify it.

The CHAIRMAN then said the Committee had found that that portion of the preamble which refers to the tramway from Kew to Richmond is not proved. As to the tramway in the south we want to ask a question about the bridges before passing the preamble. Do I understand that if one of the bridges is rebuilt and the cost is, say, £90,000, the tramway company will pay £30,000?—Yes.

Then I observe the word "reconstruction." Does that mean rebuilding?—Yes.

Then we find that the rest of the preamble is proved with the inclusion of the clause as to the Water Company.

This new clause is as follows:—"The powers of the Board of Trade under sec. 38 of the London United Tramways Act, 1898, and sec. 12 of the London United Tramways Act, 1899, as incorporated with this act, shall be deemed to include power, subject to the provisions of those sections, to make regulations requiring the company to use such reasonable precautions, including insulated returns, as the Board of Trade may think necessary for the purposes of the said sec. 12, and the Board of Trade may in like manner from time to time alter any such regulations."

The remaining clauses were adjusted and the bill ordered for third reading.

## HENDON TRAMWAYS BILL.

On July 29 Mr. Jeffrey's Committee of the House of Commons commenced consideration of this bill.

Mr. FREEMAN, K.C., in opening, said, the object of the bill was to authorise the construction of tramways, beginning at Golder's Green, Hampstead, and running to Hendon and to Mutton Brook, near Finchley, The population of the locality was increasing, and would increase much more rapidly if there were further facilities for travelling. Every body which had authoritatively to consider these tramways favoured the scheme. The Middlesex County Council opposed the scheme when it was before the House of Lords. They said repeatedly that they were in favour of the tramways being constructed, but said they would like to make it themselves.

The CHAIRMAN: Have the Middlesex County Council constructed any tramways?

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Mr. FREEMAN: No, not yet. They cannot construct tramways; they have power only to make light railways. In the other House Middlesex wished to see the tramways made, but that a clause should be inserted enabling them to get a transfer of the promoters' powers. The tramway, however, was in the district of the Hendon local authority. Therefore, under the Tramways Act of 1870 that authority, at the end of a certain period, had the right to purchase it.

The CHAIRMAN: The actual making of the tramway is not opposed by the Hendon Local Board or the Middlesex County Council.

Mr. EARLE (for the Middlesex County Council): Yes, because we say the effect of these promoters doing it will be to spoil our larger system. That there ought to be a means of traction along that road we do not dispute.

Mr. FREEMAN then referred to the petitions against the bill, and local evidence in its favour was given.

In the course of the evidence for the bill,

Mr. CLODE (for the promoters) pointed out that the Joint Parliamentary Committee had recommended extensions by means of tramways at the end of tube railways as a proper way of dealing with the difficulty of transit from the centre of London outwards.

Mr. AULAGUIER, an associate member of the Institute of Electrical Engineers, and honorary secretary of the Hendon Ratepayers' Association, whom he now represented, said the feeling of the ratepayers was that there was very great want of locomotion to the City and West End. The proposed tramway was very desirable, as it would, by connecting with the extension of the Charing Cross and Hampstead tube railway, give communication practically with all London.

Mr. C. T. YERKES said that he was connected with the Charing Cross and Hampstead Underground Railway Co., which had made an application to Parliament for power to extend that line from Hampstead to Golder's Green, where they would wish to join with it the two lines of tramway from Hendon and Finchley. There was ample capital to carry through the tramway undertaking. He saw no reason why the line should not pass and be handed over, if necessary, to the Middlesex County Council. He was the promoter and financier of the authorised Charing Cross, Euston and Hampstead line, and of the proposed extension, and next session he intended to bring in a bill to widen the authorised line and to construct the proposed extension.

Mr. DAVISON, C.E., engineer to the proposed tramway, explained that it would be 3 miles 2 chains in length, and wholly in Hendon. The line would be constructed to the standard gauge. The Hendon Council had made it a consideration of giving their consent that the road should be not less than 50ft. in width. There would be trams every five minutes, and a journey which took at present nearly an hour would be reduced to one-half—that was from Hendon to Charing Cross, a distance of 6 miles. There was no other scheme before Parliament for giving access to Hendon from London. It was proposed to take current from the Charing Cross and Hampstead Railway. He was not aware of any precedent for a bill of a tramway being sanctioned by Parliament without means of equipment and working being provided in that bill. The tramway could not be worked until the proposed extension of the Charing Cross and Hampstead line had been made, because the company were relying on the extension for their supply of energy.

This closed the case for the promoters.

Mr. ERSKINE POLLOCK, K.C. (for Miss Metcalfe, the principal freeholder, tenant and ratepayer of the district), said they were told the roadway where the tramway runs was to be 50ft. wide, but there was no power in the bill to take land compulsorily, so that even if the measure passed it would be necessary to wait until next session before the tramway could be constructed.

The CHAIRMAN: I suppose nothing would induce Miss Metcalf to meet the local council and the promoters in the matter of granting the necessary land.

Mr. POLLOCK said his client declined to part with any of her land, unless it was considered to be for the public good, and an Act of Parliament were passed to make it compulsory. Such an act could not be passed this year.

Mr. FREEMAN, said that the proposal as to the 50ft. was based on an agreement with the local council. That agreement, of course, was capable of modification.

Mr. POLLOCK said it was in view of this agreement that Lord Pirbright's Committee passed the bill. If the measure were passed by the present Committee it would entail on Miss Metcalfe the expense of an opposition in another session of Parliament. He submitted that the scheme was immature and should not be rushed forward this session. It was an isolated piece of tramway leading from Hendon to nowhere, for until another scheme were sanctioned (from Golder's Green to Hampstead) the line could not get a connection with the Charing Cross, Euston and Hampstead railway at Hampstead (which line itself, although authorised, was still unconstructed, and not even commenced). The proposed extension of the Charing Cross, Euston and Hampstead Railway between Golder's Green and Hampstead was not only not yet sanctioned, but was threatened with most strenuous opposition. Moreover, the promoters had no complete system of electric traction. They did not propose a site for a generating station, and were, it would seem, dependent upon an unauthorised tramway for their prospective supply of electricity.

Lord R. CECIL (for Middlesex County Council) opposed the measure on the ground of its immaturity, and said the county council were, in November, promoting a scheme for the construction of a light railway along these roads for the development of the general communication and through traffic in this district. If, therefore, the Committee did not assent to the scheme he would ask them not to say anything which would prejudice the county council in the minds of the Light Railway Commissioners.

The CHAIRMAN announced that the Committee had unanimously come to the conclusion that the preamble was not proved.

## METROPOLITAN TELEPHONE SERVICE.

In the House of Commons on Friday, Mr. T. DEWAR asked the Secretary to the Treasury whether, in view of the fact that the Government metropolitan telephone service was expected to be available in the autumn, he could state in what districts the service would be commenced, and when it was proposed to extend it to the east-end of London, and whether he was yet in a position to announce the tariff scale for the service.

Mr. A. CHAMBERLAIN said it was hoped to begin connecting up subscribers in October with the exchange which would serve the City and a considerable district to the west; and in the course of the autumn, or early next year, exchanges at Westminster, Kensington, Chiswick, Putney, Wimbledon, Kingston and Richmond would be available. The Postmaster-General was not in a position to name definite dates for the extension of the system to east London. The rates of subscription would be announced as soon as subscribers could be invited to join the Post Office system.

## UNDERGROUND RAILWAYS IN LONDON.

The Earl of Morley will propose in the House of Lords to-day (Friday) a resolution enabling the proceedings on the several private bills for the construction of underground electric railways, which have been under consideration by the Joint Committee of the two Houses, to be suspended until next session. This will enable them to be taken up at the point at which they are left this session. The bills include the Brompton and Piccadilly Circus Railway, Central London Railway, Charing Cross, Euston, and Hampstead Railway Bills (two), Charing Cross, Hammersmith, and District Electric Railway, City and North-East Suburban Electric Railway, King's-road Railway, Islington and Euston Railway, North-East London Railway, Piccadilly and City Railway, and West and South London Junction Railway.

## DERBY CORPORATION BILL.

This bill, which seeks powers to construct electric tramways, was considered on Monday by a Select Committee of the House of Lords, presided over by the Earl of Kintore.

Evidence having been taken, the Committee passed the preamble of the bill.

## THE PACIFIC CABLE.

On Tuesday the House of Commons went into committee on the resolution that it was expedient to make provision for the construction and working of a Pacific cable and to authorise the issue out of the Consolidated Fund of such sums not exceeding £2,000,000 as might be required for the purpose.

Mr. A. CHAMBERLAIN said this was an enabling resolution upon which to found a bill which the House would have opportunities of discussing. The object was to provide for the construction, working and maintenance of an all-British cable between Vancouver and Australia. The bill had arisen out of approaches made to this country by some of our self-governing Colonies, and was interesting and important, because it was the first occasion when this country had been invited by the colonies to unite with them in so great an undertaking. It was agreed by the British Government and the Dominion of Canada, and the Governments of New South Wales, Queensland, Victoria, and New Zealand, that the mother country should advance a capital sum of £2,000,000 for the manufacture and laying of the cable, and that for maintenance this country should be liable for five-eighteenths and the colonies for thirteen-eighteenths. The bill provided for the raising of the money and for the establishment of a Board of Control, which was to have the supervision of the manufacture and laying of the cable and its subsequent management. The Board was to consist of three representatives of this country, two of the Dominion of Canada, and two each of the Governments of Australia and New Zealand. The only thing remaining to be done in connection with the legislation undertaking their respective shares of the obligation was that of the home Government, and he now asked the Committee to pass the resolution to enable the Government to fulfil our share of the obligation.

Mr. HARRINGTON said the policy to be embodied in the bill contained a principle to which the House had never yet been committed. Public money was about to be used to interfere with private enterprise. Many interests in the country would be touched, and doubtless the scheme would be hotly criticised. Some particulars ought surely to be given. Was there to be a special tariff? Was the enormous amount of money which British citizens had already sunk in private cable undertakings to be jeopardised merely to satisfy the sentiment of a few faddists in the colonies? He could understand the Government proposing to have a cable to be used only for governmental or public purposes, but this was to be a competing commercial cable, to interfere with the existing cables. It was not to be worked, however, on ordinary commercial lines, but by nominees of the Governments concerned, doubtless with large salaries attaching to their positions.

The CHANCELLOR OF THE EXCHEQUER: No.

Mr. HARRINGTON said that that made the matter worse, as the companies would be placed under yet greater disabilities. The whole scheme was monstrous and absurd.

Mr. DILLON said the country had been embarked on a policy which might lead to the spending of many more millions of money without the Government having had the common decency to allow the House of Commons an opportunity of expressing an opinion on the matter. In this case the House was pledged even before the resolution was proposed, because the contract for making and laying the cable was already entered into. He had heard of ministers making contracts in pursuance of a well-accepted policy, but this was the first time it had ever been done without the assent of Parliament, and it involved a great new departure.

The resolution having been carried by 158 to 44 votes, was reported to the House.



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### WIRELESS TELEGRAPHY ON WARSHIPS.

In the House of Commons last night, Mr. HARMSWORTH asked the Secretary to the Admiralty whether he had any information to the effect that wireless telegraphy was fitted on board 14 French battleships now in the Mediterranean, while only three English battleships belonging to the Mediterranean squadron were thus equipped.

Mr. ARNOLD FORSTER: The Admiralty has no official information as to the extent to which wireless telegraphy is supplied to vessels of the French fleet, but the statement as made in the hon. member's question is believed to be incorrect. Seven British vessels in the Mediterranean are now fitted with wireless telegraphy. A large number of additional sets are now in course of manufacture, and will be delivered at an early date.

## LEGAL INTELLIGENCE.

### Bennis & Co. (Ltd.) v. Ransomes and Rapier (Ltd.).

This was an action tried at Newcastle-on-Tyne, and brought by plaintiffs to recover damages for alleged libel on their manufactures. Both parties are manufacturers of patent stokers, and competed for a contract invited by the Sunderland Corporation for the supply of automatic stokers. In connection with this contract tests were made of the stokers manufactured by the parties, and it was in connection with these tests that Messrs. Ransomes and Rapier were charged with libelling the plaintiff company's goods. The action was to restrain defendants from issuing a trade circular containing statements alleged to be false, and for the delivery up to plaintiffs of all copies of the circular, and damages. After much evidence the jury found for plaintiffs for £100 damages.

The LORD CHIEF JUSTICE said he would give judgment in accordance with the finding of the jury after a point of law had been argued as to whether "a libel on the plaintiffs' goods could be a good cause of action."

### Geipel and Lange v. Day.

Judge Lumley Smith heard this case in the Westminster (London) County Court on Tuesday. It was a claim for £12 for electric cable, ordered verbally and in writing in the name of the Carlton Electrical Co. (under which title the defendant was alleged to trade), and signed in the names of Davis, Clark, and Bagshaw. Defendant contended that a man named Davis, and not he, was the person who carried on the company.

Judgment for defendant, with costs.

### National Telephone Co. v. Davis & Sons.

On Friday last, at Westminster (London) County Court, the hearing of this action was continued before Judge Lumley Smith, K.C. The defendants were Messrs. J. M. Davis & Sons, chemists, Coventry-street, W., and Bishopsgate-street Without, E.C. The plaintiffs sought to recover £12. 17s. 6d. subscription for telephone services. The case was originally heard on June 19. It appeared that a contract was entered into under the usual terms for five years. The first year's subscription was paid, and another became due on Dec. 5 last. It was not paid, and the service was cut off on Feb. 5. Defendants alleged that the service was most unsatisfactory, and the line had either broken down or been cut off in January.

Counsel for the company said under the contract the service could be cut off in February, and the company recover for the rest of the year, and then connect the service again when the year's rent was paid. Under clause 8 of the contract, which he produced, the service could be cut off if a year's rent in advance was not paid within two months of when it became due.

The JUDGE said the company wanted to be paid for what defendants had not had, and under clause 8 of the contract they reserved to themselves the right of cutting off the service. They had done so, and wanted payment for a service they had discontinued. There was, however, nothing to prevent defendants claiming damages.

DEFENDANT: There is a charge of 2s. 6d.

Plaintiffs' Counsel: That is for the Post Office.

The judge adjourned the case, and advised defendants to consult a lawyer, giving leave for the filing of a counterclaim.

On the 8th ult. the case again came before the Court, and was again adjourned to give defendants an opportunity of reading the terms of the contract and for the production of a report of a case decided in the High Court.

On the hearing being resumed, a solicitor appeared for defendants and said a counterclaim had been filed in which damages were claimed for the cost of messengers and other expenses incurred in consequence of the failure of the telephone service.

His HONOUR referred to the company's complaint register, and said he saw there were 19 on one day and 18 the next.

Mr. GODDARD said that was from 6,000 subscribers.

His HONOUR asked if the Post Office contracts had such a lot of conditions as the company's.

Mr. GODDARD: I understand they are rather worse, and you cannot sue the Postmaster-General.

His HONOUR finally decided that the clause in the contract exempting the company from damages for faults meant only consequential damages, and he should give defendants 20s. damages on the counterclaim. On the claim he found for the company, with two days' costs.

### Wrigley v. Windermere District Electric Supply Co. (Ltd.).

On Tuesday, before Mr. Justice Kekewich, in the High Court, London, this case was mentioned. It is an action by plaintiff, a resident in the Lake district, to restrain defendants from causing a nuisance by vibration, noise and smoke from their electricity generating station. The action has been mentioned before, and on a previous occasion an independent party, Mr. Cartwright, civil engineer of Kendal, was appointed to make a report, and this was now brought before his lordship.

Mr. P. OGDEN LAURENCE, K.C., for defendants, said that Mr. Cartwright's report rendered it necessary that defendants should carefully consider their position. He was prepared to admit that the defendants works had created a nuisance by smoke, and he therefore asked that the matter should stand over until the next sitting, and after some discussion it was arranged that the action should be set down for Nov. 5, the company paying the costs of the present proceedings.

### Ambler & Sons (Ltd.) v. Bradford Corporation.

This was an action tried before Mr. Justice Joyce, in the Chancery Division, the hearing commencing on the 18th ult. Messrs. Jeremiah Ambler & Sons (Ltd.) claimed an injunction against the Bradford Corporation to restrain them from obstructing the flow of water in Bradford Beck, and from allowing certain sluice-gates already erected across the beck to remain. Plaintiffs claimed £33,794 damages caused on July 12, 1900, by the obstruction. Defendants allege contributory obstruction on plaintiffs' part, denied obstruction of the kind complained of, and set up that the damages were the result of *vis major*. The action turned upon whether the damages done to plaintiffs' premises was caused by defendants interference with the Bradford Beck, which passed under plaintiffs' works and which had so passed since the erection of the works in 1864. Various areas of land had been purchased by plaintiffs since 1864, until they became owners of both sides of the beck. In 1899 defendants at some distance below plaintiffs' premises erected certain sluices in connection with their electric lighting undertaking. On July 12, 1900, during a thunderstorm, the beck, in which there was usually from 6in. to 12in. of water was flooded and did damage to plaintiffs' premises to the extent of over £33,000, which plaintiffs contended would not have happened if the flow of the beck had not been interfered with by the defendants' works. A mass of evidence was given on both sides, and in the end his lordship reserved judgment.

### Bicknell v. Kalgoorlie Electrical Power and Lighting Corporation (Ltd.).

This was an action which came before the Court of Appeal last week against a judgment by Mr. Justice Grantham and a special jury, which was fully reported in our issue of June 14 last. It was a case for the rectification of the register of the company brought by a debenture holder (Mr. A. C. Bicknell) for the removal of his name as holder of 850 shares, and for the return of certain moneys paid on application for shares on the ground that he (plaintiff) had been induced to apply for shares by alleged misrepresentations in the prospectus. The defence was that there had been no misrepresentation, and the company counterclaimed for moneys alleged to be payable by plaintiff with respect of calls. The case having been fully argued by counsel, and evidence having been given, before delivering the judgment of the Court,

The MASTER OF THE ROLLS said there appeared in the cause list another action, White *v.* the Kalgoorlie Electrical Power and Lighting Corporation (Ltd.), and he asked if there was any similarity in the actions. It was stated that the decision of the Court of Appeal in the first-named action would be taken as deciding the points raised in the second action.

The MASTER OF THE ROLLS then gave the judgment of the Court, dismissing the appeal, with costs.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Finchley Urban District Council require a resident electrical engineer and manager at a commencing salary of £300 per annum. Applications to Mr. Charles Roberts, Council Offices, Ribbsworth House, Church End, Finchley, by noon, Aug. 19. See advertisement.

Applications are invited for the position of electrical engineer to the municipality of East London, Cape Colony. An advertisement contains further particulars, and applications must be received by the town clerk, East London, Cape Colony, by noon of Oct 10.

The committee of University College, Nottingham, require a demonstrator in electrical engineering. The required qualifications are set out in an advertisement. Commencing salary is from £150 to £200 per annum. Applications before September 7.

The post of assistant lecturer and demonstrator in the department of physics and electrical engineering at Hartley College, Southampton, is vacant. Salary £130 per annum, rising annually by £10 to £150. Applications to the principal. See advertisement.

The Pacific Cable Board invite applications for the post of general manager. An advertisement contains particulars of the qualifications required of the accepted candidate. Applications to the secretary, Pacific Cable Board, 24, Queen Anne's-gate, S.W., by Aug. 19.

A well-known firm of electrical engineers, which is opening a branch in Scotland, requires a manager capable of estimating and superintending high-class lighting and power installations. See advertisement.

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Engineering assistants, with experience of underground dry-core cable and overhead construction, are required by the Glasgow telephone department. Applications to general manager (M. A. R. Bennett), Castle-chambers, Renfield-street, Glasgow. See advertisement.

An electrical and mechanical draughtsman is required for preparing plans and record drawings in connection with electric lighting at Netley. Applications to Inspector-General of Fortifications, Horse Guards, London, S.W. See advertisement.

The Council of the Harris Institute, Preston, require a lecturer in mechanical engineering. Further particulars from the secretary (Mr. T. R. Jolly). See advertisement.

An assistant foreman, used to lift and crane work, is wanted in London. See advertisement.

The Bristol Electric Tramways and Carriage Co. have vacancies for steady, active, reliable men as electric car drivers. Further particulars are given in an advertisement.

Hastings Electric Light committee require a mains superintendent. Applications to borough electrical engineer (Mr. L. Andrews) by noon Aug. 13. See advertisement.

A senior demonstrator in electrical engineering and applied physics and an instructor in electrical engineering, with experience in polyphase and high-voltage work, are required at the City and Guilds Technical College, Finsbury, London. Applications to Prof. S. P. Thompson, F.R.S.

An assistant lecturer and demonstrator in physics is required for University College of North Wales, Bangor. Applications by Oct. 12.

Wexford Technical Instruction committee require a principal for the proposed municipal technical school. Applications to hon. secretary by Aug. 19.

A professor of engineering is required by University College, Bristol. Applications to secretary by Aug. 31.

The Governors of the East London Technical College, People's Palace, E., require a demonstrator in physics for the day school. Applications to Director of Studies.

There are vacancies in the teaching staff (including the lecturership on electrical engineering) of the University of Glasgow. Particulars from Prof. Barr.

Electricians are wanted for the Royal Navy. Applications to Lieut. G. South, R.N., Recruiting Officer, Devonport.

Battersea Borough Council require a shift engineer. Applications to town clerk, Municipal Buildings, Lavender-hill, London, S.W., by Sept. 3.

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The Railways and Tramways committee of the Middlesex County Council have appointed Mr. Wm. Howard-Smith assistant engineer for light railways and tramways at £600 per annum.

Mr. J. E. Saunders has been appointed assistant engineer at Bath electricity works.

Mr. A. E. Lewis has been appointed business manager of the Ealing electricity department.

Mr. R. C. Porter, M.Sc., has been appointed lecturer in mechanical engineering at the University of Birmingham.

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**Barrow-in-Furness.**—The Council have decided to lease the local tramways to the British Electric Traction Co. for 26 years.

**Birmingham.**—The Corporation decided, on Tuesday, to promote a bill for power to work tramways, to re-construct and alter existing lines, and to adapt them to such motive power as may be determined to work new tramways, and generally for obtaining such power as may be deemed necessary with respect to tramways, including authority to construct tramways between the centre of the city and Edgbaston and Harborne districts. Electric traction has practically been decided upon, but the particular system is a matter for future consideration.

The Electric Supply committee's report recommended the purchase of the site of the old Birmingham General Hospital, at £22,000, for a generating station. If the ordinary growth of the output continued within the area at present supplied, the existing stations at Waterstreet and Dale End would be working at their full capacity by the end of 1903, and any extension of the supply, independently of tramway requirements, must be provided for from the proposed new station. Electric current will be required to work about 13 miles of tramways by January, 1904, and a further 39 miles by January, 1907. The engineer had prepared plans and had reported upon the equipment of a new station on the site so as to meet the requirements of the tramways and the probable extension of lighting. The erection would take at least two years. The ultimate cost of the works is estimated as follows:—12 combined engines and dynamos, £79,500; boilers and economisers, £24,000; condensing plant, £8,860; steam piping, feed connections and exhaust arrangements, £12,000; coal-handling plant, £6,300; water tanks and water softening plant, £6,100; switchboards, balancers, transformers and accumulators, £22,300; crane, £1,400; buildings, £74,500; architect's commission and clerk of works' salary, £4,200; total, £239,220. For the present it was only proposed to provide 5,000 H P, which would supply the tramways and for certain extensions of lighting. The supply of outlying districts, such as Harborne and Bristol-road, would require to be supplemented by sub-stations. The engineer's estimate of the cost of laying the new mains and of the sub-stations was £75,000. The cost of the first instalment of plant would be £128,890. The committee recommended the Council to authorise the carrying out of the first instalment of the work, the laying of the mains, and the construction of the sub-stations. This report was considered and approved at a special meeting of the Corporation on Wednesday.

**Bristol.**—At March 25 there were 1,507 customers of the electricity department, an increase of 292 for the year. The total connections to the mains were equivalent to 119,615 30 watt lamps (compared with 91,117 last year), made up as follows:—9,389 taking energy at the power rate, 104,985 at the lighting rate, and 5,241 representing public street lighting, or an aggregate increase equivalent to 23,498 lamps. The number of units sold was 2,191,559, an increase of 379,048. The demand for electricity for power has continued to increase, and the sale of current for that purpose was more than doubled during the year. The gross receipts were £37,398. 8s., the expenditure £25,725. 19s. 8d., leaving £11,672. 8s. 4d. to meet interest, &c. (£7,327. 5s. 8d.), repayment of loan (£6,811. 11s. 7d.), and Avonbank preliminary expenses (£90. 11s. 3d.), or a total of £14,229. 8s. 6d. The credit balance at the commencement of the year was £3,062. 3s. 9d., which has met the deficiency on this year's working of £2,557. 0s. 2d. and leaves a balance forward of £505. 3s. 7d. The deficiency is attributable to the largely increased price of coal, which alone added to cost of generation over £4,000, to interest and sinking fund contribution for the unremunerative capital at Avonbank (£900) and to the management expenses being high. The Electric Light committee state that they do not anticipate a material improvement in the financial result of the current year, as although the price of coal has been considerably reduced, the unremunerative outlay is being increased, and the advantage of this outlay will not be felt until the new Avonbank works are in operation. The total capital expenditure is £299,259. 11s. 6d.; outstanding mortgage debt, £246,092. 18s. 10d.

The dispute between the tramway company and its employés assumed an acute aspect on Wednesday, when the company paid off 300 drivers and conductors who had handed in notices at the beginning of the week. The men insisted on wearing union badges, and that was regarded by the directors as an act of insubordination. The cars continue to run, but in reduced numbers. An advertisement elsewhere notifies that the company require car drivers.

**Burnley.**—An inquiry was held here last week into the application of the Council to borrow £11,448 additional for electric lighting.

**Cardiff.**—The Corporation are advised by their Tramways committee to acquire the undertaking of the local tramways company for £40,000.

**Church Lighting.**—St. Lawrence Jewry, Gresham-street, E.C., is now lighted electrically, a special service to inaugurate the installation being held yesterday (Thursday).

**Croydon.**—The third annual report of the borough electrical engineer (Mr. T. H. Minshall) states that during the year the capacity of the station has been increased from 2,520 B.P. to 4,320 H P. The equivalent number of 8 c.p. lamps connected has increased from 45,122 to 59,241. The average price per unit was 4·241d. and the cost of production 1·981. The report of the auditor (Mr. Frank Brown) stated that while there was no legal necessity to charge against profits more than interest and sinking fund, yet he thought depreciation was much greater than the amount of the sinking fund, and that if, instead of electric lighting being a Corporation department it had been a company having the privilege of borrowing money at, say, 3 per cent., the trading would, in his opinion, after writing off sufficient depreciation, show a heavy loss. In moving the adoption of the minutes, the chairman of the Electricity committee (Ald. Miller) referred to Mr. Brown's report. He pointed out that the period of their loan was 25 years. The life of a cable used to be at one time reckoned at something like 15 years, but he had received information some time ago of the cables which had been taken up at Westminster after having been laid 10 years, and of other cables taken up which had been laid a matter of 12 years, and they were as good as they ever were. They were now laying their cables on the solid principle. They had got a considerable staff at the station doing the clerical work, but he could safely say that if the concern were a company instead of a corporation the clerical work would have increased by 25 per cent. Since the Corporation took over the station they had paid in interest £10,506, sinking fund £8,421, and there was a balance of £15,097. Also

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£1,000 had been paid to the British Thomson-Houston Co. If it had been worked by a company they would have paid 5 per cent. since they started, and have a reserve of £5,000. The minutes were approved.

**Darlington.**—The Electro-Magnetic Traction Co. have offered to construct an experimental length of tramway (about a mile) on their system of electric traction, and the matter is under the consideration of the Council.

**Death from Electric Shock.**—An inquest was held at Greenwich on Monday, on the body of a switchboard attendant named Wimble, aged 24, in the employ of the London Electric Supply Corporation at Deptford. Mr. J. Owner, H.M. Inspector of Factories, represented the Home Office.

It appeared from the evidence that deceased, on July 17, went into the transformer room at the works for a fuse tube, and on turning round missed his footing and stumbled, and he put his right hand out to save himself and caught hold of a live fuse. He was severely burnt and scorched and died on the 26th ult.

Dr. WESTHOUSE said that death was due to shock. He considered that the burns were caused by an electric current.

WENTWORTH, a fellow workman, said he was passing the door of the transformer room, and saw a flash. Deceased was holding on to a rack with both hands. He did not see any broken fuse on the floor. When he touched deceased he felt a peculiar sensation, but he did not get a shock.

WILLIAM WILTON, switchman, said deceased was his assistant. He and deceased were, at the time of the accident, engaged in making up test fuses, and witness sent him to get a spare fuse tube to replace one which he had broken. He had been gone two minutes when witness heard a sharp report, and he knew that something was wrong. Deceased told witness that he took the empty fuse tube out of the rack, and in turning round slipped and caught hold of a high-tension fuse. About 10,600 volts were passing through the fuse in the transformer. Deceased was holding a plain tube. The breaking of the main fuse would have been sufficient to have caught his clothes alight. The coil was burnt out, and witness supposed that deceased fell against the rack and received the shock before he broke the tube. The rack was not in a very safe place, but witness had never heard complaints regarding it. If the transformers had been enclosed in an iron case the accident could not have happened. But these could not be so protected because of the heat. The coil could not have been burnt by the broken fuse falling upon it. He had never known of encased transformers working at 10,000 volts. Deceased told witness that he knew that the transformer was alive.

Mr. CLEMENT J. BAILEY, superintendent at the works, said the transformers had been guarded, but were not so now. The corporation were about to put in new transformers, and these would be entirely enclosed.

The jury returned a verdict that deceased died from shock following burns produced by an electric current, whilst getting a fuse from a rack placed near an unprotected platform, in the execution of his duty.

**Dublin.**—The Hill of Howth electric tramway, which has been constructed by the Great Northern Railway Co. of Ireland, was opened for traffic yesterday (Thursday).

**Epsom.**—The Council have decided to supply electric current for power at 3d. per unit.

**Eccles.**—The consulting engineer (Mr. C. H. Wordingham) has approved, with certain modifications, the plans of the borough electrical engineer (Mr. H. W. Angus) for extending the electricity works. A power station is to be erected and equipped in Cawdor-street, Patricroft. Application is to be made for sanction to borrow £20,500 for the execution of the works.

**Electric Power Schemes.**—We have received the following letter in connection with our remarks on the electric power schemes before Parliament :—

TO THE EDITOR OF THE ELECTRICIAN.

My attention has been called to your issue of May 31, 1901, in which you mention some of the electric power schemes of 1901. With reference to the Derbyshire and Nottinghamshire scheme, the engineers are given as Messrs. Bramwell and Harris. I think it only right to inform you that the engineers of this scheme are Mr. Arnold Lupton, M.I.C.E., Leeds, and Mr. John Sturgeon, Leeds. A reference to the deposited plans will show this. Evidence was given in support of the bill by Mr. Arnold Lupton, as engineer for the bill.

**Electric Railway and Tramway Competition.**—At the meeting of the South Eastern Railway Co., on Wednesday, the chairman (Mr. H. Cosmo Bonsor) said there had been a large diminution in the number of short-distance journeys, owing to the competition of the electric railways and tramways. The falling off was most marked in the metropolitan area, where trams and buses competed with their railway, and in the Isle of Thanet, where the light electric railway had been opened between Ramsgate and Margate, and was doing a great business at the expense of the South Eastern and Chatham Companies.

**Electric Tramway Accident.**—We regret to record that, at a trial run on the new tramway line from Cheltenham to Cleeve Hill, the car failed to reach the summit and commenced to run backwards. The brakes failed to arrest the downward progress, and at Southam corner the car overturned and two workmen employed in laying the line were crushed to death. The accident took place on the 29th ult., and the Board of Trade inspection was to have taken place on the 31st.

An inquest was opened on Wednesday, at Cheltenham, before Mr. S. P. Ryland, on the bodies of Thomas Holloway (30) and George Jackson (18), workmen in the employ of Mr. Nevins, promoter of the Cheltenham to Cleeve Hill electric light railway, who were crushed to death beneath a tramcar which left the rails and overturned at a curve at the bottom of Cleeve Hill on Monday. Formal evidence of identification was taken, and the inquest adjourned for a week.

It appears that the car was at the time in charge of Mr. Parkes, manager of the British Westinghouse Co., and an assistant named Kendall, for the purpose of testing the motors and the brakes. All appeared to be in working order until the car slowed down to let a passenger alight, about half-way up the hill, at which moment Mr. Nevins also got off, to see that the arm was resting on the electric trolley. Suddenly the car started down hill, and at a sharp curve near Woodmancote-road it ran off the metals and parallel to them for about 10 yds., and then fell over.

**Exeter.**—The British Electric Traction Co. have submitted proposals to the Council for the construction of electric tramways.

**Fire.**—We are asked to state, with reference to the fire which took place at the works of the St. Helens Cable Co. (Ltd.), Warrington, on Friday last, that no damage has been done to the machinery, and that work will be resumed immediately the fire insurance people have completed their assessment.

**Fulham (London).**—The Borough Council have sanctioned an expenditure of £10,000 on additional generating plant and for extending the electric lighting mains along Wandsworth Bridge-road.

**Govan.**—The following scale of charges has been fixed by the Council for electricity supply for the current year :—Lighting, ordinary consumers, 6d. per unit for first hour's maximum demand, and 1d. after ; domestic consumers, theatres, halls, &c., a uniform 3½d. ; places of worship 3d. ; for power a uniform charge of 1½d.

**Lancaster.**—The Council on Wednesday decided to expend £23,000 for additional generating plant for tramways. A numerously signed petition from Skerton ratepayers urging the reopening of negotiations for the acquisition of the tramway between Lancaster and Morecambe and for the electrical equipment of the line has been referred to the Tramways committee.

**Leicester.**—The Council have acquired a site for the erection of a tramway power station.

**Light Railways.**—The adjourned inquiry into the applications of the Middlesex County Council and the London United Tramways (Ltd.) for orders to construct light (electric) railways in Twickenham, Hanworth, Hounslow, Cranford, Southall, &c., was resumed on Monday. After taking further evidence on behalf of the London United Tramways, the Commissioners decided to grant their application so far as related to the construction of lines between Twickenham, Hanworth, Hounslow and Cranford, but refused to grant powers to construct the Southall, Hounslow and Kempton Park line. The application of the County Council was, as stated in our last issue, refused.

The Board of Trade on Tuesday heard objections to the confirmation of the order granted to the North Metropolitan Tramway Co. and the Middlesex County Council jointly for constructing a light railway of about 16 miles through Tottenham, Wood Green, Finchley, Hendon and other North London districts. Finchley District Council had also promoted a light railway scheme for their own district, but the Commissioners rejected their application on the ground that it was not intended by the Light Railway Act that a general scheme for extending the benefits of a light railway should be frustrated by an intermediate local authority through whose district it passed. Finchley Council now appealed, and after hearing arguments Mr. Hopwood reserved his decision. The London County Council asked for a clause for giving facilities as to hours and cheap fares for working men. The promoters were willing to give a clause similar to that granted by the old railway companies, and a clause is to be agreed upon between the parties.

Objections to the Swansea light (electric) railway order were considered by the Board of Trade on Wednesday. It was contended that the Borough Council could not go outside their area without consulting the county authority, and that the Corporation could only go to Parliament for such powers without consent of the County Council. The latter body proposed to construct light railways, and the Corporation were attempting to take the most profitable part of the county road. Counsel for the Corporation said it had been decided in the Taunton case that a light railway could not be made wholly within the borough, and if the contention of the County Council were correct then no borough council could promote a light railway. Mr. Hopwood reserved his decision.

**London County Council.**—At Tuesday's meeting the following electricity loans were sanctioned :—Poplar, £1,500 ; Southwark, £700 ; Hampstead, £2,810, and £19,529 for extensions ; Stepney, £3,000.

It was agreed that application be made to Parliament for power to construct 5½ miles of new tramways. The cost of the construction

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of the tramways for electrical traction is £175,400, and street widenings will cost £87,000. No part of the street widenings will be charged to tramway account. The tramways proposed are along the Victoria Embankment, along the Elgin-avenue at Paddington, Trafalgar-road, Greenwich, and at Woolwich.

**London Wiring Contractors' Association.**—We are informed that a meeting of electrical contractors was held at the offices of the Sunbeam Lamp Co., Fenchurch-street, E.C., on Monday, for the purpose of forming another electrical contractors' association for London and district, with a view to its ultimate affiliation with the "National Electrical Contractors' Association." A resolution approving the formation of the association was carried. Mr. S. Frost, 567, Battersea Park-road, Battersea, S.W., is secretary.

**Northampton.**—The Council have agreed to purchase the local tramways at £37,500. It is proposed to extend the system and to introduce electric traction.

**Manchester.**—The Electricity committee's report for the year ended March has been issued, and states that the number of customers at the close of the year was 3,790, an increase of 550 on the previous year. The total equivalent number of 8 c.p. lamps connected was—incandescent 279,860, arc 2,316, compared with 237,145 and 2,139. In addition, there were 672 motors in use, representing 6,560 H.P., an increase of 172 motors, equivalent to 4,510 H.P. The total output of the works during the year amounted to 9,639,973 units, of which 7,944,540 units were accounted for. There was a net profit on the year's working of £3,515. 10s. 6d. This amount, plus £484. 9s. 6d., withdrawn from reserve, made £4,000, which was paid in aid of rates. The total capital expenditure was £863,293. 1s. 2d., mortgage debt £722,273. 7s., amount of sinking fund to date £67,837. 13s., balance at credit of reserve £13,172. 2s. 11d. The report states that since the appointment of Dr. A. B. W. Kennedy in January last to design and equip the Stuart-street generating station and the various sub-stations for the first installation of 15,000 H P. rapid progress has been made. Tenders have been accepted for the whole of the plant required, and it is expected that a portion of the plant will be ready for supplying current by May 31, 1902. At the Bloomsbury-street station the iron and steel work of the first pair of boilers and a portion of the first engine and generator are in position. Tenders have been obtained to the specifications of the chief engineer (Mr. G. F. Metzger) for the plant required to complete the equipment of those works, and it is anticipated that one set of generating plant will be available for supply at the beginning of October. Applications from new customers cannot be considered until the committee are advised that this station can be made available for next winter's work. Upon the completion of the work at Stuart-street and Bloom-street stations the committee will be able to provide the energy required for working most of the tramway routes which the Tramways committee are preparing to work electrically in May next year, and also to supply current to several of the out-districts whose electric lighting orders have been taken over by the Corporation.

**Municipal Telephony.**—Dundee Telephone committee are considering the advisability of applying for a licence to establish a municipal telephone exchange. A Manchester firm of telephone engineers offer to introduce a syndicate which would undertake to establish the service on a £5 rate.

Barnsley Lighting committee have been instructed to report upon the advisability of establishing a municipal telephone exchange.

Before making a recommendation on the proposal to establish a municipal telephone exchange, the Aberdeen Telephone committee have decided to grant an interview on the 11th inst. to Mr. W. E. L. Gaine, the general manager of the National Telephone Co.

**Presentation.**—Mr. Edgar J. Sander, late works manager of the Sir Hiram Maxim Electrical and Engineering Co., was presented on Monday with a tobacco cabinet and salad bowl and servers by the staff and workers.

**St. Helens.**—The Council's application for a loan of £16,500 for extensions of the electricity works was investigated last week.

**Smoke Nuisance.**—At Westminster (London) Police Court last week, the Westminster Electric Supply Corporation were fined £10 and 2s. costs for smoke nuisance at Millbank-street station. It appeared that, on the day in question, a boiler broke down through one of the tubes bursting, and the engineer had to start another. During the brief time thus occupied it was impossible to prevent black smoke from issuing.

**Stoke Newington (London).**—The terms of the Hackney Borough Council for the supply of electricity in bulk have been accepted by the Stoke Newington Council. The terms are: *Lighting*—First 100,000 units per annum, 3d. per unit; next 150,000 units, 2¾d.; next 250,000 units, 2½d. *Power*—2d. per unit, less 5 per cent. The contract to be for 12 months, and to be subject to 12 months' notice on either side.

**Telephone Grievances.**—At the last monthly meeting of the Bristol Chamber of Commerce communications were read from the Postmaster-General and from the National Telephone Co. on the subject of the telephone service.

The Postmaster-General's statement was to the effect that a large number of additional trunk circuits had recently been erected, or were still in course of construction. It had, however, not been practicable to make such progress as could be desired owing partly to the difficulty experienced in many directions in obtaining the necessary wayleave facilities, and partly to the lack of an adequate supply of skilled labour. His lordship asked that public bodies and others should render further assistance by granting overhead wayleaves, "without which an efficient telephone service between distant towns could not be provided." Many cases of delay in telephonic communication arose (he continued) from unavoidable interruptions of the trunk circuits, from subscribers being engaged on other trunk calls, and from the inadequacy of the National Telephone Co.'s junction system.

The National Telephone Co., in their statement, pointed out that it was somewhat unfair to blame the company for inadequacy of the service, inasmuch as the wires were provided by them for local transit only, and not for trunk purposes. Further, the Postmaster-General was not entitled to call on the company to distribute his trunk messages over their lines, as the Post Office paid nothing for the use of them. The duty rested with the Postmaster-General to connect up towns with the trunk telephone system; but in nearly all cases he only brought the trunk wires to one town in an area, and, *ex gratiâ*, the company distributed the trunk messages to other towns therein. The statement concluded with the comment that in no case was there any large town where the junction circuits which connected the company's exchange with the Post Office were not lying idle during the busiest part of the day, and that it was possible that the fullest use of these wires was not made by the Post Office.

**Traffic Regulation.**—It would appear that the establishment of electric tramways in the North-west of London has considerably increased the business at Brentford Police Court, and the presiding magistrate (Mr. Montague Sharpe) yesterday called attention to the fact that the local authorities had not drawn up bye-laws for regulating the traffic in the thoroughfares where the tramways were running, as they were empowered to do under the Tramways Act, 1870. He suggested that the tramways company and the local authorities of Brentford, Acton, Ealing, &c., should meet and definitely decide how the traffic was to be regulated. He thought it would certainly be in the interest of the public to have such a meeting and such regulations settled. The suggestion is to be placed before the authorities.

At the same Court yesterday Mr. Montague Sharpe heard an action against a tradesman for obstruction to the tramways by allowing his cart to remain stationary in a narrow thoroughfare. Defendant said he had moved his cart six times in 10 minutes.

Mr. SHARPE: Why should you? You have as much right to conduct your business as the tramway company has theirs.

DEFENDANT: If I did not move the whole of the cars would be blocked.

Mr. SHARPE: Why not block the whole system? You tradesmen should combine and fight the case out in the courts. Put a cart on the rails and let it stay there till all the cars are stopped, and then let both sides instruct counsel and have the matter fought out. You have as much right to the road as the tramway company.

**Trowbridge.**—A site for an electricity generating station has been acquired by the District Council, who have decided to erect a refuse destructor in conjunction with the electricity works.

**Village Telegraphic Communication.**—The Postmaster-General has initiated in Yorkshire an experimental scheme for establishing telegraphic communication for rural areas during the night. Hitherto villages which have the means of telegraphing during the day have not had at night, even for emergencies, such as a great disaster, the opportunity of wiring to larger towns. Now, with the co-operation of postmasters in the North-Eastern district, there are to be in the villages emergency calls with York, Doncaster, Goole, Selby, Malton and Driffield. Parish councils will be called upon to pay 10s. per annum for the necessary apparatus, ordinary telegraph charges and late fees being levied on senders of urgent messages.

**Watford.**—An inquiry into the Council's application for sanction to a further loan of £34,000 was held on Tuesday. There was no opposition.

**West Ham.**—There is a net loss of £1,256 on the electricity department for the half-year ended March, mainly due to the increase in capital charges and the reduction of the price of current from 3d. to 2d. per unit.

**Willesden.**—The Council are inviting tenders for carrying out the electricity supply scheme prepared by their electrical engineer (Mr. E. T. Ruthven Murray). The Council do not propose to assign or transfer their provisional order or to divest themselves of the powers conferred by it, but wish to obtain offers for erecting and equipping the works and for running them for a period, similar to the arrangements at Beckenham, Croydon, &c. Already proposals have been submitted by the British Insulated Wire Co. and Callender's Company.

**Witham (Essex).**—The Council are making inquiries as to the cost of establishing electricity supply.

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# TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

## TENDERS INVITED.

*Darlington* Corporation invite tenders for the supply and erection of Lancashire boiler, 350 H.P. engine coupled to a continuous-current dynamo, and extension of steam, drain and feed pipes. Specification, &c, from the town clerk (Mr. H. G. Steavenson), and can also be seen at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. An advertisement contains further particulars, and tenders should be sent to Mr. Steavenson by Aug. 22.

*Worcester* Corporation invite tenders for the supply and erection of the plant set out in an advertisement elsewhere. Specification, &c., can be obtained of Mr. C. J. Sutherland (city electrical engineer), Guildhall, Worcester, and tenders must be sent to Mr. S. Southall, town clerk, Guildhall, Worcester, by noon of Aug. 23.

*Willesden* District Council are prepared to consider tenders from companies willing to contract for the equipment of their proposed electricity works in accordance with the plans and specifications prepared by their electrical engineer, Mr. E. T. Ruthven-Murray, from whom further particulars may be obtained after 7th inst. See advertisement.

*Manchester* Electricity committee require tenders for 70 feeder and section pillars for tramway routes. Tenders to town clerk by Aug. 7.

*Manchester* Electricity committee also require switchboards at Stuart-street station and sub-stations. Tenders to chairman by noon Aug. 14

*Dundee* Gas Commissioners require surface condensers, electrically-driven air and circulating pumps, cooling towers, &c.; electrically and steam-driven feed pumps and feed-water heaters and fittings. Tenders to Sir Thomas Thornton, LL.D., City-chambers, Dundee, by Aug. 5.

*Farnham* Urban District Council are open to contract with a responsible firm for the supply of electricity under their electric lighting order, 1900. Proposals to clerk by noon Aug. 27.

*Wigan* Corporation invite tenders for enclosed electric motors and starters as required during 12 months. Tenders to borough electrical engineer by Aug 10.

*Glasgow* Corporation invite tenders for 30,000 tons of coal. Tenders to town clerk by 6th inst.

*Croydon* Lunacy Visiting committee invite tenders for wiring the Warlingham Asylum. Tenders by noon 26th inst.

*Grays Thurrock* District Council invite tenders for electricity meters and demand indicators. Tenders by noon Aug. 8.

*Grays Thurrock* School Board require tenders for wiring three schools. Tenders by 6 p.m. Aug. 6.

*Middlesbrough* Electric Lighting committee require coal-handling plant. Tenders by Sept. 3.

*Norwegian* Government invite tenders until Aug. 12 for battery zinc, conducting wires, soldering tin, salammoniac, and sign-board shields for the Telegraphs Administration.

## TENDERS RECEIVED AND ACCEPTED.

The Municipal Council of Launceston (Tasmania) have received the following tenders for meters. All prices are calculated for delivery into Corporation stores duty paid. Only 5 ampere-meters, 110 volts, are included, except as noted, the first order being for 500 of this capacity :—

| | |
|---|---|
| *Watt-hour Meters—Induction Type.* | |
| Diamond Meter Co. U.S.A. (Scheefer) (*accepted*) each | £2 17 9 |
| Noyes Bros. (Westinghouse) | 3 19 6 |
| Australian General Electric Co. (Thomson, 3 and 5 ampere) | 3 8 6 |
| Theiler & Co. (Theiler) | 3 4 3 |
| *Commutator Type.* | |
| Gibson, Battle & Co. (Johnson and Phillips, 2½ and 5 amp.) | 4 9 8 |
| Geipel and Lange (Vulcan) | 4 3 2 |
| Australian General Electric Co. (Thomson) | 3 10 10 |
| *Electrically-driven Clockwork Type.* | |
| Lawrence and Hanson (Aron) | 4 9 0 |
| *Volt-ampere-hour Meters—Induction Type.* | |
| Edison and Swan Co. (square, 3 and 5 ampere) | 5 10 8 |
| Ditto (round ditto) | 4 6 1 |
| Chamberlain and Hookham (Hookham, 3 and 5 ampere) | 4 11 6 |
| Ditto | 3 4 3 |
| A. E. G, Berlin (A. E. G., 3 and 5 ampere) | 3 15 6 |
| Electrical Co. (A. E. G, 3 and 5 ampere) | 3 12 1 |
| *Ampere-hour Meter.* | |
| Noyes Bros. (Shallenberger) | 4 17 0 |
| *Prepayment Meters.* | |
| Australian Gen. Elec. Co. (Thomson, 3 and 5 ampere) | 7 13 3 |
| Geipel and Lange (Vulcan, 3 ampere) | 5 9 2 |
| Ditto (Vulcan, 2 ampere) | 5 2 0 |

Tenders as under for the supply of six 50kw. transformers came before the Hammersmith Borough Council on Wednesday evening :—

| | | Drop in volts. | Magnetising watts. | Temp. rise. |
|---|---|---|---|---|
| Brit. Elec. Transformer Co. (*accepted*) | £540 | 1·5 | 375 | 50°F. |
| Brush Co. | 823 | 1·5 | 450 | 40°F. |
| Johnson and Phillips | 690 | 0·2 | 425 | 52°F. |
| Electric Construction Co. | 630 | 1·5 | 460 | 85°F. |
| Ferranti (Limited) | 618 | 1·8 | 440 | 50°F. |
| John Fowler & Co. | 606 | 1·8 | 450 | 60°F. |
| Ditto | 564 | 1·8 | 450 | 60°F. |
| British Schuckert Co. | 600 | 1·5 | 880 | 70°F. |
| Siemens Bros. & Co. | 573 | 1·5 | 620 | 70°F. |
| British Thomson-Houston Co. | 570 | 1·75 | 500 | 48°C. |
| British Westinghouse Co. | 552 | 1·45 | 658 | 40°C. |
| International Electric Co. | 545 | 0·2 | 450 | 72°F. |

The following tenders were received by the Fire Brigade committee of the London County Council for the wiring and fitting of three fire stations :—

| | Manchester-sq. | Bishopsgate. | Brompton. |
|---|---|---|---|
| G. Forrest & Son (*accepted*) | £236 10 | £208 10 | £122 10 |
| Wells & Co. | 470 0 | 410 0 | 230 0 |
| J. Sperati | 378 0 | 313 0 | 186 0 |
| E. P. Allam & Co. | 312 16 | 274 10 | 164 15 |
| Laing, Wharton and Cunnington | 299 16 | 233 12 | 152 10 |
| F. J. Coleby & Co. | 295 10 | 273 12 | 165 18 |
| C. Esson | 259 0 | 215 0 | 125 10 |
| Lighting Corporation | 256 10 | 233 10 | 147 7 |
| F. A. Glover & Co. | 245 0 | 220 0 | 143 0 |
| Drake and Gorham | 243 15 | 220 15 | 123 0 |

Cardiff Corporation have accepted the tender of Messrs. Bolckow, Vaughan & Co. for about 2,000 tons of tramway rails at £6. 10s. per ton for 45ft. rails, and £7 for 60ft., and for fish plates at £8 and £8. 10s. per ton. The quotations for Continental makes were £6. 5s. per ton for rails and £6. 15s. for fish plates.

Manchester Electricity committee have accepted the tender of Messrs. De Bergue & Co. for the iron framework of the Stuart-street generating station, and that of Messrs. Higginbottom and Mannock for the supply of one 30-ton and two 20-ton cranes for that station.

Epsom District Council have accepted the tender of the Keighley Electrical Engineering Co. for cutouts at 10s. 3d. each; also that of Messrs. Chamberlain and Hookham for electricity meters at the following prices :—3 ampere, £2. 15s. (two-wire), £5. 10s. (three-wire); 5 ampere, £3 and £6; 10 ampere, £3. 13s. 6d. and £7. 7s.; 25 ampere, £3. 15s and £7. 10s.

Wigan Corporation have accepted the following tenders for their electricity department :—R. W. Paul & Co., potentiometer; O. Berend & Co., photometer; Baker & Co., car wheels; R. W. Blackwell & Co., car body lifting-jack; Kelvin and James White, balance.

The contract for the large independent condensing plant for the De Beers Consolidated Mines (Ltd.), Kimberley, has been placed with Messrs. T. Ledward & Co., London, for their patent evaporative condenser.

Barnsley Town Council have accepted the tender of Messrs. W. Arnold & Co., for two boilers at £1,865.

The French Post and Telegraph Department have accepted the following tenders for high-conductivity copper wire :—Société d'Electro-Metallurgie (40 tons, 4mm. diameter, at 218¾fr. per ton); Compagnie des Trefileries du Havre (40 tons, 2½mm. diameter, at 220¾fr.; 40 tons, 4mm. diameter, at 219fr.; and 40 tons 5mm. diameter, at 217½fr.); and Compagnie Française des Metaux (40 tons 2½mm. diameter, at 220½fr.; 40 tons ditto, at 221fr.; and 40 tons 5mm. diameter, at 217⅕fr.).

## BUSINESS NOTICES.

The partnership subsisting between A. C. Brackstone and A. McTavish, electricians, &c. (trading as Brackstone & Co.), 24A, High-street, Bath, has been dissolved.

Electromotors (Ltd.), of Openshaw, Manchester, have opened London offices at Cornwall-buildings, 35, Queen Victoria street, E.C., where Mr. G. H. Congdon will represent the company for London and district.

Accumulator Industries (Ltd.) notify the transfer of their registered offices to the works premises at Maybury, Woking, Surrey. The London offices will remain at 14, Silver-street, Bloomsbury, W.C.

## BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee (Mr. R. J. Ward) in the bankruptcy of Benjamin Symmons, electrical engineer (trading as B. Symmons & Co.), 2, North-street, Quadrant, Brighton, and 15, Holland-road, Hove, has been released.

The first meeting of the creditors of Joseph Taylor, manufacturer of electric fittings, &c., 24, Pyrland-road, Canonbury, N., and carrying on business as J. Taylor & Co. at 1A, Dyott-street, Shaftesbury-avenue, London, W.C., takes place at Bankruptcy Buildings, London, on Aug. 8, and the public examination on Sept. 3.

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It has been decided to wind-up the Southgate Engineering Co. (Ltd.) voluntarily. Mr. J. Garvie, 69, Victoria-street, London, S.W., is liquidator.

It has been decided to wind up the London Electro-Plating and Refining Co. (Ltd.) voluntarily. Mr. F. J. Mitchell, 9, Cathcart-road, London, S.W., is liquidator.

**Winding-up Petition.**—A petition for the winding-up of the English Industrials (Ltd.) will be heard at Manchester on 6th inst.

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**Sale by Tender.**—The Electric Supply and Tramways committee of St. Helens Corporation are open to receive tenders for the purchase of plant set out in an advertisement. The plant was new in 1896, and is in first-class condition.

**Electric Tramways for Sale.**—The liquidator of the Isle of Man Tramways and Electric Power Co. (Ltd.), (Mr. Wm. Henderson Walker, C.A.) notifies in an advertisement elsewhere that he has been authorised by the Chancery Division to offer for sale by tender the following undertakings of the company, *i.e.*, the Douglas and Laxey, Laxey and Ramsey and the Snaefell Mountain electric tramways, the Douglas Bay horse tramway and the Upper Douglas cable tramway. Tenders addressed to his Honour the Clerk of the Rolls, Rolls Office, Douglas, Isle of Man, by 11 a.m. Sept. 7.

**Johnson and Phillips' Plant.**—It is well known that Messrs. Johnson and Phillips claim that the large resources and experience at their command enable them to undertake the largest contracts. As a justification for this claim the firm issue from time to time in handy form illustrations and particulars of generating plant and other machinery and apparatus which has been actually installed and is in full working. One of these publications is just to hand, and in a series of about 80 quarto pages are given illustrations with brief textual particulars of plant supplied to many of the largest electricity undertakings in this country and abroad both for lighting and power. Amongst the latter class of machines are those supplied for the North-Eastern Steel Co.'s works at Middlesbro'; for the Sheba gold mine at Barberton, Transvaal, where a large stamp mill is electrically driven; and to the Raub mines. A view is given of the power-house at the Raub gold mines, Pahang, and of an alternating-current generator Pelton-wheel driven at the Rezende gold mine. The views of the machinery at the Sheba and Raub mines are particularly interesting.

**Mather and Platt Plant.**—A new price list of steel-clad motors, to the manufacture of which Messrs. Mather and Platt have, during the past few years, given considerable attention, is just issued. These motors are made from 2 H.P. up to 50 H.P., and are designed to run as open-type machines or are fitted with wire guards for protection. Recently revised rules of the chief insurance companies allow the use of fine wire gauze covers for this class of machine, and special designs of these covers are supplied by Messrs. Mather and Platt. The provision of these special covers naturally improve the ventilation, with consequent increase of output compared with machines fitted with hermetically sealed covers.

**"Pallion" Motors.**—An interesting list of "Pallion" motors for varied classes of work is issued by the Sunderland Forge and Engineering Co. Some excellent illustrations of the practical uses to which electric motors can be put are included.

**Engineering Novelties.**—Messrs. Wallach Bros., 57, Gracechurch-street, London, E.C., have issued section H of their main catalogue describing, illustrating and pricing a variety of engineering novelties, including drilling machines, pressure and vacuum gauges, boiler alarms, boiler tube cleaners, engine oil cabinets, tanks and filters, metallic tubing, lifting jacks, belt lifters, tachometers and tachographs, &c. Copies of the list can be obtained post free on application.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 24 to July 30, with the ports of destination:—

*Africa*—Alexandria, £37; Beira £66 (telegraph material); Cape Town, £2,248 (including £815 telegraph materials and sundries); Chinde, £25; Durban, £658; East London, £144; Port Said £20. *Argentina*—Buenos Ayres, £558 (including £320 telegraph wire). *Australasia*—Adelaide, £389 (including £220 telegraph wire); Lyttleton, £33; Melbourne, £527 (including £464 telegraph material); Sydney, £2,997 (£375 telegraph wire); Wellington, £2,003 (£1,778 telegraph material and telephones). *Brazil*—Rio de Janeiro, £15 (telegraph material). *Canada*—Montreal, £48 (telegraph cable); Quebec, £3,301 (telegraph cable). *China*—Hong Kong, £30; Shanghai, £31. *Chili*—Valparaiso, £74. *Denmark*—Copenhagen, £3,727 (including £569 telegraph wire and cable). *France*—Marseilles, £145 (telegraph materials). *Holland*—Amsterdam, £90. *India*—Bombay, £54; Calcutta, £191; Colombo, £112; Madras, £621; Rangoon, £40. *Japan*—Kobe, £4,356 (telegraph cable); Nagasaki £13; Yokohama, £3,518. *Mexico*—Vera Cruz, £29. *North Borneo*—Labuan, £22 (telegraph materials). *Norway*—Christiania, £41 (telegraph wire). *Spain*—Malaga, £31; Santander, £33. *Sweden*—Gothenburg, £80; Stockholm, £244 (telegraph wire). Total, £26,551, against £11,428 in the corresponding week last year (July 25 to 31).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

March 26, 1901.

6,280. A. EKSTEIN and D. B. MELLIS. Manchester. Improvements in electrically-controlled switches for electric circuits.
6,317. E. A. CLAREMONT. Improvements in apparatus for the manufacture of electrical insulating material and for the testing of the insulation of electric conductors.
6,352. B. M. DRAKE and J. M. GORHAM. London. Improvements in electric accumulators.
6,358. A. F. ALDRIDGE and C. M. LINLEY. London. Improvements in or relating to electric ignition devices for internal combustion engines.
6,363. A. CARTER. London. Improvements in electric accumulators.
6,370. J. WANNER and F. WANNER. London. Improvements in electrical means for preventing collisions on railways, tramways and the like.

March 27, 1901.

6,383. L. COOPER, jun. Manchester. Improvements in protectors for overhead electrical tramway wires.
6,393. C. H. WILKINSON. Huddersfield. New or improved means or apparatus to be employed in or for the covering in or fixing of roofs to the tops of electric tramcars.
6,396. O. A. BEREND. London. Improvements in telegraph apparatus.
6,403. A. ECKSTEIN and D. B. MELLIS. Manchester. Improvements in automatic electric circuit breakers.
6,445. H. LAMM. London. Improvements relating to switch mechanism, more especially applicable for use in electric motors.
6,451. E. J. CLARK. London. A new or improved grid or electrode for retaining plumbic oxides in accumulators to prevent disintegration during charging and discharging.
6,460. R. BARTELMUS. Manchester. Improvements in electrical signalling appliances for steam, electrical and other railways.

March 28, 1901.

6,531. B. M. TURNER and R. T. SMITH. London. Improvements in electric ignition devices for explosion motors.
6,554. C. A. CARUS-WILSON and E. H. TYLER. London. A new or improved means of varying the current in electrometers.

March 29, 1901.

6,587. A. ECKSTEIN and H. J. COATES. Manchester. Improvements in watertight electric bells.
6,594. W. H. WEQUELIN. London. A new or improved method of and apparatus for connecting electrical wires or conductors.
6,597. S. G. BROWN. London. Improvements in apparatus for use in wireless telegraphy.
6,615. H. BREMER. London. Improvements in arc lamps.
6,617. THE BRITISH THOMSON-HOUSTON CO. (LTD.) London. Improvements in charging devices for electro-mobiles. (C. H. Haskins, United States.)
6,620. G. E. HEYL-DIA. Liverpool. Improvements in drying electric cables and other goods, and in apparatus therefor.
6,624. W. R. LAKE. London. Improvements in and relating to automatic magnetic circuit breakers. (W. M. Scott, United States.)
6,635. W. R. LAKE. London. Improvements in and relating to automatic magnetic circuit breakers. (W. M. Scott, United States.)
6,645. C. A. T. JENSEN and H. S. R. SIEVEKING. London. Relay for telegraphic purposes.
6,648. W. LONGMAN. London. Improvements in the process of electrically pulverising metals (P. Bary, France).
6,649. J. R. QUAIN and T. T. TURNBULL. London. Improvements in heater cutouts and holders for electrolytic incandescent lamps.

# COMPANIES' MEETINGS AND REPORTS.

## City and South London Railway.

The thirty-fourth ordinary general meeting was held on Friday, Mr. CHARLES GREY MOTT presiding.

The SECRETARY (Mr. W. F. Knight) having read the notice calling the meeting,

The CHAIRMAN said: We meet to-day under more favourable circumstances than we have met for a long time. The extensions of this line are now almost complete, and a few weeks, I hope, will see the entire line open to public traffic. You will remember that this railway was opened in 1890 as a short line from King William-street to Stockwell. Two or three years after the line had been opened we found, to our rather painful surprise, that the traffic on the line was evidently limited, and that we could not look forward to any large increase if we remained, as we were, with a small isolated line of 3 miles in length. We, therefore, came to you and asked for authority to extend the line to Clapham Common in one direction and to Islington in the other. Now, from that time we have had much anxiety on this side of the table, and

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many difficulties, and a vast amount of time has had to be given to the question of completing these extensions. If you will turn to the first page of the report and to those figures of the traffic which are given there, you will see how completely our forecast of what would happen if we did not extend the line was verified. You may take any of the figures before the opening of any one extension. Supposing we take the half-year ending Dec. 31, 1896. We carried in that half-year 3,368,480 people, and received £25,456 for doing so. Three years later—this was just before the opening of our first extension, in the half-year ending Dec. 31, 1899—we carried 3,442,942 persons, and received £26,197, so that the total increase in three years was only 74,462 people and £741 in money. You see, therefore, that the traffic was stagnant, and that there was little or no hope for the future if we remained as we were. Well, we have carried out those extensions, but the difficulty before us was this, that although we saw that the right thing to do, if we could have done it, was to carry them out promptly and at once, yet if we had done so we should have thrown upon this small line a vast amount of extra capital, on which dividends and interest would have had to be paid, before we could in any way develop the traffic. The result would have been to sacrifice, in all probability, the whole of the dividends so far as the existing shareholders are concerned. We did not feel that we were justified in inflicting such a sacrifice upon our shareholders, and we therefore carried the thing out piece by piece as we saw our way to do so without involving any large diminution in the dividend payable. We have had, from the time we got our act in 1893, a very clear and definite idea in our minds of our policy. That policy is now nearing its completion, and we have to see whether it was justified. In the June half of 1899, by very careful economies in every direction we were able to declare a dividend at the rate of 2¼ per cent. That was without allowing anything for depreciation of any kind or for renewals. We knew that although we had earned that dividend that we were liable to very severe competition from tramways and omnibuses, that the general cost of working railways in England was advancing year by year, and that there was little or no chance of that dividend of 2¼ per cent. being long maintained except by tapping new sources of traffic. We have partially tapped those new sources of traffic at the present moment, and you will now see the result. This past half-year, notwithstanding the fact that we have had all the additional capital to pay on, we earned enough to enable us to declare a dividend at the same rate as the highest dividend we have ever paid, comparing like with like. There was no amount set aside for renewals or depreciation in the half-year in which we paid 2¼ per cent. before, and we have earned that in the past half-year if we deduct nothing for depreciation. So you see we have now arrived at a time when we are absolutely earning practically the same dividend as we earned with the restricted line which had no possibility of advance in the future, and every probability of a decreased dividend. We have now arrived at the same stage in regard to dividend as we were in at our best, with the advantage of now having a development in the traffic each week. There are, therefore, great possibilities for the future, and I think you must admit that the plan which we have had in our minds for so long has already in part been justified by results. When the extension to Islington is open we anticipate a further large increase in our traffic, and I hope we shall get it. Probably we shall not do so at first, but I believe we shall as time goes on. We have, as I have already remarked, various sources of traffic to come on in the future; that is to say, the traffic from the Islington extension, the traffic which we expect from the exchange with the Great Northern, whose station is directly opposite this building, and we have also the subway at London Bridge now nearly finished. There is also the connection which we hope will one day be made between our station at the Elephant and Castle and the Baker-street and Waterloo Railway, and there are also other connections in prospect additional to those which we now have. We have, consequently, the prospect of a steadily growing traffic, all of which would have been absolutely impossible if we had not extended this line. Now, the reason why we are not able to pay at the rate of 2¼ per cent. this half-year is that, having made no reserve for renewals, we have been met at the end of the first 10 or 11 years—in fact, the machinery has been working for 12 years—with the necessity of substituting a new and improved plant for the old one. We might have gone on with the old plant and then we should not have needed to say anything about renewals, but that would not have been wise any more than it would have been wise to have gone on contented with the original line. In substituting the new machinery for the old, we have taken what we consider to be the wise and proper course. We sold the old plant for the best price we could get, but after deducting the amount received for this old plant we are face to face with an outlay on this new machinery of £8,000, which we have to provide for. We have cleared off £3,000 of the £8,000, leaving £5,000 to be met in the future. It is a heavy pull on this past half-year, and it has practically absorbed a half per cent. of your dividend for the time being. We think it better in the next half-year or two to clear it off if we can, and then we propose in future to adopt a moderate renewal fund so that we shall not have claims of this kind coming suddenly upon us again. The amount of the renewals and depreciation on an electric line is not a very large one. You will see in this case, for instance, that if we had placed aside £350 each half-year since the line has been opened we should have had the whole amount in hand, but, of course, the machinery is larger now, and so in these altered circumstances we shall no doubt require to put a larger amount aside. That is a matter we shall consider as soon as we have cleared off the arrears. Before dealing with the accounts and the results of working, I might deal with the different items in the report. Our bill in Parliament was threatened with being sent to the Joint Committee which has been sitting on underground railways, and in that case we should not have got it through this session, as none of them are being passed, but, by dropping the proposed subway at the Angel to the Agricultural Hall, we were enabled to make it into a purely money bill, and it did not go before that Committee, and has now been passed and has received the Royal assent. The question of whether that subway at Islington should be made at some other day we can consider later. Then you will see that the arbitrator has given his award in the matter of St. Mary Woolnoth Church, but it is *sub judice*, and so I cannot make any statement about it. The Euston and Islington bill is hung up for the present and therefore we have made no arrangement about that at present. With regard to the City and Brixton bill, our arrangements have practically expired, and the question we shall have to consider is whether it is desirable to renew the arrangement. I think if we do so it will probably be in some other form, and involve less liability to this Company. The additional capital we have got by our present bill is necessary. We have been working largely with loans at different times and paying high rates of interest in some cases, and we, therefore, propose to issue a portion of this new capital so as to pay off those loans. There will be a saving in the interest charges, but we shall want a further amount to provide additional rolling stock, &c. We do not propose to issue the whole amount of the stock at present, but only such portion of it as is absolutely necessary. Now, I will take the accounts. As far as capital is concerned, we have raised from the issue of shares £13,490, from debenture stock and premium £33,730, and from renewal account £10,704 making a total of £57,924 in the past half-year. On the other hand, we have expended on works and rolling stock £102,668, and there has been interest charged to capital of £4,347, making a total of £107,015 on capital account, leaving a balance to the debit of £49,091, which has been entered as loans for the time being until this new stock is issued. As regards revenue, receipts from passengers show an increase of 1,718,069 persons and in money of £16,339. From season tickets there has been an increase of 44 and £1,067. Parcels show an increase of £102, making together £17,598. Rents have increased by £876 and sundry receipts by £136. There has been a decrease in transfer fees of £11, leaving a total increase of £18,509. Then as to expenditure. Maintenance shows an increase of £657, locomotive and generating power £1,680, carriage repairs £745, traffic expenses £2,902, general charges £218, passenger duty £124, law charges £45, and rates and taxes—that terrible thing which is always increasing—£854 more in the half-year, making a total increase of £7,235, and thereby reducing the net increase in the revenue to £11,274. There is a small difference between the balance brought in and that carried forward of £37, leaving the net figure at £11,311. This has been disposed of as follows:—increased interest on debenture stock, £2,792; transfer to the renewal fund, £2,000; increased dividend on preference stock, £1,667; and decreased interest and discounts, £2,715. With regard to this last item, I should explain that in the corresponding half-year certain amounts were brought into the accounts which had been received from the contractors, practically, you may say, as fines—but received from the contractors as interest upon certain moneys advanced to them. We have had nothing from that source this half-year. That makes a total of £9,174, leaving available for increased dividend on the ordinary stock, £2,137. The train miles run in 1901 were 444,560 against 299,723 in the corresponding half of 1900, showing the large increase of 144,837 miles in the half-year. The number of trains run in the last half-year was 93,592 against 80,437, or 13,155 additional trains run during the half-year under review. The results of all that working are very satisfactory. The number of passengers—owing of course, to the longer length of the line and the increase of the passenger traffic—have been in each train 62 against 57 in each train in the corresponding six months. The receipts per train run have increased from 8s. 8·86d. to 10s. 10d., which is satisfactory. There has been a slight decrease in the receipts per train mile because of the additional mileage run, but the receipts per passenger have averaged, as nearly as possible, 2d. We carry a very large number of workmen in the morning and other passengers at 1d. and 1½d. each, and the average fare of 2d. is a very satisfactory figure in view of all that, because it shows that the system we adopted of booking according to the distance a passenger travels, and not continuing the old average fare of 2d. with which we started, has been successful. The most satisfactory feature is, perhaps, the reduction in the working expenses. The working expenses in the corresponding half-year were 59·36 per cent., and in this past half-year they have been reduced to 52·36 per cent. We began originally with working expenses of 79 per cent., and we have gradually got them down by degrees to 52·36 per cent. You must remember that these percentages include not only the working of the railway but also of the lifts. We do two operations for every passenger. These lifts are very expensive things to work, as you will understand when I say that, apart from the cost of working the lifts, the working expenses for the past half-year were only 41¼ per cent. You see, then, what a tremendous expense these lifts are, and in considering the question, which is often raised in Parliament and elsewhere, of the fares on these underground lines, it ought not to be forgotten, in making a comparison with those on other railways, that we have to do this double service for the public. The expenses per train mile have been reduced from 1s. 4·7d. to 1s. 3·19d. The locomotive charges, again, notwithstanding the high price of coal and the greater expense of materials of that kind, have been reduced from 5·97d. to 4·93d. That is a very satisfactory reduction, and speaks well for the management of our engineering department. The traffic expenses have been increased in various ways. We have had to pay increased wages and other higher charges. All these are very satisfactory figures, proving, after all, how largely the electric railways show to advantage when compared with the ordinary steam railways. Instead of their locomotive charges being 4·93d. per train mile, you will probably find they are nearer 1s. or more on many of the lines, and that their working expenses, instead of being 52·36 per cent., including the working of the lifts, will come out close upon 70 per cent. this half year. All this points to the real advantage there is in an electric line when it goes through a district where there is a large traffic and where it has a continuous service of trains. The result that was announced to-day, or

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yesterday, of the dividends of the Central London, 4 per cent., shows that, notwithstanding the high cost of that line, they have such a magnificent traffic that they are able to pay an excellent dividend in the second half-year of their opening. All this, I think, points to the real value of electric railways. We have now in this Company, I believe, turned the corner. Our difficulties are practically at an end, and we have every prospect now of moving, as the traffic grows, steadily upward with our dividends. I now move the adoption of the report and accounts.

Mr. C. SEYMOUR GRENFELL seconded the motion.

Mr. D. HYAMS said the Company had a large amount of dead money in the portion of tunnel proposed to be used in connection with the Brixton Railway. An attempt might be made to utilise that line in some other way than by getting a bill to run it as an independent concern. He thought the large amount of space underground might be used for several different purposes, among which he instanced cold storage. An effort might also be made to induce the County Council or the City Corporation to take over the tunnel under the Thames and utilise it as a public subway. They had 10 per cent. of their capital locked up in that tunnel. He considered that the meeting would rather congratulate the Board than otherwise on having dropped the subway at the Angel, as it would have involved a very large outlay, and the return would be very problematical. If they wanted to make a subway he suggested that they should make one from Liverpool-street and Broad-street stations, where millions of people were arriving every day.

The Rev. Mr. RUSSELL thought something might be said in favour of adopting a uniform fare of 2d. and of making the return tickets available for longer than a day. Before long London would be honeycombed with such railways as theirs, and it was very probable that, in nearly every case, a uniform fare would be fixed, and he suggested to the Board whether it would not be wise for them to do the same. Would it not be possible, he asked, to extend the line to Highbury.

Mr. COX referred to the delay which he had experienced when travelling on the line in the working of the lifts, and suggested that an inspector should be appointed to look after the lift men.

The CHAIRMAN: Mr. Hyams has made a good suggestion as to the use that might be made of the non-used portion of our line. It would be a great satisfaction to us if we could find any means of using the Brixton line. All the suggestions that Mr. Hyams has made have been before us. The Corporation are proposing to widen London Bridge, and we suggested that they might use our tunnel instead as a roadway, but they did not see it. Then we have thought of utilising it for various purposes. Mr. Russell wants us to go back again to our old uniform fare. I have gone into it carefully, and, as far as I can make out, if we had adhered to the uniform fare you would not have had much dividend this half-year. No doubt uniform fares are nice to the public in many respects, but they are unjust on a long line. I very much doubt whether the Central London will not alter their system in this respect. We tried it for a number of years and were forced to the conclusion that although it might be necessary for a line 3 miles long, yet when you got a line the length of ours—and when the Islington extension is opened it will be longer than the Central London—it is not the right thing to do. With regard to the extension to Highbury, I am not at present in favour of any more extensions, and there are objections to Highbury. As regards the lifts, I am sorry to hear there has been any want of attention, and I am sure the general manager does his best—and he does it excellently well on the whole—to get these men looked after. We have inspectors for that purpose. The lifts themselves have undergone a great change. We began with hydraulic lifts, but on the new line we are working with electric lifts on the same principle as the Central London, but the Central London's are American-made lifts. We have always stuck to our country in our purchases. We were determined, if possible, that English electrical firms should make us as good a lift as we could get from America. The English firms had not quite the same experience in that work, but we gave them time, and I am glad to say they have worked out a system of electric lifts which are now in operation, and I think that in their subsequent working they are likely to prove even better than the American lifts, because the machinery is simpler. Anyhow, I think they are as good as any American lifts we could have got, and in what we have done I think we have performed a patriotic work.

The motion was then agreed to unanimously.

The dividends proposed in the report were then approved, and at an extraordinary meeting which followed, the issue of additional debenture capital was carried.

A vote of thanks to the Chairman brought the proceedings to a close.

## Direct United States Cable Co. (Ltd.).

The forty-eighth ordinary general meeting was held on Tuesday, under the presidency of E. M. UNDERDOWN, Esq., K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) read the notice calling the meeting.

The CHAIRMAN said: The statement before you in the report is of a satisfactory character. The revenue for the six months to June 30, after deducting outpayments, amounted in round figures to £50,650, while the working and other expenses, including income tax, but exclusive of cost of cable repairs and maintenance, absorbed £21,125, leaving a balance of £29,525, and this, with £5,256 brought forward, makes a total of £34,781. This has been appropriated as follows:—Interim dividend of 5s. per share to March 31, £9,106. 10s.; proposed final dividend of 3s. per share to June 30, together with a bonus of 1s. per share, £12,142; we have transferred to reserve account £10,000, and we carry forward £3,532. 10s., making together the above-mentioned total of £34,781. The revenue, as you will observe, shows a small reduction of £1,554 as compared with that of the corresponding period of last year; but having regard to the fact that additional competing cables have been working in the Atlantic since the autumn of last year, this is by no means an unfavourable result. You will, perhaps, remember that on a former occasion I made some remarks upon the probability of there soon being 14 cables working across the Atlantic. You may take that to be correct, although one of the cables does not actually reach as far as the European shore. Therefore, as I have before said, taking into account the competition we have had to meet, the result of our working is by no means unsatisfactory. We are following out the principle I then enunciated—that if we and our friends were to carry on our business in the most perfect manner, so as to meet the wants of the public, we had not much to fear. We are here now under these circumstances, and I am pleased to see that our position has not become worse than it has. With regard to the working expenses, you may take them to be practically the same. At the stations some small increases and decreases are shown, but on balance there is a total increase of only £311. It is right to say that we have made some concessions to the operating portion of the staff, more especially in connection with a long-standing question of extra payment for Sunday and holiday duty. You are all aware that in a business of this kind work practically never stops—that some portion of the staff is always employed; and we thought it was but just to follow other companies, and the telegraph department of the Post Office, and make an increase in their remuneration in that respect. These just increases, in my view, are always rather beneficial to a company than otherwise. There are no other increases likely to call for remark except that in the income tax, and I am afraid that any remarks we might make on that matter would be extremely inefficient. The cable repairs in this period you will observe are somewhat higher than usual, but after so many years working it was very necessary to put our cable into a perfect state of repair, more especially that portion of it which is close to the Irish coast. This has been very carefully done; new pieces of cable have been laid down, and the matter has been re-arranged. Including repairs on the other side of the Atlantic, an amount of expenditure—something like £19,000—has been incurred; but with respect to this I think I ought to read to you the report of our cable superintendent at Halifax, written early this month. He says: "The cable works and tests as well as if it had just been manufactured and laid. Although actually 27 years old it has never worked or tested more satisfactorily than it has done to-day." That is a very satisfactory state of things to be able to report. The investments are practically the same as last half-year. Upon the whole year they have been increased nominally to the extent of £18,000. We all know that investments do not stand as high as they did some time ago, but, at all events, our investments show a market value above their cost. The results for the whole year are as follows:—Receipts £101,184, expenses £41,951, leaving £59,233. We have paid in dividends £39,461, and we have placed to reserve £20,000, making together £59,461, less the reduced balance in hand as compared with June, 1900, £228. The reserve fund is increased on balance by £12,122, and that is made up from the interest on the reserve fund itself £14,036, from revenue £20,000, making together £34,036, less charges for cable and other repairs £21,914, making the increase of £12,122. I do not know that there is a cloud hanging over us of any kind. We are endeavouring to make the best arrangements we can both with regard to the foreign traffic and with regard to our relations with the English Government; and, on the whole, I repeat, our position is a satisfactory one. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded, and the motion was carried unanimously.

The Hon. Thomas H. A. E. Cochrane, M.P., was elected a director of the company, Mr. John Varley was re-elected a director, Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. J. and J. Sawyer & Co., were re-appointed as auditors, and a vote of thanks to the Chairman, Directors and staff terminated the proceedings.

## Globe Telegraph and Trust Co. (Ltd.).

The twenty-eighth ordinary general meeting was held on Tuesday, under the presidency of the Marquis of TWEEDDALE, K.T.

The notice convening the meeting was read by the SECRETARY (Mr. Sidney Collett), after which

The CHAIRMAN said: The report gives a very full account of the changes which have taken place in the business of the company during the past year. It will be seen that the receipts, less expenses, amounted to £197,136, a decrease of £1,284. This is not a decrease in revenue, but is almost entirely due to the fact that we have had to pay interest on money borrowed to pay for a large number of shares in the Eastern Extension Telegraph Company which were allotted to us in consideration of our holding in that company. The allotment was for 11,000 odd shares. Our receipts from the companies in which our money is invested amounted to £204,541—an increase of £1,680—and this enables us to recommend a dividend at the rate of 6 per cent. on the preferred, and a final dividend of 4s. 6d. per share on the ordinary shares. This makes 5¼ per cent. on the ordinary for the year, as well as the full dividend on the preferred. We have now paid this 5¼ per cent. on the ordinary shares for three years in succession. There is one point I wish to refer to, and that is the item "Differences on securities realised, £415,595. 13s. 8d." It is an interesting fact that, although this item, with varying amounts, has appeared in each report since the year 1897, it is only lately that we have received any inquiries to speak of on the subject, and within the last few days I have had four letters asking for an explanation. This amount is almost entirely attributable to the sale of our holding in the deferred shares of the Anglo-American Telegraph Co., which, as the shareholders will see, stand in our books at £32. 7s. 1d. per cent. Dividends on the Anglo deferred stock ceased in 1886, the result being that there was a heavy market fall. It had, in fact, gone as low as £6 and £7 per £100 stock. The directors had selected a time when the price of the stock was comparatively high and had disposed of the company's

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holding in Anglo deferred stock, a fair amount being sold at the highest market price which has ruled during recent years—viz., £17. The item in the account showed the capital loss made on this investment, but the shareholders should understand that although we spoke of this as a loss—and as a matter of fact it was a loss—yet so far as the books are concerned it is a decided gain, for the money realised from the sale of that stock has been invested in good dividend-earning securities, and the result is seen in the dividends we are distributing to-day. Further, although we show this loss, there is no diminution in the value of our securities as compared to their cost. On the contrary there is an increase of between £400,000 and £500,000. There will be a slight decrease in the interest earned on our investment in the Direct United States Cable Co. of about £500. We next come to our investment in the Eastern Extension Telegraph Company. Last year I explained to you that the company were offering new shares to their shareholders at £13, and that our proportion was 11,143 shares. Owing to the unsettled state of the market for the past 12 months we have not been able to carry out the changes in our investments which would have enabled us to pay for the whole of these shares. We, therefore, borrowed a portion of the money temporarily at a rate of interest which makes the transaction a very profitable one, as the return on the new shares is £5. 7s. 8d. per cent., which is a much higher rate of interest than we are paying on the borrowed money. We have sold during the year our London Platino Brazilian debentures at a premium. These are due to be paid off at par in 1905. our holding in the Submarine Cables Trust has been reduced by nine certificates at £120 per certificate, an amount slightly under what they stand in our books. There is, however, a coupon of reversion attached which will prove a valuable asset for this company, later on our receipts from the Telegraph Construction and Maintenance Co. show an increase of £1,094, owing to an improved dividend which we hope and believe will be maintained. In the West African Telegraph Co. we hold 4,000 shares. These have for sometime past paid no dividend, but an arrangement has been concluded with the French Government which will improve the financial position of the company, and we shall, I think, receive something in the nature of a dividend from the ordinary stock shortly. You will see by the report that Sir John Wolfe Barry, K.C.B., who occupies a very important position as chairman of two of the principal cable companies, has joined the board in the place of the Hon. St. John Brodrick, who has retired owing to his occupying the important post of Minister of War. I now move the adoption of the report and accounts, and the payment of the dividends set out therein.

The motion was seconded by Sir JAMES PENDER, Bart., and carried unanimously.

Sir Albert J. Leppoc Cappel was re-elected a director, and Messrs. Deloitte, Dever, Griffiths & Co. and Mr. John Newton were reappointed auditors. A cordial vote of thanks to the chairman terminated the proceedings.

## Crompton & Co. (Ltd.).

The thirteenth annual meeting of Crompton & Co. (Ltd.) was held yesterday, Mr. JOHN TROTTER presiding.

The CHAIRMAN congratulated the shareholders on the success achieved during the past year, and added that the accounts did not at first sight show the position to be as favourable as it really was. The gross profit for the previous year was £65,891 and for the period under review £68,633, but it would be observed that the trading expenses had risen from £20,245 to £23,769. This was disappointing until read in the light of the large item in the balance-sheet of £141,232 for stock in trade and work in progress, as compared with £95,459 in the preceding 12 months. Their accounts this year were suffering from that which must at different times affect contractors' accounts. They could settle to strike the account at March 31, but they could not arrange for the contracts which were running to be finished on that day, and it so happened that on March 31 last this company had a large amount of contracts not completed, but on which a great deal of work had been done. Not a single farthing of the estimated profit on those contracts had been credited to the present accounts, but, of course, it would be available in future. This also explained the net profit being £27,000, against £31,326 a year ago. It was proposed to pay a final dividend of 9 per cent, making with the interim declaration, 7½ per cent. for the year. The item of freehold land and premises, £41,768, showed an increase owing to extensions at Chelmsford, and plant and tools also stood at a higher figure. Competition grew stronger every year, and the board felt that they must acquire all the best machinery obtainable, whether in the new world or the old, so as to be on a level with their rivals and be enabled to turn out work rapidly and at the cheapest possible price. The stock-in-trade had been kept down to about the same as last year. With regard to the item "Chelmsford Electric Lighting Co. investment in shares and loans, and balance of account for work done," &c, £43,406, against £38,600 a year ago, he said they had now succeeded in starting that company on its own basis, and separated entirely from the works of Crompton & Co. Immediately the company began to supply a better and reliable light the consumption increased. During the year under consideration there had been an addition of 3,400 8 c.p. lamps, and orders were still coming in. In spite of the high price of coal the net profit of that company in the past year showed an increase of £300, and as the outcome of the current year's business satisfactory figures were anticipated. The item of patents had been written down to £10 only, and the goodwill of Crompton & Co. now stood at £10,000, against £30,000 four year ago. He moved the adoption of the report and accounts.

Lieut.-Col. R. E. CROMPTON seconded, and remarked that he had been on the Continent, and had taken great pains to ascertain what their rivals were doing, and in what way they were superior in methods of manufacture and in their power to turn out work rapidly and cheaply. As a patriotic Englishman, he had read with misgivings all about the decadence of English manufacturing supremacy. All he could say was, that it did not apply to this company. He was one of a few people who visited some German works the other day, and he felt that he had nothing to learn from them as regarded arrangement of the works, the attitude of the men, and the whole procedure. There was only point in which he had envied them—their system of finance, but that had recently been showing signs of weakness, and, perhaps, after all our more conservative system had its merits.

The report was adopted, and Mr. Bernard Gibson, the retiring director, re-elected.

## Sir Hiram Maxim Electrical and Engineering Co. (Ltd.).

An extraordinary meeting of this company was held on Friday last, Mr. JULES DE MERAY presiding, to make certain alterations in the articles of association, with the object of obtaining a Stock Exchange quotation for the shares.

The CHAIRMAN said they might regard the gathering as the statutory meeting, as it was the first time the shareholders had met since the acquisition of the late Maxim Corporation. The business of the company could be divided into three departments—the lamp manufactory, the engineering contracting department, and the export department. Their total capital was £175,000, and the £40,000 of working capital was almost untouched. They had the rare advantage of being advised on scientific and technical matters by the founder of the company, Sir Hiram S. Maxim. The resolution having been approved,

Sir HIRAM S. MAXIM said he did not think in this country many of them had any conception of the great advances which had been made in electric traction in the United States. It was said that more than $4,000,000,000 had been spent in the last 16 years on electrical plant there, and the greater part had been for electric traction, which had worked a complete revolution in the social condition of the people in the States. It was often said that England was about the best railroad country in the world. There were 17,000 to 18,000 miles of railroad in the United Kingdom, but in the United States 20,000 miles had been equipped for electricity during the last few years. Electric traction paid best where density of population was greatest, and no country in the world was so well calculated for the introduction of this system of travel as England, where the population is so great and the distances small. To run a train from London to Brighton propelled by an ordinary locomotive it was necessary to carry the motive power and also water with the train. The train consequently was very heavy, and it was necessary to tunnel the hills and fill up the valleys. The fire-box was small, and it was necessary to consume very high-priced coal. This was, therefore, an expensive form of power. If an electric railway from London to Brighton were built it would not be necessary to fill up the valleys or to tunnel the hills, unless they were very steep and small. The train might be made so light that there would be no trouble in mounting the hills, because there would be no locomotive to carry. Then, as the amount of power would be practically unlimited, the weight would be much less and the trains could be run at double the present speed. He did not hesitate to say that with the appliances already at hand, with only a slight change in the shape of the train, so as to avoid atmospheric resistance, it would be quite practicable to run trains at a speed of 120 miles an hour, and passengers could be carried from London to Brighton at a very much less cost than at present. Very important business, indeed, was sure to result from the introduction of electric traction on an extended scale into England.

## Dublin United Tramways Co. (Ltd.).

At the meeting in Dublin, on Tuesday, the chairman (Mr. W. M. Murphy) said the gross receipts during the half-year amounted to £109,597, against £109,373 in the corresponding half-year of 1900, an increase of £224. Last year the additional traffic due to Queen Victoria's visit was not less than £6,000. In expenditure they had effected a saving of £3,447, which was entirely due to the economy of working all the tramways from the Ringsend power station. The cost of generating current was an average of 0·756d., or less than ¾d. per unit, and their last weekly returns showed that they were producing it at still lower cost. They had made contracts for a year's supply of coal at 9s. 9d. per ton, delivered at Ringsend dock, which was 6s. per ton less than the average price charged in the accounts under review. On a consumption of 20,000 tons that meant a saving of £6,000 a year. Under the head of maintenance there was an increase of £4,000, including £1,484 on car bodies, trucks and equipments, £1,336 on permanent way (including cost of street sanding), and £536 on plant. The maintenance of cars, equipments and electrical plant was partly due to the larger number of cars and plant which had to be taken care of. By reorganising the system of car cleaning and inspection they effected a saving of £342. On the other hand, they spent £832 more on wages of drivers and conductors, but the net result was a saving of £792 in this department. The large increase of £3,592 in general charges was due to law costs and compensation. They paid in the half-year £5,181 under this head, to which the proportion of the insurance premium to June 30 (£1,155) had to be added, making £6,337, against £2,363 last year. He was glad to say that lately they had been freer from accidents than for some time back. An idea was abroad not long ago that the company was fair game for any description of claim, no matter how much the claimant's were themselves to blame, and he thought the comparative immunity from accident claims which they had lately enjoyed was due in some measure to the recent successes of the company in resisting actions in the superior courts. Liability for accidents alleged to be caused by not sanding the streets would be argued in the Court of Appeal in the next sittings. He believed they had passed through the worst half-year which the company was likely to encounter for many a day. He thought that they should have between

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£25,000 and £28,000 available for the ordinary shareholders at the end of the year, which would enable a 6 per cent. dividend to be paid, with £7,000 to £10,000 over for writing off and carrying forward. This undertaking has a very large earning power, capable of much development. Their claim against the British Thomson-Houston Co. was not yet disposed of. The claim was in respect of a capital charge which the tramway company had already incurred and paid. During the half-year the cars travelled 3,283,896 miles, an average of 89·9 miles per car per day, consuming just under a unit of current per mile. They carried 21,697,650 passengers at an average fare of 1·21d. The average receipts per car mile were just 8d., and the expenses 4·987d. The report and accounts were adopted.

## Chili Telephone Co. (Ltd.).

The directors' annual report to March 31 states that the aggregate number of subscribers at all centres was 4,723, compared with 4,613 at the beginning, a gain of 110. The gross revenue in Chili was $683,170, compared with $651,436 in 1900, an increase of $31,734. The expenditure in Chili was $347,413, against $364,549, a decrease of $17,136. The net income in Chili was, therefore, $335,757, against $286,887, an increase of $48,870.

The average rate of exchange for the year was 16·65d., compared with 15·17d., an increase of 1·48d. Converted into sterling the figures for 1901 were £23,290, against £18,130 in 1900, an increase of £5,160.

The liquid assets and liabilities in Chili on March 31 were valued at 17d., compared with 16½d. at the corresponding date last year. This increased value represented £800, which had been carried to reserve.

The balance to credit of revenue, including £1,003 brought forward, is £18,879, of which £5,199 has been carried to reserve for depreciation and renewals. The directors recommend a dividend of 5s. per share, tax free (5 per cent.), absorbing £11,000, £2,680 to be carried forward.

During the year the capital outlay was £488, and the total mileage of lines on March 31 was 8,591 miles 548 yds., compared with 8,298 miles 990 yds. in 1900, an increase of 292 miles 1,318 yds.

**DISTRICT MESSENGER AND THEATRE TICKET CO. (LTD.)**—It was announced at the meeting on Monday that there was a decrease in the profits of £1,824 compared with the previous year. The position of the company had been greatly altered by the fact that they had obtained their bill in Parliament. By this bill their royalties to the Postmaster-General had been materially reduced. The royalty for the year ended March 31 last was £1,254, but had it been calculated on the original basis it would have been £3,323. The royalty on call boxes was originally fixed at 2s. 6d. each, but after pressure this was reduced by the Post Office to 1s., and subsequently to 6d. The company's business laboured under exceptional disadvantages, which made it both difficult and expensive to manage. While they might expect to suffer to a certain extent from the new Post Office telephone service, it was quite possible the injury done to them would be very small. The payment of the preference dividend was approved.

**FLEETWOOD AND DISTRICT ELECTRIC LIGHT AND POWER SYNDICATE (LTD.)**—At the annual meeting last week the chairman (Mr. J. T. H. Baily) said the company was now in full working order, and was practically supplying current to the full extent of their powers, but up to the present no real profit had been earned. It was proposed to put the company into proper working order, so that they might be enabled to supply further customers. A further debenture issue of £3,000 (making issue £10,000) was to be made. That would enable them to carry out the suggestions of their consulting engineer (Mr. F. H. Medhurst). The equivalent of 4,500 lamps for private lighting, 500 for public lighting, and 12 arc lamps were connected to the mains. They commenced the year with 12 customers and now had 110. They had only been running in full working for 10 months. The report and accounts were adopted, and the directors were authorised to increase the capital of the company.

**GENERAL ELECTRIC CO. (1900) (LTD.)**—A meeting of this company was held on Tuesday. Mr. H. Hirst presided, and in moving the adoption of the report and accounts said that if the advance made was not quite in the same proportion as that to which they had been accustomed, there were disturbing influences which had affected trade, and also that the promotion of a company necessitated a large amount of extra work on the part of the directors and staff. On the credit side of the account there was an item of income from investments (debentures, stocks, and shares) £4,401. They were getting interest of over 10 per cent., and the investments were principally in kindred companies in which they had taken an interest. During the year they had added £23,000 to the item of freehold land, buildings, plant and machinery, which now stood at £140,000. The electro-chemical works they had started were well forward. The item "sundry debtors" seemed large, but in proportion to the turnover, it did not compare unfavourably with the corresponding item during the last 15 years. The usual provision had been made for bad debts, and the stock in trade was in very similar proportion to the turnover. The stock was valued, not at cost, but at probable selling price. The profits of the year had been produced practically on the capital they had in the business before the new flotation. They had put £18,000 to reserve, and, with the object of interesting them in the business, they had allotted to the staff 685 ordinary shares, and, apart from these shares, had given them a direct bonus dependent on the net profits. In addition to increasing the turnover of almost every supplying department, they had added a new department—that of electric traction—and during the past 12 months had succeeded in getting a number of excellent orders. The report was adopted and the dividends recommended in the report were agreed to. Mr. Max Railing was re-elected a director, and two additional directors (Mr. H. Bevis and Mr. T. Hawkins) were elected.

**GREAT NORTHERN AND CITY RAILWAY CO.**—At the half-yearly meeting yesterday (Thursday) the chairman (Sir Charles Scotter), said that the total lengths of tunnel completed to date were 6,659yds. of 16ft. tunnel and 514yds of station tunnel. There were about 1,808 tons of cast-iron segments in the station yards, 1,933 tons at King's Cross, and 200 tons in the maker's yard. The directors had hoped to be able to report that a contract for the electrical plant and equipment had been signed, and to be in a position to announce the names of the contractors. That contract, however, had not yet been signed, but he believed that it would be decided in the course of a few days. They intended to work their railway under the multiple unit system, which the experience gained in all directions had proved to be the best adapted to their particular requirements. They had had a good object lesson in the results of the working of the Central London Railwry during the last eight or nine months. He supposed that that was the only instance of a new railway on a new system being able to pay a very substantial dividend on its first six months' operations. The Central London declared a dividend of 4 per cent. on its ordinary capital, but it was not generally known that they could pay more than 5 per cent. They intended to take advantage of the lessons taught by that line, and hoped when their line was opened the same success would attend it. The report was adopted.

**LIVERPOOL OVERHEAD RAILWAY CO.**—The report of the directors for the half-year ended June 30 states that the gross receipts amounted to £41,701. 4s. 8d. and the working expenses to £30,658. 2s. 4d. The number of passengers was (including the tramways) 5,382,224, compared with 4,687,862 in the corresponding half-year of 1900. The traffic on the railway has felt the extensions of the Liverpool Corporation tramways; on the other hand, the traffic at Dingle station shows some signs of improvement. The Waterloo and Crosby tramways continue to yield satisfactory returns. From the net revenue there is available for dividend £11,722. 15s. 8d., and the directors recommend the declaration of dividends (less tax) at the rate of 5 per cent. per annum on the preference, and 2 per cent. on the ordinary shares (absorbing together £8,000), leaving £3,722. 15s. 8d. to be carried forward.

**METROPOLITAN RAILWAY CO.**—At the half-yearly meeting on Friday, Col. J. J. Mellor, who presided, said the unpleasant condition of the company's finances was entirely owing to the competition of the Central London Railway, which had taken from them in the half-year £42,000. With regard to the question of electric traction, it was in this direction that they must look for the restoration of the traffic and of the earning capacity of their line. Their neighbours and partners in adversity, the Metropolitan District Company, had been equally troubled by competition and other adverse circumstances. Each company had appointed experts to advise them. The Metropolitan Company appointed Mr. Thomas Parker, who was responsible for the plans and construction of the Liverpool Overhead Railway—a most successful line—and the District Company appointed Sir William Preece. A specification was prepared, tenders invited, and nine received from eminent electrical engineering firms in Great Britain, on the Continent and in America. The tenders were submitted to searching examination, and the tender of Messrs. Ganz & Co., Budapest, was selected by reason of its combined simplicity and economy. The two electrical engineering experts were despatched to make a thorough examination of the system at Budapest, and to report upon it fully, and it was evident from their report that the Ganz system possessed features of such novelty and importance that it amounted practically to a new departure in electric traction. At the commencement of the negotiations they appointed a joint electrical traction committee, representing the two companies, and so satisfied was that committee with the report of Sir W. Preece and Mr. Parker that they passed a resolution recommending their respective boards to address a joint letter to Messrs. Ganz & Co. accepting their tender, subject to the approval of their system by the Board of Trade and to certain other conditions to be formulated by their electrical advisers. So that up to that point the two companies had worked harmoniously for the object they both had at heart. But a new influence shortly afterwards appeared at the councils of the District Company. A group of American capitalists, with Mr. Yerkes, of Chicago, at their head, offered to find £1,000,000 if he, through a new company to be formed, might have the contract for equipping the District Company with its electrical outfit. The result of all this was that the directors of the District Company would not have the Ganz system on any consideration. It was, however, idle to attempt to arrest the progress of electrical discoveries and inventions, and if this new system of Messrs. Ganz & Co. was what their own regularly-appointed experts said it was, then it was destined to render valueless much of the electrical plant in this country and on the Continent, but especially in America; and there were not wanting signs that a determined effort would be made by interested companies, who commanded immense wealth, to stifle and strangle this new departure in Continental electrical engineering. He (the speaker) and his colleagues deplored the action of the District Company, and they asked Parliament to decide that they should not be compelled to adopt a system of which they knew nothing, when they were practically committed to a system which the District Company's engineer, and their own, had told them was the best and most advanced which had yet come before the public. The Metropolitan Company were prepared to pay cash for their electrical equipment, and wanted the very best, most advanced system which the best electrical engineering firms in the world could give them, and they were advised that they had got this in the new system of Messrs. Ganz & Co., which required no sub-stations with moving machinery, thereby saving about £150,000 in capital outlay and about £10,000 a year in annual maintenance. The total cost of the Ganz system was estimated at from 30 to 40 per cent. less than that of the American. Meantime they were proceeding with the erection of their power-house so that no delay would necessarily ensue. The Ganz system was at work now on five or

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six railways in Switzerland, and the Italian Government had constructed 65 miles of lines on the same system. He believed that electric traction would be as cheap as steam. If one of the great trunk lines of the country would offer them terms worthy of acceptance for taking over their undertaking the directors would consider them.

**WATERLOO AND CITY RAILWAY CO.**—The report of the directors for the half-year ended June 30 states that the gross receipts, less Government duty, amounted to £16,314. 19s. 1d., and the working expenses to £8,937. 13s., or 54·78 per cent. of the receipts. The difference between the two amounts was not sufficient by £1,567. 6s. 5d. to pay a dividend at the rate of 3 per cent. per annum on the ordinary and borrowed capital, and the working company (the L. and S. W.) had therefore made up the deficiency, and had deducted in respect of working expenses £7,370. 6s. 7d. The number of passengers carried during the past six months, exclusive of season ticket holders, was 2,134,062, an increase of 265,325 over the corresponding period of 1900. The season ticket holders on June 30 numbered 1,057, against 911 in June, 1900.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ELECTRIC HAULAGE CO. (LTD.)**—Reg. July 22, capital £10,000, in £1 shares, to acquire patents, inventions, and processes, and in particular to purchase certain patents relating to an invention for an improved system of distribution and collection of current for electrical traction, and to carry on the business of electrical engineers, manufacturers of electric motors and electrical apparatus and appliances, makers of electric tramcars and other vehicles, rail, conductor and trolley manufacturers, &c. The subscribers are E. Hughes, G. Davis (electrical engineer), A. Bathurst, G. H. Gordon, A. J. Borer, A. G. Hughes (engineer), and J. G. W. Aldridge (consulting electrical engineer). The first directors are G. Davis and others to be appointed by the subscribers.

**ELECTRIC PROPULSION (LTD.)**—Reg. July 23, capital £100,000, in £1 shares, to acquire patents relating to an electric motor and an electric battery, and to carry on the business of manufacturers of, dealers in and agents for the sale of electric vehicles of all descriptions, manufacturers of all articles and things used in the manufacture, maintenance, or working thereof, cycle and carriage builders and merchants, engineers, machinists, &c. The subscribers are W. L. Allcroft, C.E. (100 shares), W. M. Barber (100 shares), G. Rowell, F.R.C.S., G. H. Willis, E. J. Outram, C. B. J. Smith, and A. D. Taylor. The first directors are W. L. Allcroft, W. M. Barber, and G. Rowell. The company's prospectus is advertised on another page.

**MORGAN, MONDEY & CO. (LTD.)**—Reg. July 26, capital £3,000 in £1 shares, to acquire the business of Morgan, Mondey & Co., and the electrical portion of the business of Messrs. H. and W. Green, and generally to carry on the business at Rotherham of electricians, electrical and mechanical engineers, builders of electric tramcars, motor cars and carriages, dynamos, motors, telephones, bells, electric lamps and fittings, insulating materials, contractors for the supply of electricity, &c. The subscribers are T. C. Morgan (electrical engineer), F. W. Clayton, H. W. Green, W. W. Green, J. Phillips (electrical engineer), T. C. Lewis, and G. Bentley. No initial public issue.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26$\frac{1}{8}$d. per oz. (Aug. 1). Consols (2$\frac{3}{4}$ per cent.) 93$\frac{3}{16}$—93$\frac{5}{16}$ for money, 93$\frac{3}{8}$—93$\frac{1}{2}$ for account; 2$\frac{1}{2}$ per cent. 93$\frac{1}{2}$ (Aug. 1). Consols Pay Day, Aug. 1; Stocks and Shares Continuation Days, Aug. 13 and 27; Ticket Days, Aug. 14 and 28; Pay Days, Aug. 15 and 29; Mining Share Carry-over Days, Aug. 15 and 26.

**BLACKPOOL ELECTRIC TRAMWAYS (SOUTH) (LTD.)**—During the week this company, which has a nominal share capital of £350,000, invited applications for 10,000 5$\frac{1}{2}$ per cent. cumulative preference and 15,000 ordinary shares of £10 each and 1,500 5 per cent. mortgage debentures of £100 each.

**BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)**—The transfer books will be closed from 6th to 14th inst. inclusive, preparatory to the payment of the preference dividend.

**BRITISH INSULATED WIRE CO. (LTD.)**—An interim dividend has been declared on the ordinary shares for the half-year ended June 30 at the rate of 10 per cent. per annum, less tax.

**BRUSH ELECTRICAL ENGINEERING CO. (LTD.)**—An interim dividend has been declared on the 6 per cent. preference shares for the half-year ended June 30.

**COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING CO. (LTD.)**—An interim dividend on the preference shares at the rate of 6 per cent. per annum (less tax) for the half-year ended June 30, and on the ordinary shares at the rate of 4 per cent. per annum (less tax) have been declared, payable 22nd inst. The transfer books and register of members will be closed from 15th to 22nd inst. inclusive.

**ELECTRIC PROPULSION (LTD.)**—A company with this title has been formed with a capital of £100,000, in £1 shares, to acquire British patent rights for the manufacture of electrically-propelled vehicles and electric batteries, and for manufacturing and dealing generally in electric and other motors, storage batteries, and other electrical apparatus. The system which the new company acquires is that well known as the "Still," and on several occasions, particularly at the motor vehical exhibitions at the Agricultural Hall, vehicles fitted on this system have been on show, and have received favourable notice. It will be remembered that these vehicles are manufactured by the Canadian Electrical Vehicle Co., and their general get up has been smart and effective. The result of the various trials in which these vehicles have taken part has, it is stated, led to numerous orders being placed, and these will be passed on to the new company. Subscriptions are being invited for 75,000 £1 shares, 20,000 of which have been taken by the vendor as part payment. The subscription list for the balance of 55,000 shares remains open until Tuesday, Aug. 6. 2s. 6d. per share is payable on application, 5s. on allotment, and the balance at periods fixed in the prospectus, which is set out on another page. In the motor trials which took place under the supervision of the Automobile Club of Great Britain and Ireland in November last, the committee of judges included many of the leading men in the electrical profession, and the report upon car No. 12 (which was equipped on the "Still" system) was a very favourable one. The car weighed only 18$\frac{1}{2}$cwt. with a 7cwt. electric battery. This car carried four persons, made a high average speed in all the trials, and the actually highest speed in ascending a steep hill takenin the course of the spin.

**ELECTRICAL POWER STORAGE CO. (LTD.)**—An extraordinary general meeting of this company was held on Tuesday, under the chairmanship of Mr. John Irving Courtenay, when the resolution confirming the alterations in the articles of association agreed to at the annual meeting was carried.

**GAS, WATER AND GENERAL INVESTMENT TRUST (LTD.)**—The directors have declared interim dividends at the rate of 4$\frac{1}{2}$ per cent. per annum on the preferred and 2 per cent. on the deferred stock for the half-year ended July 28.

**KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)**—An interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the half-year ended June 30 has been declared, payable Aug. 8.

**METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)**—An interim dividend of 6s. per share on the original, and 4s. 6d. on the ordinary shares (being at the rate of 6 per cent. per annum) has been declared.

**OLDHAM, ASHTON AND HYDE ELECTRIC TRAMWAY (LTD.)**—An interim dividend has been declared on the ordinary shares at the rate of 5 per cent. per annum for the half-year ended June 30, and on the preference shares at the rate of 5 per cent. per annum for the half-year to Aug. 15.

**SANITAS CO. (LTD.)**—An interim dividend at the rate of 5 per cent. per annum for the 6 months ended June 30 has been declared.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed Aug. 8 a special settling day in £100,000 5 per cent registered second mortgage debentures of £100 each (Nos. 1 to 1,000) of the *Thames Iron Works Shipbuilding and Engineering Co. (Ltd.)*, and has ordered the same, as well as the further issue of 1,500 ordinary £10 fully-paid shares (Nos. 6,001 to 7,500) and 1,500 cumulative 4$\frac{1}{2}$ per cent. preference £10 fully-paid shares (Nos. 13,501 to 15,000) of the *Bournemouth and Poole Electricity Supply Co. (Ltd.)*, to be quoted in the official list.

**WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)**—The directors have declared an interim dividend for the half-year ended June, at the rate of 10 per cent. per annum (less tax) payable Sept. 1.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a). |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | July 27 | 1,082 | + 107 | 8 | 6,851 | + 699 |
| *Birmingham Tramways. | ,, 27 | 4,638 | ... | 3 | 14,446 | + 421 |
| *Blackburn Corporation.. | ... | ... | ... | ... | ... | ... |
| Blackpool Corporation... | ,, 25 | 1,467 | + 242 | †17 | 15,017 | + 3,440 |
| Blackpool and Fleetwood | ,, 27 | 1,038 | - 313 | 4 | 4,231 | - 361 |
| Bolton Corporation ..... | ,, 28 | 1,482 | + 1 | 17 | 25,971 | + 2,801 |
| Bradford Corporation... | ,, 28 | 990 | + 398 | 17 | 17,716 | + 9,173 |
| Brisbane Trams ..... | June12 | 1,854 | + 45 | 23 | 58,648 | + 6,997 |
| *Bristol Trams & Carriage | July 26 | 4,675 | +1,130 | 3 | 14,838 | + 4,084 |
| *Buenos Ayres & Belgrano | June30 | 2,737 | + 612 | 25 | 51,908 | +13,397 |
| Calcutta Trams. Co. ... | July 27 | R20,011 | +R1,063 | 4 | R79,853 | + R3,029 |
| Carlisle Trams. Co. ..... | ,, 27 | 208 | - 5 | 4 | 917 | + 32 |
| Central London Railway | ... | ... | ... | ... | ... | ... |
| City & South London Ry. | ,, 28 | 1,906 | + 236 | 4 | 7,550 | + 1,646 |
| Cork Elec. Trams ..... | ,, 25 | 561 | + 34 | 29 | 13,380 | + 1,765 |
| Dover Corporation ..... | ,, 27 | 269 | - 1 | 17 | 3,934 | + 269 |
| Dublin & Lucan Rly. ... | ,, 28 | 134 | + 11 | 4 | 578 | + 88 |
| Dublin United ..... | ‡ ,, 25 | 3,954 | - 82 | ‡4 | 15,163 | + 564 |
| Dublin Southern Dist.... | ‡ ,, 25 | 1,109 | - 144 | ‡4 | 4,294 | |
| *Dundee Corporation ... | ,, 24 | 832 | + 260 | 4 | 2,957 | + 1,021 |
| *Glasgow Corporation ... | ,, 27 | 11,439 | +2,927 | 8 | 94,508 | +19,519 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 27 | 1,014 | + 299 | 17 | 15,789 | + 3,836 |
| Hull Corporation ..... | ,, 27 | 1,689 | + 330 | 4 | 6,979 | + 1,572 |
| Liverpool Corporation... | ,, 20 | 10,302 | +1,439 | 29 | 252,076 | +36,115 |
| *Liverpool Overhead Rly. | ,, 28 | 1,608 | - 63 | 4 | 6,906 | + 42 |
| *Manchester Corporation | ,, 27 | 2,167 | ... | §7 | 12,138 | - 271 |
| Perth (W.A.) Elec. Trams | ,, 19 | 1,054 | + 692 | ‡3 | 2,511 | + 1,453 |
| Portsmouth Corporation | ,, 26 | 1,590 | +1,250 | ‡4 | 4,101 | + 2,708 |
| *Sheffield Tramways ..... | ,, 28 | 3,659 | +1,123 | 4 | 14,919 | + 4,366 |
| Southampton Corporat'n | ,, 25 | 921 | + 283 | 4 | 3,646 | + 1,243 |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 24. | | Price Wednesday, July 31. | | Rate per Cent. Yielded. | Dividend Due. | Business done during week ending July 31. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ¾ | ¾ | ¾ | ¾ | ... | ... | ¾ | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 12,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ | 8⅛ | 7⅞ | 8⅛ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9 | 8¾ | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅞ | 8⅛ | 7⅞ | 8⅛ | 2 2 6 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 3 18 3 | ,, ,, | 5⅜ | 5⅜ |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 102 | 104 | 103 | 105 | ... | ... | 104⅜ | ... |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5⅛ | 6 | 5⅛ | 6 | 4 11 3 | March | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 107 | 110 | 107 | 110 | 4 2 0 | June and December | ... | ... |
| 70,579 | 10 | 6/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8⅛ | 8⅛ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. xd | 12⅜ | 13⅛ | 12 | 13 | 4 12 6 | January and July | 13⅛ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 120 | 125 | 120 | 125 | 4 0 0 | June and December | 121 | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 100 | 102 | 99 | 100 | 4 10 3 | ... | 100 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 4 4 3 | ... | 9 | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 13 4 | March and September | 12⅞ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 108 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 10% | Kensington and Knightsbridge Ordinary xd | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅛ | 7 | 6⅛ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 105 | 101 | 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13 | 14 | 4 5 9 | April and October | 13 1/16 | 13⅜ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13 | 14 | 13 | 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 108 | 111 | 108 | 111 | 4 1 0 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 94 | 97 | 94 | 97 | 3 12 0 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 15 | 16 | 4 7 6 | March | 14 15/16 | 14⅜ |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6¼ | 5⅝ | 6¼ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 400,000 | 1 | 1/6 | Rand Electric | 1 3/16 | 1 5/16 | 1 7/16 | 1 9/16 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | 65 | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary xd | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | 14 1/16 | 14 1/16 |
| 30,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9⅜ | 8½ | 9⅜ | 3 13 8 | ,, ,, | 8⅜ | 8¼ |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary xd | 2 | | 2 | 2⅛ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2⅜ | 2½ | 2⅜ | 2½ | ... | ... | ... | ... |
| 109,513 | 5 | 5/6 | Westminster Electric Supply Ordinary | 11⅜ | 12 | 11⅜ | 12 | 4 7 6 | March and September | 11⅞ | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4⅛ | 4 | 4⅛ | 4 14 2 | April and October | 4⅛ | 4 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 124 | 129 | 4 13 6 | ... | 126 | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 9 | 2 4 5 | ... | 8⅛ | 8⅛ |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 97 | 102 | 97 | 102 | 4 18 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) xd | 93 | 98 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2⅜ | 2⅝ | 2 | 3 | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4⅛ | 4⅜ | 4⅛ | 4⅜ | ... | ... | 4⅛ | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 101 | 103 | 101 | 103 | 4 7 5 | ... | 102⅜ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 21⅛ | 22½ | 21⅛ | 22⅜ | 3 15 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅝ | 10⅞ | 10⅛ | 11 | 3 12 9 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 | 115 | 114 | 116 | 3 9 0 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6¾ | 7 | 6¾ | 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9½ | 9⅝ | 9⅜ | 9⅝ | 5 2 7 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅞ | 102⅞ | 100⅝ | 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 14 | 14½ | 13⅞ | 14⅛ | 7 0 4 | ... | 14 | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 12½ | 12 | 12⅛ | 4 16 0 | February and August | 12⅜ | 12⅛ |
| £250,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 123 | 125 | 123 | 125 | 4 0 10 | ... | 124⅛ | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 2/0 | Do. 6% "A" Cum. Pref. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 2 3 6 | ... | 5⅜ | 5 1/16 |
| £220,000 | Stock | 5% | Do. 5 per Cent. Debentures | 103 | 105 | 102 | 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11 | 12 | 11½ | 12⅜ | 2 8 0 | ... | 12 | 11⅜ |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 103 | 105 | 103 | 105 | 4 5 9 | ... | 105 | 104 |
| 400,000 | 1 | 1/2⅝ | Cape Electric Tramways Shares | 1⅜ | 1⅞ | 1⅜ | 1⅞ | 3 4 0 | ... | 1⅞ | 1⅜ |
| £1,969,800 | Stock | ... | Central London Ordinary Stock | 90 | 93 | 93 | 101 | ... | June and December | 102 | 93 |
| £440,100 | Stock | ... | Do. 4% Preferred Stock | 99 | 102 | 99 | 102 | ... | ... | 103 | 100½ |
| £440,100 | Stock | ... | Do. Deferred Stock | 92 | 95 | 97 | 100 | ... | ... | 98½ | ... |
| £598,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 103 | 103 | 3 16 2 | ... | 104 | ... |
| £365,000 | Stock | 1½% | City and South London Railway Con. Ordinary xd | 53 | 55 | 52 | 54 | 2 6 1 | February and August | 53 | ... |
| 47,500 | 10 | 2/0 7/8 | Do. Ordinary (Nos. 22,501 to 70,000) | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891 x d | 132 | 137 | 130 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) xd | 124 | 128 | 123 | 127 | 3 18 0 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 112 | 117 | 112 | 117 | 3 8 6 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Tramways (1896) Ltd., Ordinary xd | 11½ | 13½ | 11½ | 12½ | 5 4 0 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference xd | 15 | 16 | 14½ | 15½ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | 5⅛ | | 5⅛ | | ... | ... | ... | ... |
| 21,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 22 | 23½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15⅜ | 3 17 5 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 113 | 115 | 3 19 0 | January and July | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7⅞ | 8 | 7⅞ | 7⅞ | 4 8 10 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13⅝ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 100 | 102 | 103 | 104 | 3 16 11 | January and July | ... | ... |
| £350,000 | Stock | 34/3 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 111 | 114 | 4 7 9 | ... | 111⅜ | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1903) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) | 102 | 104 | 103 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3⅛ | 3 | 3⅛ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4⅜ | 5 | 4⅜ | 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 12 | 13 | 12 | 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 | 108 | 105 | 108 | 4 3 4 | ... | 106⅞ | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 90 | 93 | 90 | 93 | 3 5 3 | June and December | 93 | 90 |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 24. | | Price Wednesday, July 31. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending July 31. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 98 | 101 | 98 | 101 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ | 4⅛ | 3⅜ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American xd | 53 | 56 | 52 | 55 | 5 14 0 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred xd | 28 | 100 | 97 | 99 | 6 1 3 | ,, ,, | 99⅜ | 99⅛ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 9⅜ | 10⅛ | 9⅜ | 10 | 2 10 0 | ,, ,, | 9⅝ | 9⅜ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 17 9 | ,, ,, | 102⅝ | 10⅜ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 5 12 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14½ | 15½ | 6 9 0 | | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 99⅞ | 103⅞ | 99⅞ | 103⅞ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable xd | 10½ | 11⅛ | 10⅝ | 11⅛ | 6 1 9 | Jan., Apr., July, Oct. | 10⅝ | 10⅛ |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.) x i | 143 | 148 | 143 | 148 | 4 15 10 | Jan., Apr., July, Oct. | 14⅞ | 145 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 | 94 | 92 | 95 | 3 13 8 | | 94 | 95 |
| £1,132,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 114 | 1 0 | 114 | 3 10 10 | ,, ,, | 113½ | ... |
| 300,000 | 10 | 2/6 | Eastern Extension | 13¾ | 14¼ | 13¾ | 14¼ | 4 15 0 | May and November | ... | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock xd | 110 | 115 | 110 | 115 | 3 10 10 | Jan., Apr., July, Oct. | 4⅞ | 13⅛ |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 101 | 104 | 3 18 5 | February and August | 111 | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100⅞ | 103⅞ | 100⅞ | 103⅞ | 3 17 10 | May and November | ... | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 30 | 32 | 30 | 32 | 4 13 9 | January and July | 101 | ... |
| £78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos. | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red.) | 43 | 47 | 41 | 45 | 5 11 1 | May and November | 45 | 43½ |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 100 | 103 | 3 18 6 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 100 | 103 | 99 | 102 | 4 19 0 | March and September | 102½ | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ | ⅜ | ¼ | ⅜ | ... | | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 18 6 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅝ | ⅝ | ⅝ | ⅝ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 | 6 | 4½ | 5½ | ... | ,, ,, | 4⅞ | 14⅜ |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | ... | | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 | 104 | 101 | 104 | 4 16 2 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 13¾ | 14¼ | 13¾ | 14¼ | 4 18 3 | Mar., June, Oct., Dec. | 13⅞ | ... |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 100 | 103 | 100 | 103 | 3 17 8 | ... | 102½ | 10⅛ |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3¾ | 4¼ | 3¾ | 4¼ | 4 14 2 | August | ... | ... |
| 224,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 1/6 | 2/6 | 3/0 | 3/6 | 12 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | ⅝ | ½ | ⅝ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | | ... | ... |
| 590,000 | 5 | 2/6 | National | 3½ | 3⅞ | 3⅞ | 3⅞ | 7 17 2 | February and August | 3⅞ | 3 5/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 13 | 11 | 13 | 4 12 1 | ,, ,, | 11⅝ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅜ | 4⅝ | 4⅜ | 4⅝ | 5 14 3 | ,, ,, | 4½ | ... |
| £2000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 90 | 93 | 89 | 92 | 3 16 3 | June and December | 90 | 89 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 | 98 | 94 | 97 | 4 2 9 | | ... | ... |
| 171,504 | 1 | 0/8½ | Oriental | ⅞ | 1 | ⅞ | 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 | 5½ | 5 | 5½ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ | ⅞ | ⅜ | ⅞ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅜ | ⅞ | ⅜ | ⅞ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | 15/16 | 1 1/16 | 15/16 | 1 1/16 | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary xd | 10 | 11 | 10 | 11 | 6 16 4 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference x i | 6 | 6½ | 6 | 6½ | 4 12 4 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅜ | 5 | 4½ | 5 | 6 0 0 | ... | 4⅜ | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅞ | 1⅞ | 1⅞ | 1⅞ | 5 14 3 | September | 1⅞ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2¼ | 2 | 2¼ | 5 6 8 | ,, | 2⅛ | 2⅛ |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 109 | 4 4 1 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 | 102 | 99 | 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 | 15 | 14 | 15 | 5 0 0 | ,, ,, | 14⅜ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 107 | 111 | 107 | 111 | 4 1 0 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) xd | 93 | 97 | 92 | 96 | 4 13 9 | ... | £5 | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 16 7 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅜ | 4 | 3⅜ | 4 | 5 12 7 | January and July | 3⅜ | 3⅜ |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 105 | 100 | 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | 1 | 1½ | ½ | ... | | February and August | 7/16 | ½ |
| 17,139 | 5 | ... | Do. (£5 paid) | 2 | 3 | 1½ | 2½ | | ,, ,, | 3⅛ | 1⅝ |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 | 86 | 80 | 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 92 | 96 | 88 | 92 | 5 0 10 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5½ | 6 | 5½ | 6 | 4 3 4 | Half-yearly | 5 15/16 | 5 11/16 |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5½ | 6 | 5½ | 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 102 | 105 | 102 | 105 | 4 5 8 | ... | ... | ... |
| 112,100 | 5 | 1/2½ | Electric Construction Co. | 1⅞ | 2⅛ | 1⅞ | 2⅛ | 5 6 8 | January and July | 1⅞ | 1 13/16 |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅜ | 3 | 2⅜ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 | 102 | 98 | 102 | 3 18 5 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅛ | 10⅛ | 9⅜ | 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15½ | 16⅛ | 15½ | 16⅛ | 6 1 3 | February and August | 16⅞ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | 6⅛ | 5⅝ |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 104 | 112 | 104 | 113 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | 21⅜ | 21⅛ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 37 | 41 | 37 | 41 | 5 2 5 | March and July | 3⅛ | 33 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 17 0 | January and July | 102⅛ | 102⅛ |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 10⅛ | 11⅛ | 5 4 4 | ... | 10⅜ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ | 6 | 5⅛ | 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 | 11 | 10 | 11 | 5 9 0 | April and October | 10 13/16 | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ | 7 | 6½ | 7 | 4 5 9 | ,, ,, | 7 | 5½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 | 6 | 5 | 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 2/6 | Globe Telegraph and Trust xd | 10 | 10½ | 10 | 10⅛ | 5 0 0 | Jan., Apr., July, Oct. | 10⅛ | 10⅛ |
| 160,042 | 10 | 3/0 | Do. 6 per Cent. Preference xd | 14½ | 15½ | 14½ | 15½ | 3 19 8 | ,, ,, | 15⅛ | 15 |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | 7⅛ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 10 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these

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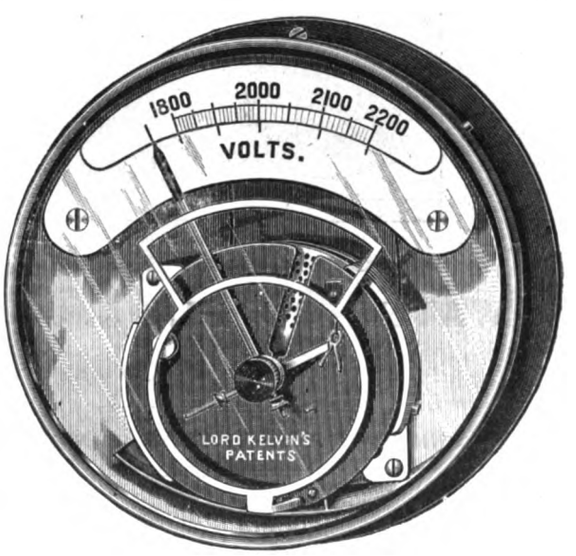


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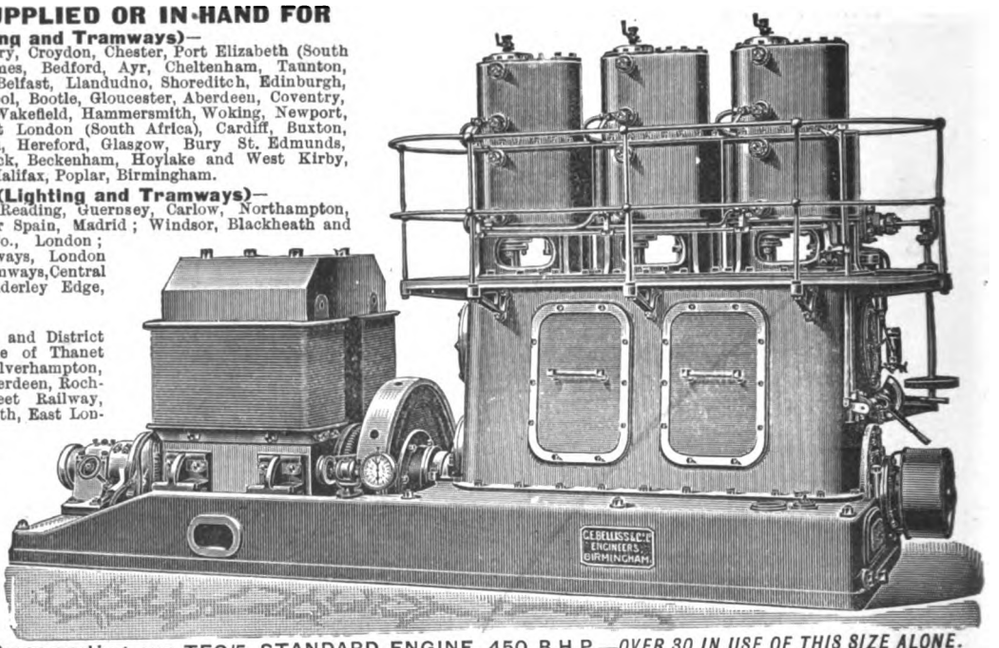


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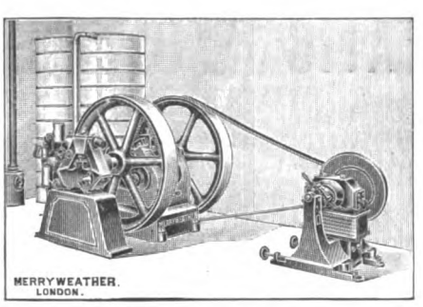


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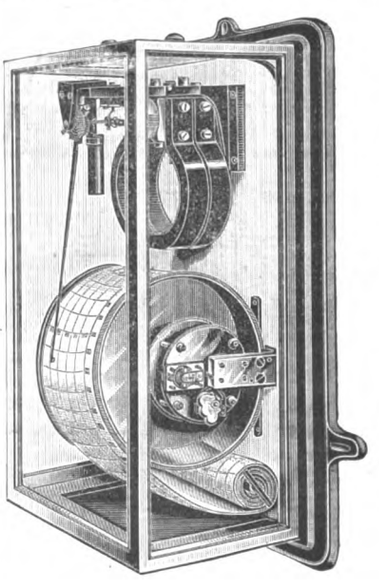

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Important Sale of the Plant, Machinery, Loose Tools, Milling Machinery, Raw Materials, Patterns and Drawings, Carts, Vehicles and Effects, being the

**ENTIRE CONTENTS**

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Applicants must state for which section or sections they wish to Tender, in order that the requisite drawings may be forwarded to them.

Tenders may be for any section but not for part of a section.

The Contract will contain a clause adopted by the Corporation requiring the Contractor to pay to his men not less than the minimum standard rate of wages in the District. Copies of the Specification with General Conditions, Forms of Tender, and Plans, may be obtained from C. J. Sutherland, Esq., City Electrical Engineer, Guildhall, Worcester, on payment of a deposit of Two Guineas, which will be returned on receipt of a bona-fide Tender.

Sealed Tenders, endorsed "Tender for Electricity Works," must be delivered at my office at or before noon on FRIDAY, the 23rd AUGUST, 1901.

SAML. SOUTHALL, Town Clerk.

Guildhall, Worcester, 23rd August, 1901.

### BOROUGH OF DARLINGTON.

**ELECTRIC LIGHTING.**

The Darlington Corporation invite TENDERS for the Supply and Delivery of the following, in connection with the electric lighting of the borough:—

Contract No. 8.—ONE LANCASHIRE BOILER. (First extension).

Contract No. 9.—ONE 350 H.P. ENGINE coupled to a CONTINUOUS-CURRENT DYNAMO. (First Extension).

Contract No. 10.—EXTENSION STEAM, DRAIN and FEED PIPES.

Copies of the Specifications, with Forms of Tender and General Conditions, can be obtained from the undersigned on payment of £2 2s. for each Specification, which amount will be returned on receipt of bona fide Tender.

The Specifications can be seen at (but not obtained from) the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, London, S.W.

Tenders, on the prescribed form, in sealed envelopes, and endorsed on the outside "Electric Lighting—Tender No. .... Contract," must be delivered at my office on or before the 22nd day of AUGUST, 1901.

The Corporation do not bind themselves to accept the lowest or any Tender, and no allowance will be made for any expense incurred in the preparation of any Tender.

H. G. STEAVENSON, Town Clerk.

Town Clerk's Office, Darlington, 30th July, 1901.

### BOROUGH OF MANSFIELD ELECTRICITY SUPPLY.

**REFUSE DESTRUCTORS.**

The Electric Lighting Committee of the Corporation of the Borough of Mansfield are prepared to receive TENDERS for REFUSE DESTRUCTORS (to deal with the whole of the Refuse of the Borough).

Specification, with Terms and Conditions and Form of Tender, may be inspected at the offices of Mr. Robert Hammond, M.Inst.C.E., the Consulting Engineer to the Corporation, 64, Victoria-street, Westminster, London, S.W., and may be obtained there on and after Wednesday, August 7th, 1901, on making a deposit of £5, which sum will be refunded on the return of the Specification filled up with a bona-fide Tender. Extra copies of the Specification may be obtained by bona-fide Tenderers at a charge of Five Shillings a copy, which will not be refunded. Tenders (sealed and marked "Tender for Refuse Destructors") must be addressed to me at the Town Clerk's office, Mansfield, and be delivered not later than THURSDAY, September 5th, 1901.

Each Tender must contain the names of two Sureties who will be prepared to execute a joint and several bond for the due performance of the Contract in the sum of 10 per cent. of the Contract amount.

The Committee do not bind themselves to accept the lowest or any Tender.

J. HARROP WHITE, Town Clerk.

Town Clerk's Office, Mansfield, July 31st, 1901.

### BOROUGH OF MIDDLESBROUGH ELECTRICITY WORKS.

The Electric Lighting Committee of the Borough of Middlesbrough are prepared to receive TENDERS for the supply and erection of the following plant in connection with the Municipal Electricity Works:—

**MECHANICAL COAL HANDLING PLANT.**

Specification, with Terms and Conditions and Forms of Tenders, may be inspected at the offices of Mr. Robert Hammond, M.Inst.C.E., the Consulting Engineer to the Council, 64, Victoria-street, Westminster, London, S.W., and may be obtained there on and after the 7th day of August, 1901, on making a deposit of £5 5s., which sum will be refunded on the return of the Specification filled up with a bona-fide Tender. Extra copies of the Specification may be obtained by bona-fide Tenderers at a charge of Five Shillings per copy, which will not be refunded. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to me at the Town Hall, Middlesbrough, and be delivered on or before TUESDAY, the 3rd day of September, 1901.

Each Tender must contain the names of two Sureties who will be prepared to execute a joint and several Bond for the due performance of the contract in the sum of 10 per cent. of the contract amount.

The Council do not bind themselves to accept the lowest or any Tender.

GEORGE BAINBRIDGE, Town Clerk.

Middlesbrough, August, 1901.



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**See Advertisement Monthly on opposite page.**

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## TENDERS INVITED—*continued.*

### COUNTY BOROUGH OF BOURNEMOUTH.

**BOURNEMOUTH CORPORATION TRAMWAYS.**

CONTRACT No. 8.—**BOILERS, &c.**

The Bournemouth Town Council invite TENDERS for BOILERS, SUPER-HEATERS, ECONOMISER, FEED PUMPS, PIPEWORK and ACCESSORIES.

Forms of Tender and Specification may be obtained of the undersigned, provided that the sum of £3 3s. has been deposited at the Borough Engineer's office, which deposit shall be forfeited unless a Tender complying with the conditions is sent in.

Further particulars and Drawings may be obtained at the office of the Consulting Engineers, Messrs. Lacey, Clirehugh and Sillar, 2, Queen Anne's Gate, Westminster.

A further deposit of a £50 Bank of England note is to accompany the Tender.

These deposits will be returned to those whose Tenders are not accepted, but in the case of the accepted Tender will be retained until the execution of the contract, and will be forfeited if the person whose Tender is accepted does not find the necessary sureties and sign the contract prepared by the Town Clerk (a copy of which may be seen at the offices of the Consulting Engineers) within two weeks from the date of notification of the acceptance of the Tender.

Tenders to be sent in, in envelopes provided for the purpose, to the Town Clerk (J. Druitt, jun., Esq.) on or before noon of THURSDAY, the 29th day of August, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

F. W. LACEY, M.Inst.C.E., Borough Engineer.

Municipal Offices, Bournemouth, August 2nd, 1901.

### ASTON MANOR URBAN DISTRICT COUNCIL.

The Urban District Council of Aston Manor are prepared to receive TENDERS for the following **PLANT** for their proposed Electric Power Station :—

Section A.—WATER-TUBE BOILERS, STOKERS and ECONOMISER.
„ B.—(1) TWO 500 KILOWATT STEAM DYNAMOS.
(2) ONE 200 KILOWATT STEAM DYNAMO.
(3) MOTOR BALANCER.
„ C.—SWITCHBOARD and TESTING ROOM.
„ F.—TRAVELLING CRANE.
„ G.—ARC LAMPS.

Contractors are at liberty to tender for one or more Sections, and in the case of Section B for one or more parts, but the Council do not bind themselves to accept the lowest or any Tender.

Specifications, General Conditions and Form of Tender may be obtained at the offices of the Consulting Engineer, Mr. Reginald P. Wilson, 66, Victoria-street, London, S.W., on payment of Five Guineas, which will be returned on receipt of a bona-fide Tender.

All Tenders to be endorsed "Electric Power Station," and must be addressed to the Chairman of the Electric Lighting and Tramways Committee and delivered at the Council's Offices not later than 12 noon on SEPTEMBER 4th, 1901.

J. ANSELL, Clerk.

Council Offices, Aston Manor, August 7th, 1901.

### MANCHESTER CORPORATION TRAMWAYS.

The Tramways Committee of the Manchester Corporation are prepared to receive TENDERS for the following, viz.:—

ELECTRICAL ACCESSORIES.
MACHINE TOOLS, &c.
CAR CLEANING MATERIALS.
VETERINARY SERVICES.

Specifications and Forms of Tender may be obtained on application to Mr. J. M. McElroy, General Manager, Tramways Department, 55, Piccadilly, Manchester.

Tenders are to be addressed to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, and must be received not later than 1 p.m. on SATURDAY the 17th instant.

The Committee do not bind themselves to accept the lowest or any Tender.

WM. HENRY TALBOT, Town Clerk.

55, Piccadilly, Manchester, August 2nd, 1901.


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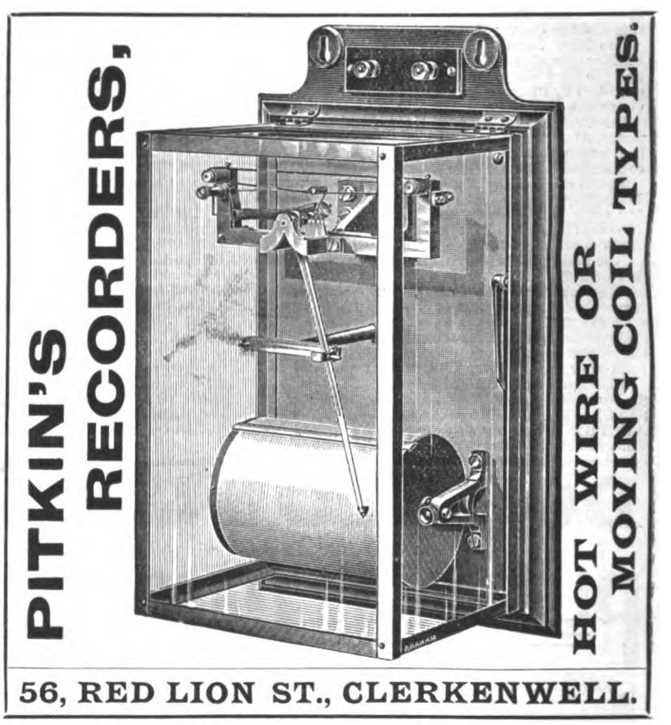


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## TENDERS INVITED—*continued.*

EDINBURGH CORPORATION.

The Lord Provost, Magistrates, and Council are prepared to receive TENDERS for the **ELECTRIC LIGHTING INSTALLATION**, &c., of the second portion of the Colinton Mains Fever Hospital, the number of lighting points being about 800.

The Specification, Plans of the Building, and Form of Tender, can be obtained on and after Monday, 12th August, at the office of the Resident Electrical Engineer, Electricity Supply Station, Dewar Place, Edinburgh, on deposit of £1 4s., which will be returned on receipt of a bona-fide Tender.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders, endorsed "Electric Lighting Installation, Colinton Mains Fever Hospital," must reach me not later than 11 a.m. MONDAY, 9th September, 1901.

THOMAS HUNTER, W.S., Town Clerk.

City Chambers, Edinburgh, 5th August, 1901.

ST. ANNES-ON-THE-SEA URBAN DISTRICT COUNCIL.

The above Council are prepared to receive TENDERS for **ONE 180 K.W. CONTINUOUS-CURRENT DIRECT-COUPLED STEAM DYNAMO**. The Engine to be "Single Acting."

Specification and Form of Tender to be obtained from the undersigned on payment of a deposit cheque for £5, which will be returned on receipt of a bona-fide Tender.

Tenders, endorsed "Steam Dynamo Tender," to be lodged with the undersigned not later than FRIDAY, August 23rd, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

P. J. S. TIDDEMAN.

Carlton Chambers, St. Annes-on-the-Sea.

**NOW READY.**

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# A POCKET BOOK OF ELECTRICAL ENGINEERING FORMULÆ.

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## APPOINTMENTS VACANT.

APPLICATION for the post of ELECTRICAL ENGINEER to the MUNICIPALITY of EAST LONDON in the CAPE COLONY.

Applications for the above-named appointment addressed to the Town Clerk, East London, Cape Colony, and endorsed "Application for Electrical Engineer," will be received up to noon on OCTOBER 10th, 1901.

The Electrical Engineer will have oversight and control of the entire installation, comprising lighting of streets and private properties, current for power to private consumers and tramways.

The salary offered is £500 per annum with extra £50 horse allowance.

Applicants to state age, and record of previous engagements, accompanied by copies of testimonials, together with a medical certificate of health.

By order,

R. N. MOIR, Town Clerk.

Town Office, East London, 6th July, 1901.

FINCHLEY URBAN DISTRICT COUNCIL.

**ELECTRICAL ENGINEER AND MANAGER.**

The above Council are prepared to receive APPLICATIONS for the APPOINTMENT of a RESIDENT ELECTRICAL ENGINEER and MANAGER at a commencing salary of £300.

Applications for the appointment must be made accompanied by not more than three testimonials (copies only) endorsed "Electrical Engineer," and delivered to the undersigned on or before 12 o'clock at noon on MONDAY the 19th August next.

Full particulars of the duties and position may be obtained on application to me

CHAS. ROBERTS, Clerk to the Council.

Council Offices, Bibbsworth House,
Church End, Finchley, 22nd July, 1901.

BOROUGH OF BEDFORD.

**ELECTRICAL ENGINEER.**

The Corporation of Bedford invite applications for the appointment of Electrical Engineer to take charge of their electricity undertaking, at a commencing salary of £350 per annum. Applicants must have had experience in electrical supply stations with alternating current.

Applications, endorsed "Electrical Engineer," stating age and experience, and accompanied by three recent testimonials, must be delivered to me by 20th AUGUST next.

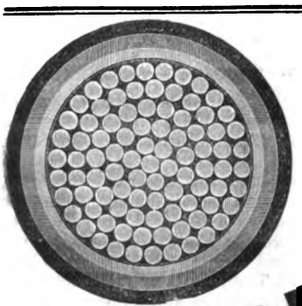
Town Hall, Bedford, July, 1901. T. S. PORTER, Town Clerk.

BOROUGH OF TUNBRIDGE WELLS.

First-class **STOKER** required, accustomed to Water-tube Boilers. Apply, giving full particulars, to the undersigned.

HORACE BOOT, Consulting and Resident Engineer.

***Offlolal Announoements* continued on next page.**



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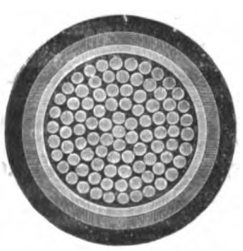

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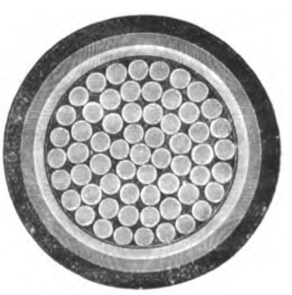

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**GLASGOW: 62, Robertson Street.**
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## APPOINTMENTS VACANT—*continued.*

UNIVERSITY COLLEGE, NOTTINGHAM.

**DEMONSTRATOR IN ELECTRICAL ENGINEERING.**

The Committee invite applications for the above post. Canditates must have a technical knowledge of Electrical Engineering, including Electric Testing and the Management of Dynamos, Alternators, Motors, Transformers, Arc Lamps and Secondary Cells. They should also have practical experience in the design and construction of Electrical Instruments and Machines. The Demonstrator will be expected to take charge of the Electrical Laboratory and Tutorial Classes in Electrical Engineering, and in the applications of Mathematics to alternate current work for day and evening students. He will also assist generally in the Engineering Department. Salary £150 to £200. Applications, which must be sent in on or before SEPTEMBER 7th, should be made on Forms supplied by the SECRETARY.

HARRIS INSTITUTE, PRESTON.
Principal: R. WALLACE STEWART, D.Sc. London.

The Harris Council invite Applications for the post of **LECTURER** in **MECHANICAL ENGINEERING.** Salary, £150 per annum.
Duties to commence in September. Applications must be sent in by WEDNESDAY, August 14th.
Further particulars as to the conditions and duties of the appointment may be obtained on application to

T. R. JOLLY, Secretary.

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WANTED, FOREMAN for Electric Car repairs, near London. Must be thoroughly experienced in this class of work and have highest references. Good wages and permanent situation to suitable man.—Apply to H. L. T., *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED by a Consulting Engineer, ASSISTANT with knowledge of tramway and lighting work and experienced in estimating.—Apply, stating salary required, to TRAMWAY, *Electrician* Office, Salisbury-court, Fleet-street, London.

UNIPOLAR DYNAMO and ELECTRO-MAGNETIC APPLIANCES. Expert assistance required in connection with design of above.—Please state qualifications and terms in confidence to INVENTOR, Deacon's Advertising Offices, Leadenhall-street, E.C.

A JUNIOR ELECTRICIAN WANTED for Test-room work in a large Cable Works near London. Some knowledge of Arithmetic essential, knowledge of Logarithms and Sliding Rule desirable. State age, experience and salary, to Z. H. 49, care of Deacon's Advertising Offices, Leadenhall-street, E.C.

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**The Glasgow Corporation Tramways, and The New Electric Power Supply of Tyneside.**

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Electric Power at Barrow-in-Furness.
The Lancashire Electric Power Company.
Electric Power Supply on Tyneside (Plates LXXXIX. to XCVII., and Illustrations in Text).
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*Enquiries as to Advertisements and Publishing Department matters generally should be addressed to the Manager.*

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By Dr. J. A. FLEMING, M.A., F.R.S.,

*Professor of Electrical Engineering at University College, London.*

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This Handbook has been written especially to meet the requirements of Electrical Engineers in Supply Stations, Electrical Factories and Testing Rooms. The Book consists of a series of Chapters each describing the most approved and practical methods of conducting some one class of Electrical Measurements, such as those of Resistance, Electromotive Force, Current, Power, &c., &c. It does not contain merely an indiscriminate collection of Physical Laboratory processes without regard to suitability for Engineering Work. The Author has brought to its compilation a long practical experience of the methods described, and it will be found to be a digest of the best experience in Electrical Testing. The Book includes a Chapter on the Equipment of Electrical Laboratories and numerous Tables of Electrical Data, which will render it an essential addition to the library of every practical Electrician, Teacher, or Student.

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| CIVIL ENGINEERING | Henry Robinson, M.Inst.C.E. |
| ELECTRICAL ENGINEERING | E. Wilson, M.I.E.E. |
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| METALLURGY | Lecturer: G. Melland, B.Sc., A.R.S.M. |

The SESSION 1901-2 commences on TUESDAY, October 1st, 1901. Professor Burstall will attend to consult with intending students on October 1st from 10 a.m. to 1 p.m.

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| | |
|---|---|
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| Chemistry | H. E. ARMSTRONG, Ph.D., LL.D., F.R.S. |
| Mechanics and Mathematics | O. HENRICI, Ph.D., LL.D., F.R.S. (*Dean*) |

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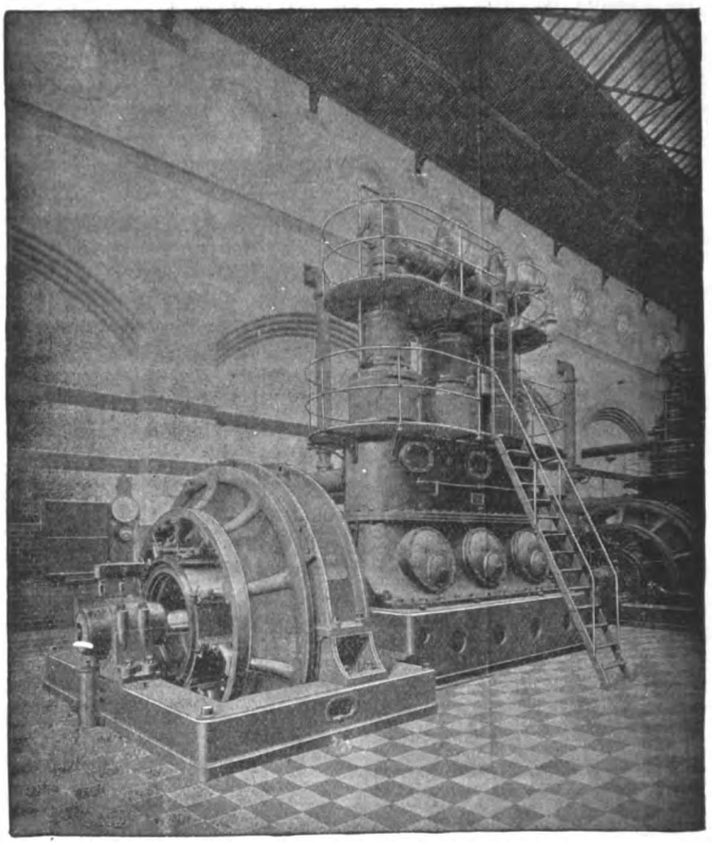

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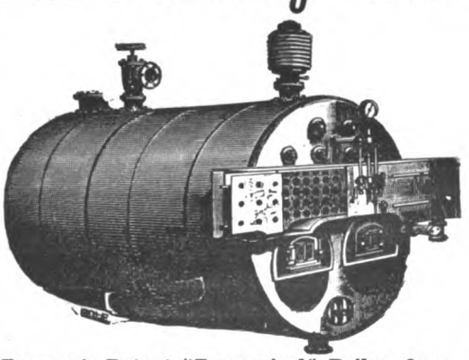

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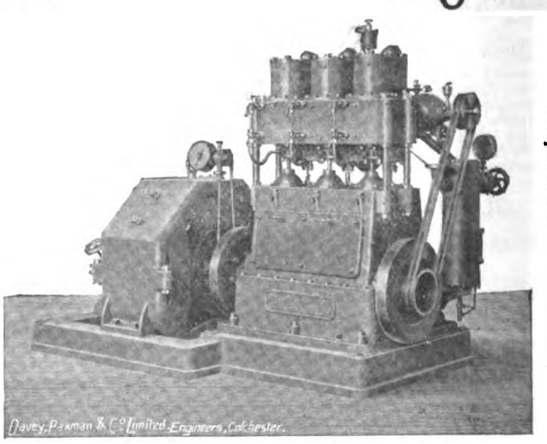


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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,212. [No. 16. Vol. XLVII.] FRIDAY, AUGUST 9, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 2d., or 16 cents, or 30c., or 70pf.


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## NOTES.

IN the Wednesday issue of *The Times* is published a letter by Mr. SOMERS CLARKE, architect to the Dean and Chapter of St. Paul's, giving a very complete history of the settlements that have taken place in St. Paul's Cathedral from its completion up till the present time. Portions of the foundations commenced to sink within the first 100 years after the cathedral was finished, but of late years there have been several disturbing causes that, if they have not already weakened the structure, may yet make themselves felt in years to come. The two principal causes in recent times have been the deep drain in Godliman-street and the Metropolitan District Railway. Mr. CLARKE sees an added danger to the security of the cathedral in the electric railways, and his views on this subject will be found in full on page 585 of this issue. The objections raised to the tubes have hitherto been two in number: the disturbance to the soil caused by the boring of the tube and the vibration from passing trains. Mr. CLARKE raises a third objection, which he considers the most important; it is the danger of diverting underground streams in sinking the shafts at the stations, and making the subsidiary excavations for footways and passages.

WE most completely agree with Mr. CLARKE in his contention that the safety of St. Paul's Cathedral should be secured, and we consider it an excellent thing that the possible danger of stations near the structure should be pointed out; at the same time we are of opinion that the dangers can be easily guarded against, and that when the question of these railways comes before Parliament, the action of the Committees should be rather to insert clauses to prevent any risk than arbitrarily to alter the lines of route or the positions of the stations. Of the three dangers, the first is more or less imaginary; the use of the Greathead shield deep in the London clay causes as little disturbance at the surface as the burrowing of an earth-worm. The second,—vibration,—is more serious, but Lord RAYLEIGH's Committee which investigated the matter, considered that under proper conditions vibration could be prevented. This being so, the objection to deep-level tubes disappears. The question of a station, say, at the junction of Cannon Street and Queen Victoria Street still remains. It is of course probable that when the shaft is sunk no running water will be touched, and consequently no precautions will be necessary. But even if a stream were diverted, there is a possibility that the diversion might counteract the mischief already caused by the drain and the District Railway. If, however it was decided that the diversion of the stream would in the slightest degree endanger St. Paul's, we have no doubt that our civil engineers have sufficient skill to lead the stream round the shaft so that the drainage of the substratum of sand and gravel would be neither increased nor diminished. The main drain, cited by Mr. CLARKE, and leading almost into the churchyard, may very likely have affected the substratum round the cathedral, as also may the shallow underground railway which has cut into the sandy stratum; but this constitutes no precedent applicable to the case of a deep-level railway tunnelled under entirely different conditions.

THE leading article in our issue of July 12th advanced reasons why we believe Parliament should control the electrical line equipment of standard railways, with a view to the maintenance of a working interchangeability between the various lines forming our railway system. Apparently in some quarters our views have been sadly mistaken, and it is quite erroneously supposed that we wish Parliament once for all to choose an entire system and then compel all companies to adopt it as the only standard. We wish nothing of the sort, and we sought to guard against any such mistaken inference. Nothing could be more disastrous than that electric railway traction in all its details should be thus rigidly crystallised for all time. But the suggestion is a mere caricature of our own proposals.

IN the first place, our remarks related only to the line equipment. There might be endless diversity in power generation

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and transmission; also in the mode of utilising the electric power within the trains or cars, without interfering in any way with the interchangeability of service. But in the single matter of bringing the electric power to the moving vehicles on the line—*i.e.*, the line equipment—there unquestionably ought to be standardisation in all the details that affect through working. Imagine two conjoint railways worked on the third-rail system—the one with the rail in the centre of the track, and the other with its rail on one side; or one rail a foot above the track and the other only 6in. above it; or one rail at 1,000 volts and the other at 500 volts. We might easily draw other equally ludicrous pictures of a disconformity that will readily arise unless there is proper legislative pressure and control. Those who admit the absolute necessity for uniform working on the Inner Circle—and our critics are among the number—are really admitting in little what we ourselves have been contending for on a much larger scale.

That regulations of the kind we demand would crystallise practice and retard progress is a criticism absurd on the face of it. Does a standard gauge on our railways crystallise practice? Assuredly not; there is perfect freedom left for advance and improvement in every direction. Consider, for instance, the varieties of locomotive design in our railway systems—the absolute freedom of choice in such questions as outside or inside cylinders, compound or high-pressure working, and a host of technical matters that may be solved in a diversity of ways—and the danger of paralysis through standardisation of track is seen to be a myth. So also is it a myth in electric railway traction.

In the House of Commons on Monday, Sir J. Dickson-Poynder asked the President of the Board of Trade whether his department proposed to send an engineer to examine into the subway tramway system now in use in certain towns in the United States and on the Continent of Europe, and to report as to the advantages afforded by the system over the underground tubes now in use in London. Mr. Gerald Balfour replied that it might be, even with the information they at present possess, that the inspecting officers would be in a position to deal with undertakings of this description if an effort was made by promoters to embark in such enterprises in this country.

As a matter of fact, an endeavour to obtain powers to build such a line was promoted in this country more than 10 years ago, and it appears that but for the action of the London County Council the probable course of progress in connection with this method of transit would have been for American engineers to have visited England to report on the system, instead of it being necessary for the London County Council to send their tramway manager and engineer to the United States. Sir W. H. Preece, in a letter published in *The Times* of August 6th, reminds the public, the House of Commons, and the London County Council that a bill for a London Central Subway Railway was submitted to a Committee of the House of Commons so long ago as during the Parliamentary session of 1889, the proposal being to construct such a line from Holborn Circus to Piccadilly. It was supported by the late Harrison Hayter, Cunningham and John Hopkinson, and by Lord Kelvin, Sir W. H. Preece and Colonel Crompton, but was thrown out through the opposition of the London County Council!

The Light Railways Act will not be allowed to lapse, but the closing of the Parliamentary session has not left enough time for the new bill to be passed. The proposed amendments to the Act will, therefore, not become law, and the Act will continue in force in its present form until next session, when the Government will have an opportunity of reconsidering the question. As there appears to be some opposition to the proposed amendments, and Parliament is already tired, this is perhaps the best course that could have been adopted.

**The Institution of Junior Engineers.**—We are informed that the summer meeting of this institution will take place at Plymouth from August 12th to 17th.

**A Marconi Air-wire struck by Lightning.**—According to the *Daily Mail*, the Marconi apparatus on board H.M.S. "Glory," off Hong Kong, was struck by lightning last Sunday.

**Glasgow and West of Scotland Technical College.**—The next session opens on September 24th, and the entrance examination begins on September 16th. Some particulars of the course of instruction are given in an advertisement.

**Wireless Telegraphy at the Naval Manœuvres.**—It is interesting to see that the special correspondents of *The Times* with the "B" and "X" fleets were both allowed to send messages by wireless telegraphy of the battle that took place on the 5th inst.

**Electric Lift at the Washington Monument.**—The *Western Electrician* of Chicago, for July 6th, describes the elevator plant which has just been installed in the Washington Monument. The lift weighs 7,000lb., carries 35 passengers, and makes the ascent of 498ft. in 5 minutes.

**University of Birmingham.**—There is set out on another page particulars of the department of engineering at the University of Birmingham. The session for 1901-2 commences on Tuesday, October 1st, when Prof. F. W. Burstall will attend to consult with intending students from 10 a.m. to 1 p.m. The detailed syllabus with full particulars can be obtained from the secretary at the University.

Cable Interruptions and Repairs:—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... | Mar. 2, 1900 ... | — |
| Cayenne—Pinheiros ..... | April 21, 1901 ... | — |
| Anjer—Kalianda..... | July 30, 1901 ... | August 5, 1901 |
| Trinidad—Demerara ..... | July 30, 1901 ... | August 6, 1901 |
| Cadiz—Teneriffe..... ..... | August 6, 1901 ... | — |
| Nase, Rinkin-Kelung, Formosa | August 2, 1901 ... | — |

**Dangers of Wireless Telegraphy.**—We learn from *Nature* that the French Minister of War has asked the Paris Academy of Sciences to give an opinion as to the possibility of danger arising from the establishment of wireless telegraphy stations in the neighbourhood of magazines containing powder or other explosives. It is suggested that the nature of the cases containing the explosive may be an important matter for consideration in connection with the subject.

**Appointment of an Electrical Inspector.**—At the instance of a consumer of electrical energy in Fleetwood, the Board of Trade has appointed an electrical inspector (Mr. C. H. Wordingham) under the Fleetwood electric lighting order. The supply in Fleetwood is by a company, in which case, it will be remembered, that the local authority is empowered to appoint an electrical inspector; or if the local authority make no appointment, or imperfectly attend to the matter, the Board of Trade may appoint such an officer on the application of any consumer or of the undertakers. Although this provision is included in the Electric Lighting Acts, where the duties of an

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electric inspector are also set forth, little advantage has been taken of it hitherto, and the number of electrical inspectors in connection with electrical undertakings is small.

**Wireless Telegraphy on Atlantic Liners.**—The Paris edition of the *New York Herald* contained the following interesting piece of news on Wednesday last:—

By the establishment of the *Herald's* wireless telegraph station on the Nantucket lightship the Transatlantic voyage is virtually shortened by almost a day. That is to say, passengers by incoming vessels equipped with the Marconi instruments will enter into communication with the American continent, and through it with the whole world, from 14 to 16 hours earlier than is the case at present. The installation of the station is rapidly approaching completion. By the end of the current week everything will be in readiness for the reception and despatch of telegrams.

The "Lucania," sailing from Liverpool to-morrow, will be the first vessel to make use of these facilities. The experiments made of wireless telegraphy to the "Lucania" on this side of the Atlantic have also been continued.

**"The Bow Lamp."**—The Berlin correspondent of the *Standard* has discovered the "bow lamp"—in fact, a singing variety of this device—at the Fire Brigade Exhibition in that city. On an examination of his article, however, it appears that the "bow lamp" and "bow light" are merely mistranslations of the German for arc lamp. At the exhibition the speaking arc of Dr. Simon (christened Dr. Sim by our contemporary) is employed in a manner similar to Alexander Graham Bell's photophone, to transmit sound for a short distance by means of a beam of light and without the assistance of intermediate wires. A speaking arc projects a beam of light upon a selenium cell, which is placed in circuit with a battery and telephone, with the result that speech and musical notes emitted by the arc are reproduced at the distant point in the selenium cell circuit. The experiment is an exceedingly pretty one, and it is to be hoped that it will lead to some quantitative experiments to ascertain whether the phenomenon is likely to have any practical applicability.

**Visit of the Institution of Electrical Engineers to Germany.**—On Friday last a presentation was made to Mr. and Mrs. McMillan and the secretarial staff of the Institution of Electrical Engineers by Mr. Alexander Siemens on behalf of the members who had taken part in the visit of the Institution to Germany. In a few well-chosen words, Mr. Siemens referred to the untiring energy with which Mr. McMillan had worked to ensure the success of the tour, and reference was also made to the spontaneous manner in which the subscriptions to the fund had been forthcoming. Mr. McMillan, in thanking on behalf of himself and his wife, was evidently deeply moved by the generous recognition of his efforts, and paid a tribute to his staff, who had readily responded to the call for extra work in connection with the preparations for the visit. The testimonial took the form of a handsome brooch for Mrs. McMillan, a card case containing a cheque for £100 to Mr. McMillan, and a cheque for £50 to the staff. Both the brooch and card case bore suitable inscriptions.

**Motor Car Trials at Glasgow.**—The Automobile Club of Great Britain and Ireland, with the co-operation of the Scottish Automobile Club, has organised in connection with the Glasgow Exhibition a 500 miles' road trial of motor cars and some hill-climbing competitions. There will be three sections: a section for vehicles entered by manufacturers or agents, a section for private owners, and a third section for parts of motor vehicles. The first section will be divided into five classes: Class A for cars at a selling price of £250 or less; Class B for cars at a selling price of more than £250 and not more than £350; Class C for cars at a selling price of more than £350 and not more than £500; Class D for cars at a selling price of more than £500; Class E for motor cycles carrying two or more persons. Sir J. H. A. Macdonald, Lord Justice Clerk of Scotland, has consented to act as chairman of the judges' committee. The trials will begin on Monday, September 2nd, and continue until Friday, September 6th. Each day the competing cars will leave Glasgow and make a tour of about 100 miles, returning to Glasgow at night. The *maximum* legal limit of speed in Scotland being 10 miles per hour, stringent regulations have been laid down to discourage higher speeds. A large number of cars have already entered for the competition.

**The Security of St. Paul's Cathedral.**—Under the above title Mr. Somers Clarke, architect to the Dean and Chapter of St. Paul's, writes a long and interesting letter, published in the *Times* of the 6th inst. From this letter we give in full the remarks made on the question of electric deep tube railways, which are as follows:—

But now comes the attack by the electric railways. One of these—the Victoria, City and Southern Electric Railway—proposes to come under the churchyard, taking a line between the cathedral and the great warehouses on the south. The centre line of the tube or tunnel would be about 40ft. from the south-west tower and 50ft. to 60ft. from the south transept. Another—the Piccadilly and City Railway—proposes to pass under Carter-lane—that is to say, under the first street immediately south of St. Paul's Churchyard. The centre line of this tunnel is at a distance of 170ft. both from the south-west tower and the south transept. It would be a little nearer to the cathedral than the width of the west front. It would be but 300ft. from the centre of the dome. We must not forget that the cathedral is already attacked on the north. Here is the tube of the Central London Railway, and this is but 460ft. from the centre of the dome. We know that this tunnel, passing, as it does, close to Bow Church, has already, in the few short years since it was pierced caused the steeple to overhang 1ft. 9in. towards itself. Bow Church tower is a mere toy compared with the enormous weight of St. Paul's. The area of one of the western towers of St. Paul's is just double the area of Bow Church tower. But, Sir, the chief danger to the cathedral lies by no means only in piercing the tubes or in the vibration from passing trains. The tubes may be sunk ever so far down, the vibration may, and, no doubt, will be very much reduced, but wherever the tube may be a tremendous hole must be made for the public to get at it. Then, when the bottom is reached, there are footways, cross passages, and all manner of subsidiary excavations. Who knows what underground streams may not be tapped in making these big shafts, or how much superincumbent weight may affect excavations? The Piccadilly and City Railway proposes to place its terminus under the space where Cannon-street is crossed by Queen Victoria-street. The tunnels in which is the terminus must necessarily be of considerable length, and can hardly fail to come within 600ft. of the cathedral. The great hole and excavations to the east are, however, not more dangerous than would be those to the west on the slope of Ludgate Hill, where a station is projected. There is already, on the north, the Post Office Station of the Central London Railway. The results of these big excavations and disturbances would very probably not show themselves seriously in the fabric of the cathedral for a good many years; but what is, let us say, 50 years in the life of a great national monument, one of the most magnificent buildings in the world, and which, taken due care of, may last for 1,000 years and more?

This matter is commented on in our editorial columns.

**Power Transmission at Massena, N.Y.**—The *Electrical Review* of New York for July 27th gives a very full description of the electrical power installation now nearly completed at Massena, N.Y. The development consists of the utilisation of a curious natural conformation of territory by which the Grasse River, a tributary of the St. Lawrence, runs parallel with the larger stream and at a distance of about 3 miles from it, yet no less than 42ft. below it at a point about 9 miles above the confluence of the two streams. A canal from the St. Lawrence to the Grasse River has been cut, and a power house erected on the bank of the latter. The normal depth of water in the canal is 27ft. and the flat bottom is 187·5ft. wide. The banks of the submerged portion are built at a slope of 1½ to 1, making the width at the water-level 262·5ft. No embankments were required, and the deepest cutting is about 95ft. deep. A velocity of flow in the canal of 13½ miles per hour is secured by a water gradient of 6¾ft. per 1,000, and at the power-house, on the Grasse River, the available head is about 32ft. When completed thirty 5,000 H.P. units will be installed. At present seven are being fixed; each consists of six 54in. Victor wheels, installed tandem on a horizontal shaft, which is direct-coupled with the dynamo shaft. Three suction tubes are connected with these six wheels, which are submerged, the suction tubes being of steel and 10ft. in diameter. The horizontal shaft, which is 12½ft. in diameter, passes through a water-tight journal, 30in. long, in a steel plate, closing one end of the chamber in which the wheels are submerged, and thence to the coupling connected with the dynamo. The dynamos are of the Westinghouse revolving field external armature type, and generate three-phase currents at 50 cycles and 2,200 volts in each phase. The revolving field has 20 poles, and the armature winding has 12 slots per pole per phase. Each of these machines is constructed to deliver a normal output of 3,750kw. and a maximum capacity of 5,500kw. at 150 revs. per min. For excitation there are at present in course of erection three 300kw. direct-current 125 volt machines, each direct-coupled to a Victor turbine of 27in. diameter, running at 275 revs. per min

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## THE DUBLIN UNITED TRAMWAYS SYSTEM.

FIG. 1.—MAP OF THE DUBLIN UNITED TRAMWAY CO.'S SYSTEM.

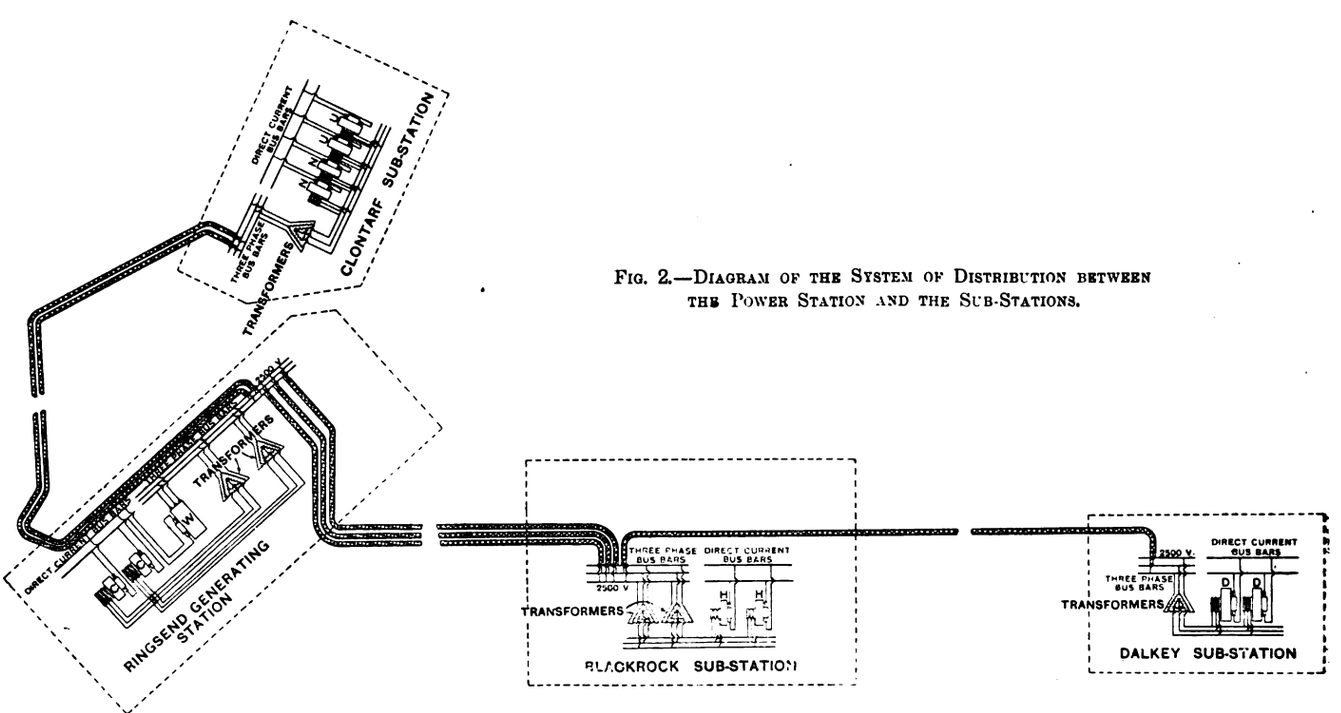


FIG. 2.—DIAGRAM OF THE SYSTEM OF DISTRIBUTION BETWEEN THE POWER STATION AND THE SUB-STATIONS.

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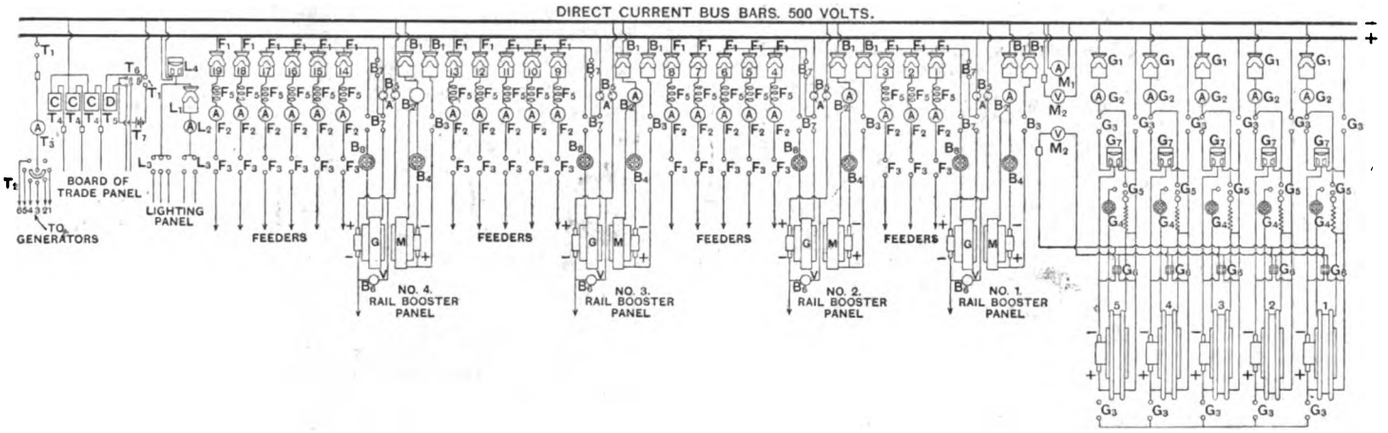
# THE DUBLIN UNITED TRAMWAYS SYSTEM.

The development of electric tramway traction has proceeded in the United Kingdom, not only at a much later period than in the United States, but also, in many essential details, upon running of the plant. Lessons, therefore, which our American *confrères* are able to draw from the results obtained on the older and more extensive of their tramway systems are, to a large




*B. O. T. Panel.*

$T_1$—S. P. S. T. Switch.
$T_2$—Eight-way Switch.
$T_3$—Leakage Test Ammeter, 0·001 to 0·5 amperes.
$T_4$—Recording Voltmeter, 0–10 volts.
$T_5$—Recording Ammeter, 0–10 amperes.
$T_6$—Two-way D.P. Switch.
$T_7$—Two Secondary Cells.

*Lighting Panel.*

$L_1$—Circuit Breaker, mag. blow-out, 30–100 amperes.
$L_2$—Ammeters, 0–200 amperes.
$L_3$—S.P.Q.B.S.T. Switches, 100 amperes.
$L_4$—Recording Wattmeter, 50 amperes.

*Feeder Panels.*

$F_1$—Circuit Breaker, mag. blow-out, 500–800 amperes.
$F_2$—Ammeter, 0–1,000 amperes.
$F_3$—S. P. Q. B. Switch, 600 amps.
$F_5$—Lightning Arrester; Reactance Coil.

*Motor Booster Panels.*

$B_1$—Circuit Breaker, mag. blow-out, 75–150 amperes.
$B_2$—Ammeter, 0–200 amperes.
$B_3$—S. P. Q. B. Switch, 100 amps.
$B_4$—Starting Rheostat.
$B_5$—Ammeter, 0–1,200 amperes.
$B_6$—Voltmeter, 0–50 volts.
$B_7$—S. P. Q. B. Switches, 1,200 amperes.
$B_8$—Field Rheostat Handle.

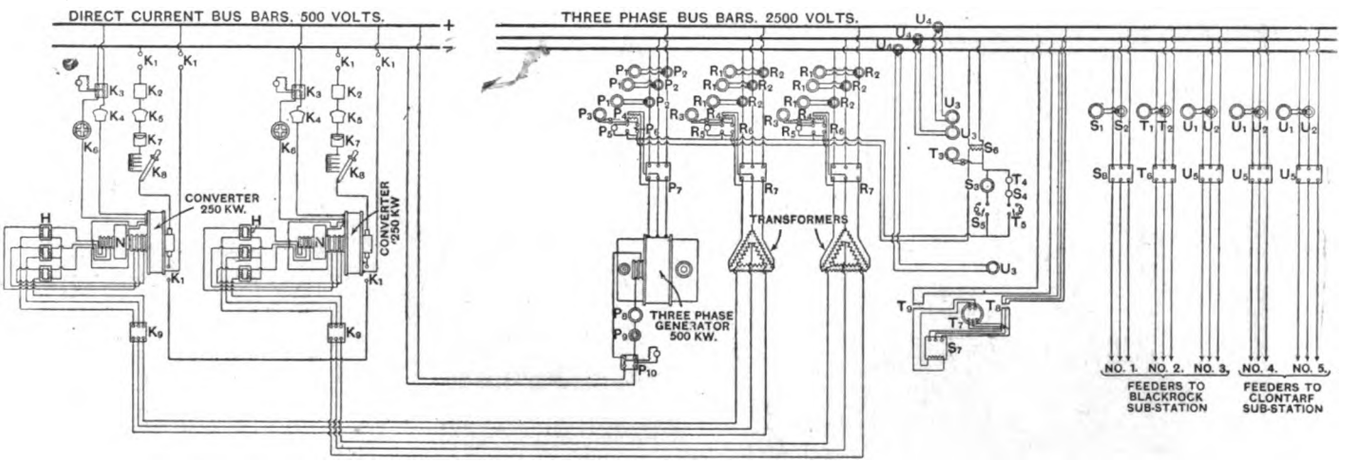
*Meter Panel.*

$M_1$—Ammeter, 0–8,000 amperes.
$M_2$—Voltmeters, 0–750 volts.

*Generator Panels.*

$G_1$—Circuit Breaker, mag. blow-out, 800–1,200 amperes.
$G_2$—Main Ammeter, 0–1,500 amperes.
$G_3$—S.P.S.T.Q.B. Switches, 1,200 amperes.
$G_4$—Field Rheostat Handle.
$G_5$—Field Switch, Lamp and Discharge Resistance.
$G_6$—Four-point Plug Receptacle for Voltmeter.
$G_7$—Wattmeter, 1,800 amperes capacity.
C—Recording Voltmeter.
D—Recording Ammeter.

FIG. 3.—DIAGRAM OF 500-VOLT CONNECTIONS IN THE GENERATING STATION.


DIRECT CURRENT BUS BARS. 500 VOLTS.
THREE PHASE BUS BARS. 2500 VOLTS.
CONVERTER 250 KW.
CONVERTER 250 KW.
TRANSFORMERS
THREE PHASE GENERATOR 500 KW.
NO. 1. NO. 2. NO. 3. NO. 4. NO. 5.
FEEDERS TO BLACKROCK SUB-STATION
FEEDERS TO CLONTARF SUB-STATION

H—Series Transformers for Boosters.
N—Booster for additional Excitation of Field.

*Rotary Converter Panels.*

$K_1$—S.T.S.P.Q.B. Switches, 600 amperes.
$K_2$—Automatic Circuit Breaker, 800–1,200 amperes capacity.
$K_3$—D.P. Carbon Break Field, Switch Lamp and Resistance.
$K_4$—Field Ammeter, 3–0–3 amps.
$K_5$—Main Ammeter, 750–0–750 amperes.
$K_6$—Field Rheostat.
$K_7$—Integrating Wattmeter, 500 amperes.
$K_8$—Four-point Starting Switch.
$K_9$—T. P. S. T. Switches for 600 amperes. (These switches are mounted on the rotary converter.)

*Three-Phase Generator Panel.*

$P_1$—Alternating-current Ammeter, 0–150 amperes.
$P_2$—Ammeter Transformers.
$P_3$—Voltmeter reading 0–3,000 volts.
$P_4$—Potential Transformer.
$P_5$—Pilot Lamp.
$P_6$—Four-point Plug Receptacle.
$P_7$—T. P. S. T. Double Break Oil Switch for 200 amperes at 2,500 volts.
$P_8$—Field Ammeter for 500 volts, 0–80 amperes.
$P_9$—Field Rheostat for Gener't'r.
$P_{10}$—D.P. Carbon Break Field Switch with Lamp and Discharge Resistance.

*Transformer Panels.*

$R_1$—Alternating-current Ammeter, 0–100 amperes.
$R_2$—Ammeter Transformers.
$R_3$—Alternating Voltmeter, 0–3,000 volts.
$R_4$—Potential Transformer.
$R_5$—Pilot Lamp.
$R_6$—Four-point Plug Receptacle.
$R_7$—T. P. S. T. Double Break Oil Switch for 100 amperes at 2,500 volts.

*Feeder Panels.*

$T_1$—Alternating-current Ammeter, 0–50 amperes.
$T_2$—Ammeter Transformer.
$T_3$—'Bus Bar Voltmeter reading 0–3,000 volts, mounted on swivel bracket.
$T_4$—Synchronizing Lamp, 100 volts.
$T_5$—Four-point Plug Receptacle and Fuse.
$T_6$—T. P. S. T. Double Break Oil Switch for 100 amperes at 2,500 volts.
$T_7$—Indicating Wattmeter, 400 amperes.
$T_8$—Potential Transformer for same.
$T_9$—Current Transformer for Wattmeters.
$U_1$—Alternating-current Ammeter, 0–50 amperes.
$U_2$—Ammeter Transformers.
$U_3$—'Bus Bar Ammeters, 0–400 amperes.
$U_4$—'Bus Bar Ammeter Transformers.
$U_5$—T. P S. T. Double Break Oil Switch for 100 amperes at 2,500 volts.
$S_1$—Alternating-current Ammeter, 0–50 amperes.
$S_2$—Ammeter Transformers.
$S_3$—Synchronizing Voltmeter, 0–250 volts, mounted on a swivel bracket.
$S_4$—Synchronizing Lamp, 100 volts.
$S_5$—Four-point Plug Receptacle and Fuse.
$S_6$—Potential Transformer, 2,500/100 volts.
$S_7$—Integrating Wattmeter, 400 amperes.
$S_8$—T. P. S. T. Double Break Oil Switch for 100 amperes at 2,500 volts.

FIG. 4.—DIAGRAM OF THE THREE-PHASE CONNECTIONS IN THE GENERATING STATION.

markedly different lines. In drawing this distinction we are not paying regard so much to the outward and visible appearance of the equipment, whether of the line or of the power station, as to the conditions and circumstances which affect the extent, inapplicable to British practice, and British engineers are, therefore, left to discover on their own ground the object lessons which they may require to aid them in improving their methods. Such lessons are sometimes to be learned by the

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study of newly opened lines, and wherever such occasion has arisen we have invariably presented our readers with the technical particulars that would be calculated to assist them in this direction. But there are other and, perhaps, even more important lessons which can only be learned by the study of a tramway system that has been in operation for some time—one that has passed through the infantile and

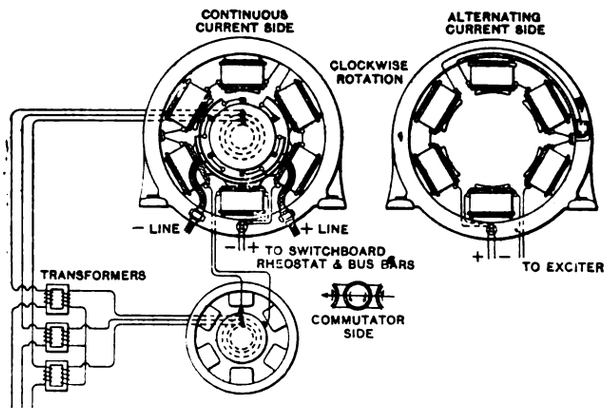
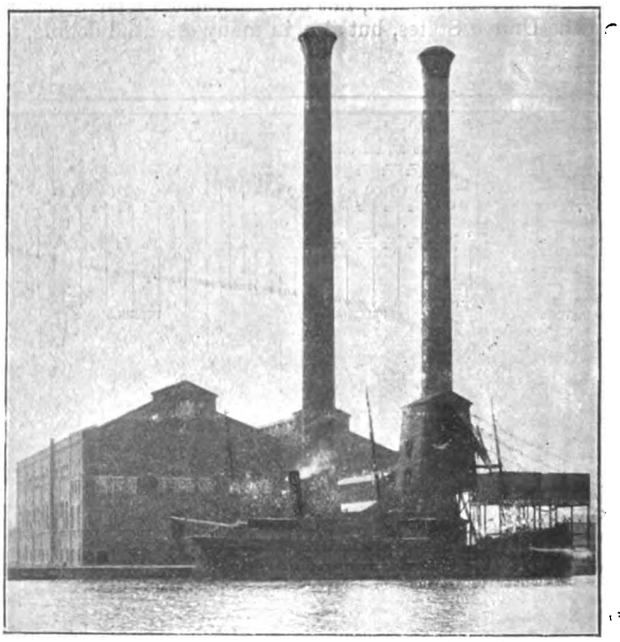



FIG. 5.—DIAGRAM OF CONNECTIONS BETWEEN THE ROTATORY CONVERTER AND BOOSTER.

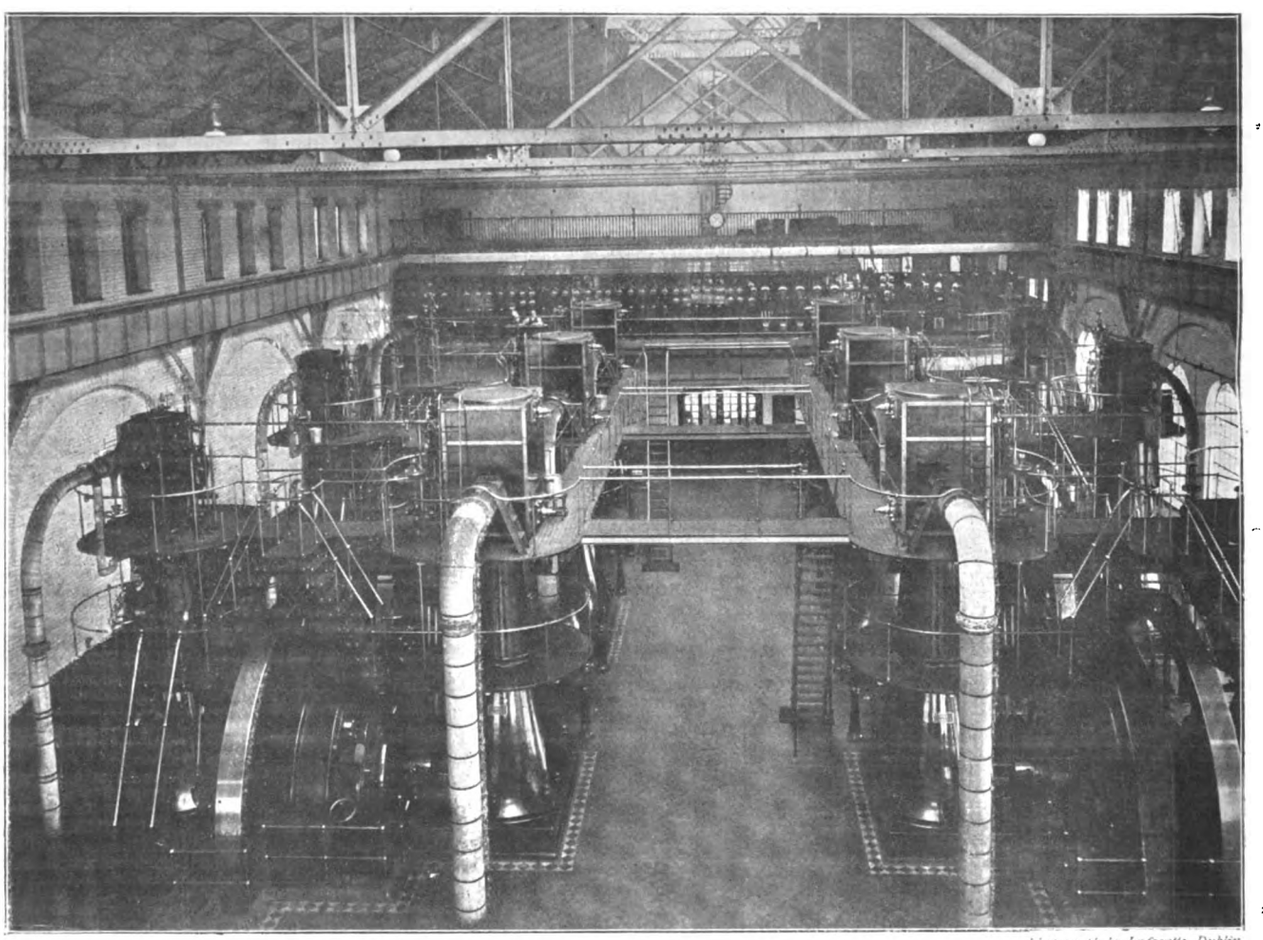
youthful stages and has approached the more settled condition of maturity. In one sense, no successful tramway system ever attains maturity, for it must always be growing; but there are several examples of electric tramway systems in the United Kingdom which are sufficiently far developed to aid

view to give our readers a detailed account of its present condition and of its gradual development from the earliest stage at which electric traction was introduced into it. For great assistance in the preparation of this description of the Dublin



*Photograph by Lafayette, Dublin.*

FIG. 7.—VIEW OF DOCK SHOWING COAL-HANDLING APPARATUS.



*Photograph by Lafayette, Dublin.*

FIG. 6.—GENERAL VIEW OF THE INTERIOR AT THE RINGSEND POWER STATION.

engineers in learning these useful lessons. Among these the tramway system of the Dublin United Tramway Co. is probably the most instructive; we have selected it, therefore, with a

system we are much indebted to Mr. H. F. Parshall, the company's consulting engineer, who has been responsible for the execution of the constructive work at its various stages

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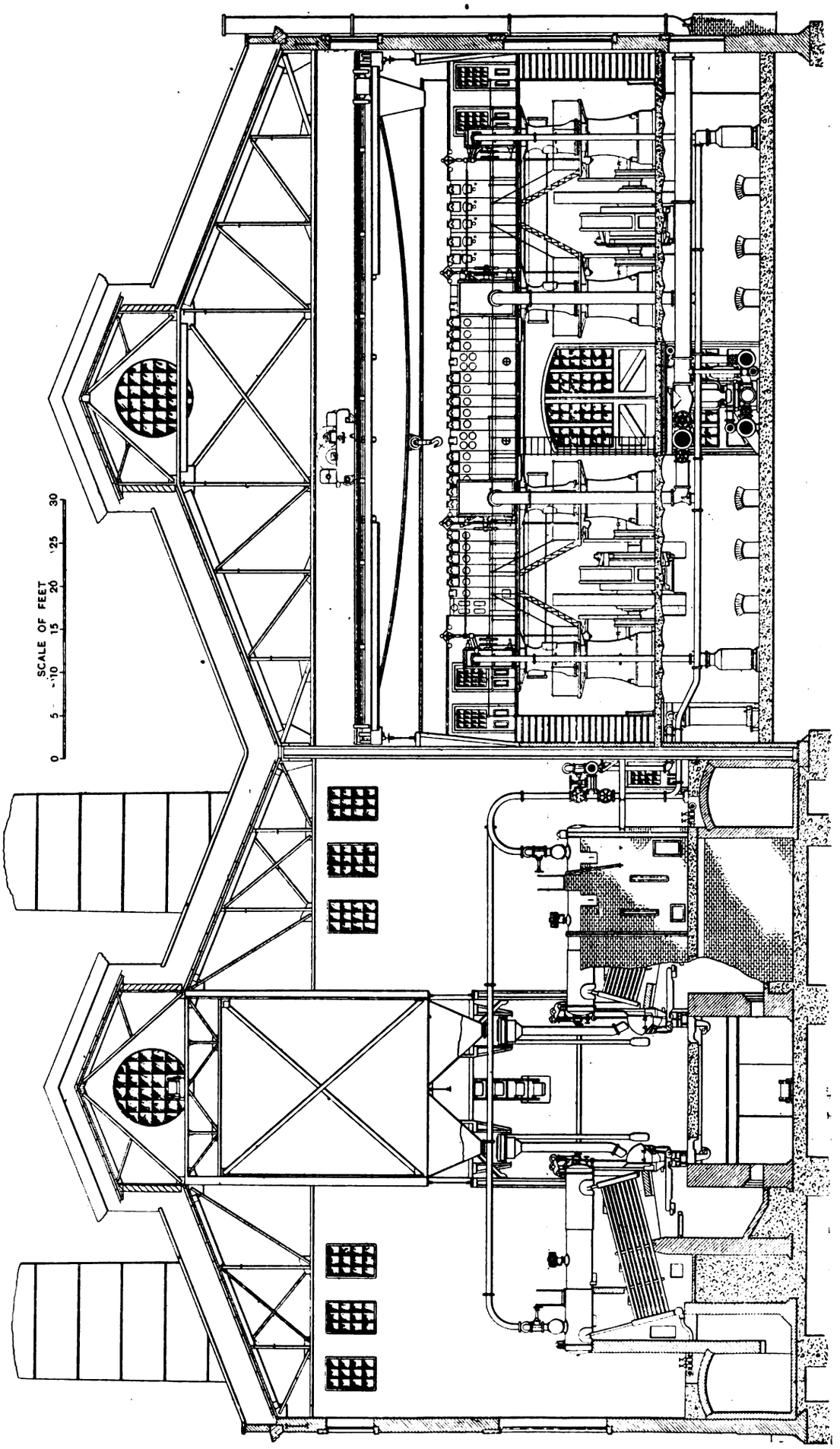


FIG. 8.—SECTIONAL ELEVATION OF GENERATING STATION.

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of development. Our thanks are also extended to the chairman and directors, and to other officials of the Dublin United Tramways Co. for permission to visit their works and to take the accompanying photographs of the various departments, also for their courtesy during our recent visit.

Although the main system of the Dublin United Tramways Co. has been running for over 18 months several important extension works have been carried out. The two original generating stations have been shut down, and the whole power is now supplied from Ringsend generating station, and existing sub-stations are changed over from motor generator to rotary converter sub-stations. The company obtained powers for the electrical working of their tramway system in 1897. At that time they owned two lines which were operated electrically, namely, the Clontarf line, running from Annesley Bridge to Dollymount, about 8 miles long and worked from a generating station situated in Dollymount, and the Haddington-road to Dalkey line, about 8 miles long, worked from a generating station located at Ballsbridge. This latter line was purchased from the Dublin Southern Districts Tramways Co., by whom it had been equipped. The company retained Mr. H. F. Parshall, M.Inst.C.E., to carry out the electrical equipment, and the whole of the works at present under notice have been carried out from his designs and under his supervision.

Fig. 1 is a plan of the system at present operated electrically by the Dublin United Tramways Co. The total length of the route is 50 miles and the length of single track 89 miles, served by a total number of 250 cars normally. Out of this, a length of about 5 miles, extending from Dollymount to Howth, is worked by the Clontarf and Hill of Howth Tramroad Co., the power being supplied by the Dublin United Tramways Co. Referring to Fig. 1, the generating station is located on the Grand Canal basin at Ringsend, with sub-stations at Blackrock, Dalkey and Clontarf. About 40 miles of the system, served by 200 cars, is supplied with current direct from the generating station. The remainder or suburban part of the system, consisting of the Clontarf and Howth line, served by 20 cars, and the Dalkey line between Merrion and Dalkey, served by 20 cars, is supplied indirectly by means of sub-stations located as shown on the map.

The main or city system is divided up into 19 sections independently supplied and controlled from the generating station, but these can be interconnected at will. These sections have been carefully arranged so as to provide alternative routes into the city in case of fire or accident on any one route. Each main section is subdivided into half-mile lengths, in accordance with the Board of Trade requirements, each section being supplied from a distributing feeder connected to a main feeder. The average area of the main feeders is about 0·6 sq. in., and of the distributing feeders 0·25 sq. in. In order to reduce the leakage from the rails and to maintain the system within the Board of Trade limits, four negative booster points have been provided. These are connected to the generating station by means of insulated cables, making a total area of return cables of 6 sq. in. The four return cables are connected in series with the armature of the negative boosters, the fields of which are placed in series with certain of the positive feeders.

A key plan showing the system of transmission from the generating station to the sub-stations is given in Fig. 2. The sub-stations

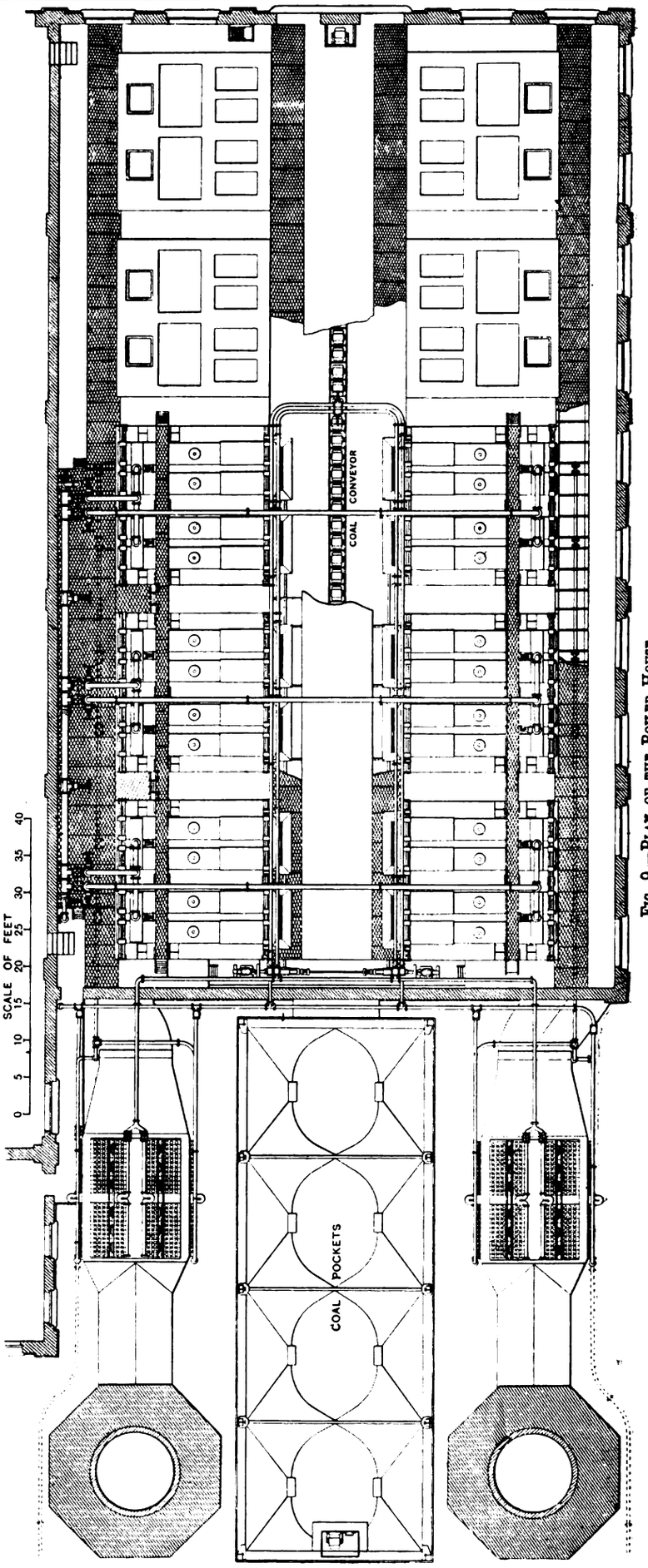


FIG. 9.—PLAN OF THE BOILER HOUSE.

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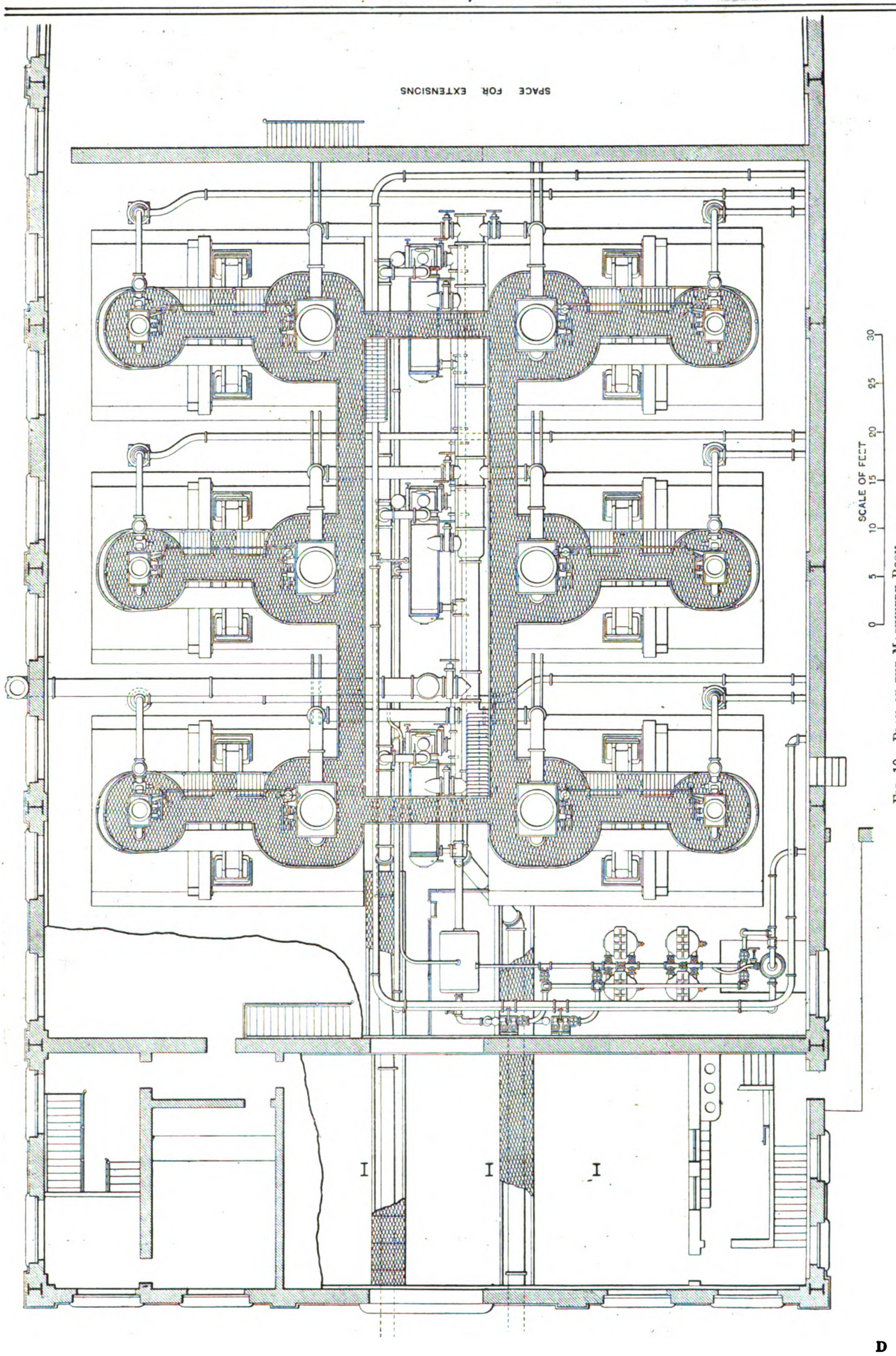


FIG. 10.—PLAN OF THE MACHINERY ROOM.

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are supplied by three-phase currents at a pressure of 2,500 volts. The transmission cables between the generating station at Ringsend and the Clontarf sub-station consist of two 3-core cables, paper insulated and lead-covered, the area of each core being 0·075 sq. in. The Dalkey line was originally supplied from a generating station located at Ballsbridge, which was equipped with continuous current generators for supplying part of the line direct, and also with three-phase generators for transmission to the Blackrock and Dalkey sub-stations. The high-tension cables consisted of two triple concentric cables between Ballsbridge and Blackrock, the area of each core being 0·05 sq. in., and one triple concentric cable between Blackrock and Dalkey, the area of each core being 0·05 sq. in. This line being now worked from Ringsend, the transmission cables have been continued from Ballsbridge to Ringsend, and also supplemented by means of a three-core cable laid between Ringsend and Blackrock, the area of each core being 0·1 sq. in. In Fig. 3 we give a diagram of connections between the 19 feeders above referred to and the return boosters and the direct current generators. The diagram also shows the connections on the Board of Trade panel. Weston instruments and magnetic blow-out circuit breakers are used throughout. A schedule of the apparatus is given as a footnote to the illustration. Fig. 4 shows the diagram of connections of the power station switchboard, the rotatory converters, transformers, three-phase generator and the high-tension feeders, together with a schedule of the apparatus on the switchboard.

On referring to Figs. 3 and 4 it will be seen that there are five direct-current generators for supplying the main part of the system, and one three-phase generator for supplying the suburban lines from the sub-stations already referred to. In addition to this, two rotatory converters are provided as a spare to the three-phase generator, their normal function being to convert from direct current to three-phase alternating current, which is then transformed up by means of static transformers to the transmission voltage of 2,500 volts. They can, of course, also be used for supplying direct current by transformation and conversion from the three-phase 'bus bars. At the present time, however, they are used as a supplement to the three-phase generating unit. It often happens during light load that the load on the three-phase side is not sufficient to warrant the running of a three-phase generator. On these occasions the sub-stations are supplied through one of the rotatory converters and transformers from the direct-current 'bus bar. This at the same time improves the load factor on the direct-current plant. When the tramway service is in full swing, four of the direct-current generators are in service and fully loaded; at such times the three-phase generator is run, being also fully loaded, and the rotatory converters are out of service.

A reference to the diagram of connections (Fig. 4) shows a peculiar feature of the rotatory converters, each converter having a small booster attached to the end of the shaft. This booster is really another rotatory converter and consists of an armature with three collector rings and a commutator revolving in the field ring with six poles, but without any field winding. The function of this booster is, in conjunction with three series transformers, to keep the speed of the rotatory converter constant, and thus maintain its periodicity and synchronism. The necessity for this apparatus arises in this way. When converting from alternating to continuous current, the speed of the converter is fixed by the frequency, and cannot be varied by altering the field excitation. When converting, however, from continuous to alternating current, the speed of the converter, as in a continuous current motor, depends upon the field strength, being increased by a weak field and decreased by a strong field. It is evident, therefore, that it is liable to a change in speed under conditions of increased load and phase displacement, and will deliver alternating current at a variable frequency in consequence. An alternating lagging current weakens the field, thus tending to increase the speed and frequency, so that, under certain conditions with an inductive load, a converter may get out of synchronism. To meet this difficulty, the main current on the alternating side is made to pass through three small transformers, one in each phase. The secondary windings of these three transformers are connected together in star fashion, and the three leads carried to the collector rings of the auxiliary rotatory converter or booster, the commutator of which is in series with the field winding of the main converter. By this means the field current is varied to correspond with the load and phase displacement. A diagram of connections for the rotatory converter and its auxiliary is also shown in Fig. 5, and this shows somewhat more clearly the nature of the connections.

The power station is erected on a large piece of ground adjacent to the Grand Canal block, from which feed water and condensing water are obtained, and by which the coal and supplies are brought into the station. Fig. 6 is a general view of the power house, and Fig. 7 a back view, showing the coal handling apparatus. The building is 180ft. long by 160ft. wide, the engine room being 80ft. wide and the boiler room 76ft. wide, inside measurements. The engine room is 62ft. high from basement to roof, and the boiler room 66ft. high. The building is a steel structure resting on concrete foundations and covered in with brick. The total weight of steel used in the building, including columns, girders, coal bunkers, roof trusses, &c., was about 700 tons. An elevation in section through the boiler and machinery departments is shown in Fig. 8, the plan of the boiler room in Fig. 9, and the plan of the engine room in Fig. 10.

*(To be continued.)*

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

*(Continued from page 556.)*

### MESSRS. SIEMENS AND HALSKE'S DYNAMO WORKS.

Messrs. Siemens and Halske's dynamo works are situated at Charlottenburg, on the Salzufer. These works were moved here from Berlin in 1886, as the Berlin works were overcrowded.

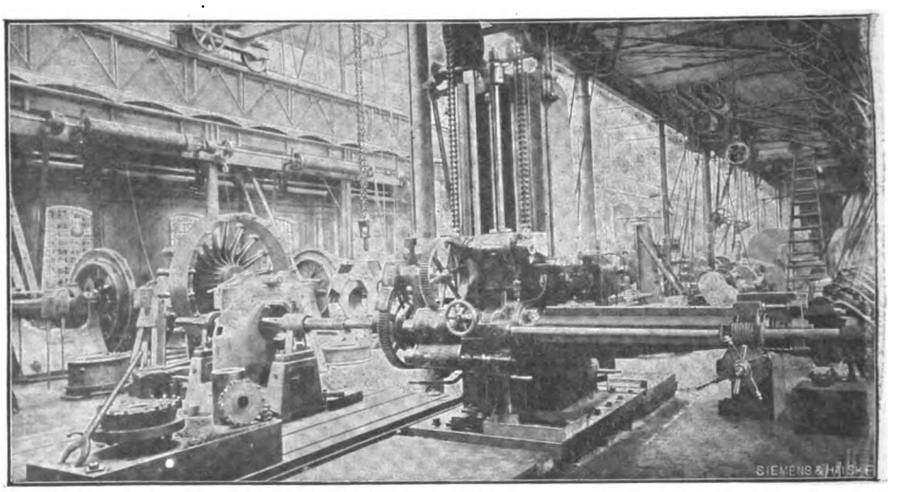


FIG. 21.—BORING MACHINE.

First both dynamo and cable manufacture was carried on in the new works, but in 1899 the new cable works (described in the last issue of *The Electrician*) were built, and the entire buildings on the Salzufer were then devoted to the making of dynamos and certain accessories. In the latter category come motors, transformers, switches, fuses and cut-outs, lightning

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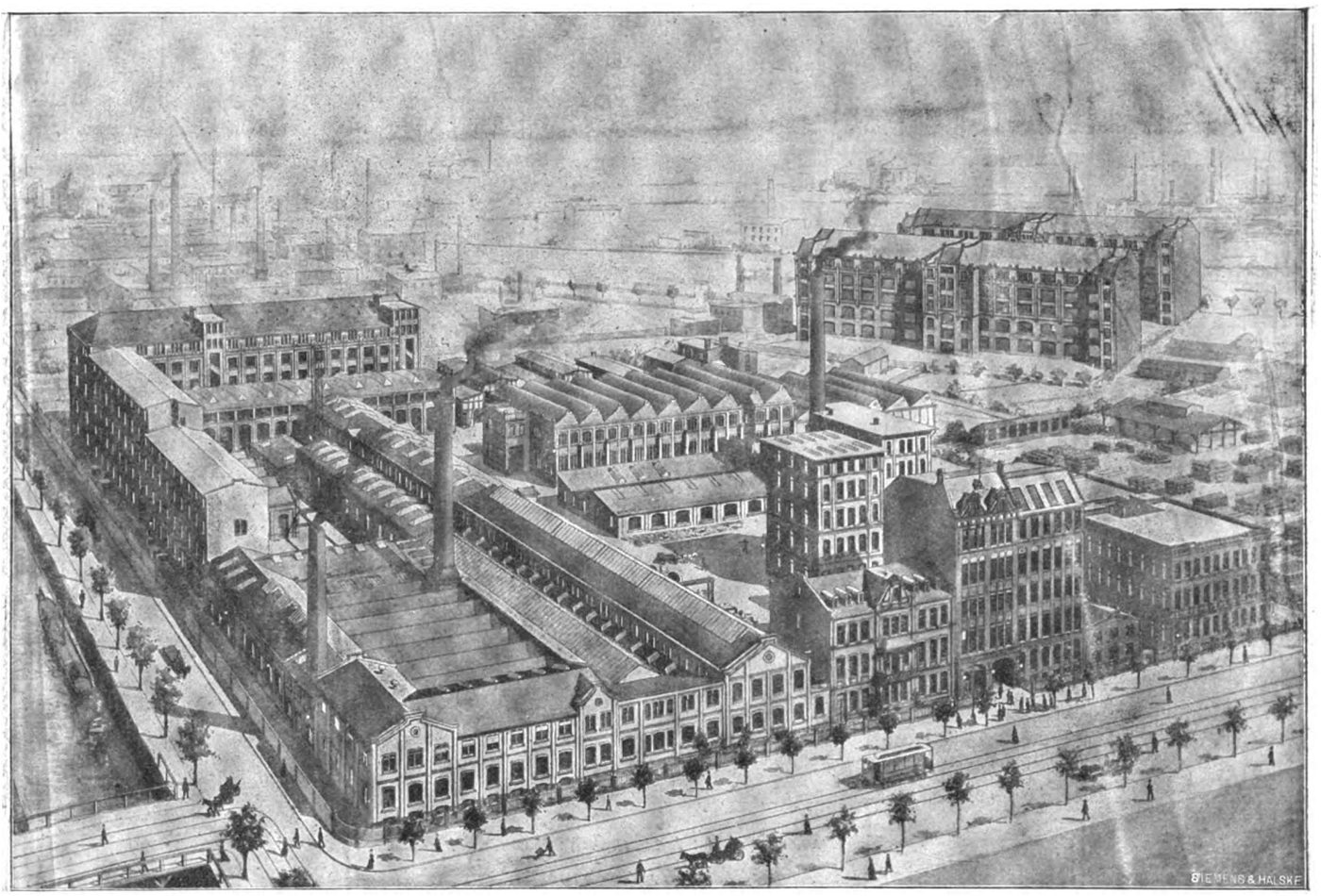


FIG. 20.—GENERAL VIEW OF THE WORKS.

protectors, measuring instruments, arc lamps, and special appliances, for instance, rock drills, &c.

All the machine tools and cranes are electrically driven, the larger ones singly, the smaller ones in groups. For supplying the motors and lighting there is a power station containing five steam dynamos, delivering current at 2 × 110 volts on the three-wire system. These machines are of the old internal pole type with ring armatures which serve also as commutators. Reference has been made to their excellent wearing properties in a previous article; the ones at these works have been running since the commencement, and in the dynamo works I observed that some machines of a similar type were being erected among others of the most modern design. A battery is employed to regulate the pressure and is charged through boosters in the ordinary manner.

The main part of the works, in which dynamos and motors are built, is so arranged that the machinery and erecting of parts, *i.e.*, all iron work, is carried out in one building, and the winding of the armatures and fields in another. A great advantage of this separation of the mechanical and electrical work is that there is less danger of the coils being damaged mechanically, as, for instance, by iron chips or turnings. To facilitate transporting the work from one shop to another, the workshops, as well as the yard, are provided with rails and a large number of electrically-driven cranes, and the machine tools are, moreover, so arranged as to render unnecessary, as far as possible, the moving of parts of machines from one end of the workshop to another. Electric driving and the employment of portable electrically-driven machine tools renders this arrangement easy.

Lathes, planing machines and slotting machines are mostly provided with their own motors, and not driven in groups, Fig. 21 shows a boring machine occupied with the pole-

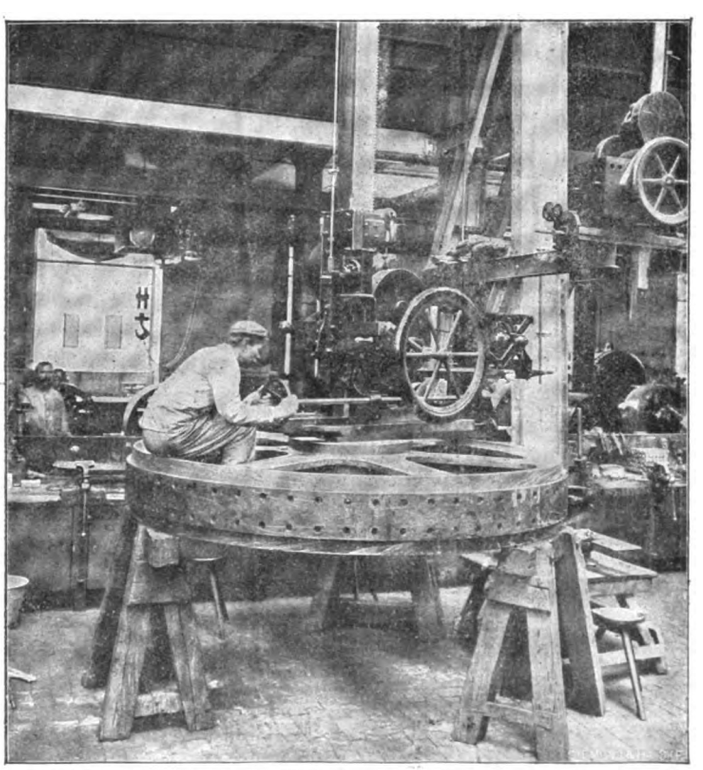

FIG. 22.—KEY-WAY SHAPING MACHINE.

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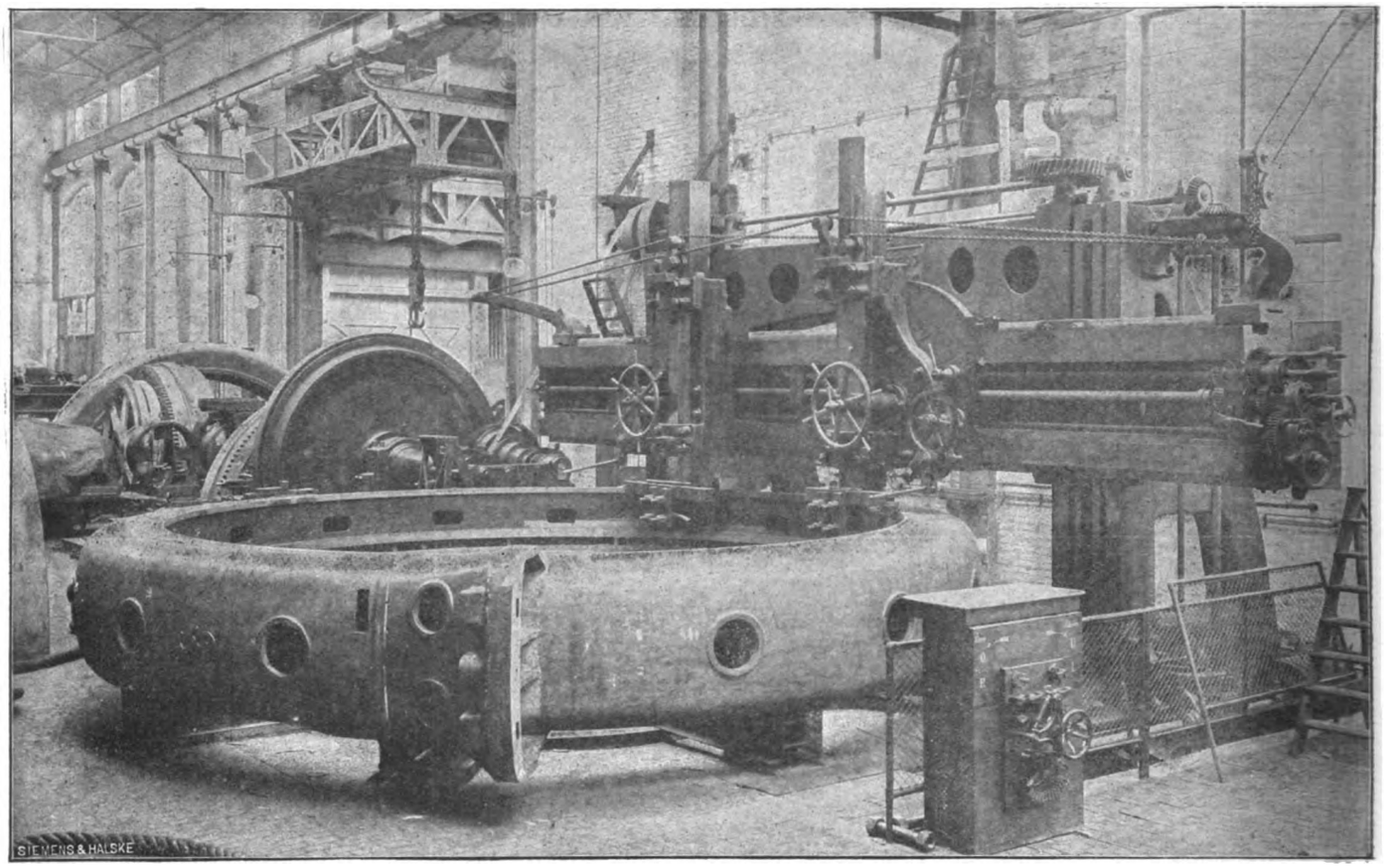


FIG. 23.—STATOR OF LARGE ALTERNATOR IN HORIZONTAL LATHE.

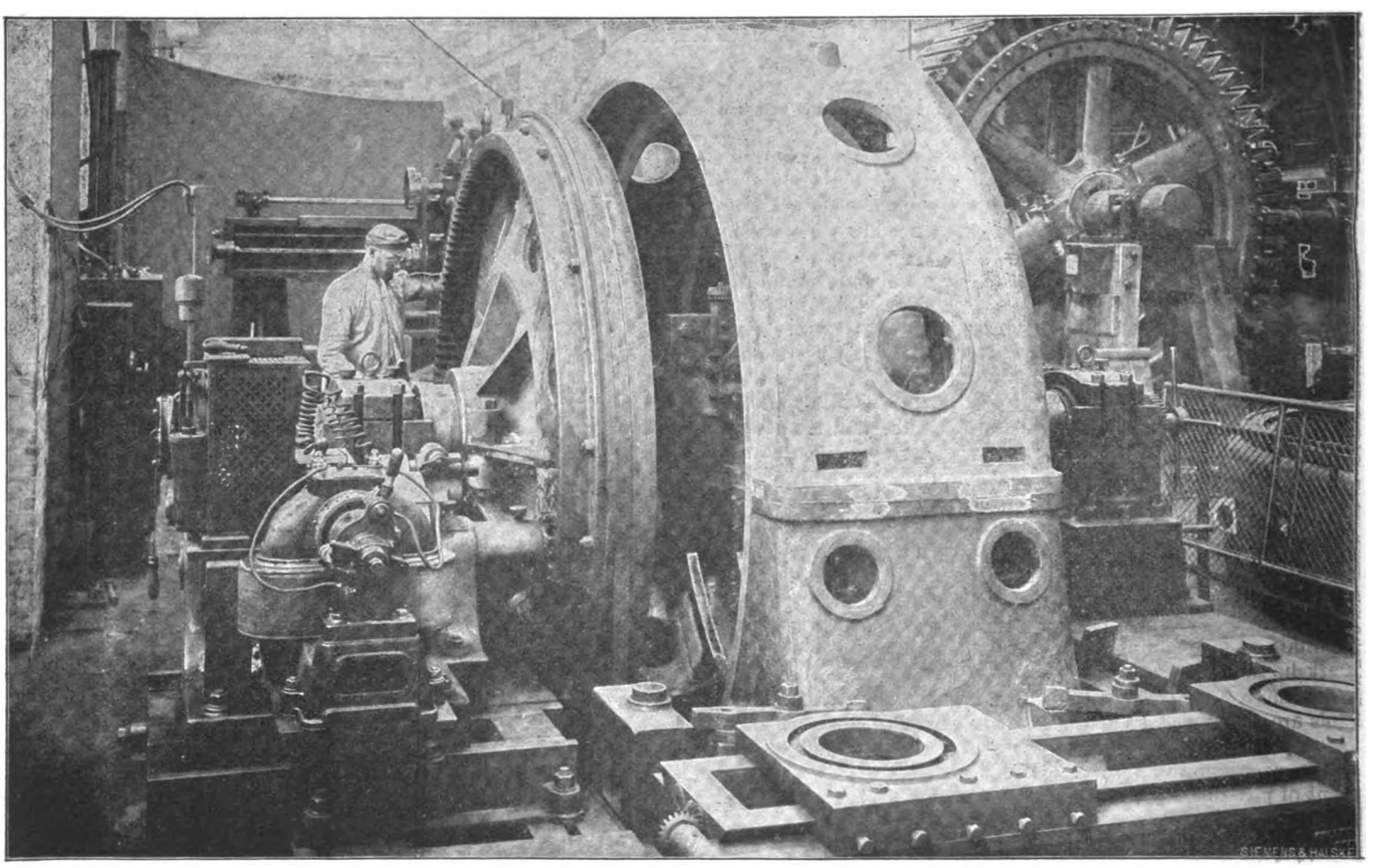


FIG. 24.—STATOR OF LARGE ALTERNATOR IN VERTICAL LATHE.

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FIG. 25.—CORE-STAMPING SHOP.

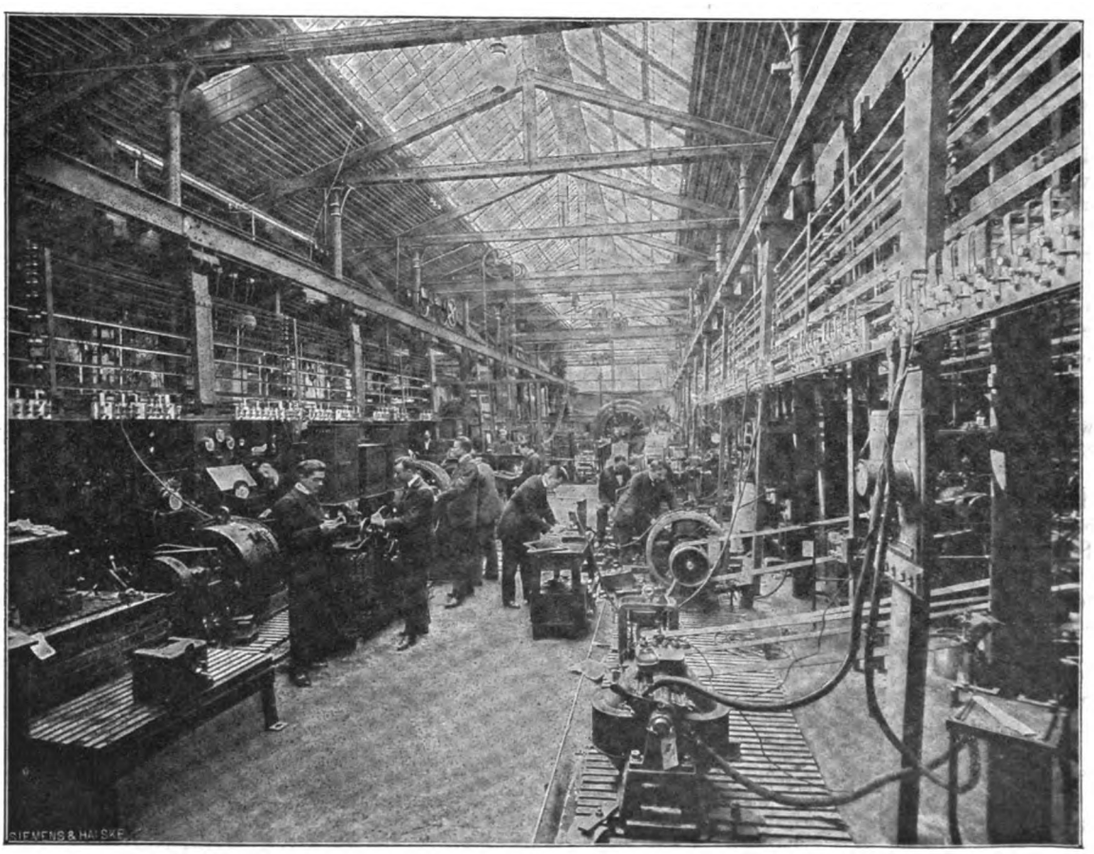

FIG. 26.—TESTING SHOP.

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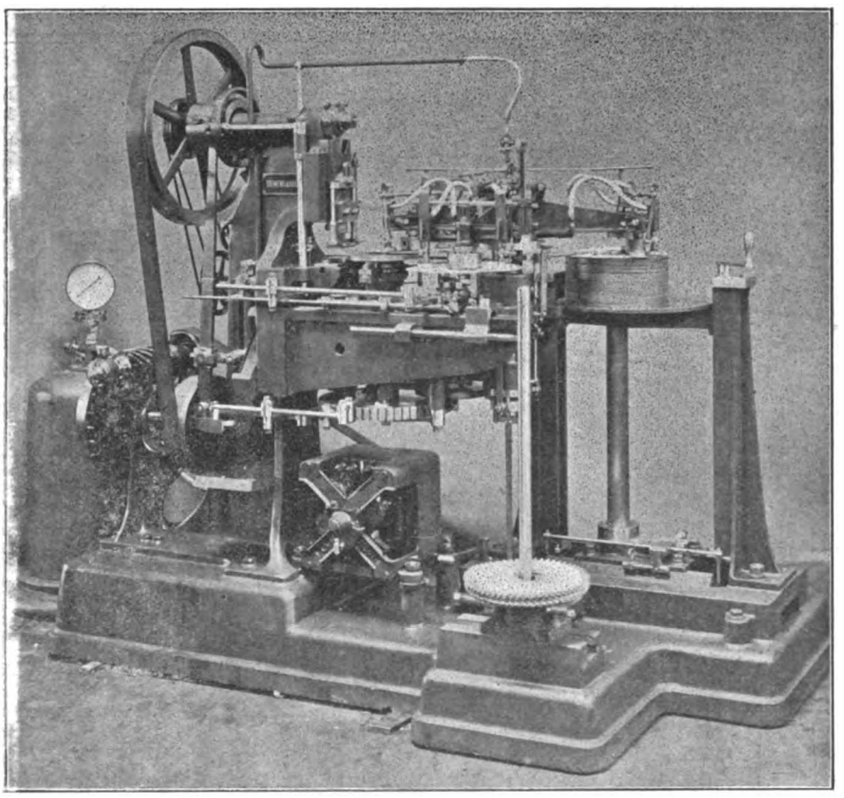

FIG. 27.—AUTOMATIC CORE-NOTCHING MACHINE NO. 1.

pieces and bearing of a two-pole machine. The key-way shaping machine in Fig. 22 is interesting, as is also the smaller one seen next to it on the right of the same illustration. This latter machine, which also has its own motor and is complete in itself, is of light weight and can be moved by the overhead crane to any part of the shop and connected to the electric supply by a flexible cable and plug contact. These two machines illustrate one of the great advantages of electric driving. The larger machine can be moved vertically within an enormous range, and this adjustment can be made momentarily, while the smaller one can be taken to a casting in any part of the shop.

Figs. 23 and 24 show two different types of lathe, in both of which the stator of a large three-phase generator is being machined. In Fig. 23 the work revolves in a horizontal plane, and the tool is stationary except for its vertical feed. In Fig. 24, on the other hand, the work is fixed and the tool revolves.

A view of the core-stamping shop is given in Fig. 25. Before coming to the stamping machines, the sheet iron is covered with thin paper in machines specially made for this purpose. Some of the stamping machines have large dies which stamp out the whole piece in one stroke, while others (as seen in Fig. 25) stamp out slot by slot, the core disc moving round automatically. A third type is the one exhibited at the Paris Exhibition last year, in which the discs are, in addition, fed to the machine and removed automatically by means of suction washers; two of these were in use, and their general construction is evident from Figs. 27 and 28.

As has already been mentioned, winding and fitting the coils is done in a separate building to the machinery and erecting. Except in special cases, the coils are all wound on formers and then placed in position. A large number of the alternator fields are wound with flat copper on edge in a special machine. The connections between the armature and commutator of continuous-current machines are made in the same shop. In passing through the shops, I noticed that in some cases cast-iron slip rings had been adopted for alternators, a practice recently adopted also by the B. T. H. Co. Fig. 29 shows a section of a former-wound stator being put into the vacuum drying chamber. Separate shops are provided for the fitting of tramway motors and small motors.

The testing shop is very large, as is seen in Fig. 26. For testing small motors a practical form of eddy-current brake, balanced by a steel-yard, is employed in place of a Prony brake. At the distant end of the test room is seen a 13,500 volt three-phase alternator, which was tested with 18,000 volts. Nine of these machines, for direct coupling to 1,000 H.P. turbines at 375 revs. per min., are in course of construction at the works. Among other fine machines being erected was a three-phase generator wound for 850kw. at 8,000 volts, 83·5 revs. per min. and 50 ~ per sec. The outside diameter of the stator of this machine was 8 metres.

Besides the objects already referred to, a large number of things were displayed for our visit to the works. These included the 10,000 : 2,000 volt 1,200kw. transformer and

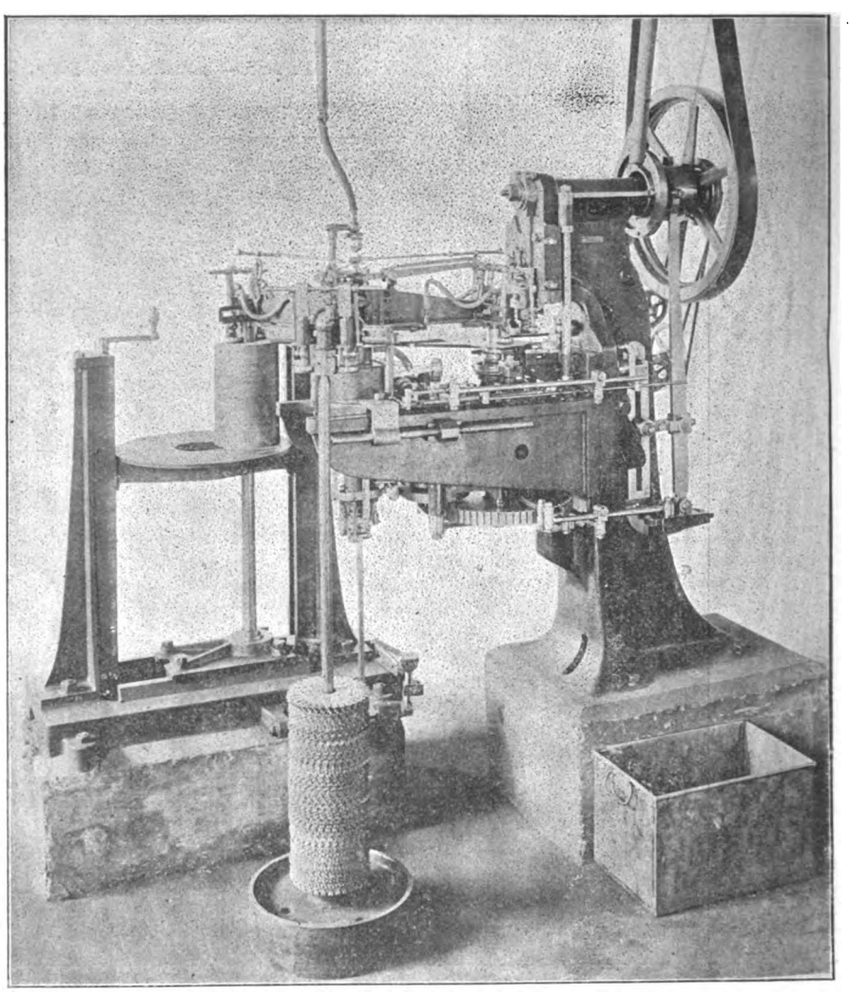

FIG. 28.—AUTOMATIC CORE-NOTCHING MACHINE NO. 2.

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pneumatically-controlled switching gear used in the extra-high-pressure experimental locomotives. Experiments with the firm's non-interchangeable standardised plaster fuses were shown. These fuses blew quietly on short-circuit, and although easily replaceable can only be replaced by fuses of the same size. The well-known horn pattern lightning arrester discharged 20,000 volts with 50 H.P. behind it for the visitors' edification. Another of the finished things that was on view was a single-rail towing locomotive for canals. On this the wheels on one side were flanged for the rail, and on the other side were flat. It has been built for a French company, and is designed to tow two

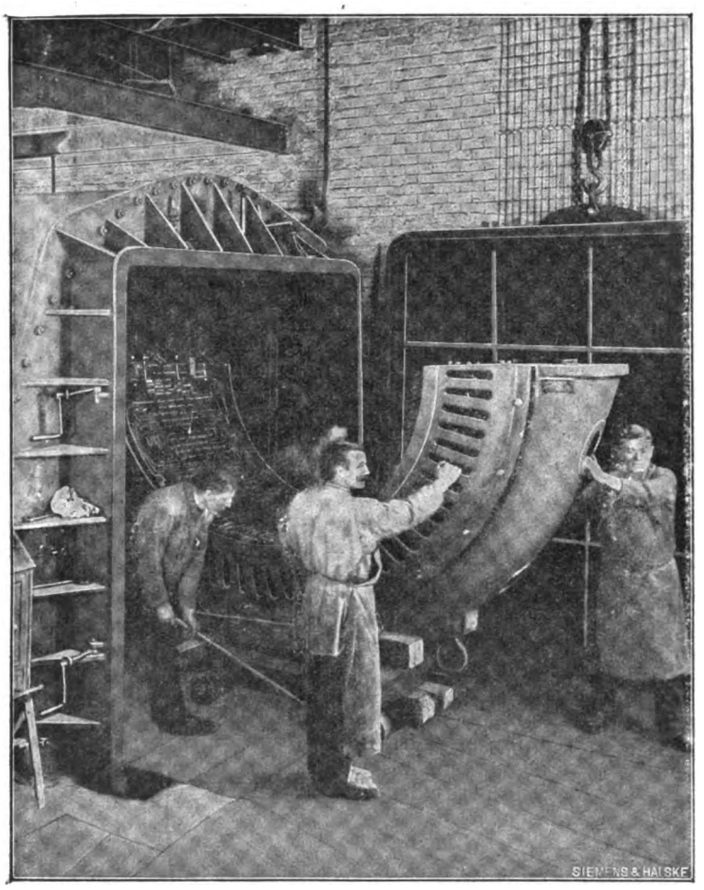


FIG. 29.—VACUUM DRYING CHAMBER.

300-ton barges at a speed of 8·6km. (2 miles) an hour. The motor, which will take continuous current at 500 volts, is rated at 13 H.P., and the tractive effort is 900kg.

## THE PACIFIC CABLE BILL.

A measure has been presented to Parliament entitled "A bill to provide for the construction and working of a submarine cable from the Island of Vancouver to New Zealand and to Queensland." It is marked 1 Edw. VII., and textually is as follows:—

Whereas it is expedient to provide for the construction of a submarine cable (in this act called the Pacific cable) from the Island of Vancouver on the west coast of the Dominion of Canada to Norfolk Island in the Pacific ocean, and thence by means of two cables to New Zealand and to Queensland respectively, at an estimated cost of £2,000,000:

And whereas it has been arranged that any sum required for the repayment of any money borrowed under this act and for the annual expenses of the cable (including interest at the rate of 3 per cent. on borrowed money) shall (so far as not covered by receipts) be ultimately provided as to $\frac{5}{16}$ths thereof by His Majesty's Government and as to $\frac{11}{16}$ths thereof by the Governments of Canada, of the States of New South Wales, Queensland, and Victoria, and of New Zealand (in this act referred to as the Colonial Governments) and that any profits arising from the cable shall be divided between His Majesty's Government and the Colonial Governments in the same proportion.

And whereas it is expedient to make provision with respect to the construction and working of the cable by a board of management to be called the Pacific Cable Board.

Be it therefore enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal and Commons, in this present Parliament assembled, and by the authority of the same as follows:—

1. The Treasury shall, as and when they think fit, issue out of the Consolidated Fund, or the growing produce thereof, such sums not exceeding in the whole the sum of two million pounds as may be required by the Pacific Cable Board for defraying the costs of the construction of the Pacific cable, and for the repayment of any temporary loan raised for the purpose of the cable before the passing of this act.

2.—(1.) The Treasury may, if they think fit, at any time borrow money for the purpose of providing for the issue of sums out of the Consolidated Fund under this act, or repaying to that fund all or any part of the sums so issued, and all sums so borrowed shall be paid into the Exchequer.

(2) Any sums so borrowed shall, during the construction of the Pacific cable, bear interest at the rate of 3 per cent. per annum, and after construction shall be repaid with interest at the same rate by means of terminable annuities for such period not exceeding 50 years from that time as the Treasury fix.

(3) The principal of and interest on any money so borrowed and after construction the annuities created for the purpose of the repayment of that money shall, unless otherwise provided for, be charged on and paid out of the Consolidated Fund or the growing produce thereof.

3.—(1) The amount required in each year for the annual expenses of the Pacific cable, including any such expenses incurred before the passing of this act, shall be defrayed out of the receipts arising in connection with the cable, and, so far as those receipts are not sufficient, out of moneys provided by Parliament.

(2) For the purposes of this act the annual expenses of the Pacific cable include any sums required for the payment of interest on money borrowed for the purposes of this act (including the interest on any temporary loan raised for the purpose of the cable before the passing of this act), or for the payment of annuities created under this act, and any expenses of the Pacific Cable Board or other expenses properly incurred in working or maintaining the cable.

(3) Such sums as are received from any Colonial Government on account of the annual expenses of the Pacific cable shall be paid into the Exchequer.

4. If in any year the receipts arising in connection with the Pacific cable exceed the amount required for the annual expenses of the cable, as hereinbefore defined, the surplus shall be applied, in such manner as the Treasury direct, in reduction of any sums outstanding on account of money borrowed under this act, and, if there is no such sum outstanding, $\frac{5}{16}$ths of the surplus shall be paid to the Colonial Governments, and the residue shall be dealt with as the Treasury determine.

5. Any sums available for the payment of interest on money borrowed under this act, or of annuities created under this act, and any sums available as surplus under this act shall be paid over by the Pacific Cable Board in such manner and at such times as the Treasury direct.

6.—(1) The construction and working of the Pacific cable shall be under the control and management of a board constituted in manner provided by the schedule to this act, and called the Pacific Cable Board, and the cable and all property used for and in connection with the cable, and any rights and obligations under any contract for or in connection with the construction of the cable entered into before the passing of this act, shall be vested in, and be rights and obligations of, the Board.

(2) The provisions of the schedule to this act shall apply with respect to the constitution and proceedings of the Pacific Cable Board.

7. The Pacific Cable Board shall in every financial year cause to be made out an account, in such form as the Treasury require, of the money received, expended, and borrowed, and of the securities created under this act, and that account shall be audited in manner directed by the Treasury and laid before Parliament.

8. This act may be cited as the Pacific Cable Act, 1901.

### SCHEDULE.

PROVISIONS AS TO THE CONSTITUTION AND PROCEEDINGS OF THE PACIFIC CABLE BOARD.

1. The Pacific Cable Board shall consist of three members representing His Majesty's Government, two members representing the Government of Canada, two members representing the Governments of the States of New South Wales, Victoria, and Queensland, and one member representing the Government of New Zealand.

2. The first members of the Board shall be:—

| | |
|---|---|
| Sir Spencer Walpole, K.C.B. (chairman)<br>G. E. Y. Gleadowe, Esq., C.M.G.<br>W. H. Mercer, Esq. | Representing His Majesty's Government. |
| Lord Strathcona and Mount Royal, G.C.M.G.<br>Alexander Lang, Esq. | Representing the Government of Canada. |
| Hon. Henry Copeland<br>Hon. Sir Andrew Clarke, G.C.M.G. | Representing the Governments of New South Wales, Victoria, and Queensland. |
| Hon. W. P. Reeves | Representing the Government of New Zealand. |

3. The Pacific Cable Board shall be a body corporate by that name, with perpetual succession and a common seal, and with power to purchase, take, hold and dispose of lands and other property for the purposes of this act.

4. Any vacancy occurring in the office of the members representing His Majesty's Government by reason of death, resignation, incapacity, or otherwise, shall be filled by the Treasury; and any such vacancy in the office of the representatives of any of the Colonial Governments shall be filled by the Government or Governments which the member whose office is vacant represented.

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5. The Treasury may appoint a member of the Board to be chairman of the Board, and so long as the chairman does not hold any office of profit under the Crown or under any Colonial Government there shall be paid to him such salary not exceeding £600 a year as the Treasury direct.

6. The Board may appoint such officers and employ such persons, and take such other steps as they think necessary and expedient for properly carrying out their duties, and may provide an office for the transaction of their business.

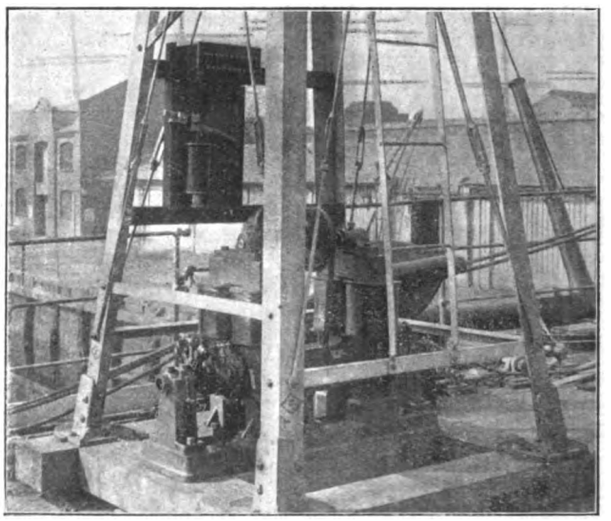
7. The Board may regulate their proceedings in such manner as they think fit, but on any matter on which the votes of the Board are equally divided the person presiding at the Board shall have a second or casting vote, and the quorum of the Board shall be three.

8. The Board may act notwithstanding any vacancy in their number.

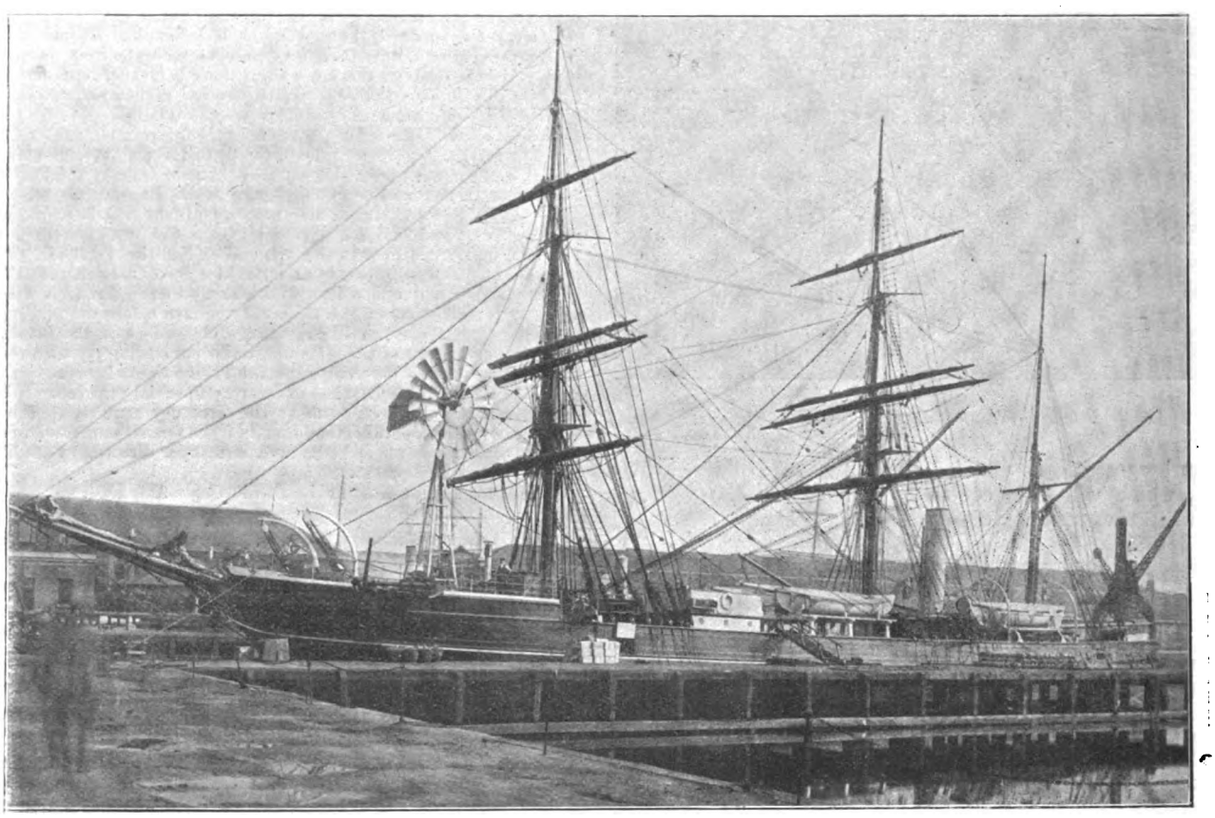
## ELECTRICAL PLANT ON THE SS. "DISCOVERY."

Last week we published a short note mentioning that the ss. "Discovery" had been fitted with a windmill connected to two dynamos for lighting purposes. Through the courtesy of the contractors, Messrs. Bergtheil and Young, we are now able to give a couple of illustrations showing the windmill and motors. The plant consists of a steel-geared windmill 16ft. diameter and 20ft. high, it is of the American type, and constructed that it can be easily shifted from one point to another. This mill is coupled to two dynamos, one having an output of 1·25kw., the other an output of about 1kw. These two generators are connected in series, the smaller machine opposing the larger. The regulation is provided by an automatic switch of the solenoid type. When the windmill is driving the dynamos at 500 revs. all the extra resistance is in series with the shunt of the small machine, and there is no resistance in series with the shunt of the large machine. As the speed increases the switch acts, resistance is cut out from the smaller machine, and at the same time the resistance of the shunt of the larger dynamo is increased. By this means the pressure is kept constant at about 65 volts, with a speed ranging from 500 to 2,000 revs. per min. The windmill is designed to run at 200 revs. per min., driving the dynamo at 800 revs. in a 15-mile wind. An automatic cut-in and cut-out is provided in the main circuit in series with a battery of accumulators.

The entire plant is extremely compact, and is so designed that it can be stored away in the hold of the ship until she arrives at her destination. In the event of it becoming necessary to light observation cabins or instrument sheds in the vicinity of the vessel, flexible cables have been provided with lamps attached so that these may be illuminated from suitable plugs placed about the ship. The windmill is so designed that it may be placed complete with its dynamos at a distance of 200yds. from the vessel for the purpose of obtaining the very best results from the wind, and connected to the vessel by means of an armoured cable wound on a drum.



THE WINDMILL-DRIVEN DYNAMOS.



THE SS. "DISCOVERY."

The plant was designed by Mr. Arthur Bergtheil, and both the windmill and dynamos were specially manufactured for the installation, the former by Messrs. Alfred Williams & Co. and the latter at the Newton Electrical Works.

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## TABLE OF ELECTRIC SUPPLY STATIONS OF AUSTRALIA.

| Locality. | Date of commencement of supply. | Supply authority or company. | Engineer or manager. | Secretary or town clerk. | System employed. | Voltage at consumer's terminals. | No. of consumers. | No. of incandescent lamps, equiv. 16 c.p. | No. of arc lamps. | Horse-power in motors. | Capacity of plant. Kw. | Capacity of plant. Eqv. 16cp. lamps. | Boilers. | Engines. | Dynamos. | Price per unit. Lighting. | Price per unit. ower. | Price of gas in neighbourhood. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Syndey ... | ... | Corporation ..... | Major Cardew (consulting) | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| ,, ... | 1898 | Empire E.L. Co. | J. W. Gardam | C. Leplastrier. | D.C. ..... | 200 | ... | 3500 | ... | 17 | 400 | 6400 | 2 × 140 H.P. B&W. 3 × 80 HP. Multbl. | 3 × 90 H.P. & 2 × 165 Alley & Maclellan | 3 × 60 kw. & 2 × 110kw. Parker | 6d. | 4½d. | 4/- | New station being erected. |
| ,, ... | 1894 | G. Adams ..... | ... | ... | D.C., 2-wire | 110 | ... | ... | ... | ... | 225 | 3600 | 3 Multitubular... | 2 × 150 H.P. & 1 × 60 H.P. Willans | 2 × 90 kw. & 1 × 45kw. Siemens | ... | ... | 4/- | Supplies 2 theatres, & motors for printing & sewing machines. |
| ,, ... | ... | Strand E.L. Co. | John Kent ... | ... | D.C. ..... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4/- | |
| Redfern ... | 1892 | Corporation ..... | J. W. Balfour | ... | A.C., 1000 v. 85 cycles | 100 | 105 | 1730 | 13 | Nil | 240 | 3800 | 2 × 200 H.P. Multi-tubular | 2 × 200 H.P. Hor. Comp. | 2 × 120 Mather & Platt | 5½d. | ... | 4/- | Public lighting by 400 25 c.p. series incandescent lamps. |
| Tamworth. | 1889 | Municipal Council | J. E. Mellor ... | W. Hughes ... | D.C., 2-wire | 220 | ... | 200 | 10 | Nil | 44 | 700 | 2 × 30 H.P. Multi-tubular | 2 × 30 H.P. Comp. | 2 × 22kw. Crompton | ... | ... | 7/11 | Public lighting only. |
| Penrith ... | ... | Corporation ..... | ... | ... | A.C. ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Broken Hill | 1890 | B.H.E.L. and P. Co. | F. J. Mars..... | ... | A.C., 1000 v. 133 cycles | 50 & 100 | 150 | 1800 | 15 | 4 | 220 | 3500 | 3 × 90 H.P. B.& W. | 2 × 110 H.P. Westgh 1 × 175 H.P. Belliss | 2 × 30kw. Westg. 1 × 50kw. Mordey 1 × 110kw Brown | 1/- | 7½d. | 15/- | Fan motors. |
| Hillgrove.. | ... | Hillgr. & Armidale E. Cor. (Ltd.) | A. L. Cadogan | E. J. Erskine.. | A.C. lighting, D.C. power | 110 & 1500 | 60 | 528 | 2 | 200 | 530 | 8500 | Water-power ... | ... | 3 D.C., 2 A.C. Crompton | ... | ... | None | Power for mining. |
| Lambton .. | ... | Corporation ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Mossvale... | ... | M.V.E.L. Co. ... | Chas. Taylor... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Newcastle. | ... | Corporation ..... | G. H. Lofts ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Young..... | ... | Corporation ..... | G. H. Lofts ... | G. E. Spark ... | A.C., 1000 v. 126 cycles | 56 | 140 | 1060 | 1 | Nil | 105 | 1500 | 2·75 H.P. Multi-locomotive | 2 Fowler Under-type Comp. | 3 T.H., 35kw. | 8d. | ... | None | Rate per 16 c.p. lamp, 8d. per week. |
| Melbourne | 1894 | Corporation ..... | A. J. Arnot ... | ... | D.C. & A.C. | 230 & 100 | 970 | 20000 | 1120 | 92 | 2700 | ... | 4 × 250 B. & W... 4 × 500 B. & W... | ... | ... | 5d. | 3d. | 5/- | Converting to 3-wire |
| ,, ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Geelong ... | ... | E.L. and T. Co. of Aust. ..... | ... | ... | D.C., 3-wire | ... | ... | ... | ... | ... | 320 | 5100 | ... | ... | Brush ..... 3 × 25kw. Brush | ... | ... | ... | |
| Bendigo ... | 1892 | E.S. Co. of Vic. | B. Sluytermann | G. S. Morison.. | A.C. & D.C. | 100 | 112 | 1950 | 81 | 76 | 165 | 2600 | 4 × 70 H.P. B. & W. | 5 × 70 H.P. Comp... | 4 × 12kw Arc lts, 1 × 40kw G'nz AC | 8d. | 8d. | 8/4 | System in course of reconstruction. |
| Ballarat ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Nhill ..... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Brisbane... | 1888 | B.E.S. Co..... | E. C. Barton... | W.M.L'Estr'nge | D.C., 3-wire | 110 | 160 | ... | 20 | ... | 180 | 2900 | Lancashire ..... | ... | ... | ... | ... | 5/- | Output 260,000 units per annum. 100 fan motors. |
| Charters Towers | 1897 | C.T.E.S. Co. ..... | F. Warden ... | A. W. Wilson.. | A.C., 2200 v. | 100 | 82 | 1598 | Nil | Nil | 80 | 1300 | 2 × 80 H.P. Multi-tubular | 2 × 70 H.P. Browett Lindley | 2 × 40kw Crompton | 1/- | ... | 13/4 | |
| Ipswich ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | |
| Rockhmptn | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Adelaide... | 1900 | E.L. and T. Co. of Aust. | F. W. Wheadon | F. C. Howard | D.C., 3-wire | 220 | 11 | 900 | 39 | Nil | 360 | 5800 | 3 × 200 H.P. B.& W | 3 × 200 H.P. Willans | 3 × 120kw. Bruce Peebles | 8d. | 3d. | 6/6 | Supply carried on by temp. plant during completion of station |
| Pt. Ad'laide | 1399 | E.L. and T. Co. of Aust. | F. W. Wheadon | F. C. Howard | D.C., 3-wire | 200 | 75 | 3000 | 30 | Nil | 120 | 1900 | 3 Cornish ..... | 5 Alley and Maclellan | 5 Johnson and Phillips | 7d. | 4d. | 7/6 | |
| Hobart ... | 1898 | H. Gas Co. ..... | A. C. Parker... | W. J. Campbell | A.C. ..... | 110 | 58 | 2000 | 15 | ... | 52 | 800 | ... | Crossley Gas Engines | ... | ... | ... | ... | 100kw. steam set being installed. |
| Launceston | 1896 | Municipal Council | Wm. Corin ... | C. W. Rocher | A.C., 2000 v. | 110 & 220 | 1136 | 9186 | 118 | 96 | 565 | 9000 | Water-power ... | 5 × 160 H.P. Thompson vert. turbines | 1 × 100k. Siemens A.C., 5 Siemens 35 Arc Lighters | 6d.-3d. | 2d.-1d. | 7/1 | |
| Perth ..... | 1893 | Perth Gas Co. .. | H. Broadbent.. | T. Blackney ... | D.C., 3-wire | 220 | 650 | 10000 | 120 | 100 | 410 | 6600 | 5 × 100 H.P. B&W. | 4 × 80 & 2 × 160 H.P. Willans | 4 × 50 & 2 × 100 kw. Castle | 9d.-6d. | 7d.-4d. | 7/6 | Extensions in hand. |
| Kalgoorlie. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Coolgardie. | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| Claremont. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | |

EXPLANATION OF ABBREVIATIONS.—A.C., Alternating Current; D.C., Direct Current; B. & W., Babcock & Wilcox boilers; Kw., Kilowatts.

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## ELECTRIC SUPPLY STATIONS OF AUSTRALIA.

We reprint from *Australian Hardware and Machinery* of June 1st the table on the preceding page, furnishing data of the electric supply stations of Australia, and compiled on the same lines as *The Electrician* annual table of electricity supply works of the United Kingdom. It will be seen that the electrical industry has not been making the greatest of progress in that continent, though we trust with the advent of a United Commonwealth a rapid advance will soon take place. It would appear that a town like Sydney, with a population of over 426,000 inhabitants, must be bound hand and foot by gas monopolists to account for the fact that only a plant of a capacity of 625kw. has been installed. It is certainly greatly to be wondered at that electric light has not completely superseded gas and electric fans become a question of absolute necessity in a country with the hot climate of Australia, and which enjoys the most expensive unskilled labour in the world. In contradistinction, Calcutta with its cheap punkah coolie labour has nearly as many electric fans as Sydney has lights. For its size the most promising station is at Launceston, in Tasmania. With a population of about 26,000 inhabitants it has the equivalent of 9,200 16 c.p. lamps connected, but, as will be seen by the works accounts published in our last week's issue, a capital of £176 per kilowatt has been expended. It will be noticed that in the whole of Australia there are only 27 towns that have electricity supply stations. Of these ten are in New South Wales, five in Victoria, four in Queensland, two in South Australia, four in Western Australia and two in Tasmania.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Proceedings of the Royal Society." No. 448. Vol. LXVIII. (London: Harrison & Sons). 1s. 6d.

"Theoretical Elements of Electrical Engineering." By C. P. Steinmetz. (New York: *Electrical World and Engineer.*)

"The Management of Engineering Workshops." A course of six Lectures, by A. H. Barker, before the Institution of Junior Engineers. (London: The Institution.) 3s.

Original Papers. By the late Dr. John Hopkinson, F.R.S. Two Vols. Edited, with a Memoir, by B. Hopkinson. (Cambridge: University Press.) 10s. 6d each.

## ELECTRICITY WORKS ACCOUNTS.

### Hanley Municipal Electric Supply Works.

Although a deficit is again the result of a year's working at Hanley, yet the position of the undertaking is rapidly improving. A glance at our table will serve to show that as compared with 1899 a general and consistent improvement has been effected in those items of cost which were abnormal. The result is that there is but one item—that of repairs and maintenance at the station—which can fairly be considered still above the average. The expenditure under this head shows a diminution within the last year of more than 0·2d., but we believe it is possible to arrive at a value little more than half the present one of 0·389d. per unit. Last year we recorded the circumstances which led to the adoption of the scale of tariff, which, perhaps, even more than the rather high cost of working contributed to the disastrous deficit arrived at in 1899. The difficulty of raising the price was apparently surmounted in the course of last year, and from August to December inclusive the charge for supply was according to the higher rate given in our table.

The load factor for the year was 11·6 per cent., as against 11·2 per cent. in 1899. The output increased by nearly 20 per cent., and the lamp connections by over 18 per cent.

### Bury Municipal Electric Supply Works.

We are sorry, though not surprised, to see that the Bury undertaking has failed to maintain the excellent results of the year 1899-1900. In many respects the operations of last year were most satisfactory—the aggregate costs, even in the face of the greater price of coal, being by no means above the average. We learn from Mr. Watson's report that in 1898-9 the price paid for coal was 6s. 11d. per ton, in 1899-1900 9s. 6½d. and last year 12s. 6d. As between 1899-1900 and 1900-1 this represents an increase of nearly 81 per cent., while the fuel item in our table shows an increase of only 22·7 per cent. The consumption of coal was thus reduced by 8 per cent.

An examination of our table will show that the expenditure on repairs has gone up considerably. The report states that £65 was spent in rebuilding a retaining wall damaged during a storm in August, £30 on repairs to a flue, £100 on repairs due to deterioration of vulcanised rubber cables, and £92 for maintenance of accumulators; they being previously covered by a three years' guarantee. The alteration of pressure was carried out in April, the increase being from 220 to 440 volts across the outers of the three-wire system used. For lighting purposes, consumers are supplied at 220 volts, 440 volts being used only for the larger sizes of motors. At March last there were connected to the mains 29 motors, equal to a total of 98 H.P. Of these 15, aggregating 58 H.P., were connected during the year ended at March last. To a great extent, this increase in the use of motors follows upon the committee's decision in June to let motors on hire. The majority of the hired motors are in daily use for driving workshops, and during the year the output for motors and heating purposes was 24,471 units, as compared with 8,328 in the preceding year. The effect of the increased motor load is shown in the increased and high load factor of 13·3 per cent., although nearly half of the total motor supply was used in the last quarter of the year.

An advance of 26 per cent. has taken place in the equivalent lamp connections, and the total output shows an increase of 22·4 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Bath (Municipal) | April 20, 1900 | Leith (Municipal) | May 17, 1901 |
| Bedford (Municipal) | Aug. 3, 1900 | Leyton (Municipal) | Jan 18, 1901 |
| Belfast (Municipal) | July 6, 1900 | Liverpool (Municipal) | Mar. 22, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | London (Company) | July 26, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bournemouth (Company) | May 3, 1901 | Morley (Municipal) | June 14, 1901 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | July 12, 1901 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 10, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | May 3, 1901 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | July 26, 1901 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | April 19, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Municipal) | July 5, 1901 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 26, 1901 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | South London (Company) | May 31, 1901 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | Southport (Municipal) | July 7, 1899 |
| Folkestone (Company) | April 26, 1901 | Stafford (Municipal) | Aug. 17, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Guildford (Company) | Oct. 19, 1900 | Taunton (Municipal) | June 16, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Hammersmith (Vestry) | June 29, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hanley (Municipal) | July 27, 1900 | Wandsworth (Company) | April 19, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Hast'gs & St. Leonards (Mun.) | July 12, 1901 | Winchester (Company) | May 17, 1901 |
| Hove (Company) | May 10, 1901 | Windsor and Eton (Co.) | July 19, 1901 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woking (Company) | Dec. 22, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Kens'gton & Knightsbr'(Co.) | Mar. 16, 1900 | Woolwich (Company) | May 31, 1901 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Worcester (Municipal) | July 19, 1901 |
| Kingston-on-Thames (Mun.) | July 20, 1900 | Great Yarmouth (Mun.) | Dec. 24, 1900 |
| Lancaster (Municipal) | Feb. 15, 1901 | | |

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| | HANLEY. | | BURY. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Corporation of Hanley. | | Corporation of Bury. | |
| *Date of Commencement of Supply* | July, 1894. | | November, 1896. | |
| *System of Supply* | Alternate-current transformer sub-stations. | | 3-wire continuous-current. | |
| *Chief Engineer* | C. A. Cowell. | | S. J. Watson. | |
| **YEAR ENDED** | DEC. 31, **1899.** | DEC. 31, **1900.** | MAR. 31, **1900.** | MAR. 31, **1901.** |
| **QUANTITIES—** | | | | |
| Units generated | 638,025 | 740,664 | 228,546 | 282,056 |
| „ **SOLD (TOTAL)** | 537,893 | 643,200 | 213,395 | 261,247 |
| „ sold to consumers | 414,823 | 530,719 | 167,890 | 28,997 |
| „ sold for public lighting, &c. | 123,070 | 112,481 | 45,505 | 51,250 |
| „ used on works | 14,199 | 11,575 | 6,939 | 8,231 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 14·0 | 16·8 | 12·3 | 15·1 |
| Maximum supply demanded | 550 kilowatts | 634 kilowatts | 197 kilowatts | 224 kilowatts |
| Number of public lamps | 65 arc, 80 glow[a] | 67 arc[g] | 31 arc | 33 arc |
| Number of consumers | 456 | — | 198 | 254 |
| Connections to mains in 8-c.p. lamps | 35,160 | 41,612 | 14,733 | 18,559 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 38,300 | 38,300 | 17,300 | 17,300 |
| **CAPACITY OF PLANT IN KILOWATTS** | 1,224 | 1,224 | 554 | 554 |
| **CAPITAL—** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** |
| **AUTHORISED (TOTAL)** | £70,009 / £57·2 | £75,009 / £61·2 | £50,000 / £90·3 | £50,000 / £90·3 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 70,009 / 57·2 | 75,009 / 61·2 | 50,000 / 90·3 | 50,000 / 90·3 |
| **RECEIVED (TOTAL)** | 64,990 / 53·1 | 68,990 / 56·3 | 34,395 / 62·1 | 39,765 / 71·8 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 64,990 / 53·1 | 68,990 / 56·3 | 34,395 / 62·1 | 39,765 / 71·8 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 5,019 / 4·10 | 6,019 / 4·91 | 15,605 / 28·2 | 10,235 / 18·5 |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | 5,019 / 4·10 | 6,019 / 4·91 | 15,605 / 28·2 | 10,235 / 18·5 |
| **REPAID (TOTAL)** | nil / — | nil / — | 1,426 / 2·57 | 2,246 / 4·05 |
| **RESERVE OR SINKING FUND** | 5,638 / 4·61 | 7,786 / 6·36 | 829 / 1·50 | 1,020 / 1·84 |
| **DEPRECIATION FUND** | nil / — | nil / — | — / — | — / — |
| **EXPENDED (TOTAL)** | 67,829 / 55·4 | 73,330 / 59·9 | 40,715 / 73·5 | 46,300 / 83·6 |
| Lands and buildings | 9,232 / 7·54 | 9,886 / 8·07 | 9,008 / 16·3 | 9,398 / 17·0 |
| Plant | 35,548[b] / 29·0 | 38,307 / 31·3 | 15,915 / 28·7 | 19,776[c] / 36·1 |
| Mains | 21,850 / 17·8 | 23,662 / 19·3 | 15,203 / 27·4 | 16,520 / 29·8 |
| Miscellaneous | 1,199 / 0·980 | 1,474 / 1·20 | 589 / 1·06 | 606 / 1·09 |
| **BALANCE OF CAPITAL ACCOUNT** | −2,839[c] / −2·32 | −4,340[c] / −3·54 | −6,320[a] / −11·4 | −6,535[a] / −11·8 |
| **REVENUE—** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** |
| **TOTAL** | £8,809 / 3·933d. | £11,640 / 4·345d. | £3,644 / 4·099d. | £4,365 / 4·010d. |
| Revenue from supply | 7,068 / 3·155d. | 9,714 / 3·622d. | 3,033 / 3·412d. | 3,619 / 3·325d. |
| „ meters, &c. | 268 / 0·120d. | 287 / 0·107d. | 118 / 0·133d. | 150 / 0·138d. |
| „ public lighting | 1,447 / 0·646d. | 1,639 / 0·612d. | 474 / 0·533d. | 568 / 0·522d. |
| „ sale of lamps, &c. | 26 / 0·012d. | — / — | 19 / 0·021d. | 27 / 0·025d. |
| „ miscellaneous sources | — / — | — / — | — / — | — / — |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £7,632 / 3·406d. | £8,010 / 2·990d. | £1,657 / 1·864d. | £2,714 / 2·494d. |
| **WORKS COSTS** | 6,400 / 2·857d. | 6,519 / 2·433d. | 1,053 / 1·184d. | 1,821 / 1·673d. |
| *Generation of electricity* | *5,301* / *2·366d.* | *5,438* / *2·029d.* | *962* / *1·082d.* | *1,547* / *1·421d.* |
| Fuel (including cartage, &c.) | 2,540 / 1·134d. | 3,134 / 1·170d. | 489 / 0·550d. | 734 / 0·675d. |
| Oil, waste, water, stores | 460 / 0·205d. | 273 / 0·102d. | 73 / 0·082d. | 78 / 0·072d. |
| Wages at station | 975 / 0·435d. | 988 / 0·369d. | 339 / 0·381d. | 463 / 0·426d. |
| Repairs and maintenance at station | 1,326 / 0·592d. | 1,043 / 0·389d. | 61 / 0·069d. | 273 / 0·251d. |
| *Distribution of electricity* | *613* / *0·274d.* | *447* / *0·167d.* | *28* / *0·032d.* | *152* / *0·140d.* |
| Wages, &c. | 93 / 0·042d. | 65 / 0·024d. | 28 / 0·032d. | 152 / 0·140d. |
| Repairs, renewals of mains, &c. | 520 / 0·232d. | 382 / 0·143d. | | |
| *Public lighting* | *486* / *0·217d.* | *634* / *0·237d.* | *63* / *0·071d.* | *122* / *0·112d.* |
| Attendance | 343 / 0.153d. | 336 / 0·125d. | 38 / 0·043d. | 42 / 0·039d. |
| Renewals | 142 / 0·063d. | 298 / 0·111d. | 25 / 0·028d. | 81 / 0·074d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 1,233 / 0·551d. | 1,491 / 0·557d. | 606 / 0·682d. | 893 / 0·821d. |
| *Royalties* | nil / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *586* / *0·262d.* | *753* / *0·281d.* | *179* / *0·201d.* | *324* / *0·298d.* |
| *Management* | *647* / *0·289d.* | *738* / *0·275d.* | *427* / *0·480d.* | *569* / *0·523d.* |
| Salaries | 507 / 0·226d. | 593 / 0·221d. | 353 / 0·397d. | 438 / 0·403d. |
| Stationery, &c. | 31 / 0·013d. | 44 / 0·016d. | 22 / 0·025d. | 34 / 0·031d. |
| Establishment charges | 46 / 0·021d. | 43 / 0·016d. | 52 / 0·059d. | 97[d] / 0·089d. |
| Law charges, &c. | 63[d] / 0·028d. | 58[h] / 0·022d. | | |
| **FINANCIAL RESULTS—** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** |
| **WORKING PROFIT FOR YEAR** | £1,177 / 1·83% | £3,631 / 5·14% | £1,987 / 5·39% | £1,651 / 3·80% |
| Sum carried to Depreciation Fund | — / — | — / — | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 1,316 / 2·05% | 2,148 / 3·05% | 808 / 2·19% | 1,013 / 2·33% |
| Net interest on loans (incl. Debenture charges) | 2,131 / 3·32% | 2,124 / 3·01% | 996 / 2·70% | 1,294 / 2·97% |
| **BALANCE FROM LAST ACCOUNT** | — / — | — / — | — / — | — / — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — / — | — / — | 183 / 0·493% | — / — |
| *Deficit* | *2,269* / *3·53%* | *641* / *0·908%* | — / — | *658* / *1·51%* |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 86·6% | 68·8% | 45·5% | 62·2% |
| Expenditure per kilowatt capacity | £6. 4s. 7d. | £6. 10s. 10d. | £2. 19s. 10d. | £4. 18s. 0d. |
| **REVENUE PER KILOWATT CAPACITY** | £7. 3s. 10d. | £9. 10s. 2d. | £6. 11s. 7d. | £7. 17s. 7d. |
| Expenditure per 8-c.p. lamp capacity | 3s. 11¾d. | 4s. 2d. | 1s. 11d. | 3s. 1½d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 4s. 7¼d. | 6s. 1d. | 4s. 2½d. | 5s. 0½d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 5s. 0d. | 5s. 7d. | 4s. 11½d. | 4s. 8½d. |
| Price charged for lighting, per unit | 5d. to 2½d.[e] | 6d. to 3d.[i] | 6d. to 3d.[b] | 6d. to 3d.[b] |
| Price charged for power, per unit | 2½d. to 1d.[f] | 3d. to 1d.[j] | 3d. to 1d.[b] [per ann. | 3d. to 1d.[b] [per ann. |
| Price charged for public lighting | £19 per arc, £3 per incan. | £22 per arc, 6s. per glow | £17. 10s. & £15 per arc | £17. 10s. & £15. per arc |

HANLEY.—REMARKS—*a* Includes 60 400-watt arcs and 5 500-watt alternating arcs. *b* Includes £2,581 on street lamps and posts. *c* Over-expended. *d* Inclusive of £40 to insurance. *e* 5d per unit for first two hours in winter half-year and for first hour in summer half-year, 2½d. afterwards; chapels 4d. per unit. *f* 2½d. for first four hours, 1d. after; maximum demand system. *g* The arcs are of 400 watts capacity; there are 130 columns with brackets fitted with glow lamps equivalent to 317 8 c.p. (32 watt) lamps. *h* Insurance £43. *i* Maximum demand system, 6d. for first two hours, 3d. after; to churches and chapels 4½d. per unit. Discount of 5 per cent. for early payment. *j* Maximum demand system, 3d. for first four hours, 1d. per unit after. Discount of 5 per cent. for early payment.

BURY.—REMARKS—*a* Over-expended. *b* By maximum demand system, 1 hour scale. *c* Includes £967 on public lamps. *d* Insurance £23.

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## THE OUTLOOK IN THE ELECTRICAL INDUSTRY.

During the last year or two attention has been continually directed to the activity in Germany in electrical engineering matters. That country has been held up to us as a pattern, and we have been told that in the electrical industry, and even in mechanical engineering, we are gradually resigning to Germany our position as the leading industrial nation. Whether we have actually been outstripped or not, it cannot be denied that we are losing headway in more than one branch of engineering construction, and this fact has been fully made use of by agitators for reform in all possible directions. Some have attributed our backwardness entirely to the inadequacy of or want of organisation in our technical educational facilities. Others say that, so far as the electrical industry is concerned, the cause is the restrictive legislation with which its progress has been hampered, and the craze of municipalisation in opposition to private enterprise. The manufacturers have asserted that the want of standardisation is at the root of the matter, and have found fault with the consulting engineers for not encouraging this to a greater extent; while the user of electrical machinery and his advisers complain that the British manufacturer does not keep up-to-date in following the progress made in technical matters and in modifying his methods and designs to embody the newest inventions and improvements. Finally, it has been said that the system of financing electrical undertakings has been superior in Germany, and that what was wanted in this country was a number of industrial banks to find capital for the various new ventures which should constantly be undertaken.

From the engineering and technical point of view the German electrical industry is still in the first rank, but of late much has been spoken of its financial status being unsound. The unfortunate failure of a fairly large firm of manufacturers in Saxony, the "slump" in the stock and shares of other electrical companies, and the stoppage of one of the most important industrial banks have been made much of, and Cassandras have not been wanting (including our esteemed contemporary *Engineering*) to write down the present state of affairs as a crisis and to prophesy further disasters. At the moment matters are not so serious, in our opinion; but they might easily be made so by a panic causing a run on the remaining industrial banks, some of which are,

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we believe, largely interested in and intimately connected with electrical undertakings. If this general panic is averted things will, no doubt, gradually recover their former stability. It cannot be denied that at the present moment orders may be rather "shy" in coming in to mechanical and electrical engineering works in Germany, but this should be merely a temporary phase brought about by the general industrial depression due to the "tightness" of money, the low value of Consols and all securities, and primarily to the continuance of the war in South Africa. That business is bad is the general cry here as well, although, fortunately, our electrical manufacturing works are still as busy as they can be.

As electrical engineers in this country have constantly been told to profit by the good example of Germany, we may perhaps also learn some lessons by the misfortune which has been threatening. As stated above, we believe that the danger has been considerably exaggerated, but if there is any risk of calamity at present, it would seem to be entirely due to the much-praised system of financing with the assistance of industrial banks; a system which is not capable of bearing the strain of a temporary industrial depression must be an imperfect one. In this country, when capital is needed for an undertaking, it is either supplied by independent capitalists, or a joint-stock company is formed and subscribed for either in whole or in part by the public. This system has no doubt led to much over-capitalisation, both of large and small concerns, in passing through the hands of the company promoters and pioneer companies, but the German system is not free from this blemish either. A comparison of the two systems broadly leads to this: In Germany the public invests its capital in the banks, and the capital is applied to industrial undertakings without the individual investor having much voice in the matter; in England the investor subscribes to the undertaking directly, and knows precisely what he is putting his money into. To the investor who subscribes for shares merely on the strength of the names of the directors the difference is nil, otherwise it appears that the public should feel securer when investing on the English plan.

Another matter may also be alluded to. At present British manufacturers are busy; their customers are to a large extent municipal authorities embarked in electric supply business whom the state of the money market hardly affects. Our manufacturers are, therefore, turning out plant on the lines they are accustomed to as fast as they can, and many of them are not particularly anxious to embark on the manufacture of a new class of machinery. In consequence, large orders for plant of certain types go from England to America and the Continent, and as Germany is at the moment capable of making excellent electrical machinery of the most modern design for exceedingly quick delivery a number of these orders will go across the North Sea. But if the British manufacturer goes on quietly in this way there is a danger of the buyers of the newer types of machines getting into the habit of placing their orders abroad, and as the "repeat orders" for the older patterns get less and the demand for the newer types grows, the British manufacturer may be left behind. It behoves him therefore to devote much more energy than hitherto to the development of the more recent patterns of electrical machinery. Let him get out his new designs, let him standardise them, and, if necessary, enlarge his works so that he can manufacture the new machines side by side with his old ones on a remunerative scale. The market is already there for him: only a few months ago electrical machinery for an output of thousands of horse-power was ordered by one of the London electric supply companies from a German firm.

## ELECTROMAGNETIC THEORY.—CXXIV.*

BY OLIVER HEAVISIDE.

(*Continued from page 85.*)

§ 492. Digging out the details of the problem under consideration deserves to be done with care, for this reason. The results of the two important cases of the steady motion of an electron at a speed either less or greater than that of light, hitherto treated separately, though abundantly verified, do not exhibit much compatibility. But in the present investigation the spherical and the conical states are both in action together, and we shall see how they are harmonised. It is done by means of the spherical pulse due to the sudden change of velocity at the initial moment. Or, if the change is not quite sudden, or the charge is of finite size, then by a shell wave of finite depth. In fact, the wave on the surface of the cone is continued upon the surface of the sphere and, by leakage therefrom, connection is made between the displacement inside the sphere and that inside the cone, which are of different densities.

In the first place, as regards the potential A in the cone and $A_0$ in the sphere, equations (36) and (38). The outermost equipotential surface is the wave surface itself, partly the surface

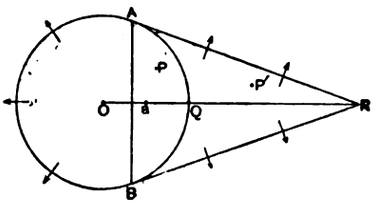


FIG. 34.

of the cone, partly of the sphere; $A=0$ on the one, and $A_0=0$ on the other. Also $A=A_0$ upon the portion AQB of the sphere, Fig. 34. Prove by (38). We have identically

$$l^2-h^2=\frac{(v^2t-uz)^2}{u^2-v^2}+v^2t^2-h^2-z^2, \tag{43}$$

and when $v^2t^2=h^2+z^2$, we get

$$A_0=\frac{\mu C}{4\pi}\log\left\{\left(\frac{u-v}{u+v}\right)^{\frac{1}{2}}\frac{(ut-z)v\pm(uz-v^2t)}{(u^2-v^2)^{\frac{1}{2}}(vt-z)}\right\} \tag{44}$$

on the circle. Here $uz-v^2t$ is + on the right side and − on the left side of the plane AB, and the value of the radical $(l^2-h^2)^{\frac{1}{2}}$ in (38) must be always taken +. Allowing for this, $A_0=0$ on the left side, and

$$A_0=\frac{\mu C}{4\pi}\log\left(\frac{vt+z}{vt-z}\frac{u-v}{u+v}\right) \tag{45}$$

on the right side of AB. This also agrees with A derived from (36) in the cone.

The innermost equipotential surface is a surface enclosing infinitely closely the axial current C, on the line OQR. There $A=\infty$, $A_0=\infty$. Now we know already that the equipotential surfaces in the cone are co-axial cones, § 477, and since the outermost cone is made complete by a spherical continuation, it is an easy guess that the internal cones are completed within the sphere by means of ellipsoids of revolution. That is, the equipotential lines in the plane of the figure are ellipses with their major axes on the line OQR. In fact, it is quite easy to draw them roughly by the mere look of things. They must all pass round the point O on the left side. For the help of anyone who may wish to go further in this respect, I give the equation of the ellipses, without the complicated work. Let

$$X=\left(a^2\frac{u+v}{u-v}-1\right)\frac{v}{u-v}-a\frac{2v^2-u^2}{(u-v)^2}, \tag{46}$$

$$Y=1+2a\frac{v}{u-v}-a^2\frac{u+v}{u-v}, \tag{47}$$

$$Z=1+a^2\frac{u+v}{u-v}, \tag{48}$$

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where $a$ is a constant. Then,

$$\left(z+\frac{uvt\mathrm{Y}}{2(u-v)\mathrm{X}}\right)^2+\frac{\mathrm{Z}h^2}{4a\mathrm{X}}=\frac{au^2v^2t^2}{(u-v)^2\mathrm{X}}+\left(\frac{uvt\mathrm{Y}}{2(u-v)\mathrm{X}}\right)^2 \quad (49)$$

is the equation required, in a form showing the position of the centre upon the axis of C, and the size of the semi-axes. The co-ordinates are $z$ and $h$, origin at O; and $ut$ is the distance OR.

The position of the centre, from the values of Y and X, may be represented by

$$z=\frac{\frac{1}{2}vt}{\frac{v}{u}+\frac{b}{1-b^2+(v/u)(1-b)^2}}, \quad (50)$$

if $b=a^{-1}$. From this we can see that when $u<v$ the position of the centre varies between $z=0$ and $\frac{1}{2}ut$. When $u=v$,

$$z=\frac{1-b}{2-b}vt, \quad (51)$$

going from $\frac{1}{2}ut$ to 0 as $b$ goes from 0 to 1, and all the ellipses touch at the point Q, that being the extremity of their major axes. The line of impressed current is then OQ without the extension QR. The ratio of the minor to the major axis is $\sqrt{b(2-b)}$, and the semi-axis major is $vt/(2-b)$.

That is enough about the nature of distribution of A, for its only utility here is to lead to the physically significant magnetic force by equation (31). It happened to be easier to obtain H through A than directly. We may also use it to derive the electric force, at least partly, and fully by the use of an auxiliary potential function, but for electrical clearness there is a better way than that, which will be used presently.

§ 493. Denoting by $\mathrm{H}_0$ and H the intensities of magnetic force inside the sphere and the cone (outside the sphere), we have

$$\mathrm{H}=\frac{\mathrm{C}}{2\pi h}\frac{l}{(l^2-h^2)^{\frac{1}{2}}}, \quad (52)$$

$$\mathrm{H}_0=\frac{\mathrm{C}}{4\pi h}\left\{\frac{l}{(l^2-h^2)^{\frac{1}{2}}}+\frac{z}{(z^2+h^2)^{\frac{1}{2}}}\right\}. \quad (53)$$

These are valid whether $u$ be $>$ or $<v$. But in the latter case, $l$, which is the semidiameter of the cone when $u>v$, should be put in terms of $u$ and $v$, by $l=(ut-z)\tan\theta$, and $\sin\theta=v/u$. This makes

$$\mathrm{H}_0=\frac{\mathrm{C}}{4\pi h}\left\{\frac{ut-z}{\{(ut-z)^2+h^2(1-u^2/v^2)\}^{\frac{1}{2}}}+\frac{z}{(z^2+h^2)^{\frac{1}{2}}}\right\}, \quad (54)$$

which is equivalent to (53), and is valid at any speed, provided we keep inside the sphere. But this $\mathrm{H}_0$ is not continuous with H. We have

$$\mathrm{H}-\mathrm{H}_0=\frac{\mathrm{C}}{4\pi h}\left\{\frac{l}{(l^2-h^2)^{\frac{1}{2}}}-\frac{z}{\mathrm{R}}\right\}, \quad (55)$$

at the junction $\mathrm{R}=(z^2+h^2)^{\frac{1}{2}}=vt$ of the sphere and inside of cone. This indicates a current sheet upon the part AQB of the sphere. It has no energetic significance, but makes continuity with the current elsewhere. It may be made to be of finite volume density by having a not quite sudden start.

The value of $2\pi h\mathrm{H}$ is C on the axis between Q and R, and the value of $2\pi h\mathrm{H}_0$ is C between Q and O, but is zero on the other side of O. These results are necessitated by the initial datum about impressed current. H is infinite at the wave front, where $l=h$, as well as at the axis. There is a minimum value in the cone when $h^2=\frac{1}{2}l^2$.

There is no impulsive wave. On the spherical boundary H increases from O at the extreme left, to

$$\mathrm{H}=\frac{\mathrm{C}}{4\pi h}\frac{u}{v} \quad (56)$$

at the top (and bottom, of course, negatively). At the junction of the spherical and conical portions of the wave front it is infinite.

When $ut$ is very large, we should approximate, round about O, to the magnetic force due to an infinitely long (one way) straight current. The formula (53) or (54) leads to

$$\mathrm{H}_0=\frac{\mathrm{C}}{4\pi h}\left(1+\frac{z}{h}\right), \quad (57)$$

which is a well-known elementary result, provided there be a proper radial continuation at the origin of the axial current C. The conditions of the present problem necessitate this as ultimate result.

In general, the current density is got by the first circuital law, making

$$\mathrm{C}_h=-\frac{d\mathrm{H}_0}{dz}, \qquad \mathrm{C}_z=\frac{1}{h}\frac{d}{dh}h\mathrm{H}_0, \quad (58)$$

and these, applied to (53), give

$$\mathrm{C}_h=\dot{\mathrm{D}}_h=-\frac{\mathrm{C}}{4\pi}\left(\frac{h}{\mathrm{R}^3}+\frac{h\tan\theta}{(l^2-h^2)^{\frac{1}{2}}}\right), \quad (59)$$

$$\mathrm{C}_z=\dot{\mathrm{D}}_z=-\frac{\mathrm{C}}{4\pi}\left(\frac{z}{\mathrm{R}^3}-\frac{l}{(l^2-h^2)^{\frac{1}{2}}}\right), \quad (60)$$

the transverse and axial components of the current density—the rates of increase of the displacement. Here the first parts represent the components of the inward radial current. The rest ultimately vanishes. It is directed radially towards the other end, R, of the impressed current, though not equably, like the first part, but of increasing density outwards from the axis.

Similarly, it will be found that in the cone outside the sphere

$$\mathrm{C}_h=-\frac{\mathrm{C}}{2\pi}\frac{h\tan\theta}{(l^2-h^2)^{\frac{1}{2}}}, \qquad \mathrm{C}_z=+\frac{\mathrm{C}}{2\pi}\frac{l}{(l^2-h^2)^{\frac{1}{2}}}, \quad (61)$$

and this represents a radial current towards R exactly like that last mentioned, but with $2\pi$ in the denominator instead of $4\pi$. The current therefore doubles itself in crossing over from the sphere into the cone, without changing its direction.

To account for this singular behaviour, we have the current sheet before mentioned, equation (55). It may be reduced to

$$\mathrm{H}-\mathrm{H}_0=\frac{\mathrm{C}}{4\pi\mathrm{R}}\cdot\frac{\frac{u}{v}\left(1-\frac{z^2}{\mathrm{R}^2}\right)^{\frac{1}{2}}}{\frac{u}{v}\frac{z}{\mathrm{R}}-1}, \quad (62)$$

where $\mathrm{R}=vt$, the radius of sphere. The direction of both H and $\mathrm{H}_0$ is positive, or up through the paper above the axis, and down below, and H is the greater. So, by the rule of curl applied to a surface, if $\beta$ is the polar angle, reckoned from the forward pole of the sphere, and $\mathrm{C}\beta$ the surface density of the current along the lines of longitude, reckoned positive from the forward pole, the value of $\mathrm{C}\beta$ is

$$\mathrm{C}\beta=\frac{\mathrm{C}}{4\pi\mathrm{R}}\frac{\frac{u}{v}\sin\beta}{1-\frac{u}{v}\cos\beta}, \quad (63)$$

between $\beta=0$ and the value of $\beta$ making the denominator vanish. That is, at the circle of contact with the cone.

Beyond this, on the left part of the sphere, the surface density is given by the value of $\mathrm{H}_0$ alone, because there is no external magnetic force. It works out to the same formula. That is, (63) is the proper formula all over the sphere, and this is true whether $u$ is less or greater than $v$. If $u/v<1$, $\mathrm{C}\beta$ is positive everywhere, from the forward to the backward pole. But if $u/v>1$, $\mathrm{C}\beta$ is positive behind the cone only, and negative forward, or from the circle of contact to the axis. Continuity is made at the circle of contact by the current at the boundary of the cone.

The reader who is practised in making translations of application of electrical formulæ (by interchanges of electric and magnetic quantities, or by differentiations) will perhaps be able to see the application of (63) to the problem of a moving electron. It is this. Let a charge $\rho$, initially at O, be suddenly started and moved along the axis to Q at speed $u$, then the spherical impulse is fully represented by

$$\mathrm{H}_0=v\mathrm{D}_0=\frac{\rho}{4\pi\mathrm{R}}\frac{u\sin\beta}{1-\frac{u}{v}\cos\beta}, \quad (64)$$

all over the sphere, at any speed. This is important in the theory of Röntgen rays, and is the generalisation of the result (11) in § 489 for small speeds. $\mathrm{H}_0$ and $\mathrm{D}_0$ mean the values of

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H and D multiplied by the depth of the pulse, positively reckoned in direction in the same way as for $C\beta$ above. But as the translation of meaning is not very obvious, I will give a demonstration when the present problem of an axial impressed current is completed.

§ 494. So, returning to (63), consider its connection with the internal currents. Multiply by $2\pi R \sin\beta$, making

$$\tfrac{1}{2}C\frac{u}{v}\frac{\sin^2\beta}{1-\frac{u}{v}\cos\beta}, \tag{65}$$

This is the total current in the sheet crossing the circle R, $\beta$, from right pole to left when positive. Its rate of decrease with $R\beta$ is therefore the leakage from the sheet between two circles at unit distance apart. The result is

$$\frac{C}{2R}\sin\beta\left\{1-\frac{1-\frac{u^2}{v^2}}{(1-\frac{u}{v}\cos\beta)^2}\right\}. \tag{66}$$

Now by (59), (60), the outward radial component of the internal current, say $C_R$, is

$$C_h\frac{h}{R}+C_z\frac{z}{R}=\frac{C}{4\pi R}\left\{\frac{zl-h^2\tan\theta}{(l^2-h^2)^{\frac{1}{2}}}-\frac{1}{R}\right\}, \tag{67}$$

in which $R=vt$. Putting in the values of $l$ and $\tan\theta$, this reduces to

$$C_R=\frac{C}{4\pi R^2}\left\{\frac{\left(1-\frac{u^2}{v^2}\right)\left(1-\frac{u}{v}\cos\beta\right)}{\left\{\left(1-\frac{u}{v}\cos\beta\right)^2\right\}^{\frac{1}{2}}}-1\right\}; \tag{67A}$$

and, since there is a radical concerned, we must be careful about the sign. When $u<v$, there is no trouble. For (67A) is then the negative of (66) divided by $2\pi R\sin\beta$. That is, the leakage per unit area from the current sheet is equal to the sum of the two internal currents reckoned from the sheet, thus making continuity. The same applies precisely when $u>v$, provided we keep on the left side of the circle of contact with the cone.

But it is different on the right side. Then $1<(u/v)\cos\beta$, because $\cos\beta=\sin\theta=v/u$ at the circle of contact. The radical is always to be positive in these physical problems (a rigorous demonstration of the necessity might, however, be lengthy and obscure). So the denominator in (67A) is positive whilst $1-(u/v)\cos\beta$ in the numerator is negative. So (67A) becomes

$$C_R=\frac{C}{4\pi R^2}\left\{\frac{\frac{u^2}{v^2}-1}{\left(1-\frac{u}{v}\cos\beta\right)^2}-1\right\}. \tag{68}$$

This is inside and towards the surface. On the outside, there is the current (61). Its radial component outward is double the first part of (67A). That is

$$C_R=\frac{C}{2\pi R^2}\frac{\frac{u^2}{v^2}-1}{\left(1-\frac{u}{v}\cos\beta\right)^2}. \tag{69}$$

The excess of (69) over (68) therefore represents the leakage per unit area from the sheet. This excess is exactly the quantity in (66) divided by the circumference $2\pi R\sin\beta$. So there is continuity all over, except that we have not considered the circle of contact, where the current divides; but the conical sheet current joins on there and makes things right. The current, being the curl of the magnetic force, is necessarily circuital when the discontinuities and junctions are properly attended to. The value of $C\beta$ is infinite only at the circle of contact, and the leakage from it also. The current in the conical sheet is infinite, too; but just under it there is a reverse current of infinite value going the other way, which makes matters right, for, of course, the infinite current at the conical wave front could not be continuous with finite currents in the spherical sheet.

§ 495. So far nothing has been done as regards the electric field. An impressed current C of any kind has been assumed, and the magnetic force and external current due to it have been established. There was no magnetic force initially. To fix the electric force similarly let there be none initially also. Two principal suppositions may be made about the nature of C. It may be the impressed current of increasing intrinsic electrisation. If so, there will be no electrification at any time. Or, it may be supposed that there is a continuous electric separation going on at the point O, generating equal amounts of positive and negative electrification, and that the positive moves along the axis at speed $u$, so that $C=\sigma u$, where $\sigma$ is the linear density of electrification, whilst the negative remains stationary, so that there is a negative charge $-Ct=-\sigma ut$ at the origin at time $t$. In either case the external displacement will be the same. In the case of intrinsic electrisation there will be fictive electrification of amount $-\sigma ut$ at the origin, indicating the convergence of displacement there, but this displacement will pass along the axis and leak out uniformly all the way along, producing the same effect as if there was electrification $\sigma$ along the axis.

For distinctness, take the case of $C=\sigma u$, or real convection of electrification, with stationary compensating charge. Now, we had two formulæ for H; but it is easy to see that by time integration they will lead to three for D, the displacement.

For let P be a point where D is required. From the origin O draw a cone passing through the circle of contact. Call it the secondary cone. Now, if P lies to the left of this secondary cone, it is never inside the primary cone at any moment. It will be traversed, first, by the spherical shell, and then by a portion of the sphere. This makes one formula for D. But if P is on the right side of the secondary cone, it will be first traversed by the conical wave front and then be within the primary cone for a time. This makes a second formula. But later on it will be traversed by the spherical wave front and then be inside the sphere. This makes the third formula.

But to avoid the complications of the wave front and the shell, we had better calculate results a little differently. Since the electric current is the curl of the magnetic force, the displacement outside the axis is the curl of the time-integral of the magnetic force. Let

$$Z=p^{-1}H, \quad \text{then} \quad \text{curl } Z=D,$$

where D is the time-integral of curl H, therefore the electric displacement required. This would be also true on the axis in the case of electrisation; but with convection current there, since it exists as current in the first circuital law, its time-integral also counts. The theorem of curl has no exceptions. This Z is also the vector potential of the magnetic current (*El. Pa.*, Vol. I., p. 467), but we need not employ that curious property.

If the point P is inside the cone at time $t$,

$$Z=\int H\,dt=\int H\frac{dl}{u\tan\theta}=\frac{C\cot\theta}{2\pi hu}\left[(l^2-h^2)^{\frac{1}{2}}\right]_{t_1}^{t}.$$

That is,

$$Z=\frac{C\cot\theta}{2\pi hu}(l^2-h^2)^{\frac{1}{2}}, \tag{70}$$

by the H formula (52), remembering that $l=(ut-z)\tan\theta$. This state of thing lasts until the sphere reaches P. The time limits are then $t_1$ and $t_2$, given by

$$(ut_1-z)\tan\theta=h, \qquad (vt_2)^2=h^2+z^2. \tag{71}$$

This value of $t_2$ used in $l$ in (70) gives Z at time $t_2$. Later on, we must add on to this Z the integral of $H_0$ according to (58) in the sphere from $t_2$ to $t$. This makes

$$Z_1=\frac{C}{4\pi h}\frac{z(t-t_2)}{(z^2+h^2)^{\frac{1}{2}}}+\frac{C\cot\theta}{4\pi hu}\left\{\sqrt{l^2-h^2}+\sqrt{l_2^2-h^2}\right\}, \tag{72}$$

where $l_2$ is $l$ with $t_2$ in it. This formula continues valid.

Thirdly, when P is on the left of the secondary cone the time limits for the integral of $H_0$ are from $t_2$ to $t$, without any extra. The result is

$$Z_2=\frac{C}{4\pi h}\frac{z(t-t_2)}{(z^2+h^2)^{\frac{1}{2}}}+\frac{C\cot\theta}{4\pi hu}\left\{\sqrt{l^2-h^2}-\sqrt{l_2^2-h^2}\right\}. \tag{73}$$

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Comparing $Z_1$ with $Z_2$, and calling it $Z_0$ for the sphere, we may write it

$$Z_0 = \frac{C}{4\pi h}\frac{z(t-t_2)}{(z^2+h^2)^{\frac{1}{2}}} + \frac{C\cot\theta}{4\pi hu}\left\{\sqrt{l^2-h^2} \pm \sqrt{l_2^2-h^2}\right\}. \quad (74)$$

The complete Z is now given by (70) in the cone and $Z_0$ in the sphere, $Z_0$ being really two formulæ. Use the + sign on the right and the − sign on the left side of the secondary cone. It may be inferred that $\sqrt{l_2^2-h^2}$ vanishes on the secondary conical surface, and the fact may be verified. It is suggested that (74) may be converted to a form not involving any $\pm$. This is the case, for the quantity under the radical sign is the perfect square of a function which changes sign in passing through the secondary cone. We get

$$Z_0 = \frac{C}{4\pi h}\left\{\frac{zt}{R} - \frac{R}{u} + \frac{\sqrt{l^2-h^2}}{u\tan\theta}\right\} \quad (75)$$

anywhere inside the sphere, at distance R from its centre.

We may now derive D from Z in the same easy way as the current from the magnetic force, since Z is like H, in circles round the axis, though unlike H, it is continuous at the spherical boundary between sphere and primary cone.

*(To be continued.)*

## REFUSE DESTRUCTORS IN COMBINATION WITH ELECTRIC POWER STATIONS.*

BY J. S. HIGHFIELD.
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In writing this Paper the author has found himself in a somewhat difficult position. He started off with the fixed idea that it was useless to deal with the subject without personal working experience of the plant of which he was writing, and from the results of working such plant. He endeavoured to gain such knowledge so that he could write of plant other than the one for whose operation he is responsible, and so arrive at more general conclusions. He found, however, that the knowledge he could gain of other plant was exceedingly limited, and so he has kept to his original idea that nothing but personal working experience is of any use when writing on this subject, and at the risk of narrowing the issue, he decided to deal only with the plant whose working he controls and draw general conclusions to but a limited extent. He writes, however, with the hope that other engineers who have charge of similar plant will give the results of their experience.

It is absolutely certain that in most towns—in all but coast towns—there is no better method of getting rid of town refuse, gathered from ashbins, markets, abattoirs, &c., than by cremation; and the primary object of every destructor must be to cremate the refuse in a perfectly sanitary manner. The temperatures attained in modern destructor furnaces worked with forced draught are always sufficiently high to insure that no fumes or foul gases come from the chimney; any smell that comes from a destructor is due to decaying matter, or to the heating of the refuse before it enters the furnace.

The site for a destructor must be chosen so that the cartage is made through streets other than the main or residental streets, and also so that the average distance to be traversed, from the point at which the refuse is collected, to the destructor is as short as possible. In towns having 100,000 inhabitants or more it will generally be more economical to have two sites, and in very large towns more than two sites, as any saving that can be made by burning all the refuse in one large central destructor is more than counterbalanced by the extra cost of carting. In St. Helens there are two destructors; the cost per ton of carting to No. 1 is 2s. 6½d., and to No. 2, 2s. 6½d.; if all the refuse were carted to No. 1 the cost per ton would be 2s. 11d. The policy of the committee responsible for the cremation of refuse must be decided very largely by this question of cartage, taking into account the value of the refuse as fuel to produce steam for the power station, which value will be treated of later in the Paper. In considering the question of site, where two or more destructors are necessary, and where no power station already exists, it is advisable to place the largest destructor on a site also suitable for the power station, and to choose this site so that the cartage shall not be very heavy from the districts where the refuse having the best fuel value is obtained. If a power station already exists and the site is sufficiently large and in a sufficiently favourable position from the cartage point of view, then, of course, this is the position for the refuse destructor.

* Paper read before the Incorporated Municipal Electrical Association at Glasgow, June 21st.

Without the addition of boilers there are certain points that should obtain in any really first-class destructor. These points may be tabulated:—

1. Forced draught, preferably provided by a blowing engine as being more economical than a steam jet.
2. A suitable arrangement of duplicate flues, so that one set can be cleaned while the other set is working.
3. Charging appliances so that the refuse can be quickly transferred from the carts to the furnace without unnecessary handling.
4. Baffling chambers or other devices to prevent dust entering the chimney stack.
5. Arrangements for quickly and cheaply removing the clinker.

If, in addition to the destruction of the refuse, steam raising on a serious scale is contemplated, it is further necessary to provide:—

1. A high-pressure boiler in connection with each furnace, of which there must be at least two, one as a stand-by.
2. Each furnace must have two divisions or cells, one of which must always be in full blast when the other is being clinkered or charged.
3. By-pass flues so that any surplus heat can be sent direct to the chimney.
4. Arrangements to prevent cold air getting to the boiler during charging and clinkering operations.
5. Duplicate flues to enable the furnaces to be worked continuously from week to week, one set of flues being cooled down for the necessary periodical cleaning operations.

Generally when a destructor is used as an adjunct to an electric power station, a separate grate is provided so that coal can be burnt under the boiler. This is only necessary when it is contemplated to steam the boilers without refuse, that is, with coal only, or when the refuse is of extremely variable quality. The writer has never yet used coal to help out the destructor fires, but occasionally the refuse is of poor quality, and then it is necessary to help the destructor with steam from other boilers. He has found it a good plan to burn the clinker and ashes from the electric works boilers in the destructor when the refuse consists largely of fish or paper; by this means he burns these substances in a better manner, and gets more steam and also gets rid of a waste product in an economical way.

Referring to the details above-mentioned, the most important, so far as steam production is concerned, is a rapid means of charging and clinkering the furnaces; with regard to the latter, some form of chain grate seems to promise the best station; with regard to the former, the sloping platform is exceedingly simple, but it involves much labour in raking the refuse into the furnace doors. The arrangement the writer is now using is one due chiefly to Alderman Forster, and consists of a platform on to which the carts are tipped, and which can be tilted to an angle of about 45deg. by means of winding tackle operated by an electric motor. The refuse slides or is easily raked over the charging doors and against a screen; the doors can be racked open, and the refuse falls and is raked into the furnace. This gear works well, and enables more refuse to be burnt in the same furnace than could be done by the former method. The flue, as above-mentioned, must be duplicated or arranged so that the furnaces need never be shut down, and the forced draught arrangements should be also duplicated; in short, all the usual arrangements made by engineers to obviate a shut-down at the power station must be made in connection with any destructor designed to supply steam to its engines.

Having noted the above general considerations, it is necessary to consider the conditions of steam production from a destructor, and the first point is that the steam is produced steadily for at least 16 hours, and possibly for 24 hours each day. It is not in any way desirable to operate the destructor to follow, for instance, the variations of a lighting load: if a lighting load only is to be worked, and the day load is small, the use of a destructor is limited to the working of only a small part of the load. In the case of direct current plant, a large storage battery is a most useful adjunct in this respect as in others; it enables the plant load factor, and hence the utilisation of the steam, to be greatly improved. If a lighting station only is to be supplied, the remarks above as to the addition of an extra grate for burning coal do not apply. The correct way to design the destructor in such a case, is to erect a boiler considerably too large for the destructor to steam alone to its full capacity; when the heavy load comes on coal may be burnt in the second furnace to drive the boiler to its full capacity. The writer regards such an arrangement, however, as only suitable for small installations; in such cases it would be very useful. If, however, the steam is used in connection with a traction station, or a station which supplies energy for both lighting and traction, then the destructor steam can be put to very much better use.

The plant of which the writer has charge consists of two Beamen and Deas' furnaces, each divided into two cells; each furnace serving to steam, to its full capacity, a Babcock boiler with 1,470 sq. ft. of heating surface. The forced draught is provided by an 18 H.P. motor-driven fan, the average pressure in the closed ash-pits being 3in. on the water gauge. The plant at the power station consists of five steam generators of a total output of 1,000kw. In addition to the

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steam from the destructor boilers, steam is supplied from a battery of four 30ft. by 8ft. Lancashire boilers. The steam ranges are designed so that two steam sets, each of 125kw. capacity, can be run from the destructor independently of the other boilers, or the destructor boilers and Lancashire boilers can supply the whole range in parallel; in each machine circuit, a watt-hour recording meter is fixed to meter the output from the generator. The usual practice is to drive one or both of the 125kw. sets from the destructors only, for a part of the day, and later on when more plant is required, to parallel both sets of boilers on the whole load. The working this year has been somewhat interfered with from the usual causes incident to any new installation; a considerable amount of alteration and reconstruction has been done, which has prevented the fullest efficiency of working being attained; the figures given below show the results of the first year's working of a new plant, and give a fair idea of the actual value of a small destructor plant in a town where the refuse has a good calorific value. It was found that the calorific value of the fuel was distinctly better in the summer than in the winter. The refuse varies somewhat from day to day, and, therefore, if no other boilers were available, it would be necessary occasionally to use coal under the destructor boilers, or to hold a reserve of boiler ashes and clinker to use when the calorific value of the refuse was poor.

The figures relating to 12 months' working from March 31, 1900, to March 31, 1901, are as follows :—

*Figures for one year's working of a two-furnace Refuse Destructor.*

| | Total for year. | Average per week. |
|---|---|---|
| Weight of refuse burnt ..... | 9,778 tons | ..... 188 tons. |
| Electric energy used to drive fan and other motors..... | 70,000 units | ..... 1,346 units. |
| Units generated by steam ..... ... | 365,000 „ | ..... 7,019 „ |
| Wages on burning ..... | £750 0 0 | ..... £14 8 6 |
| Wages on repairs..... | 86 0 0 | ..... 1 13 1 |
| Total wages ..... | 836 0 0 | ..... 16 1 7 |
| Weight of clinker produced ..... | 3,900 tons | ..... 75 tons |
| Value of mortar sold ..... | £221 9 8 | ..... £4 5 2 |
| Value of electric units generated at 0·3d. per unit generated ... | 450 0 0 | ..... 8 13 1 |

*Averages per ton of Refuse Burnt.*

| | |
|---|---|
| Units generated..... | 37·3 |
| Units used on works..... | 3·1 |
| Cost of burning, including wages, light and power..... | 22·1d. |
| Cost of repairs (wages and stores) ..... ..... | 3·0d. |
| Total cost of destruction..... | 25·1d. |
| Cost of removing clinker not otherwise used ..... | 5·5d. |
| Total cost of destroying refuse and removing part clinker..... | 30·6d. |

From the above figures, it will be seen the net saving to the destructor department due to combining the electric works and the destructor works, is £450, less £50 on boiler repairs, and less the interest and sinking fund charges on £1,500 (which represents the extra capital cost on the boiler plant above what would have been necessary for smaller boiler plant for working the mortar mills, the blowing fan and other plant on the works), which may be taken as £90, leaving £310, or 41 per cent. of the total wage bill. The cost of cremating the refuse and removing the clinker is therefore reduced from 2s. 6 6d. per ton to 1s. 11d. per ton.

It should be noted here, that in addition to supplying steam to the electric works, the destructor also supplies steam to drive two mortar mills and a steam winch. Considerable care was taken to prevent dust from the destructor getting into the power station; it is almost impossible to do this quite successfully, but no serious harm was done by the small amount that did enter. In conclusion, the writer would say that in certain cases where a suitable site for destructor and electric works exists, and where the works are not very large, the combination can be usefully made, when a traction or other good all-day load exists. For a very large works, or for a station which only drives a lighting load, there are not many instances where there is any economical value in the combination. Without desiring to generalise, the writer thinks that in these cases it is better to use the destructor furnaces to provide steam for driving mortar mills or other machinery, on which the calls are not so exacting as on an electric power plant.

## DISCUSSION.

Mr. C. H. WORDINGHAM (Manchester) said he must first of all congratulate the author on the very sensible attitude he had taken up on this matter. The conclusions he had drawn were right. He did not hold out the hope that the use of a destructor was going to give them electric energy for nothing. There were very rash estimates put forward some years ago and there was a danger of the pendulum making a swing over to the other side and of people coming to the conclusion that destructors were of no use whatever. He thought there could be no doubt that the heat from the destructors ought to be utilised if there was any possible way of doing so, and in most cases it was possible. He believed that in Liverpool the destructors were used to provide additional help at certain points along the tramway lines. That appeared to be a most useful way to use them in a large town. There were one or two points upon which he would like to have the author's opinion more fully with respect to the operation of the destructors. One was whether he considered it desirable to roast the refuse, or rather partially dry it, before it is actually burned. A month or two ago he was very much interested in the destructors at Rochdale. There they seemed to have reduced everything to the utmost simplicity. They did not go in for automatic stokers or charging arrangements, but simply tipped the dirt down in front of the destructor cells and fed it by hand direct into the furnaces. From what he could see the results were excellent. They were making little or no smoke and very little smell. With regard to the draught they were there using a steam blast, and he was told that the steam consumption was one-seventh part of the total amount raised by the boiler. That seemed rather high. There could be no doubt about the convenience, and be was interested to hear the author somewhat modify his first condition by saying that he thought there were other advantages to be gained by the production of water gas. If that production did take place, it seemed very much in favour of a steam blast as opposed to a fan blast. He would ask the author whether he had any trouble with forced draught when the doors were open for firing. At Rochdale they had a balance established. They had a chimney 250ft. high and 4ft. 7in. in diameter, which by itself would maintain a draught of 1⅛in. That given by the steam blast was about 1in., and thus there was nearly a balance, and there was no tendency for the flame to come out during firing.

Mr. STANLEY CLEGG (Darwen) said that to his mind the time was coming when most towns, unless they were on or near the sea coast, would have to consider the question of refuse destructors. It was an open question as to which of the officials of a town council they should be in charge of. He agreed with the author that all towns under 100,000 of population ought, as a rule, to arrange for one central site for the station to which the refuse could be brought from all parts of the town, especially as with all up-to-date destructors there was neither smoke nor smell. He was glad that the author had somewhat modified his remarks about the steam draught as compared with the blowing engine. From what he had been able to find out, if the steam blast was carefully regulated to the fire he did not think the consumption of steam need exceed 12 per cent. of the total make. He thought there should be a duplicate set, so that one complete unit could be used at one time, and when the flues needed cleaning the other could be used in its place. He rather deprecated the suggestion of the author that there should be duplicate flues, because if they had a duplicate unit they had no need. Besides, if they had duplicate flues, it was rather likely to remove the boiler rather further from the furnaces than was necessary. The boilers should be as near as possible to the furnaces compatible with the proper handling of the dirt. With regard to the method of firing, they had at Darwen an arrangement for hand firing. He thought that refuse should be treated even more carefully than coal. He should never think of dumping a hundredweight or two of coal into a coal-firing boiler. He would be only too careful to spread it about, and with hand firing they could fire as often as they liked and put the refuse where they liked, and the result was that by the time they fired one furnace they went straight back to the one they had done before and they found that it was entirely incandescent. If they dumped a whole lot of refuse on the fire the gases went away by the chimney without being properly burned. Undoubtedly the best load for a destructor was a tramway load. He did not understand the author when he said that his refuse was better in summer than in winter. At Darwen they found the reverse owing to the fact that more coal was burned in the cold weather, and Lancashire people were not over careful with their ashes. He could only account for it by supposing that at St. Helens they might have open ashpits and the refuse got wet in wet weather. With regard to dust getting into the generating station, if they separated the buildings, as at Darwen, about 30ft., they would get no dust.

The HON. SECRETARY read a communication on the subject of the Paper sent by Mr. W. Morton, of Llandudno. Mr. Morton said that he was in a position to thoroughly endorse Mr. Highfield's statement that there was no better mode of disposal of towns' refuse than cremation, and at the same time it was a useful adjunct to a power station. Two Beaman and Deas destructors had been erected in Llandudno in conjunction with two Babcock boilers of 1,741 sq. ft. of heating surface, and each capable of evaporating 5,000lb. of water per hour. The boilers had been fitted with side-firing doors, with the idea of utilising coal or coke fires in the event of the refuse being of a poor class and not fit to generate steam. This was, however, of no avail, as the dust carried over with the hot gases from the destructor extinguished the fires almost immediately. It would, however, be found advisable to make a provision for hand firing at the side, as the boiler might thus be worked when the destructor was standing, it only being necessary to cover the destructor firebars with clinks or an unburnt charge of paper, straw, &c., to keep the cold air from rising through the bars and entering the boilers. With regard to keeping the steam steady, this was a difficult matter for the nature of the refuse did not always permit of charging the cells alternately. The theory of the manufacturers of destructors of this class, that an equal temperature can be maintained, and, therefore, steady steam, by the fact of the cells being charged alternately, was not always found to hold in practice. The writer had found that steadier steam may be maintained by working the hand fire and destructor's boilers in parallel, the isolating valves being removed in the boilers; the destructor's boilers are allowed to do their utmost, the steam pressure being regulated by the dampers of the coal-fired boilers. In this way the consumption of fuel was greatly reduced. This method he found to be better than working the destructor boilers separately on a portion of the plant. In Llandudno, refuse in the summer was of the poorest possible nature—fish offal, garbage and tradesmen's refuse—but even this had good steaming power when helped out with the dirt and coke breeze. With regard to the allocation of accounts, a difficulty arose. No doubt the best method was to be paid at a certain rate per ton for the disposal of the refuse, and then the electricity department



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to utilise the refuse to the best advantage. In Llandudno 5,630 tons were destroyed in one year, the cost of destruction being 1s. 7d. per ton. This did not include the cost of repairs to the destructor. This, however, was reduced to 1s. 2d. per ton by the amount paid by the electricity department for the use of the steam generated. This, again, might be considerable reduced by the disposal of the clinker for mortar making but for the fact that sand was plentiful in the neighbourhood. In certain districts there would be a little gold mine in the clinker, as little or no lime need be added when crushed in a mortar mill. The amount of clinker produced was 30 per cent. of the refuse destroyed. Average units generated per ton of the refuse burnt in Llandudno were 32·7, as compared with 37·3 at St. Helens. With regard to forced draught, the writer was of the same opinion as Mr. Highfield that a fan was preferable to a steam jet, but the fan could be more economically driven by steam, still the motor had its advantages in so much that the fan might be at any time started without raising steam where a battery was in use. The writer was of opinion that the cost of repairs to boilers would be heavier on destructor boilers than on those hand fired. He had noticed considerable bogging of the two lower rows of water tubes of the boilers, due, in his opinion, to the intense heat at times of the gases and from the impinging of cold air on the tubes at the time of charging of the furnaces. He further mentioned that notwithstanding the very increased cost of fuel a net profit of over £700 had been made in this, the second year's working of the station.

Mr. McCOWAN (Belfast) said that in recent years they had heard a great deal about the advantages of combining refuse destructors with electric supply works, but it had not always been easy to obtain reliable figures regarding the actual results, nor did the accounts show the net money value of the advantages accruing to the different departments by the combination. The difficulty of utilising to the best advantage in an electric supply works steam generated practically at a constant rate for the 24 hours was well known, and in the absence of an efficient thermal storage system he believed secondary batteries would probably be the best solution. The author of the Paper stated that a considerable amount of alterations and reconstructions had been done. This was not an uncommon complaint in connection with refuse destructors, and the figure given for repairs, 3d. per ton of refuse burned, was not low by any means, amounting on the quantity burned to about £120 per annum. It appeared from the Paper that two boilers of about 4,000lb. per hour evaporative duty were installed in the destructor plant. Were both worked together, or was one kept as a stand by? It would be interesting to know the maximum rate at which steam had been taken from the plant, and the total capital outlay on the whole. It would be noticed that out of 365,000 units generated 70,000 were used for driving the necessary fans, &c., or about 20 per cent. of the total. The quantity of clinker produced appeared to be excessive, practically 40 per cent. This ought to be between 25 and 33 per cent. With reference to the cost figures per ton of refuse burned, they recently erected a 12-cell destructor in Belfast, and in obtaining offers the parties tendering had to quote a price per ton for burning the refuse and for the repairs and maintenance of the plant. Offers from Messrs. Beamen and Deas, the makers of the St. Helens destructors and also from Messrs. Goddard, Massey and Warner were obtained, and as these were so very different from the results obtained in St. Helens, they might be interesting for comparison :—

| St. Helens. | | Beamen and Deas. | Goddard, Massey and Warner. |
|---|---|---|---|
| Burning, per ton of refuse | 1s. 10·1d. | 1s. 2d. | 10½d. |
| Repairs, „ „ | 3d. | 2⅔d. | 1d. |
| | 2s. 1·1d. | 1s. 4⅔d. | 11½d. |

These prices were for continuous burning, 168 hours per week, and supplying steam for electric lighting purposes, and included everything. Messrs. Goddard, Massey and Warner gave an alternative offer to destroy refuse without supplying steam for electric lighting purposes at a total price of 9½d. per ton, leaving 9d. for burning and ½d. for repairs. This offer was accepted, and the destruction of refuse was now being carried out at this price. It would be noticed that a lower figure was quoted for destroying the refuse under ordinary destructor conditions than when supplying steam for electric lighting purposes. This was no doubt due to the smaller number of burning hours per week, and also probably to a reduction in the stoking staff. In order to get at the total cost of destruction, we would like to know from the author what the interest and sinking fund amounted to per ton of refuse burned, also if he had experienced any trouble owing to a variable pressure in the steam supply, and how he estimated the quantity of steam supplied from the destructor plant when working in parallel with the other boilers.

Councillor WORTHINGTON (Wigan) said it seemed to him that one way in which they might utilise electric tramways in connection with refuse destructors was to sectionise a town and to have small depots where the refuse might be deposited during the day, and after the tramway traffic was over the lines could be used for conveying the refuse from the depots to the destructor. Two or three advantages would be obtained in this way. In the first place, there would be economy in horses and men, the cleaning could be more quickly effected, and they would relieve the streets of a great deal of the dust and consequent distribution of germs during the daytime.

Mr. SCHOFIELD (Shipley) said that in regard to the general conclusions of the author of the Paper he was entirely at one with him. The objects of a destructor in combination with a generating power station were sanitary and engineering, and the sanitary part should always come before the steam-raising aspect. Practice, however, showed that the nearer they came to the ideal of the sanitarian, the better they would please the station engineer, and that with increased temperatures and quicker rates of combustion the risk of allowing noxious gases to escape from the chimney was done away with, and the steam-raising qualities of the plant were increased. In connection with this point he said that the question of boiler working was a very important one. The nearer they fixed the boiler to the destructor the better it would be for steam-raising purposes, but at the same time they increased the risk of allowing noxious gases to escape unconsumed, as they could readily see that the nearer the cold plates or tubes of the boiler were placed to the cells of the destructor the greater would be the difficulties from a sanitary point of view. He would ask the author of the Paper if he had experience of water-tube boilers in connection with destructors, and how often the tubes had to be cleaned and what was the longest uninterrupted run he had had without stopping to clean? With regard to the question of charging the furnaces, he did not think that the plan would answer in more than a very few stations. If he understood rightly, the system was to destroy the refuse as fast as it was brought in. In Shipley they had on an average from 25 to 30 tons of refuse brought in from 12 at night to 6 in the morning. That was the time when there was neither a light load nor a fraction load, and they could not burn the refuse as fast as it came in ; they had to burn it during the day. The percentage of moisture in the refuse varied very much from day to day and from month to month. He had taken their refuse when there was practically 90 per cent. of moisture in it. That was when the carts were loaded. On the other hand, the percentage would go down as low as 10 per cent. and even as low as 5 per cent. With regard to the steam-raising power of refuse, he would give them a test which he made on the November 26, 1900, simply to see whether the daily working would bear out the weekly totals. The type of destructor was a four-cell Meldrum, two cells only being in use. The total refuse burned was 19tons 6cwt. on a grate area of 45 sq. ft. ; the total water evaporation was 3,800 gallons, and the temperature of the feed-water was 50°F. ; the water evaporation per pound of refuse (actual) was 0·8781b. ; the percentage of moisture in the refuse was 51 ; the duration of the test was 19 hours ; the average steam pressure was 120lb. ; the quantity burned per hour was 1 ton ; the weight of the clinker was 5tons 5cwt. 2lb. ; the percentage of weight of clinker to refuse was 27 ; and the cost per ton in wages for destroying was 10·9d.

Mr. J. K. BRYDGES (Eastbourne) said that in that town they had an air-pressing station which compressed air for the purpose of ejecting sewage. This system was situated close to the destructor, but having been 10 years in existence and having no forced draught, it was practically useless, and they had to use boilers as well. This was all being altered now, but he was afraid they would not get very much out of it, for the reason that the Eastbourne refuse was of very poor quality, especially in the summer.

Ald. FOSTER (St. Helens) said that the suggestions that had been thrown out might have a considerable amount of weight if they were to consider this question of working an electricity station purely from an electric point of view. It might be done cheaper. The destructor works at St. Helens were arranged for before Mr. Highfield came on the ground, and before an electric station was intended to be put down on that particular spot. He differed entirely from Mr. Wordingham with regard to the desirability of putting the destructor works at the outskirts of the borough. They had tried that, and it had been an expensive failure. They now had destructor works in the very centre of the town.

Mr. WORDINGHAM pointed out that he did not recommend that ; he simply said they were generally put there.

Mr. FOSTER : Yes, and they were very expensive. Their destructor works were laid down on right lines, and if constructed on scientific lines they were not the slightest nuisance to anybody. Mr. Highfield had suggested certain modifications with regard to the dust chambers. Although in St. Helens they had a great deal of opposition in locating the destructor, they never had a word of complaint from the neighbours from that day to this, except as to the amount of smoke on Sundays, when only the boilers were working, and the destructors were stopped. It was not fair to compare the cost of working at St. Helens with that of Belfast. He had seen a good many of the conditions in connection with the letting of destructor contracts, and he was quite sure that what was undertaken by destructor builders did not cover by any means all the costs covered by Mr. Highfield. If they were to eliminate from Mr. Highfield's cost many of the charges for lighting, for power and for repairs they could get the costs down below a shilling. As a matter of fact, the burgh surveyor of St. Helens, in his monthly reports, stated that the costs to the sanitary department were practically a shilling per ton. The sanitary committee at St. Helens got a fairly decent income out of the steam. They got as much income as covered their sinking fund and interest on the whole capital expenditure, and yet the electricity committee only paid them the exact amount it would cost them to produce the steam by fuel at current prices. Mr. Highfield had produced in St. Helens a very satisfactory system, both from a sanitary and an electric point of view.

Mr. J. H. RIDER (London) said he wished to ask one or two questions. The first was how much had the air pressure of the furnaces to be increased on account of the baffling chambers or other devices required to keep the dust from going into the chimney stack? The second question was how Mr. Highfield paid for the steam? He did not gather from the Paper whether the electricity department found that labour and did all the burning, or whether the destructor department did that and sold the steam to the electricity committee. To his mind this method of charging for the steam was a very simple one, because if a destructor was put down, as it should be put down, from a sanitary point of view, and they had so much steam to spare, and the electricity works were asked to take this steam how were they going to pay for it? Now they could pay for it by the water evaporated, but that would not do because the engineer did not want to buy hot water ; he wanted to buy steam, and, so far as he knew, there was no sure method of measuring the actual amount of steam. If they had to pay for steam coming from the destructor the only sure way was to pay for it on the units generated by the engine which they were

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driving from that steam. That meant, of course, getting a plant specially to run from the destructor steam, and it also meant that the destructor department had to stand all the losses in the steam pipes and in the steam engine. Now, from the electrical point of view that was quite right. In a destructor which he had a little to do with some time ago he was enabled to enter into an arrangement whereby the electricity department simply bought the steam from the destructor department, and the output of the dynamo was measured, and we agreed to buy on that output at ¼d. per unit, which was all right from his point of view. He thought the chairman of St. Helens spoke of the destructor there as being in the centre of the town, and that no nuisance was caused; that it was only on Sundays that a nuisance was found. Those of them who knew St. Helens would understand the reason of that. His opinion of destructors could be summed up in a few words. He thought they were very proper things from the sanitary point of view, and that they should be put down and the whole expenses borne by the sanitary department. If the electrical engineer liked to buy the steam on the terms mentioned let him, but if he took his advice he would let it alone.

Mr. EDGCOMBE (Kingston-on-Thames) said he should be glad to know from the engineers how they got so little dust in the machinery? Another point he should like information on, was as to whether they got any dust from the shaft, not deposited absolutely round the destructor works themselves, but at a distance of, say half a mile? He was interested in this matter because of a deadlock that had arisen in London. The South London Electrical Corporation had entered into contracts with two or three large vestries almost wholly for the purpose of supplying electric lighting, and the only condition attached to the arrangement was that they should destroy the whole of the refuse in these districts. They put down very expensive plant—something like £70,000—and had continued destroying the dust for a time under heavy penalties in the event of stoppage. There was no trouble at all; no smells. But after a short period complaints came in from the residents in the district. There were a lot of old-fashioned houses with large conservatories and gardens, and the whole district was covered with a thin film of dust for a distance of a half or three-quarters of a mile. Such pressure was brought to bear upon the vestries that they obtained an injunction against the company, and forced them to shut down the destructor station. They then proceeded against the company for not carrying out their contract to destroy the refuse, and the case at the present moment was going through the Courts. They were unable to start destroying the dust because of the injunction, and they were under heavy penalty for shutting the destructor up. At Kingston they had not exactly the same conditions as at St. Helens; theirs was one of the prettiest towns along the Thames valley, and the people could not stand having ash or fine dust deposited in the neighbourhood.

Mr. TREMLETT CARTER (London) spoke as to the relative advantages of steam blast and air draught. The author of the Paper had stated that about one-seventh of the water evaporated was used as steam, and another speaker had said that about 12 per cent. of steam was used. On the other hand, Mr. Highfield suggested that there was a water gas action which improved the furnace efficiency. It did not, of course, actually increase the total amount of heat generated in the furnace, but deferred combustion. The flame was produced closer to the heating surface. They got a better evaporation in the boiler and a more efficient action because of a greater proportion of the heat being abstracted from the furnace gases. On the other hand, the enormous amount of steam used, namely, 12 per cent. or thereabouts, would naturally make one pause before using a steam blast. He, therefore, suggested that a modification of the air draught method might be tried. He did not know if it had been tried. If, instead of using an ordinary air draught, they were to saturate the air with water before it was forced into the furnace, it would have exactly the same action as steam blast.

Mr. HIGHFIELD, in replying to the discussion, said that he had endeavoured to put the case as well as possible for destructor works. He purposely did not put down any fancy figures, but gave a complete year's pratical working. A great deal had been said as to the design of destructors. One of the most important objections taken to a point in his Paper was as to the system of charging until the whole load was dumped straight into the furnace. In the case of a small destructor there might be something in the objection, but refuse was most abominable stuff for men to handle, and the ideal destructor should be one in which the refuse should be tipped straight into the furnace and the clinkers taken out at the other end, so that there should be no handling of the refuse at all except in filling the carts By using chain brakes or other method, the refuse could be burned continuously, and that was the right way to design a destructor. The question of using duplicate flues brought them to the whole question of the design of destructors. The time was not long enough at present to treat that question in detail, but if it was determined after deliberation to use a destructor in connection with electrical works, the first man to consult as to the sort of destructor to be used was the electrical engineer. He had found that the other officials who generally looked after these destructors did not recognise the extremely stringent calls made on electric works. With regard to duplicate flues, the amount of dust deposited in the flues was so great that once every week the whole flue had to be opened out and cleaned. If they did not have baffling chambers and so forth it would go up the chimney, which was very objectionable and could be stopped if proper baffling arrangements were made. The right way to work destructors was to work 24 hours a day week in, week out, and never shut down at all. If they cooled the furnace every week the depreciation was very much greater than if they kept them hot all the time. With regard to accounting, the health committee in St. Helens pay for the whole equipment. They regarded the boilers and extra plant necessary for steam raising as an investment out of which they were going to make a profit, and they made no charge to the electricity committee for the use of the boilers and for the working of the destructors; and the electricity committee simply pay ¼d. per unit generated for the steam supplied to the electric works.

## TESTS OF AN ELECTRICALLY-DRIVEN PUMP.

The *Engineering News* of New York, for July 4th, publishes a Paper by Mr. H. A. Pattison, giving the results of some tests on a Quimby screw pump electrically driven by an Eickmeyer motor. The water is propelled in this pump by screws, which are mounted in pairs on parallel shafts, arranged in such a way that the thread of one screw projects to the bottom of the space between the threads of the opposite screws. The sides of the screw threads are undercut, and the faces are left flat, so that the width of the face and the base of the thread is one-half the pitch. The cylinders of the pump fit the perimeter of the threads snugly. There is space enough left between the screws and the cylinder and between the faces of the intermeshing threads to allow a close running fit without actual contact. There is absolutely no end thrust in the pump, because the water is delivered from the middle of the cylinder, and the pressure of the column of water is exactly the same in one direction as it is in the opposite, therefore all pressures counterbalance each other. Such a combination cannot successfully compete with a high-duty pumping engine where it is desired to move a large amount of water, and a full load for the pump is assured. But from tests the author made he considered it to be more economical than any single or duplex steam pump, or, in fact, than any steam pumping engine that is not provided with automatic cut-off.

Tests were taken separately of the pump and motor, and then a further test was taken of the combination. The results are embodied in the tables below:—

**Table I.**—*Results of Tests of Direct-Connected Electric Pump.*

| Time. | Volts, machine. | Amperes. | | | Head and lift from water level. | Gallons per minute. | Weight of discharged water. | Foot-pounds. | Input. Kw. | Output. Kw. | Efficiency, per cent. | Speed, revs. per min. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Machine. | Field. | Magnet. | | | | | | | | |
| 3·44 | 494 | 113 | 1·07 | 0·222 | 239 | 793 | 6,620 | 1,582,000 | 55·85 | 35·8 | 64·1 | 648 |
| 3·47 | 495 | 114 | 1·08 | 0·222 | 239 | 793 | 6,620 | 1,582,000 | 56·45 | 35·8 | 64·1 | 648 |
| 4·01 | 500 | 115 | 1·03 | 0·222 | 243·5 | 798 | 6,660 | 1,620,000 | 57·5 | 36·65 | 63·7 | 650 |
| 4·22 | 496 | 118 | 1·07 | 0·222 | 239 | 804 | 6,710 | 1,603,000 | 58·55 | 36·25 | 62·0 | 660 |
| ... | 476 | 250 | ... | 0·212 | 285 | ... | ... | ... | 119·0 | ... | ... | 560 |
| 4·49 | 516 | 118 | 1·09 | 0·232 | 250·5 | 818 | 6,825 | 1,710,000 | 60·9 | 38·65 | 63·5 | 670 |
| 5·07 | 510 | 118 | 1·08 | 0·232 | 250·5 | 818 | 6,825 | 1,710,000 | 60·2 | 38·65 | 64·2 | 665 |
| 5·28 | 517 | 132 | 1·09 | 0·232 | 255 | 825 | 6,880 | 1,758,000 | 63·1 | 39·75 | 63·0 | 675 |

**Table III.**—*Net Results of Test of Electric Pumping Plant.*

| Machine. | | Head and lift from water level. | Gallons per minute. | Weight of discharged water. | Foot-pounds. | Input. Kw. | Output. Kw. | Plant efficiency. | Size of nozzle. | Head pressure. |
|---|---|---|---|---|---|---|---|---|---|---|
| Volts. | Amperes. | | | | | | | | | |
| 514 | 131·5 | 285·5 | 750 | 6,260 | 1,788,000 | 67·55 | 40·4 | 59·9 | 1¾ ins. | 123·7lb. |
| 512 | 122·8 | 262·5 | 776 | 6,480 | 1,700,000 | 62·90 | 38·45 | 61·2 | | 113·9lb. |
| 514 | 116·2 | 239·0 | 814 | 6,790 | 1,623,000 | 59·65 | 36·75 | 61·6 | 2 ins. | 103·7lb. |
| 514 | 96·5 | 193·0 | 889 | 7,420 | 1,431,000 | 49·55 | 32·40 | 65·4 | 2½ ins. | 83·8lb. |
| 516 | 75·6 | 151·5 | 914 | 7,630 | 1,155,000 | 39·0 | 26·15 | 67·0 | | 65·8lb. |



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**Table II.**—*Test of* 75 H.P. *Electric Motor.*

| Volts, machine. | Amperes, machine. | Core loss and friction. | $C^2R$ armature and brushes. | $C^2R$ series field. | $C^2R$ shunt field rheostat. | $C^2R$ magnet. | Total loss. | Input. Kw. | Output. Kw | Efficiency, per cent. |
|---|---|---|---|---|---|---|---|---|---|---|
| 494 | 113 | 2,385 | 1,460 | 850 | 529 | 109 | 5,333 | 55·85 | 50 52 | 90·5 |
| 495 | 114 | 2,385 | 1,485 | 865 | 535 | 110 | 5,380 | 56·45 | 51·07 | 90·4 |
| 500 | 115 | 2,385 | 1,515 | 880 | 540 | 111 | 5,431 | 57·5 | 52·07 | 90·5 |
| 496 | 118 | 2,385 | 1,595 | 928 | 531 | 110 | 5,549 | 58·55 | 53·0 | 90·5 |
| 476 | 250 | 2,385 | ... | ... | ... | ... | ... | ... | ... | ... |
| 516 | 118 | 2,385 | 1,595 | 928 | 563 | 120 | 5,591 | 60·9 | 55·31 | 90 8 |
| 510 | 118 | 2,385 | 1,595 | 928 | 551 | 118 | 5,577 | 60·2 | 54·64 | 90·8 |
| 517 | 122 | 2,385 | 1,700 | 990 | 564 | 120 | 5,759 | 63·1 | 57·34 | 90·8 |

# PARLIAMENTARY INTELLIGENCE.

## LOCH LEVEN WATER POWER BILL.

The Select Committee of the House of Lords, presided over by Lord Newton, on Thursday last had under its consideration the Loch Leven Water Power Bill, which has already passed through all its stages in the House of Commons.

Mr. LITTLER, K.C., said the bill had been carefully discussed in the other House, the only objection then made being to their proposal to acquire 230 acres of land beyond the quantity required for the works, the reason being that they intended to utilise this land for factories and works using the water power. It was said there was no precedence for taking lands not required; but it had been done in the case of the Shannon Power Bill, which had just received the Royal assent, and whatever commercial success the Manchester Ship Canal had achieved had been by selling and letting the lands along its banks.

Mr. R. W. Wallace, K.C., Chairman of the British Aluminium Co., Lord Kelvin, Mr. J. F. Albright (Messrs. Albright and Wilson, Ltd.), and Mr. Worth, managing director of the Acetylene Co., gave evidence as to the advantages which would follow the passing of the measure.

Mr. W. V. GRAHAM, joint engineer with Mr. George Anderson of the scheme, said the proposal was to make dams at the West End of the Blackwater Loch and the Loch Eilde Mor, and to carry it to Loch Leven in an aqueduct. The physical contour of the line was very well adapted for utilisation of water power. The fall was very great, quite 1,000ft. He knew no other plant where there was as great a fall with so large a volume of water. They would raise the level of the Blackwater Loch 15ft. by means of a concrete dam. From that point the water had been carried to the works in an aqueduct 5,700 yds. long in cover and 600 yds. in the open. There had been, except during construction, very little interference with the sporting rights. They would dredge the narrows of Loch Leven, and construct a pier. The cost of the whole works had been £575,000. They estimated they could obtain 18,758 H.P., so that the capital cost would be on the average £30. 13s. per horse-power developed. It would take two or three years to carry out the works.

Mr. BLYTH, civil engineer, Edinburgh, corroborated the evidence of Mr. Graham.

The case for the promoters was closed on Friday, and

Mr. POLLOCK, K.C., for the present tenant of the land, contended that there was no existing want for water power. It was a new departure to take land which was not required for works for the purpose of building factories in which there were never any works. The capital was £800,000. He contended that in no case would this amount be expended.

In the course of the evidence which followed it was admitted that the tenant's lease provided that in case the land was let for electrical purposes the lease should be terminated.

The Committee ultimately passed the preamble of the bill, and, the remaining clauses having been adjusted, the measure was ordered to be reported for third reading.

## LIGHT RAILWAYS LEGISLATION.

In the House of Commons on Monday the order for the second reading of the Light Railways Bill was discharged and the bill withdrawn.

On Tuesday the SECRETARY to the TREASURY (Mr. A. Chamberlain) moved for leave to introduce a bill to continue various expiring laws, including the Light Railways Act, 1896, which is to be continued so far as relates to the power of the Light Railway Commissioners.

## THE POST OFFICE LONDON TELEPHONE SYSTEM.

In the House of Commons Mr. BARTLEY asked on Monday whether the regulations of the Post Office telephones in London, when in working order, would permit of private firms obtaining private wires.

Mr. A. CHAMBERLAIN said the establishment of the system in London would not affect the provision of private wires of moderate length by the Postmaster-General. They would continue for the present to be provided at the same rates and under the same conditions as hitherto. It was, however, hoped that in many cases the exchange service would serve the same purposes as the more costly private-wire system.

## LONDON UNDERGROUND RAILWAYS.

In the House of Commons on Monday, in reply to Sir J. Dickson-Poynder,

Mr. G. BALFOUR said he would consider with the technical officers of the Board of Trade whether an inquiry into the subway system now in use in certain towns in the United States was desirable. It might be that even with the information they at present possessed the inspecting officers would be in a position to deal with undertakings of this description, if an effort were made by promoters to embark on such enterprises in this country. He understood that the system was also about to be tried in Paris.

Answering a further question as to whether, in view of the fact that the London County Council thought the system so important that they had sent two experts to the United States to investigate the matter, the Department would make similar investigations,

Mr. G. BALFOUR said he would consider the question. Such a course of action would be an unusual one, as no legislation was contemplated.

## PORTMADOC, BEDDGELERT AND SOUTH SNOWDON RAILWAY BILL.

This bill came up for consideration on Tuesday before the Committee of the Chairman of Ways and Means (Mr. J. W. Lowther) in the House of Commons. The object of the measure is to construct a short line through the Aberglaslyn pass, worked by electricity, current being generated by water power from two tarns—Llyn Llydan and Llyn Teyrn.

Sir DOUGLAS FOX, engineer to the scheme, said the opponents of the bill must be under some misapprehension, as the construction of the line would not affect the scenery in the least. In the original plans the railway went along the pass, but it was now intended to carry it in a tunnel. There were two mountain tarns from which they would abstract water for power; but the only effect of their doing so would be to lower the level for 2in. or 3in. The water would be conveyed in a 9in. pipe to their station, and, having been used, would be returned to the stream.

Sir E. CHANDOS LEIGH asked how it was the opposition had come forward so late. No objection had been raised to the first or second reading of the bill.

Mr. BRYCE suggested that the power station should be placed at Portmadoc and that power should be produced by steam. The aluminium works at Foyers had, he contended, already destroyed the most beautiful waterfalls in the British isles.

The CHAIRMAN said the bill would pass through Committee, and it would be left to the House of Commons to deal with the matter.

On the order for the consideration of the bill in the House of Commons on Tuesday evening,

Lord BALCARRES moved the omission of a clause in the bill enabling the promoters to use the waters for the purpose of obtaining electric power.

Mr. LLOYD-GEORGE supported the bill, and said local opinion in the district was unanimously in its favour. It would be a good thing for tourists to be able to ascend Snowdon by a neat electric tram instead of by a shaky char-à-banc.

Mr. J. BURNS was anxious to help local authorities, but some of them were willing to destroy all objects of national interest and places of scenic beauty if the rates could thereby be reduced, or the field of industrial employment enlarged.

Mr. BRYCE said the objectionable clause gave the company power to take water from the mountain turn. If they were not allowed to do that they would generate their electricity by coal. Therefore it was a mere question of money.

The motion for the omission of the clause was rejected by 162 to 52.

# LEGAL INTELLIGENCE.

## Chamberlain and Hookham v. the Corporation of Huddersfield.

In the Chancery Division on Saturday, before Mr. Justice Kekewich, Mr. Walter appeared in support of a summons asking leave to discontinue this action. Plaintiffs the were registered owners of letters patent for improvements in electrical meters, and an injunction was claimed against defendants for infringment and for other relief. Defendants denied infringement, and pleaded invalidity.

Mr. TERRELL, K.C., said what he was going to ask for was that no other action should be brought with respect of the same infringement; next he submitted they should have the costs as between solicitor and client; and, thirdly, that they should have the costs of the particulars of objections as if they had been certified as proper and reasonable. With regard to the point that the plaintiffs should be put upon the terms of not being allowed to bring any other action in respect of the same infringement, he might say that the makers of these alleged infringing meters were the Westinghouse Electric Co., and they were bearing the cost of these proceedings. They were indemnifying their customers, among whom were the Corporation of Huddersfield, and it would be very hard if, after having been put to all the expense necessitated by this action, another action should be commenced against another customer then discontinued, and another action brought, and so on. In these cases an indemnity by the manufacturer to the customer was customary. They were driven to that or they would have no customers. What the plaintiffs were trying to do by the present proceeding was to get a judgment covering an alternating meter when the alternating meter was not there to protect itself,

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and he submitted the court ought not to help them to do that. Defendants were prepared to go to trial, and now plaintiffs wanted to discontinue simply on the terms of paying the costs, when they would be at liberty to begin again.

Mr. Justice KEKEWICH: Against somebody else.

Mr. TERRELL: Perhaps, but really against the Westinghouse Company, because they will have to pay the costs. Defendants had been put to enormous expense in preparing for trial, and they were ready to go on. He did not mind admitting that they were trying to force the plaintiffs to go on.

Mr. Justice KEKEWICH: You are tempting me to try and get rid of the action.

Mr. WALTER, for plaintiffs, said his clients desired to discontinue the present action because there was an important action pending in the Court of Appeal, in which the interpretation which had been put upon the plaintiff's specification by Mr. Justice Farwell would be submitted for review. No doubt plaintiffs desired that the decision on that matter should be obtained before the costs of the present trial were ascertained. As to the question whether plaintiffs were to be at liberty to bring another action against defendants, he submitted plaintiffs ought not to be put upon terms. This was a continuing infringement, and, presuming the defendants were going to continue to infringe, there was absolutely no authority for a court holding that no public proceedings should be taken. He was willing that no further proceedings should be taken against the Huddersfield Corporation in respect of past infringements.

Mr. TERRELL pointed out that the plaintiffs' first and principle patent had expired.

Mr. WALTER said there were two other patents.

Mr. JUSTICE KEKEWICH said it was entirely within his descretion to give or refuse leave to discontinue, and, if he gave it, to impose such terms as he thought fit. He was asked by Mr. Terrell to impose upon the plaintiffs the burden of not bringing any other action in respect of the same meter. If he had limited his request to any other action against the present defendants he should have had no hesitation in imposing such a term; but, put as Mr. Terrell put it, there was a complete answer to his argument, in that the defendants had nothing to do with any other infringement, and they could use these meters so long as they pleased. But he was told, and it was uncontradicted, that the manufacturers of the meter were the Westinghouse Electric Co., and that they had indemnified the present defendants, and were bound to indemnify other customers. Therefore he was really being asked to say that no other action should be brought against the Westinghouse Company or other persons who dealt with them. The immediate reason why this action should be discontinued was that there was an appeal pending at the present moment from the decision of Mr. Justice Farwell, who had held that the patent had not been infringed, and of course, if Mr. Justice Farwell's judgment stood, they would hear no more of any actions of this kind.

Mr. TERRELL: I don't think Mr. Walter will say that.

Mr. JUSTICE KEKEWICH: But in the meantime plaintiffs were unwilling to bring this action in for trial. Under the circumstances he could not think it fair to impose upon plaintiffs the terms of not bringing any action against any other persons who might deal with the Westinghouse Company. He should give leave to plaintiffs to discontinue the action on the terms that they paid defendants' solicitor and client costs, the costs of the particulars of objections, and that they undertook not to bring any other action against the present defendants in respect of the infringement alleged in the proceedings.

Mr. WALTER said he was willing not to bring any other action against the defendants in respect of infringements up to the date of the writ, but as to not bringing actions for continuing infringements he could not give an undertaking without first consulting his clients.

Mr. JUSTICE KEKEWICH said he would give the plaintiffs a week to consider the matter. If they would not agree to the conditions imposed, the application to discontinue would be refused, with defendants' costs in any event.

## Bell v. Blakey.

At the Liverpool Summer Assizes on Tuesday, Mr. Justice Bucknill and a special jury heard an action for the cancellation of apprenticeship indentures or a return of the premium, £75. The action was brought by father and son, and it appeared that Mr. Bell, sen., apprenticed his son for four years to Messrs. A. B. Blakey & Co., of Wigan and Southport, to learn electrical engineering in all its branches. After having been 10 months at the Wigan office, the father withdrew his boy, alleging that he was taught little or nothing about the business, his time being occupied in attending men who were putting up wires or in sweeping out the office. For the defence it was contended that the representations made to plaintiffs by defendant about his business were true; that the boy Bell had been given as much instruction as he was capable of receiving in his first year, and that there was no ground whatever for the rescission of the contract. The jury found that defendant had not made untrue representations, and that defendant had not taught the boy whilst he was with him. £55 damages were awarded the father, but the jury considered the son had not sustained damage.

On Wednesday his Lordship gave judgment for plaintiff, and made an order that defendant should have such costs as on taxation were attributable to the issue on which he succeeded—viz., that there was no misrepresentation. Stay of execution was refused.

## British Electric Works Co. (Ltd.)

In the Chancery Division, on Tuesday, Mr. Justice Cozens-Hardy heard a summons in the action by which Mr. R. F. Hall, late general manager of the defendant company, asked that he might be paid £1,200, being 2 per cent. of the price at which the defendant company, works, &c., were sold. Defendants contended that the sum was too high. It was said that Mr. Hall was a director, in addition to being general manager, but resigned as director before the arrangement for a commission on the sale was entered into.

Counsel for the liquidator said he had never seen Mr. Hall's letter of resignation.

His LORDSHIP said he could not deal with the claim until he had seen the letter, and the summons must stand over till next sittings, the company to pay £1,250 into court to answer the claim and costs.

On further consideration of the action, it was stated that judgment was pronounced on June 22 last in the ordinary form, and the receiver and manager was authorised to act until the 10th inst., by which date it was contemplated the sale of the company's business would be carried through. The sale had been completed on the previous day, and there was now in court sufficient to pay all the encumbrances in full and leave a balance.

His Lordship discharged the receiver subject to the adjustment of various matters between him and the purchasing company.

## Claim for Damage by a Tube Railway.

In the Under-Sheriff's Court, London, Mr. Under-Sheriff Burchell and a special jury on Friday last heard a case for the assessment of damages against the Great Northern and City Electric Railway Co. It appeared from the statement of claim that the house, No. 1, Highbury-place, London, N., was let at £140 a year, and that the work of boring for the railway was commenced before terms could be come to between the parties. The work was done at a depth of 52ft. below the surface, and was of the regular 16ft. diameter. Shortly after the work of driving the tunnel commenced cracks appeared in the ceilings and walls of the house.

A surveyor for the claimant, a Mr. W. Catlin, estimated damage and depreciation at £3,976, and considered a further £500 should be added for future damage.

On behalf of the railway company, counsel (Mr. Cripps, K.C.) contended that the claim was excessive, and the whole of the damage could be put right for a few pounds. He called Sir Douglas Fox, who said there would be practically no damage in the future. There used to be difficulty and danger of subsidence in sinking tunnels in London, but by the adoption of the Greathead method of forcing grout at high pressure between the soil and the cast-iron casing of the tunnel that was all overcome.

After further evidence the jury awarded £660 damages, and judgment was entered for this amount, with costs.

## Ambler & Sons (Ltd) v. Bradford Corporation.

In our last issue, we set out briefly the points raised in this action for alleged damage to plaintiffs' premises caused by works at the defendant Corporation's electricity supply station.

Mr. Justice JOYCE, on Saturday last, delivered judgment, dismissing plaintiffs' action with costs, on the ground that the Corporation's works did not materially contribute to the damage caused by the flooding of Bradford Beck.

## The Law Relating to Trade Unions.

An important decision was given in the House of Lords on Monday in the appeal action "Quinn *v.* Leathem." The appeal was against decisions in the lower Court and of the Court of Appeal in Ireland. In both actions judgment was given for the plaintiff. It was an action in which a number of trade unionists were charged with interfering with the due liberty and business of the plaintiff, a butcher of Lisburn, by the publication of black lists and other forms of intimidation by which plaintiff had suffered. The decision was regarded in trade unionist circles as of the utmost importance and seriousness, and the decision of the jury in the lower Court, giving plaintiff £200 damages, was at once appealed against. The appeal was, however, dismissed, and the case now came before the House of Lords for final decision.

In lengthy judgments the Lord Chancellor and Lords Macnaghten, Shand, Brampton, Robertson and Lindley dismissed the appeal with costs. In the judgment delivered by each law lord the decisions of the Irish Courts were practically supported in every particular. The defendants relied to some extent upon the decision in "Allen *v.* Flood," but were unsuccessful in all their contentions.

**Scarcity of Platinum.**—We understand from the *Financier and Bullionist* that the scarcity of platinum has become so marked that disused Russian coins have been used up for industrial purposes. Platinum coins to the value of about 4,250,000 roubles were minted during a period of 17 years in the early half of the last century, but even then the fluctuations in value were sufficiently great to cause the issue to be discontinued. The same paper says that the introduction of platino-type processes in photography has led the German electricians to appeal for legislative protection to prohibit photographers from using platinum.

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Finchley Urban District Council require a resident electrical engineer and manager at a commencing salary of £300 per annum. Applications to Mr. Charles Roberts, Council Offices, Ribbsworth House, Church End, Finchley, by noon, Aug. 19. See advertisement.

Applications are invited for the position of electrical engineer to the municipality of East London, Cape Colony. An advertisement contains further particulars, and applications must be received by the town clerk, East London, Cape Colony, by noon of Oct 10.

Bedford Corporation require an electrical engineer to take charge of their electricity department. An advertisement contains further particulars, and applications must be delivered to the town clerk by Aug. 20.

The committee of University College, Nottingham, require a demonstrator in electrical engineering. The required qualifications are set out in an advertisement. Commencing salary is from £150 to £200 per annum. Applications before September 7.

An assistant lecturer and demonstrator in physics and electrical engineering is required at Hartley College, Southampton. Applications to principal.

The Pacific Cable Board invite applications for the post of general manager. Applications to secretary, 24, Queen Anne's-gate, S.W., by Aug. 19.

A well-known firm of electrical engineers, which is opening a branch in Scotland, requires a manager capable of estimating and superintending high-class lighting and power installations. See advertisement.

The Council of the Harris Institute, Preston, require a lecturer in mechanical engineering. Further particulars from the secretary (Mr. T. R. Jolly). See advertisement.

Hastings Electric Light committee require a mains superintendent Applications to borough electrical engineer by noon Aug. 13.

An assistant lecturer and demonstrator in physics is required for University College of North Wales, Bangor. Applications by Oct. 12.

Wexford Technical Instruction committee require a principal for the proposed municipal technical school. Applications to hon. secretary by Aug. 19.

A professor of engineering is required by University College, Bristol. Applications to secretary by Aug. 31.

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Mr. Carl A. L. Prusmann, of Doncaster, has been appointed borough electrical engineer at Swansea, in succession to Mr. Cawthra. After Mr. Prusmann had been chief electric inspector at Manchester for some time he migrated to Bradford, where he was engaged as chief assistant, and he subsequently went to Doncaster as electrical clerk of works, being appointed resident engineer in 1899. There were 66 applicants for the position at Swansea. This number was reduced to six—viz. C. A. L. Prusmann (Doncaster), J. H. Clothier (Stafford), H. Morton (Llandudno), R. Blackmore (Wakefield), T. C. Parsons (Halifax), and H. Drewett (Morley). These names were further reduced to three—viz., Messrs. Prusmann, Blackmore, and Clothier, and eventually Mr. Prusmann received the appointment.

Mr. Edward Fazackerley, who has for some years been engaged with Messrs. Mather and Platt in supervising the erection of municipal electric lighting and tramway plants, has been appointed electrical engineer at Rainhill Asylum, Lancs.

Mr. Alexander Allan, engineer of the Nelson gas and electricity works, has been appointed engineer of the Scarborough gas works.

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**Alloa.**—The municipal buildings are to be wired for electric lighting.

**Aluminium Production.**—The *Berliner Tageblatt* states that negotiations are proceeding between the leading aluminium manufacturers on the Continent and in the United States with a view to arriving at an understanding to improve the industry. The companies concerned are the Aluminium Co., of Neuhausen, and the Pittsburg Aluminium Production Co., the leading American company.

**Batley.**—The Corporation have obtained six months' further time in which to comply with the terms of their tramway provisional order.

**Birkenhead.**—In moving the adoption of the report of the Tramways committee on Wednesday, the chairman (Dr. D. L. Pearson) said the committee could say, on their 6 months' working, that there would be a profit on the first year. It was expected that within the next few days the Claughton-road, Higher Tranmere and Conway-street routes would be officially inspected, and they hoped to have them opened within 10 days or a fortnight.

**Bognor.**—The District Council are recommended to appoint Mr. J. S. Enright consulting electrical engineer.

**Bradford.**—The Great Horton electric tramway route has been opened for traffic.

**Bristol.**—The accounts of the Electricity department, which were abstracted in our last issue, were presented and passed at the meeting of the City Council on Friday.

**British Westinghouse Works at Trafford Park.**—Two functions of an interesting nature were performed on Saturday last by the Lord Mayor and Sheriffs of London—one at Trafford Park and the second at Broadheath, Manchester. At Trafford Park the foundation stone was laid of the British Westinghouse Electric and Manufacturing Co.'s extensive range of works, which are gradually covering a vast area. The site of the works covers 130 acres adjacent to the Manchester Ship Canal and the Bridgwater Canal, and also in direct communication with the main lines of railway of the country. The building works are finding employment for about 3,000 workmen. There are six large buildings of rectangular form arranged side by side, which, when completed and equipped, will give work to 5,000 employés in the manufacture of gas engines, dynamos, motors, converters, transformers, &c. Many leaders of industrial enterprise in the Midlands were present on the occasion, as well as a large number of gentlemen connected with municipal undertakings. Many of the leading manufacturing firms were represented, and the gathering included several corporation electrical engineers, amongst whom were Mr. J. H. Rider, of the London County Council, Mr. C. Turnbull, of the Tynemouth electricity works, and Mr. R. A. Chattock, of Bradford. Chairmen of municipal electrical committees gathered in strong force. Mr. George Westinghouse, chairman of the company, was unavoidably absent through illness, and the duties of the occasion fell upon Mr. Sheriff Lawrence, M.P., chairman of the Linotype Co., who was also host in the second function, held at Broadheath, when there was inaugurated considerable extensions to the Linotype Co.'s works. An unusually large gathering of London and provincial men joined in the double event, which was a great success. An interesting souvenir of the ceremony of laying the foundation stone of the new works has been issued by the company.

**Cardiff.**—In the monthly report of the borough electrical engineer (Mr. Arthur Ellis) it is stated that the electricity undertaking has now turned the corner. Last year the revenue was equivalent to a dividend of 5¾ per cent. on capital.

**Cheltenham.**—Sanction to a further loan of £25,000 for electric lighting has been obtained by the Council.

**Cheltenham Tramway Accident.**—The adjourned inquest into the death of the two men Holloway and Jackson, who were killed on 29th ult. by the overturning of an electric tramcar, was resumed on Wednesday.

Mr. T. A. Nevins explained that the cars were each supplied with a hand brake and an electric brake, the latter being applied by power generated by the wheels of the car. Prior to the day of the accident witness had taken a car up the Cleeve Hill, and it completed the journey safely both up and down.

Mr. C. W. Parkes, who was on the car superintending its ascent in order to test the motors, stated that when three-fourths of the way up the hill the electric current suddenly went off, and the car began to skid back. He heard Mr. Nevins, who had just got off the car, call out to the driver to put on the brake quickly, and the driver did so, with witness's assistance. The chain brake was first tried, and it somewhat retarded the backward progress of the car, but did not stop it, and witness then released the hand-brake, and put on the electric brake, which took one grip of the rails, but failed to bring the car to a standstill. The driver and himself "worked" the brake in order to make it do so, but they did not succeed, and they then "set her tight," with the result that the wheels were locked, and the car skidded down the hill, at what pace he was unable to say. Just before coming to the bend in the road, where the car overturned, witness jumped off. Had the car been lighter the accident probably would not have happened. He did not, however, consider the car too heavy for the gradient.

Police-constable Harvey said the pace of the car did not appear to him to be more than 8 or 9 miles an hour.

John Webb, a labourer, who was on the car, said the two deceased men were standing on the step (off the platform), holding by a bar and handle, when the car left the rails and went over the side the men were standing, and they were dragged under. If they had remained on the platform they would probably have been uninjured.

Mr. J. A. Lovell, who was on duty at the Manchester-street sub-station of the Corporation electricity works, said the circuit-breaker went at 6:20, and was immediately adjusted, after which the machinery for the supply of the current remained in perfect working order.

Mr. T. Nevins said when the car slowed he jumped off to see if the trolley was on the wire, and found it was. Immediately afterwards the car reversed. He expected it to be brought to a standstill by the application of the brakes after the first declivity was passed, but it did not, and looking again at the trolley, he found the current was on, as sparks came from the trolley wire. He did not think the car too heavy for the gradient with proper brakes, and they were taking steps to provide stronger ones. In future they intended to run up the hill only cars from which the tops

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had been removed; there would be no outside seats on the cars used on the hill. The jury returned a verdict—

That the deceased died from injuries accidentally sustained by the overturning of an electric car which was not under proper control, but they attached no blame to anyone.

A rider was added to the verdict, as follows:—

The jury consider that in consequence of the steep gradients and sharp curves on Cleeve Hill the proposed tramcars are too heavy to be used with safety to the public on the hill portion of the tramway system, and they express approval of the steps taken to remedy the brake power used at the time of the accident.

The jury did not wish their rider forwarded to the Board of Trade, being satisfied with Mr. Nevins's assurances that the difficulties were being attended to. The Board of Trade intimated early in the proceedings that it was not their intention to be represented at the inquest.

**Colchester.**—The Council have obtained sanction to a loan of £15,825 for electric lighting. The Tramways committee have been informed by the Board of Trade that their proposal to run cars or omnibuses by overhead electric wires, without laying rails, cannot be entertained under the Tramways Act, 1870. The Board intimate that they are willing to receive a deputation on the subject.

**Costa Rica.**—At San Jose there is well established in popular favour an electric tramway constructed, equipped and worked by the Costa Rica Electric Lighting and Traction Co., a British company. The railway is 3½ miles in length and the machinery at the power station is turbine-driven. The lowness of the river in the dry season necessitates the cars ceasing to run after 5:30 p.m., as the whole available current is then required for lighting. It is intended to extend the line a further distance of 2 miles when the disputes with the local telephone company are adjusted. When the extensions are made water power some miles distant from San Jose will be utilised, and the difficulties of lack of water will be overcome.

**Dewsbury.**—Notice has been given to the Dewsbury, Batley and Birstall Tramway Co. requiring them to sell to the Corporation so much of their undertaking as is within the municipal borough. After purchase the lines are to be transferred to the British Electric Traction Co, who are constructing a system of electric tramways in the district.

**Eastbourne.**—The Corporation have obtained sanction to borrow £43,287 and £7,500 for electricity supply. The Local Government Board consider the Council's proposal to apply £2,000, which the Council expect to obtain by the sale of old plant, in defraying the cost of new works undesirable, and suggest that the amount should be raised by loan for a short period.

**Electric Haulage in Canals.**—It is stated that an arrangement has been made between the River Lea Conservancy Board and the Electrical Power Distribution Co. to install electric haulage plant for working the traffic on the river Lea from Hertford to Walthamstow, a course of about 18 miles.

**Electric Railways in France.**—An electric railway has been opened for traffic between Fayet and Chamonix. Electrical energy is furnished by two water-power-operated stations—one at Servoz and the other at Pont Pelissier.

**Electric Traction on Standard Railways.**—At the meeting of the Great Central Railway Co., on Wednesday, the directors were urged to consider the possibility of utilising electric traction on those parts of the line where a more cheap and frequent service was needed. The chairman (Mr. A. Henderson, M.P.) replied in the old, old strain—that he regarded electricity as still in the experimental stage with regard to its use upon railways. "When one of the more prosperous companies has taken the matter up and shown that electricity has passed the stage of experiment, then the Great Central will be glad to follow the example."

**Electrolysis of Gas and Water Pipes.**—In the report of the directors of the South Metropolitan Gas Co. it is stated that the company has been so far unsuccessful in obtaining from Parliament protection against the serious damage which they believe will result to their mains and pipes by action caused by the return currents of electricity from electric railways and tramways. The directors state that these undertakings must be compelled to prevent damage to gas and water pipes.

**Erdington.**—After consideration of a report by their consulting engineer (Mr. Green), the Council decided on Wednesday to promote a bill for powers to construct and electrically equip a system of electric tramways.

**Exeter.**—The Tramways committee have been authorised to engage a consulting engineer to prepare a report on tramways, and to advise on the merits of the proposals of the British Electric Traction Co.

**Felixstowe.**—A special meeting of the Council has been called for discussing electricity supply proposals.

**Germany.**—Messrs. Siemens and Halske have secured a contract for the erection of electricity supply works at Schwenningen.

**Glasgow.**—The effect of reducing the hours of tramway employés to 52 per week has been to add £10,000 to the annual expenditure. Mr. Paton explained to the Council on Friday that the strain on the men was greater than under the horse system, and the Tramways committee had practically agreed to reduce the hours before the matter came before them on the action of the men. No unpleasantness had occurred between the department and the men. The capital expenditure on the tramways now amounts to £1,793,934, and Mr. Paton said they had still to expend about half a million on the lines that had to be constructed, bringing the capital up to about £2,300,000. The revenue for the year had been £489,469, or £19,503 over the previous year. The increase of revenue would have been larger but for the adverse climatic conditions and for the repairs, &c., that had taken place on the streets. The working expenses were £372,080, an increase of £27,359 over last year. The Springburn route, which had been worked during the past year wholly by electricity, had yielded a splendid return. The revenue per car mile had been 14·62d. and thi cost of working 6·62d., leaving a net profit of 8d. per car mile—that is, the working expenses of electric traction to Springburn had been 45 per cent. of the receipts, while the working expenses of the horse cars had been 82 per cent. The number of passengers carried was 132 millions, or five millions more than the previous year. He maintained that with the new system of accounts and electric traction the future before the tramways department was a bright one. The accounts were approved.

**Heckmondwike (Yorks.)**—The Council have resolved to adopt a system of "free" wiring.

**Hill-of-Howth Electric Tramway.**—The Sutton and Howth electric tramway, owned by the Great Northern Railway Co. of Ireland, was opened for traffic from the railway station at Sutton to the summit of the Hill on June 17. The remaining portion of the tramway (to Howth railway station) would be opened on 1st prox.

**Kingston-on-Thames.**—The receipts of the electricity department for the 12 months ended March were £6,562. 11s. 4d., compared with £7,511. 18s. 9d. for the preceding 15 months. The expenditure was £9,283. 13s. compared with £7,559. 17s. 8d., leaving a deficit of £2,721. 1s. 8d. The cost of coal went up from £2,407. 14s. 1d. in the 15 months to £4,236. 6s. 8d. last year, and there was a considerable increase also in management expenses and in interest and repayment of loans. The works cost of the current per unit sold last year was 4·353d. against 2·608d. in the preceding 15 months; the remaining items of expenditure averaging 2·844d. per unit, against 2·359d. The revenue was equal to 5·09d. per unit, and the cost to 7·197d. There are now 376 consumers, an increase of 65 during the year, while the equivalent number of 8 c.p. lamps connected was 18,899, an increase of 2,769. The total number of units supplied was 308,860. The total deficit on the works from the date of establishment in 1893 has been £8,680. 14s. 2d., but £6,463. 4s. 11d. represents repayment of capital, leaving a net loss of £2,217. 9s. 3d.

**Leyton.**—An inquiry was held here into the Council's application for sanction to borrow £15,545 for electric lighting extensions. Technical details were supplied by the electrical engineer, Mr. F. Harman Lewis. There was no opposition.

The District Council are threatened with another action for an injunction to abate an alleged nuisance caused by the electricity works. Mr. Hawkes' solicitors have informed the Council that unless the noise and vibration caused by the steam plant are stopped their client will commence proceedings.

**Light Railway.**—An inquiry has been held by the Light Railway Commissioners into the application to construct a light railway between Canterbury, Herne Bay and Whitstable. Objections by local authorities led to the scheme being rejected.

**Liverpool.**—Sanction to a further loan of £300,000 for electricity supply has been obtained by the Corporation.

**Ludlow.**—The Electric Lighting committee have received 22 tenders for the supply of electricity generating plant, &c., but only two firms tendered for the complete equipment. A committee has been instructed to inspect plant supplied by one of the tendering firms to other stations.

**Manchester.**—The Electricity committee now recommend the Corporation to increase the price of electric current to all consumers by ½d. per unit from Sept. 29. The committee estimate that at the end of the current year's working there will be a deficiency of £5,014 to come from reserve, which now stands at £13,172. The committee state that their provisional order sanctions the setting aside of 10 per cent. on the capital expenditure, which would have allowed the reserve fund in March last to stand at £86,329. In view of heavy capital expenditure on generating plant and mains the amount required next year for interest and sinking fund is estimated at £76,178, an increase of £20,000 on the current year's figure. The committee anticipate that the extra ½d. per unit will increase receipts by £11,000.

**Merchant Venturers' Technical College, Bristol.**—The calendar for the 46th session (1901–2) of this college is ready, and contains full information relating to the day and evening classes in electro-technology, which are a feature of the training at this institution. Prof. A. Philip, B.Sc., late assistant professor at Heriot-

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Watt College, is chief of the applied physics and electrical engineering branch, assisted by a large staff of lecturers, demonstrators and instructors, and in chemistry and metallurgy Prof. J. Wertheimer, principal of the college, is the head of a large teaching staff. It may be mentioned that the total value of the scholarships gained by pupils in the applied science branch of study at this college during the last three years has amounted to £4,855, the whole of which was won in open competition. In the neighbourhood of the college there are situate a number of large works, which, by the kindness of their owners, are open to the students. There are 20 of these works, including the Bristol Corporation electricity station, the power station of the Bristol Tramways and Carriage Co., the Great Western Railway works at Swindon, the Midland Railway Co.'s workshops at Barton Hill, coal mines, and a miscellaneous variety of general works, in their visits to which the students are accompanied by members of the teaching staff, in order that all possible advantage may be taken of the lessons which such visits convey. A series of illustrations in the calendar under notice give photographic views of the laboratories, workshops, testing rooms, &c., at the college.

**Melbourne (Victoria).**—The accounts of the electricity department of the Council for the year ended Feb. 28 show a gross profit of £11,005. 6s. 1d. and a net profit of £4,541. 11s. 9d. The gross profit is £1,026. 1s. 5d. less than in 1899-1900, and the net profit somewhat less. The capital expended to date is £204,051. 0s. 3d., and the sinking fund now totals £24,006. 5s. 7d. The gross receipts in 1900-1901 were £35,466. 15s. 6d., and the expenses £24,461. 9s. 5d.

**Municipal Telephony.**—The National Telephone Co. have agreed to sell the Eastbourne section of their undertaking to the Town Council on the basis of 21 years' purchase on last year's net profit.

Liverpool Corporation are recommended to establish a municipal telephonic service and to apply for a licence.

At the Glasgow Corporation meeting last week Mr. Shaw inquired if there was any chance of the Corporation telephone connections progressing more rapidly. Only 860 connections had been made out of 5,256 applications. The chairman of the Telephone committee (Mr. J. Alexander) said 1,050 connections had been made, and they were going ahead as rapidly as possible. Mr. Stewart said at the present rate of progress it would take five or six years to complete the connections, and they had only 11 years altogether for the concession. The Lord Provost said he had recently seen the engineer, who had assured him that the difficulties they had had to encounter were now practically surmounted and that within a year every applicant would be connected. The number of connections formed was a record in telephone installation.

The Postmaster-General has granted a licence to the West Hartlepool Town Council to equip and work a municipal telephone exchange. The borough engineer has been instructed to visit Tunbridge Wells and Huddersfield to collect information.

The Hastings Council are considering a proposal to establish a municipal telephone exchange, and the National Telephone Co. are to be invited to reduce their charges to their new Tunbridge Wells scale.

Application has been made by the Grantham Council for sanction to borrow £2,000 for establishing a municipal telephone service.

**Neath.**—The gas manager has been instructed to report on electric lighting.

**New Acts.**—The following acts have received the Royal assent:—
Electric Lighting Order Confirmation Acts, 1901, Nos. 1, 5, 6 and 10.
Notting Hill Electric Lighting Act, 1901.
King's Norton and Northfield Urban District Tramways Act, 1901.
Bexley Tramways Act, 1901.
Cleveland and Durham County Electric Power Act, 1901.
Yorkshire Electric Power Act, 1901.
Derbyshire and Nottinghamshire Electric Power Act, 1901.
Metropolitan Railway Act, 1901.
Shannon Water and Electric Power Act. 1901.

**North Berwick.**—The ratepayers are being polled as to municipal electricity supply. The Council has entered into a provisional agreement with Messrs. Crompton & Co., under which the firm bind themselves within 18 months of the Council obtaining a provisional order, to erect and equip a generating station, and to maintain and carry on the works for at least 21 years, unless they are sooner acquired by the Council, who reserve certain rights of purchase.

**Perth (W.A.).**—The City Council have resolved to establish municipal electricity supply, notwithstanding the recent adverse poll of the ratepayers.

**Poplar (London).**—A uniform charge of 4½d. per unit has been adopted for electric current supplied to places of worship.

**Postal Telegraphs.**—The sixth annual conference of the Amalgamated Association of the Postal Telegraph Engineering Department was held at Birmingham on Monday, Mr. E. Morgan presiding. The statement of accounts showed a balance in hand of nearly £100. Mr. F. Blackburn, Manchester was re-elected editor of the *Telegraph Engineering Journal*, and the secretary, Mr. Young, of Northwich, was also re-elected. Holloway, London, was chosen for next year's conference. Replies to petitions which had been forwarded to the engineer-in-chief were read, giving promise of better conditions for the employés upon the established lists. As to those unestablished, Mr. Blackburn pointed out that, while many messengers and postmen had recognition, many of the men who were sent out in charge of linemen to do repairs or other engineering works were not on the list, and he considered that was a disgrace to the service. He suggested that men should be placed on the established list after two years' service, and a motion approving this proposal was carried. The name of the association was altered to the Engineering and Stores Association of the Postal Telegraphs.

**Rotherham.**—The borough electrical engineer (Mr. Edward Cross) recently reported that there were 78 customers of the electricity department, representing an equivalent of 5,053 8 c.p. lamps. The consulting engineers (Messrs. Kennedy and Jenkin) have been asked to report as to extensions being required within the next 12 months.

**St. Helens.**—An understanding has been arrived at between the Tramways committee and the New St. Helens Tramways Co. as to the terms of the lease of the tramways, which the company contend are too onerous. At the end of the first five years the payments under the lease (both retrospective and prospective) are to be reconsidered and revised if necessary. In the meantime the Council are recommended to accept, in addition to the charge for electric current, the fixed rent of £3,000 per annum, and a further sum sufficient to cover their actual out-of-pocket payments for interest and sinking fund and repairs and upkeep. The above proposals will be discussed at the next meeting of the Council.

The borough electrical engineer (Mr. J. S. Highfield) has reported that the equivalent number of 8 c.p. lamps connected on June 30 was 25,984, against 14,713 in the corresponding period of 1900.

**Scarborough.**—The Council's consulting engineer (Mr. J. E. Waller) has submitted a tramway scheme, involving the constructing of over 6 miles of line, which is at present under the consideration of a committee.

**Southport.**—A portion of the Southport Tramways Co.'s system was opened for traffic on Thursday last. With the completion of the Roe-lane route the whole of the company's lines will have been electrically equipped.

**Sowerby Bridge.**—Halifax Council have offered to supply electricity in bulk to the Sowerby Bridge Council at 2¾d. per unit up to 15,000 units per annum, at 2⅝d. between 15,000 and 30,000 units, and at 2½d. over 30,000 units per annum.

**Torquay.**—The Council have a second time rejected a proposal to apply for Parliamentary powers to construct electric tramways.

**Tramway Strike at Bristol.**—Fortified by the recent decision of the House of Lords in the Taff Vale Railway action, and more especially by the House of Lords decision on Monday last in the action "Quinn *v.* Leathem," the directors of the Bristol Tramway Co. have decided to issue writs to be served on several prominent trade unionists and others who recently spoke to a resolution inviting the public to aid the drivers, &c., on strike by boycotting the company's cars. In the meantime the Tramways Company are gradually improving the service of the cars and overcoming the difficulties which the men have placed in the way of their regular running.

**Wakefield.**—The receipts of the electricity department for the year ended March 31 amounted to £4,197. 17s. and the expenditure to £3,734. 15s. 10d.

**West Bromwich.**—The Electric Lighting and Power committee recommend the Corporation to continue the alternative system of charging for electric current from April 1 to Sept. 30 on the basis of a flat rate of 4d. per unit, and that the maximum demand system be continued from Oct. 1 to March 31 at present rates. They also recommend that customers be allowed the option of adopting either the demand or the flat system during the summer quarters by giving notice in April; and also that a flat rate of 4d. per unit all the year round be fixed as the charge for current supplied to places of worship.

On Wednesday the Council decided to acquire so much of the undertaking of the Birmingham and Midland Tramways Co. as lies within the borough for £5,500, and also that of the South Staffordshire Tramways Co. for £32,000, this sum to include also compensation for the company foregoing their rights to sell to the Corporation a portion or the whole of the equipment of their undertaking, and a sum equal to the loss of rent which the company would sustain under the terms of its lease by selling the lines before it is obliged to do so. As soon as the purchase is completed the lines will be reconstructed and equipped electrically. The Council have appointed Mr. R. C. Quin, of Blackpool, to act as consulting engineer and supervise the whole of the work for an inclusive fee of £2,000.

**West Hartlepool.**—The electric lighting cables are to be extended to Seaton Carew at an estimated cost of £2,657. The Council have declined the offer of the local tramway company to re-lay the permanent way at an estimated cost of £20,500 on condition of obtaining an extension of lease.

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**Witham.**—A preliminary estimate of the cost of electric lighting has been submitted by Messrs. Christy Bros. and Middleton. The cost is put at £1,075 approximately, if an engine which the Council have already installed is utilised. Messrs. Christy Bros. think the Council should consider the advisability of putting down a small plant for public and private lighting at an additional £400 in the cost. The electric light would then cost £220 per annum, against £150 now paid for gas. The question of applying for a provisional order will be discussed at the next meeting of the Council.

**Woodbridge.**—The Suffolk Electricity Supply Co. will apply for a provisional order for this district.

**Outings.**—The employés of the lamp works of the Sir Hiram Maxim Electrical and Engineering Co. held their annual excursion on Thursday last week at Clacton, where a party numbering over 100 had a pleasant holiday.

The London staff of Messrs. Veritys Limited held their outing at Brighton on 27th ult. The London manager, Mr. C. S. Northcote, M.I.E.E., presided at the dinner.

**Cricket.**—In the annual match between the members of the Robertson Electric Lamp and the General Electric cricket clubs, the lamp makers secured a victory, the score being 79 to 75.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

### TENDERS INVITED.

*Bournemouth* Corporation invite tenders for boilers, super-heaters, economiser, feed pumps, pipe work and accessories. Forms of tender may be obtained of the borough engineer (Mr. F. W. Lacey) and further particulars and drawings may be obtained at the offices of the consulting engineers (Messrs. Lacey, Clirehugh & Sillar), 2, Queen Anne's Gate, Westminster, London, S.W. Tenders must be sent to the town clerk (Mr. J. Druitt, sen.) by noon of Thursday, the 29th inst. Some particulars are given in an advertisement.

*Darlington* Corporation invite tenders for the supply and erection of Lancashire boiler, 350 H.P. engine coupled to a continuous-current dynamo, and extension of steam, drain and feed pipes. Specification, &c, from the town clerk (Mr. H. G. Steavenson), and can also be seen at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to Mr. Steavenson by Aug. 22. See advertisement.

*Worcester* Corporation invite tenders for the supply and erection of the plant set out in an advertisement elsewhere. Specification, &c., can be obtained of Mr. C. J. Sutherland (city electrical engineer), Guildhall, Worcester, and tenders must be sent to Mr. S. Southall, town clerk, Guildhall, Worcester, by noon of Aug. 23.

*Middlesbrough* Electric Lighting committee invite tenders for the supply and erection of mechanical coal handling plant at their municipal electricity works. Specifications may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W. Tenders to the town clerk (Mr. George Bainbridge), Town Hall, Middlesbrough, by Sept. 3. An advertisement contains further particulars.

*Mansfield* Electric Lighting committee require tenders for refuse destructors. Further particulars are given in an advertisement, and specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W. Tenders to the town clerk (Mr. J. Harrop White) by Sept. 5.

*Edinburgh* Corporation invite tenders for the electric lighting installation, &c., of the second portion of the Colinton Mains Fever Hospital. An advertisement contains further particulars. Specifications after Monday from the resident electrical engineer (Mr. F. A. Newington), Electricity Station, Dewar-place. Tenders to town clerk (Mr. Thomas Hunter, W.S.) by 11 a.m., Sept. 9.

*Manchester* Tramways committee invite tenders for electrical accessories, machine tools, &c., car-cleaning materials and veterinary services. Specifications from the general manager (Mr. J. M. McElroy), Tramways Department, 55, Piccadilly, and tenders to chairman of committee by 1 p.m., 17th inst. See advertisement.

*Aston Manor* Urban District Council invite tenders for water-tube boilers, stokers and economiser, two 500kw. and one 200kw. steam dynamos and motor balancer, switchboard, travelling crane and arc lamps. Specifications from the offices of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W., and tenders (addressed Chairman of the Electric Lighting and Tramways committee) to the Council offices, Aston Manor, by noon of Sept. 4. See also advertisement.

*St. Anne's-on-the-Sea* Urban District Council invite tenders for a 180kw. continuous-current, direct-coupled steam dynamo. Specifications, &c., from the electrical engineer (Mr. P. J. S. Tiddeman), to whom tenders by Aug. 23. An advertisement contains some further particulars.

*Glamorgan* County Asylums committee invite tenders for electric lighting of Parcgwyllt asylum. Tenders to the offices, Bridgend, by 24th inst.

*Ilford* District Council invite tenders for the construction of about 11 miles of tramways. Tenders by 5 p.m. Aug. 31.

*Farnham* Urban District Council are open to contract with a responsible firm for the supply of electricity under their electric lighting order, 1900. Proposals to clerk by noon Aug. 27.

*Croydon* Lunacy Visiting committee invite tenders for wiring the Warlingham Asylum. Tenders by noon 26th inst.

*Doncaster* Corporation invite tenders for unarmoured waterproof cables and wires for tramway feeders and feeder and section pillars. Tenders by noon 17th inst.

*Batley* Corporation invite tenders for the erection of electricity station buildings and chimney shaft. Tenders by 21st inst.

*Brighton* Guardians invite tenders for the electric lighting of a portion of the workhouse premises. Tenders to clerk by 20th inst.

*Leigh* Electricity and Tramways committee invite tenders for steam dynamo. Tenders by 24th inst.

*Birkenhead* Corporation invite tenders for steam dynamo. Tenders by 23rd inst.

Tenders are invited for the electric lighting of the "Carcel Modelo," *Madrid*, for 15 years, at about £857. 3s. per annum. Tenders by 31st inst. to the president of the "Audiencia Territorial," Madrid.

### TENDERS RECEIVED AND ACCEPTED.

Newcastle-upon-Tyne Corporation have accepted the tender of Messrs. R. C. Brebner & Co. for the construction of about 1,060yds of double tramway track in Gosforth at £5,779. 12s. 6d. It was reported that the tender of Messrs. Dick, Kerr & Co. had been originally accepted by the Tramways committee for rails, but it was afterwards found that there was a qualifying letter attached to it which had escaped notice and so modified the contract that the committee could not proceed with it. They had accepted the next lowest tender, that of Messrs. Walter Scott & Co. The price was 1s. 9l. per ton higher than that of the original contract, but the rails were to be 60ft. in length instead of 45ft. The alteration was sanctioned.

Blackburn Corporation have accepted the tender of Mr. W. J. Woof for extending the electricity station buildings at £14,884.

Bedford Town Council have accepted the following tenders :—

W. T. Henley's Telegraph Works Co., for 800yds. of service cable at £113. 6s. 8d.

British Insulated Wire Co., for cable for duplicating the high-tension mains to the central sub-stations at £482. 17s. 11d.; and also 12 disconnecting boxes at £38. 5s.

Johnson and Phillips, for an exciter at £263.

E. Green & Son, for new sections to economiser at £110.

Peterborough Corporation have accepted the tender of Messrs. D. Bruce Peebles & Co. for a 200 H.P. set (Willans engine) and a spare armature.

Longton Town Council have accepted the tender of Messrs. E. J. Clark (Ltd.) for wiring the Sutherland Institute at £154, and the High School for £35.

### BUSINESS NOTICES.

In consequence of the expansion of the electrical branch of their business Messrs. Witting Bros. have decided to make this branch a separate one and to form a special company for the conduct of the electrical business under the style of Witting Bros., Electrical Engineers and Contractors, Ltd. All orders and contracts in hand and unexecuted on July 1 have been transferred to the new company, who have taken over all liabilities from that date. Mr. A. C. Eborall remains chief engineer to the new company.

Mr. F. Hartmann, 22, Great Tower-street, London, E.C., has been appointed representative for the United Kingdom of Messrs. Himmelsbach Bros., Freiburg, Baden, Germany, manufacturers of wooden railway sleepers, telegraph poles, conducting masts, &c.

Messrs. Francis and Spilsbury, 20, Bucklersbury, London, E.C., are sole agents in the United Kingdom for the Elektrotechnische Industrie, Slikkerveer, Holland. New lists of dynamos and motors manufactured by this firm can now be obtained by the trade post free on application.

**Plant for Sale.**—An extensive piecemeal sale by auction of valuable fixed and loose plant, engines, boilers, timber, &c., will take place at Wickham Market Ironworks, Wickham Market, Suffolk, on Aug. 13, 14, 15 and 16, by Messrs. Wheatley Kirk, Price & Co. The sale consists of nearly 2,300 lots, and comprises a large quantity of engineers' stores and accessories. Admission to the sale is by catalogue only, which are ready and can be obtained of

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the auctioneers, 46, Watling-street, London, E.C., and Albert Chambers, Albert-square, Manchester. The sale commences each day at 10 for 11 prompt. An advertisement on another page gives some further details.

**B.T.H. Plant.**—Pamphlets No. 103, 104 and 105 of the British Thomson-Houston Co. deal in an interesting way with (*a*) electric power contracts recently executed or now constructing by the Company ; (*b*) polyphase induction motors ; (*c*) electric hoisting and hauling machinery.

**Price Lists.**—Messrs. Wm. McGeoch & Co. have ready price lists of an improved high-voltage keyholder specially designed for 250 volts and fitted with a patent high-voltage cap interior, preventing loose strands from short circuiting. Lists are also ready of high-voltage main switches and Wilson's patent motor starting switches. These are fitted with a special short-circuiting device by means of which switching-off a quick brake is effected.

A new list of continuous-current dynamos, motors, &c., manufactured by Messrs. Thomas Parker (Ltd.), Wolverhampton, is now ready, strongly bound, for the pocket.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from July 31 to Aug. 7, with the ports of destination :—

*Aden*—£15,120 (telegraph cable). *Africa*—Alexandria, £40 (telegraph wire) ; Cape Town, £2,008 (including £375 telegraph material) ; Durban, £826 ; East London, £2,628 (including £2,618 telegraph material) ; Port Elizabeth, £370. *Argentina*—Buenos Ayres, £323 (including £236 telegraph wire). *Australasia*—Fremantle, £370 ; Melbourne, £800 ; Otago, £22 ; Perth, £296 ; Sydney, £352. *Belgium*—Ostend, £100. *Canada*—Halifax, £474. *Ceylon*—Colombo, £69. *China*—Shanghai, £134. *Denmark*—Copenhagen, £1,135 (including £999 telegraph wire). *Germany*—Hamburg, £83. *Gibraltar*, £32. *Holland*—Amsterdam, £134 ; Rotterdam, £53 (telegraph wire). *Hong Kong*, £91. *India*—Bombay, £68 ; Calcutta, £1,138 (including £217 telegraph wire) ; Madras, £772. *Japan*—Nagasaki £364 ; Yokohama, £239. *Siam*—Bangkok, £86. *Straits Settlements*—Penang, £520 (including £460 telegraph material) ; Singapore, £37. *Sweden*—Gothenburg, £125 ; Stockholm, £717 (including £97 telegraph wire. Total (for eight days), £29,526, against £518,303 in the corresponding eight days last year (Aug. 1 to 8).

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during July was £42,107, against £54,367 in the preceding month and £129,022 in July last year. The total for the seven months ended July 31 was £595,073, against £549,275 for the corresponding period last year.

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

March 30, 1901.

6,660. B. BRANDER. Nottingham. Improved double-action electric bell.
6,663. CROMPTON & CO. (LTD.) and W. A. PRICE. Chelmsford. Improvements in electrical measuring instruments.
6,720. A. T. JORDAN and A. C. OAKES. London. Improvements in means for driving dynamo-electric machines.
6,723. T. PRESCATORE. London. Improvements in means for applying the active material to the plates of secondary batteries.
6,749. G. KÖRNER. London. Improvements relating to insulating substances.

April 1, 1901.

6,757. E. BARNARD and H. G. STEDMAN. Christchurch. An improved electric fire alarm which might also be applied to notify overheated bearings in machinery.
6,760. A. D. SMITH. Bradford. Improvements in electrical switches.
6,765. T. MCCLELLAND, Jun. Glasgow. Improvements in phonographs, graphophones and like instruments.
6,780. H. HIRST and H. BEVIS. London. Improvements in vessels for use with electrical liquid resistances.

April 2, 1901.

6,851. C. W. KEMP. Birmingham. Improvements in or relating to electric lamp shade holders.
6,862. S. H. HOLDEN. Birmingham. Improvements in apparatus for generating electric current and in means for registering its consumption.
6,870. E. G. LEWIS. London. Coin-controlled apparatus for telephones.*
6,881. E. D. SPEER and H. N. SPEER. London. Improvements in fireproof insulating ducts.*
6,884. C. E. HUDSON. London. Improvement in protecting covers for steam pipes, water pipes, rods, chains, wire ropes, or electric wires for ship purposes.*
6,898. W. G. KING. London. An electric racecourse (E. P. dal Pozzo, France).
6,910. W. S. BOULT. London. Improvements in or relating to starting and controlling electro-motors.
6,933. B. NORTH. London. Improvements in or relating to prepayment electrolytic electricity meters.
6,935. B. NORTH. London. A new or improved method of and means for passing a known fraction of an electric current through an electrolytic meter.
6,946. H. J. HADDAN. London. Improvements in automatic telephone exchanges. (The Strowger Automatic Telephone Exchange, United States.)*
6,947. C. DEKANDÓ. London. Improvements in the suspension of conducting wires.*
6,949. R. OXLADE and W. J. W. RICHARDSON. London. Improvements in audible electric telegraphy.

April 3, 1901.

6,998. J. T. NOBLE. London. Improvements in the method of and apparatus for adjusting the points of electric tramway lines or the like.
7,013. W. ROWBOTHAM and K. A. ROWBOTHAM. Birmingham. Improvements in and relating to arc lamps and the like.
7,015. THE JANDUS ARC LAMP AND ELECTRIC CO. (LTD.), B. M. DRAKE and A. D. JONES. London. Improvements in the suspending mechanism for electric arc lamps.
7,016. THE JANDUS ARC LAMP AND ELECTRIC CO. (LTD.) and A. D. JONES. London. Improvements in or relating to electric arc lamps.
7,040. C. HYDE. Liverpool. Improvements in or relating to safety devices applicable to overhead trolley wires for electric railways and tramways.
7,054. N. W. STORER. London. Improvements in systems of electrical distribution. (Date applied for under Patents, &c., Act, 1883, sec. 103, Sept. 6, 1900, being date of application in United States.)

April 4, 1901.

7,076. S. FILDES. Manchester. Improvements in time switches for electric signs.
7,086. C. A. CARUS-WILSON and J. S. WARNER. London. Improvements in electro-dynamic equipments.
7,113. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in apparatus for rectifying alternating electric currents. (C. M. Green, United States.)*
7,114. THE BRITISH THOMSON-HOUSTON CO. (LTD.) London. Improvements in electric regulators. (A. R. Everest, United States.)*
7,115. THE BRITISH THOMSON-HOUSTON CO. (LTD.) and F. SAMUELSON. London. Improvements in trolley stands for electric railways.
7,118. F. DE MARE. London. Improved electric motor.
7,136. D. M. BLISS and N. H. HOLLAND. London. Telephone metering system.*
7,150. L. H. ENGELHARDT, H. M. MCNALLY and M. GALLERT. London. An improved electro-magnet motor.*
7,196. J. J. JOHNSON. London. Improvements in electromagnetic devices for controlling the rotation of shafts. (P. V. Avril and the Société Marinier Navoit and Jeanson, France.)
7,201. E. A. JEFFREYS and C. B. KETLEY. Birmingham. Improvements in phonographs, graphophones and like talking machines.

April 6, 1901.

7,221. E. A. CLAREMONT and J. STRATTON. Manchester. Improvements in apparatus employed for covering telegraph cables and wires with lead or other metallic substance for electric purposes, or for manufacturing metallic pipes or tubes or like uses.*
7,248. A. M. CLARK. London. Improvements in and in the method of and apparatus for the manufacture of air-damping appliances for electric measurement instruments and the like. (Hartmann and Braun, Germany.)

April 9, 1901.

7,284. J. ASPINWALL. Liverpool. Improvements in pulleys for trolley heads, applicable to electric traction.
7,325. W. P. THOMPSON. Liverpool. Improvements in electric motors. (Charles D. Fuller, United States).
7,338. C. P. E. SCHNEIDER. London. Improvements in and relating to electric furnaces.*

April 10, 1901.

7,368. A. WILKES. Staffs. Improved means for connecting electric wires and cables.
7,371. H. W. BUTLER. London. Improvements in terminals or bolts and nuts for use in electric batteries as connectors.
7,374. T. WEIL. London. Improvements in electrically illuminated letters.*
7,397. A. BROCHET and G. RANSON. London. A new or improved process for the electrolytic production of caustic alkalies.

April 11, 1901.

7,459. E. CERVENKA, J. BERNT and G. MEYER. London. Improvements in or relating to electric tramways or railways on the overhead system.
7,462. B. KLEIN. London. A new or improved apparatus for automatically charging accumulators.
7,492. H. H. WAIT. London. Improvement in winding electromagnetic inductive apparatus. (Date applied for under Patents, &c., Act, 1883, sec. 103, January 12, 1901, being date of application in United States.)*

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7,497. B. CRUVELLIER. London. Improvements in contact boxes for the distribution of electricity. (Date applied for under Patents, &c., Act, 1883, sec. 103, November 21, 1900, being date of application in France).*

April 12, 1901.

7,524. J. R. QUAIN. London. Improvements in electric heating and in apparatus therefor.

7,539. W. FRIESE-GREENE. London. Improvements in and connected with the electrical transmission of images and in the recording of images.

# COMPANIES' MEETINGS AND REPORTS.

## Edison and Swan United Electric Light Co. (Ltd.).

The eighteenth annual general meeting was held on Friday last, under the presidency of Major SAMUEL FLOOD PAGE.

The SECRETARY AND GENERAL MANAGER (Mr. H. Charles Gover) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I am sure every proprietor regrets that Mr. Forbes, who has been the chairman and has presided over every meeting since the commencement of the company, is not here to preside to-day. He is detained elsewhere. I ask for your indulgence in the arduous task I have to perform. Taking the report according to the paragraphs, No. 1 speaks for itself, No. 2 simply shows the amount of money that has been carried to net revenue, and tells you that nearly the whole of it has been absorbed in the payment of interest on the debenture stock. Then we come to clause 3, which states what is just the ordinary position in which most companies, or many companies at this moment, find themselves involved. We state that competition has been very keen, that prices have been higher, and that business has been smaller. Hence the fact that the revenue is diminished. Since the expiry of our patents great competition with constantly reduced prices has been going on. There has been a constant change in the articles which we have had to manufacture. The engineers have forced upon the lamp-makers, without due consideration, the change from low to high voltage, and high-voltage lamps are much more difficult and more expensive to make, and do not last as long, and fittings and other things have made the position of the company extremely difficult. We have, however, I am very glad to state, greatly improved the high-voltage lamp. We have two factories working, one at Newcastle and the other near London—at Ponder's End—practically in competition, and the result of this is that we have a cheaper and a better lamp. Now, in addition to this loss of trade, we have been in a transition state in the fittings department, which has rendered it very difficult for us. We have been changing over from one manager to another. The loss in trade is large—£235,433, compared with £285,667 last year. In 1893 the sales of lamps and fittings amounted to £183,641. In 1894 they fell to £131,250—£52,000 less than in the previous year. In 1895 they fell to £114,890, so that in two years there was a loss of trade of £68,751. It began to go up again a little in 1896, and went to £128,101, and in 1897 it improved a little more, but even then it was some thousands of pounds below what it was five years previously. The moral I wish you to draw from that is this: First, that the fluctuations have been common. We are accustomed to them. And, what is more, we have recovered the lost business, and I firmly believe, and strongly believe, that we shall do so again. The public have not lost faith in the name of Swan. They have not lost faith in Mr. Swan, and presently you will hear him say few words in reference to improvements that he is going to make. We began the year very well, in this way: For a long time past we have been passed over, in consequence of our prices, by the Admiralty, but they recently sent an urgent order for 100,000 lamps, and they wanted to know how many we could deliver at once. We were probably the only people in the world—for the Admiralty do not use the ordinary lamp—who could have delivered immediately, as we did, 15,000, and we got an order for 100,000. Now, gentlemen, there are certain changes which have got to be made. When the board are reconstituted they will find that a great many matters have been under consideration already which they will have to deal with—changes in price and reductions in cost of distribution. Of necessity, the carrying out of these things has been postponed; but what I want you to take to heart, for I believe it to be absolutely true, is this—that because of this loss of trade there is no reason for despair or alarm. We have gone through a decline of business before and recovered, and you may rest assured we shall do so again. Your chairman last year, in connection with the fittings department of our business, said:—"Our fittings business is developing rapidly, and has, in fact, outgrown the machinery ready for it, and I am not sure it has not also outgrown the brains which have conducted it. We have reconstituted the whole affair under a very capable man, in whom we have confidence—an engineer by profession, of some ability and reputation. He has accepted the office with the declaration that he is perfectly satisfied that this is a business out of which we may make very large profits in the future." When Mr. Joyce, the gentleman referred to, got to work, some months afterwards he found that the fittings factory was not in good order. He devoted a long time towards trying to get it into order, and when he had been there for some time he overhauled and examined everything—stock, stores and everything that was in the factory—and during that investigation, to our immense surprise, he found that in the past work which had been completed at a loss was carried forward as work in hand, and carried forward as a good asset. That item is £14,772. 18s. 7d., a sum which ought to have appeared in previous accounts. Clause 6 of the report refers to the time when the company absorbed the Manchester Edison-Swan company, and took over the Broadheath factory. It was a small business when we took it over; we tried to develop it but could not make a profit. It was mixed up with Altrincham, and we came to the conclusion that it should be closed. You may ask why we absorbed the Manchester company. We were obliged to do so. They had the right to use our name and manufacture lamps, and they might, I believe, have put their name on lamps which were not of our manufacture at all and sold them as Edison and Swan lamps, and perhaps have cut into our lamp business. Clauses 5 and 7 refer to the changes in the staff and to the special enquiry the directors had made into the value of the whole of the stock. It was found necessary to write off £31,048. 5s. In addition to this £31,048. 5s. depreciation of stock, £19,875. 14s. 4d. was written off special outlays, £9,069. 7s. 9d. loss on closing factories, and £4,578, provision for bad and doubtful debts. This, with debenture interest, absorbed the whole of our reserve, leaving only £784 to be carried forward.

Now, gentlemen, no shareholder could have been more astonished than we were when we found out these facts, and as soon as we found them out we have revealed them to you in their full nakedness. We can only express our intense regret that it is so, but it is not possible for us to alter the figures. I am confident of this, however, that if the cost of manufacture, which is well within the range of possibility, is reduced, and if the cost of distribution is reduced, it will lead to very large sales. The value of the assets you can satisfy yourself of by looking into the accounts. I believe, as the result of the changes and reductions which we have been compelled to make, that the company is in a sounder position to-day than it has been for years. I for one utterly decline to acknowledge or confess in any way that the company is a failure. Its record is good, and it has assets of the value of £550,000. One word more, and I will keep you no longer. What we are responsible for—and if you want to know where I think we have failed it is here—is for the selection of men to carry out the work, and we have failed in that. There we confess we have failed, but beyond that I leave the board with the feeling that the company is in a sound state. Let me say that your directors hold between them nearly £50,000 in the company, and no director has ever sold a share. We are not going to part with our shares now. We have every confidence that, as before, when the Company has had trouble it has pulled round, so now, with the improvements we will tell you about, we believe that it will come all right again, although it may be that for a year or two you will have to devote profits to building up another reserve. With good management, and with Mr. Swan's improvements, I feel assured that there is no cause for despondency, but that the future will again show a great improvement in the business. I now move the adoption of the report and accounts.

Mr. J. WILSON SWAN seconded the motion, and said: I do not think it is necessary for me to say anything further as to the report. I am sure that Major Page has very fully gone into it, and explained how it is that such a very unsatisfactory record of the year's working has to be presented to you; but I do feel that I can endorse what he has said as to the essential soundness of the company, and there is every reason to hope that, with good management, the company can be carried on in a highly profitable manner. The part I have taken in the company's affairs has been somewhat exceptional. I have devoted myself chiefly to the technical part in connection with the lamp manufacture. Of course, I also share with the other directors full responsibility for the general management; but beyond that I have had an additional responsibility thrown on me in the technical department of the company's business. I have tried, and I am sure not altogether unsuccessfully, to improve and cheapen the lamp. At this moment there are being carried out several very important improvements which will have the effect of further reducing materially the cost price of the lamp, and at the same time of greatly improving its efficiency. Therefore our power of extending our business, as far as the lamp manufacture goes, is on the point of being greatly increased. When the improvements to which I have referred are carried out there will be no longer any question as to the high-voltage lamps being fully equal in efficiency to those of lower voltage. As the result of these improvements, and the extensions to our works, we have the full right to expect a large increase in the most profitable branch of our business.

Col. STROUD: I would ask if it is right that the auditors should draw their fees and then not do their duty. How could the auditors have gone through the stock-in-trade and then say it was all right? Then as to the Altrincham company, and particularly the Manchester Edison-Swan company. I say the £40,000 paid for that business was a dead loss. The auditors may say that they have nothing to do with these things, but judges have ruled otherwise. I say that the loss to this company is due to the directors being supine.

Mr. LEE SMITH: I do not think we can improve on this balance-sheet, and it is no good wasting time on it. The worst point of it I do not think has been been brought out. You take credit for £64,895 in connection with this Altrincham company. We are told they owe £20,383 for goods, and here are the debentures with interest accruing since 1897. That is the worst thing in the balance-sheet. We now for the first time hear something about this from the auditors. They say the interest is still outstanding, yet there is not a word of that in the report. I have great confidence in this company. I will not go into the past. I think it should be buried. We want good sound business men on the board, and if we have not these on the directorate now I hope the directors will retire.

Mr. HANBURY: I think there is no doubt that during the year £74,000 odd have been lost, and that includes the dividend paid in March, because that dividend was never earned, and, therefore, should not have been paid. If you add up the other items you will find the total amounts to £74,156. I see it is proposed that two new gentlemen should go on to the board. I should like to know, before I voted for them, if Mr. Ellice-Clark and Mr. Wolfenden have any knowledge of the business, or if they are mere guinea-pigs and are going to join the board to get their fees. Salaries and directors' remuneration are all lumped together. I should like to know how much the directors receive.

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The CHAIRMAN, in reply, said: As to the Altrincham company, that is an asset of this company, and they have not and never have held a share in this company in any way. We inherited the Altrincham company, and it is owned by this company—the greater part of it. The directors of this company are the directors of the Altrincham company. Since the report was printed there has been a further issue of debentures, making the total number of debentures up to £25,000. It is quite true that goods supplied have not been paid for in cash, but the interest that has not been paid has been added to the cost of goods and included in this amount of £20,000. Acting under the solicitor's advice, it is intended almost directly to issue more shares and a corresponding number of debentures, so that this company will then hold £32,000 of debentures in addition to £23,000 of shares. We believe this to be an admirably good asset. The company has turned the corner. We propose to realise the amount represented by the Altrincham company at a favourable opportunity. With reference to the attendance of the board, we have had 32 board and committee meetings since last January, and we have been working just as hard as if it were our own private business. With regard to Mr. Hanbury's remarks, we have told you that we have had, unfortunately, to strike that large amount of money off as lost, that the stocks have not come up to the value put upon them; but when you speak as though we were responsible for that I would refer you to a decision in to-day's (Friday) *Times*, which lays down that directors are entitled to rest in the belief that those they employ are honest and are doing their work properly, and that directors are not expected to turn themselves into auditors and go down to the factories and see. We could not check these millions of goods. The gentlemen who are to be proposed as directors are fully competent. The fees of the directors amount to £3,000.

The motion was then carried.

It was then proposed that Mr. Edward Bedouin Ellice-Clark and Mr. Henry Wolfenden be elected directors of the company, which was carried.

On the motion for the re-appointment of the auditors,

Mr. WELTON (Messrs. Welton, Jones & Co.) said: I think it only fair and reasonable that the auditors should be heard. The auditors have challenged the stock account as far as they were able. Under the articles the stock has to be entered and approved by ourselves in conformity with the returns made by the officers of the company. The officers have been required to go through the stock and certify every part of it. A year ago we were blamed because we refused to pass quite so large a sum as we supposed to be right. We would not pass any more than we properly certified, and we were blamed for that. As respects the work in progress, in every manufacturing company where there is a large amount of finished work there is sure to be some in progress. Where there is a matter of that sort before us, accompanied by a proper certificate, it is our duty to accept that certificate under the articles; but for any auditor, in this case or any other, to pretend to go round and value the stock is a perfect delusion. It would be out of the power of any auditor to do anything of the sort.

The motion was then agreed to and the proceedings terminated.

## Chili Telephone Co. (Ltd.).

The twelfth ordinary general meeting was held on Friday last. Mr. GEORGE KEITH presiding.

The SECRETARY (Mr. Edmund Petley) having read the notice convening the meeting,

The CHAIRMAN said: The business of the Company has been working very favourably and efficiently during the past year, and the accounts now show a considerable improvement in its financial position. The gross revenue in Chili for the year amounts to $683,170, an increase of $31,734, and the total expenditure is $347,413, a decrease of $17,136. For the past two years the revenue has been steadily increasing, while the expenditure has been reduced. The average rate of exchange for the year is 16·65d., compared with 15·17d. for the previous year. The net profit in Chili converted into sterling amounts to £23,290, an increase of £5,160. Including the amount brought forward, the available balance is £18,879. Out of this £5,199 has been placed to reserve. The proposed 5 per cent (tax free) dividend for the year amounts to £11,000. Last year it was 4 per cent. The balance carried forward is £2,680, compared with £1,003. During the past year considerable improvements and extensions have been made to the Company's plant in Chili. An additional line has been erected between Santiago and Valparaiso to meet the growing traffic between those places. The central exchange at Santiago serves a large number of subscribers and in order to maintain the efficient service there, we have on order a new, up-to-date multiple switchboard, and expect to have it installed and working during the current year. Our relations with the public authorities all over Chili are cordial and harmonious. The service is well maintained and is giving satisfaction, and the business, as far as it has gone this year, continues to progress favourably. I now move the adoption of the report and accounts.

The motion was carried unanimously. Resolutions approving the dividend, re-electing the retiring director (Mr. Frank W. Jones), and reappointing the auditor were approved, and a vote of thanks to the chairman terminated the proceedings.

## Anglo-American Telegraph Co. (Ltd.).

The half-yearly meeting was held on Friday last, under the presidency of Mr. FRANCIS A. BEVAN.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting,

The CHAIRMAN said the only business before them at that, their half-yearly meeting, was the adoption of the report and accounts for the half-year. The directors had to congratulate the shareholders on the results shown, for they had lost the outgoing German traffic, which might fairly be put at about £27,000 for the half-year for their company, whereas the decrease in their receipts, compared with those of the corresponding six months of 1900, was under £4,000. No doubt this satisfactory result was in some measure due to the great boom in American shares; but that did not last very long, and therefore they might say that generally the increase was spread over the whole of their receipts. They had, besides, an improvement in the uncertain item of profits earned by their repairing ship, the "Minia," an increase, compared with those of the June half of 1900, of £6,255. Great credit was due to the captain and crew for this very satisfactory result. Repairing work, especially in deep water, required considerable skill and experience, and he thought it was their duty to express their high appreciation of the skill and diligence which had been displayed. He was glad to say that the company's cables were all in good working order, excepting one of the small Duxbury cables on the other side, and this might be repaired any day. They could not, however, lose sight of the fact that their 1873 and 1874 cables were getting old, and they might reasonably assume that the oftener they lifted one of these cables for repairs the less likely were they to be able to lift it another time. He mentioned this in connection with the renewal fund. The proprietors would bear in mind that they had to carry out a good many repairs, and that they had two rather old cables. He hoped, therefore, they would support the board in their policy of maintaining the renewal fund, which might at any time have to be considerably depleted if they had to lay one or two cables. There had been a slight increase in the expenses, £4,195, which was chiefly owing to three items—increase in salaries, renewal of instruments, and advertising. The first item was beyond the directors' control. The Government paid high salaries, and if the company were to keep good and efficient men they must have a good staff and must pay them well. There had been an item of £600 for advertising carried out on the other side by their partner, the Western Union Co. That company had thought it necessary to go into a rather large advertising business, and asked this company, in consideration of their being partners, to help them, and the directors consented to put £600 towards the cost, which they hoped had come back to them in the shape of increased traffic. The result, altogether, was that there was a reduced amount for dividend of £2,363 compared with last year, and the balance carried forward (£6,379) was decreased by that amount. The large sum in the balance-sheet of sundry debtors and sundry creditors was accidental. They were always owed a large amount and themselves always owed a considerable sum. They had been carrying a great deal of traffic for the Western Union and the Direct United States Companies, and, therefore, had to account to those companies for this money; and, on the other hand, the Government owed the Anglo-American Company a large amount. What they were owed was perfectly good. He only had one other matter to refer to—as to the Pouyer-Quertier cable. He had been frequently asked how they were getting on with their action against the old French company, and at last he had something to tell them. After an immense deal of litigation the Court at Rouen heard the case, which was then referred to a committee of experts. It then had to be brought back to the Rouen Court, which had just given their decision, to the effect that they ordered the Pouyer-Quertier Co. to pay to the Anglo-American Company a first instalment of 1,000,000fr., with interest according to law, with a reservation as to the surplus and certain costs, and a small deduction of 1,500fr. This was a first instalment of a much larger sum, which he supposed the Anglo Company were to get some day. This decision had, he believed, been appealed against, and would be heard by the Court of Cassation, and if the Anglo Company succeeded that was the last thing that could happen. The first court they went to (the Tribunal of Commerce) gave a decision in their favour. Their opponents had been appealing and appealing, and at last the Court at Rouen, which was one of the highest, had practically confirmed the orginal decision, and they might fairly presume that the Court of Cassation would endorse this decision, and if so there would be an end of the litigation. It was, however, easy to get a decision against a man, and to say he was to pay costs, but the important point was whether they could get the costs. What they would get out of this action he could not say. He thought, however, the result obtained had justified the directors in the course they had taken. He concluded by moving the adoption of the report and accounts.

Mr. BURT seconded the motion, which was carried unanimously, and a vote of thanks to the chairman and directors terminated the proceedings.

## Central London Railway Co.

The twelfth half-yearly meeting was held yesterday, Sir HENRY OAKLEY, presiding.

The SECRETARY (Mr. R. O. Graham) read the notice calling the meeting.

The CHAIRMAN, after stating that the number of proprietors had increased during the half-year by 232, and now stood at 2,800, said this was the first time they had met after the completion of a full six months' working, and he hoped the results, which, however, the board did not consider to be final, would be regarded as satisfactory. The capital account item had not been altered, except by the issue of the debenture bonds to the contractors and some part of them, £84,000, on behalf of the company. Those were sold at a satisfactory price. The company now had £27,000 cash balance in hand and unexercised powers to the extent of £177,000. The expenditure in the course of the half-year had been comparatively trifling, because they had now come to the end of their large outlay, apart from the final completion of the contract, and this, it was hoped, would be wound up before they met again. It had been necessary to extend their boiler power at Shepherd's Bush by the addition of four boilers, so as to ensure a constant supply of steam. On the whole,

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however, they had sufficient capital to carry out all that there was at present in hand or contemplated. With regard to revenue, they had earned a total of £164,823 in the half-year, including £4,100 from advertisements, the hire of bookstalls, &c. This was sufficient, after deducting working expenses, to pay a dividend at the rate of 4 per cent. per annum on the whole of the share capital, including the proportion due to the deferred shareholders, whose dividend, however, could not be distributed until the year's working had been completed, and there was left to be carried forward £8,532, against £3,000 brought into the account. To earn that money they had carried 20,385,739 passengers, of whom 2,190,000 were workmen, who travelled at half-price. Their earnings had been at the rate of rather more than £950 per mile per week. The ordinary railway was considered to do well if it earned £100, £120, or £140 per mile per week; but although, in the case of this company, the fares were low, yet the concentration of the traffic was so great that the business actually yielded nearly £1,000 per week for every mile of railway they possessed. This was all the more gratifying when they considered the future possibilities of the line. A series of electric trams had recently been started from Shepherd's Bush, spreading out to Kew, Ealing, Acton, Hounslow, and other places. They were started on April 4 last. In the week ended about April 1 this railway was carrying about 130,000 passengers per week to and from Shepherd's Bush, but at the present time they were carrying 161,000 per week, so that the development of the suburban traffic, first by means of the railway to Shephead's Bush and next by the running of the new trams to the surrounding districts, had brought them an additional 5,000 passengers per day. The expenses of the half-year had been about 54 per cent., compared with 58 per cent. during the first five months' working. Experience showed that about 4 per cent. of the expenses was due to the working of the lifts. A start was about to be made in utilising the upper part of some of their stations, and this would be an extra source of revenue. The bill deposited by the company in Parliament, for loops at each end of the line with a view to facilitate the working and to enable a greater number of trains to be run, had been, with other bills relating to underground railways, referred to a Joint Committee. They obtained permission, however, to divide the bill into two, one relating to the loop lines, and the other for the acquisition of land to enable additional lifts to be constructed at Shepherd's Bush, and for authorising further capital. The report of this Joint Committee hung on the question of vibration. A committee of scientists was appointed early in the year to consider this question, and what steps should be taken to prevent or control it. The directors felt it to be their duty to facilitate that inquiry, and they undertook to make experiments to see if any alterations in the engines, or any modifications of working would so lessen the vibration as to render it innocuous. They had now running a modified engine, which had so far given them great satisfaction, and bid fair to settle the question. The second course of experiments, which had been undertaken and would be completed in a month or two, was the division of the power on the principle of multiple motors. That was, dividing the weight of the engine over several carriages so as to lessen the force of impact between the wheels and the rails as the train progressed. That was not quite ready, so he was unable to say anything definite about it; nor could he say absolutely that the committee would be satisfied with the improvement which had been made in the engines, because it had not yet been before them, but the company's engineer said that he (the chairman) might speak out boldly to the proprietors, and say that, in his opinion, the modification that had been carried out, and which had worked successfully so far, would so lessen the effect of the running of the trains that they might dismiss from their mind any further anxiety on the subject. He moved the adoption of the report and the payment of the proposed dividends.

Lord COLVILLE OF CULROSS seconded the motion.

Mr. CHATTEN drew attention to the overcrowding on the line, and said that he believed passengers would prefer to pay a higher fare and travel in comfort.

The CHAIRMAN said the board regretted the discomfort arising from overcrowding, and spoke of the practical difficulties of keeping people out of the trains when the platform was crowded, adding that the British public would not wait.

The resolution was carried unanimously, and the proceedings terminated with a vote of thanks to the chairman.

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The directors' report for the half-year ended June 30 states that the capital expenditure to date is £22,575. 19s. 4d. The receipts for the half-year amounted to £164,823. 6s. 6d., and the working expenses to £90,266. 15s. 9d., being 54·77 per cent. of the receipts, leaving £74,556. 10s. 9d. The traffic has shown steady and satisfactory progress during the half-year, the average earnings per train mile being 5s. 1·28d., compared with 4s. 10·28d. in the previous five months, whilst the working expenses were 03·5d. per train mile less than previously. The number of passengers carried since the opening of the railway has been 35,302,661, of which 14,916,922 were carried during the first five months of the running of the line. This gives 20,385,739 for the half-year under review. Including £3,527. 8s. 4d. from last half-year, the net revenue account shows a total of £79,496. 16s. 7d., and, after providing for interest on debenture stock, there is an available balance of £65,532. 16s. 2d. The directors recommend out of this an interim dividend of 4 per cent. per annum on the undivided ordinary and preferred ordinary stock. The result of the half-year's working is sufficient to pay a dividend at the rate of 4 per cent. per annum on all classes of capital stock, but, under the Companies Acts, the dividend on the deferred ordinary stock is not payable until the result of the working of the year ended Dec. 31 has been ascertained. It is therefore proposed that £9,899. 17s. 2d., part of the general balance of £18,432. 13s. 5d., be carried to a dividend suspense account, which will be dealt with at the end of the year.

Of the company's 4 per cent. debenture stock (amounting to £876,000) £698,201 has been issued, including the amount due to the Electric Traction Co. under their contract. The company's shares were converted into stock as from June 14 last, and the various stocks are now quoted on the Stock Exchange.

Reports by the engineer of way and works (Mr. H. H. Holt) and the chief mechanical engineer (Mr. P. Walter D'Alton) accompany the report, in each case certifying to the adequate upkeep of the railway during the half-year.

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## Waterloo and City Railway Company.

The fifteenth half-yearly general meeting was held yesterday under the presidency of Lieut.-Col. the Hon. H. W. CAMPBELL.

The SECRETARY (Mr. Godfrey Knight) having read the notice calling the meeting,

The CHAIRMAN, in proposing the adoption of the report and accounts, stated that the authorised capital was £720,000, of which £599,000 had been created (£540,000 ordinary and £59,000 debenture stock); £599,184 had been expended on capital account, including £4,392 during the past half-year. Of the latter sum £734 had been spent on electric pumps, and £3,657 had been paid to the contractors for electrical equipment. The total expenditure was well within the original capital powers of the company, and there was still £112,482 available to meet any future expenditure. Passenger fares during the past half-year amounted to £16,429, against £14,357 in the corresponding period of 1900. Deducting Government duty, the net amount was £16,101, compared with £14,070. The directors considered this satisfactory. The working expenses in the half-year were £8,937, against £7,773, but the ratio of expenses to receipts was a little less—54·78 per cent. against 55 per cent. As a matter of fact, the actual working expenses for the half-year ended June 30, 1900, were £9,445, and if the figure of £8,937, the actual working expenses for the past half-year, were compared with it, it would be seen that there had really been a saving of £500. The figure of £7,773 was shown in the accounts for the half-year to June, 1900, because under the working agreement the South-Western Co. were not entitled to more than 55 per cent., although the actual working expenses might exceed that amount. The difference between the receipts and expenses was not sufficient to pay a dividend at the rate of 3 per cent. on the ordinary and borrowed capital, and the deficiency—£1,567—was again made up by the working company under their agreement. This made £7,370 retained by the South-Western Co., and adding to this £263 for general charges, there remained a balance of £8,691 to be carried to net revenue account. Other items brought this to £9,415 on the credit side. On the other side, debenture interest absorbed £844, rent charge payable for the terminal station at Waterloo £378, and the balance available for dividend was £8,192. A dividend of 3 per cent. would absorb £8,100, leaving £92 to be carried forward. The number of passengers carried in the half-year showed an increase of 265,325 over the corresponding period of 1900, and season ticket holders had increased by 146. There had been an unbroken line of increases since the opening of the railway, and although they could wish to see the increases greater, yet they were not, on the whole, disappointed.

Sir CHARLES SCOTTER seconded the resolution.

Mr. STURBY said the Central London and the City and South London Companies were working at a lower rate than the City and Waterloo, and he hoped that they would be able to work the Waterloo and City Railway more cheaply. He considered that the management of the traffic was extremely good.

The CHAIRMAN said they went on from year to year doing all that they could to reduce the working expenses, and they would continue to do so as far as possible. It must be remembered that the Waterloo and City Company could not very well compare with either the Central London or the City and South London railways. In the case of this company there were only two terminal stations, while the other companies had a great many stations; and the latter, also, had not the disadvantage of working with a very severe gradient.

The motion was unanimously adopted, and a dividend was afterwards declared on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended June 30 last, payable, subject to income tax, on the 10th inst.

A vote of thanks to the chairman and directors terminated the proceedings.

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## National Telephone Co. (Ltd.).

The report of the directors for the half-year ended June 30 states that the income for the half-year amounted to £775,482. 8s. 3d., compared with £700,603. 2s. 6d. for the corresponding period of 1900. The working expenses, including special expenditure of £17,673. 5s. 6d. in repairing damage caused by snowstorms in the early part of the year, amounted to £457,363. 14s. 2d., compared with £403,528. 2s. 6d. The net result (after deducting Post Office royalties amounting to £73,229. 17s. 2d.) is a profit of £244,888. 16s. 11d., compared with £228,609. 14s. 6d., an increase of £16,279. 2s. 5d. The rentals carried forward for unexpired running contracts was £784,755. 14s. 11d., compared with £733,614. 16s. 5d. Out of the available balance of £184,954. 17s. 11d., the dividends for the half-year on the 6 per cent. first and second preference shares, and the 5 per cent. third preference shares, are recommended, and 5 per cent. per annum on the ordinary shares (less tax in all cases). It is also proposed to transfer £65,000 to reserve, and to carry forward £5,954. 17s. 11d.

The company's total income for the half-year was £770,626. 12s. 2d., less £73,229. 17s. 2d. paid to the Post Office on account of royalties.

£303,696. 18s. 3d. has been expended during the half-year on capital account in the erection of 7,393 additional exchange and private lines, and in the construction of underground works. This makes the total capital

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issued £7,000,000, leaving £3,500,000 still unissued, of which £2,000,000 is 4 per cent. debenture stock, and £1,500,000 is in ordinary shares.

Lord Harris having retired from the position of vice-president, the vacancy has been filled by the election of Sir Henry Fowler, M.P., to that position. Lord Harris remains a director of the company.

The directors who retire and seek re-election at the meeting on Aug. 15 are Mr. James Staats Forbes, Sir James Fergusson, Bart., M.P., Mr. Eli Heyworth, and Mr. Samuel Herrick Sands.

**BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)**—The directors' annual report to March 31 states that for the purpose of raising funds to meet liabilities already incurred, and to provide for further extensions, the balance of unissued preference capital (6,400 preference shares of £10 each) was recently offered for subscription, and were all allotted. Gross receipts were $496,796, an increase of $46,174; working expenses $297,565, increase $13,445; net earnings $199,231, $2,729 increase. The net profit, including £132 brought forward, was £37,553. After payment of debenture interest and interim dividends, absorbing £19,103, it is proposed to write £1,218 off preliminary expenses, to declare a final ordinary dividend of 2 per cent. (making 4 per cent. for the year), and to transfer £5,000 to capital amortisation account and £5,000 to reserve, carrying forward £64.

**GAS LIGHT AND COKE CO.**—At the 179th half-yearly meeting on Friday last Colonel Makins said the company's income from sales of gas showed the large increase of £192,532. This was wholly due to the increase in the price, for there had been a decrease of just over 4 per cent. in the quantity of gas sold. A valuable agent to the company had been incandescent gas lighting. Local authorities were becoming increasingly interested in this system for street lighting, notwithstanding that the purveyors of electric light were so ardent in claiming to be the suppliers of the only cheap street light. Turning to the accounts, Colonel Makins said the position of the company in the June half-year, 1902, would, he thought, be greatly improved, and would warrant a reduction in the price of gas of 5d. per 1,000 as from Jan. 1 next. Mr. George Livesey, a prominent personage in the gas world, said the directors of the Gas Light and Coke Co. were living in a fool's paradise. Parliament had made up its mind that the initial price of gas must be reduced.

**LONDON, CHATHAM AND DOVER RAILWAY CO.**—At the meeting on Friday, Mr. Newby referred to the heavy burden which the railway companies had to bear on account of local rates and taxes, and said the proprietors were face to face with a tremendous opposition, for the London County Council were about to oppose all the London railways with electric traction. The County Council would pay nothing for the road on which they would lay their rails, and little or nothing for rates and taxes. This was a serious matter, for the County Council electric cars were likely to take much of the railway companies' traffic away. He thought the best thing the companies could do would be to look after their fast traffic. The chairman (in reply to Mr. Newby) said the seriousness of the competition between electricity and the steam railways was not likely to be only in passenger traffic. If 100 tons of passengers could be pulled by electric traction, 100 tons of coals could probably be drawn by electric traction. He had no doubt that the same weight could be pulled by electricity for 35 per cent. of the receipts as could be pulled by steam at 65 per cent.

**NORTH METROPOLITAN TRAMWAYS CO.**—At the meeting on Wednesday the chairman (Mr. Geo. Richardson), replying to a discussion on regulating the running of and putting on additional cars, said it had to be remembered that once cars were put on they had to be run all day. It was one of the advantages of electric traction that on a wet day the number of cars could be reduced without inconvenience, but that was not the case with horse traction. When the London County Council called upon them to adopt electric traction the Council would have to find the necessary capital, and the company would have to pay interest on it. As soon as the Council were ready the directors would be prepared to carry out the alteration, but the company could do nothing until the Council took the initiative.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**J. CARTER, SONS & CO. (LTD.)**—Reg. July 31, capital £50,000 in £1 shares (17,000 preference), to acquire the business of J. Carter, Sons & Co., at Salford, electrical, mechanical, ventilating, heating, hydraulic, mining, and general engineers, manufacturers of and dealers in electrical and other appliances, &c. The first directors are G. E., W., J. O., and F. Carter, the first two being permanent managing directors.

**TRACTION AND POWER SECURITIES (LTD.)**—Reg. July 27, capital £1,000,000 in £10 shares, to acquire and hold shares, stocks, debentures, debenture stocks, bonds, obligations, and securities issued or guaranteed by any company carrying on business in the United Kingdom, or any colony, dependency, or possession thereof, or in any foreign country, to deal with and turn to account any securities, and to carry on the business of bankers, financiers, concessionnaires, &c. The first directors are George Wseting-house, J. H. Lukach and C. W. Benson.

**ROTHESAY TRAMWAYS CO. (LTD.)**—In the report for the year ended May 31, it is stated that the British Electric Traction Co. have taken over the interest of about two-thirds of the former shareholders, the other third having elected to remain as preference holders. The conversion of the lines to electric traction is shortly, we believe, to be effected.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26$\frac{1}{16}$d. per oz. (Aug. 8). Consols (2$\frac{3}{4}$ per cent.) 93$\frac{7}{16}$—93$\frac{7}{16}$ for money, 93$\frac{7}{16}$—93$\frac{9}{16}$ for account; 2$\frac{1}{2}$ per cent. 93$\frac{1}{4}$—93$\frac{3}{4}$ (Aug. 8). Consols Pay Day, Sept. 2; Stocks and Shares Continuation Days, Aug. 13 and 27; Ticket Days, Aug. 14 and 28; Pay Days, Aug. 15 and 29; Mining Share Carry-over Days, Aug. 12 and 26.

**CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)**—The directors, after providing for other interest and preference dividend, have declared an interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30 on the ordinary shares, and carry forward £11,890.

**GENERAL ELECTRIC CO. (1900) (LTD.)**—By an error in transcribing his notes of the general meeting of this company last week our representative stated incorrectly the method of valuing stock adopted by the company. The words used in our report were "The stock was valued, not at cost, but at probable selling price." We are asked to state that this should read as follows: "We have all along taken our stock at the lower value—that is, if we buy cheaper than the price ruling at the time the stock is taken, we take the cheaper price; if the article has gone down in price on that day, we take it at the market value, and our managers, in taking their stock, value such things as are out of fashion or getting obsolete at the probable selling price, and not at the cost price. Our managers have had those instructions, and have signed the stock sheets accordingly, and, therefore, I feel quite content in stating that this is a very sound item."

**LA CAPITAL TRACTION AND ELECTRIC CO, BUENOS AYRES (LTD.)**—The report for 1900 states that the profit amounted to £18,321. Payment of the 5 per cent. cumulative dividend (less tax) on the preferred shares from date of issue to September 30, 1900, is recommended.

**LONDON GENERAL OMNIBUS CO. (LTD)**—In the report of the directors for the past half-year, it is stated that the closing or partial closing of important thoroughfares for laying down Government telephone and electric light mains seriously affected the earnings of many of the company's services. The receipts were £5,766 less and the expenses £15,857 more than in the corresponding period last year.

**MERTHYR ELECTRIC TRACTION AND LIGHTING CO. (LTD.)**—This company is inviting applications for £30,000 4$\frac{1}{2}$ per cent. first mortgage debenture stock at par.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has ordered the further issue of £100,000 4$\frac{1}{2}$ per cent. debenture stock of the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)* to be quoted in the official list. The committee has also been asked to appoint a special settling day in and to grant a quotation to the further issue of 10,436 ordinary £5 shares of the *Chelsea Electricity Supply Co. (Ltd.)* and £75,000 5 per cent. debenture stock, and the further issue of 10,000 6 per cent. cumulative preference £5 shares of the *Electric Lighting and Traction Co. of Australia (Ltd.)*.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Aug. 3 | 987 | + 205 | 9 | 7,837 | + 904 |
| *Birmingham Tramways. | ,, 3 | 4,913 | + 343 | 4 | 19,359 | + 764 |
| *Blackburn Corporation.. | ,, 2 | 466 | - 23 | †31 | 14,792 | + 1,269 |
| Blackpool Corporation... | ,, 1 | 1,605 | + 471 | †18 | 16,623 | + 3,911 |
| Blackpool and Fleetwood | ,, 6 | 1,310 | + 19 | 5 | 5,541 | 342 |
| Bolton Corporation ..... | ,, 4 | 1,545 | + 180 | 18 | 27,517 | + 3,482 |
| Bradford Corporation... | ,, 4 | 1 193 | + 736 | 18 | 18,909 | + 9,910 |
| Brisbane Trams ..... | June19 | 1,933 | + 249 | ... | ... | ... |
| *Bristol Trams & Carriage | Aug. 2 | 3,798 | + 347 | 4 | 18,636 | + 4,431 |
| *Buenos Ayres & Belgrano | July 7 | 2,584 | + 358 | 1 | 2,584 | + 358 |
| Calcutta Trams. Co. ... | Aug. 3 | R20,952 | +R1,632 | 5 | R100,805 | + R4,661 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | ,, 3 | 5,679 | +1,356 | ... | ... | ... |
| City & South London Ry. | ,, 4 | 1,718 | + 177 | 5 | 9,268 | + 1,823 |
| Cork Elec. Trams ..... | ,, 1 | 586 | + 60 | 30 | 13,966 | + 1,825 |
| Dover Corporation ..... | ,, 3 | 300 | + 24 | 18 | 4,234 | + 264 |
| Dublin & Lucan Rly. ... | ,, 4 | 143 | + 29 | 5 | 721 | + 118 |
| Dublin United ..... | ‡ ,, 2 | 4,117 | + 163 | ‡5 | 19,280 | + 835 |
| Dublin Southern Dist.... | ‡ ,, 2 | 1,247 | + 201 | ‡5 | 5,541 | |
| *Dundee Corporation ... | July 31 | 733 | + 242 | 5 | 3,690 | + 1,263 |
| *Glasgow Corporation ... | Aug. 3 | 12,344 | +3,274 | 9 | 106,852 | +22,793 |
| Halifax Corporation..... | ,, 4 | ¶2,600 | + 841 | ... | ... | ... |
| *Huddersfield Corpn. ... | ,, 3 | 1,029 | + 271 | 18 | 16,819 | + 4,107 |
| Hull Corporation..... | ,, 3 | 1,855 | + 547 | 5 | 8,835 | + 2,116 |
| Liverpool Corporation... | July 27 | 9,622 | + 537 | 30 | 261,697 | +36,651 |
| *Liverpool Overhead Rly. | Aug. 4 | 1,749 | + 114 | 5 | 8,655 | + 156 |
| *Manchester Corporation | ,, 3 | 2,314 | ... | §8 | 14,452 | + 147 |
| Perth (W.A.) Elec. Trams | ,, 2 | 866 | + 476 | ‡5 | 4,967 | + 3,184 |
| Portsmouth Corporation | ,, 3 | 1,112 | + 72 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 5 | 3,909 | +1,437 | 5 | 18,828 | + 5,803 |
| Southampton Corporat'n | ,, 1 | 905 | + 297 | 5 | 4,551 | + 1,545 |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Fortnigh

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 31. | | Price Wednesday, Aug. 7. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Aug. 7. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Hl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ⅝ | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) ... | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. ..... | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. ..... | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ... | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 19,681 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord ..... | 7⅞ | 8⅛ | 7⅞ | 8⅛ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 8¾ | 9 | 8¼ | 8⅜ | 4 0 0 | March and September | ⅛ | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) ..... | 7¾ | 8⅛ | 7⅞ | 8 | 2 8 9 | ... | ... | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp.... | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... | 5½ | 5¾ | 6½ | 5¾ | 3 18 3 | ,, ,, | ... | ... |
| £250,000 | Stock | 3/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) ... | 103 | 105 | 103 | 105 | ... | ... | 103⅜ | ... |
| 24,000 | 5 | 3/6 | Chelsea Electricity Supply Ordinary ..... | 5½ | 6 | 5½ | 6 | 4 11 3 | March ..... | 5⅝ | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) .... | 107 | 110 | 107 | 110 | 4 2 0 | June and December ... | ... | ... |
| 70,579 | 10 | 3/0 | City of London Electric Lighting Ord. ..... | 8 | 9 | 8 | 9 | 4 8 11 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. ..... xd | 12 | 13 | 12 | 13 | 4 12 6 | January and July ..... | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) .... | 120 | 125 | 120 | 125 | 4 0 0 | June and December ... | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) ..... | 90 | 100 | 99 | 101 | 4 9 7 | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary..... ... | 8¼ | 8¾ | 8¼ | 9¼ | 4 4 3 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference..... | 12 | 13 | 12 | 13 | 4 13 4 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ..... ... | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary ..... | 5⅛ | 5¼ | 5⅛ | 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary..... ... | 7⅛ | 8¼ | 7⅜ | 9⅜ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary ..... xd | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. .... ..... | 6⅜ | 7 | 6¾ | 7 | 4 2 7 | January and July ..... | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)... [Deb. Stk. (red.)xd | 101 | 104 | 101 | 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 8 | ... | London Electric Supply Ordinary ..... | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 42,840 | 5 | 3/0 | Do. 6 per Cent. Preference ..... | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £360,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ..... | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) ..... | 13 | 14 | 13 | 14 | 4 5 9 | April and October..... | ... | ... |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) ..... | 13 | 14 | 13 | 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage .. | 108 | 111 | 108 | 111 | 4 1 0 | June and December ... | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) ..... | 94 | 97 | 94 | 97 | 3 12 0 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary ..... | 15 | 16 | 15 | 16 | 4 7 6 | March ..... | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary ..... | 5⅝ | 6⅛ | 5⅝ | 6⅛ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock ..... ..... | 99 | 102 | 99 | 102 | 3 18 5 | ... | 100⅜ | ... |
| 300,000 | 1 | 1/0 | Rand Electric ..... | 1/16 | 1/8 | 1/16 | 1/8 | 18 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. .... | 65 | 75 | 65 | 75 | ... | January and July ..... | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October..... | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary ..... xd | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | 14⅞ | ... |
| 20,000 | 5 | 2/6 | Do. 7 per Cent. Preference..... xd | 8½ | 9⅜ | 8⅜ | 9⅜ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) ..... | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ..... .. xd | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2½ | 3½ | 2½ | 2½ | ... | ... | ... | ... |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary ..... | 11⅜ | 12 | 11⅜ | 12 | 4 7 6 | March and September | 11 15/16 | 11 13/16 |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... | 4 | 4¼ | 4 | 4¼ | 4 14 2 | April and October..... | 4⅛ | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock..... | 124 | 129 | 124 | 129 | 4 13 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary ..... | 8 | 9 | 8 | 10 | 2 4 5 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference .. ..... | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures ..... xd | 97 | 102 | 95 | 100 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) ..... xd | 92 | 97 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways..... .. ..... | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. ..... ..... | 4½ | 4¾ | 4½ | 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. ..... | 101 | 103 | 101 | 103 | 4 7 5 | ... | 103 | 101⅛ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary ..... | 21½ | 22½ | 21⅛ | 22½ | 3 15 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) ..... | 10½ | 11 | 10⅝ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... | 114 | 116 | 112 | 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary ..... | 6¾ | 7 | 6¾ | 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference ..... | 9½ | 9⅝ | 9½ | 9⅝ | 5 2 7 | May and November ... | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs.... ..... | 100⅝ | 102⅞ | 100⅝ | 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary..... | 13¾ | 14¼ | 13⅞ | 14¼ | 7 0 4 | ... | 14⅛ | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref..... | 12 | 12½ | 12 | 12¼ | 4 16 0 | February and August | 12 7/16 | 12⅜ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... | 123 | 125 | 123 | 125 | 4 0 10 | ... | 124⅜ | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary ..... | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. ..... | 5⅜ | 5⅝ | 5⅜ | 5⅝ | 5 4 4 | ... | 5⅝ | ... |
| 27,500 | 5 | 2/6 | Do. "B" ..... | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 2 3 6 | ... | 5 1/16 | ... |
| £320,080 | Stock | 5% | Do. 5 per Cent. Debentures ..... | 102 | 105 | 102 | 105 | 4 15 3 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) . | 96 | 99 | 96 | 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) ..... | 11½ | 12⅜ | 11½ | 12½ | 2 8 0 | ... | 12 | ... |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) ..... | 103 | 105 | 103 | 105 | 4 5 9 | ... | 105 | ... |
| 400,000 | 1 | 1/2½ | Cape Electric Tramways Shares ..... | 1⅝ | 1⅞ | 1⅝ | 1⅞ | 3 4 0 | ... | ... | ... |
| £1,262,800 | Stock | ... | Central London Ordinary Stock ..... | 98 | 101 | 99 | 102 | ... | June and December... | 100⅜ | 99 |
| £440,100 | Stock | ... | Do. 4% Preferred Stock .. ..... | 99 | 102 | 102 | 105 | ... | ... | 101 | ... |
| £440,100 | Stock | ... | Do. Deferred Stock .. ..... | 97 | 100 | 98 | 101 | ... | ... | 99½ | ... |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs ..... ... ... | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5½ | 5¾ | 5½ | 5¾ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. ..... | 103 | 103 | 100 | 103 | 3 16 2 | ... | ... | ... |
| £355,000 | Stock | 1¾% | City and South London Railway Con. Ordinary xd | 52 | 54 | 52 | 54 | 2 15 7 | February and August | ... | ... |
| 47,500 | 10 | 2/0 7/16 | Do. Ordinary (Nos. 22,501 to 70,000) ..... .. | 5½ | 5¾ | 5½ | 5¾ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) xd | 132 | 134 | 129 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 6% | Do. (1896) ..... xd | 128 | 127 | 123 | 127 | 3 18 9 | ... | ... | ... |
| £418,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... ..... | 112 | 117 | 112 | 117 | 3 8 6 | May and November ... | ... | ... |
| 80,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary xd | 11½ | 12½ | 11½ | 12½ | 4 0 0 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference ..... xd | 14½ | 15½ | 14½ | 15½ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) ..... .. | 98 | 102 | 98 | 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | | 5½ | | 5½ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 30,000 | 10 | 7½% | †Imperial Tramways Ordinary..... | 22 | 23½ | 21½ | 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference..... | 14½ | 15⅝ | 14⅝ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... | 112 | 114 | 111 | 113 | 3 19 8 | January and July ..... | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary ..... | 7⅞ | 7⅞ | 7⅞ | 7⅞ | 4 8 10 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ..... | 13 | 13½ | 13 | 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... ... | 103 | 104 | 103 | 104 | 3 16 11 | January and July ..... | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 7 9 | ... | ... | ... |
| £80,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908) .. | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) ..... xd | 102 | 104 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary ..... | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference ..... | 4½ | 5 | 4½ | 5 | 6 0 0 | May ..... ..... | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary .. ..... ..... | 12 | 13 | 12 | 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 9/0 | Do. 5 per Cent. Cumulative Preference..... | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... ... | 105 | 108 | 105 | 108 | 4 3 4 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) ..... ..... | ... | | ... | | ... | April and October..... | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) ..... | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) ..... | ... | | ... | | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary ..... .... | 90 | 93 | 90 | 93 | 3 5 3 | June and December ... | 91½ | 91½ |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, July 31. | Price Wednesday, Aug. 7. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Aug. 7. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) ... | 98 101 | 98 101 | 3 19 0 | January and July ..... | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph ..... | 3½ 4½ | 3½ 4½ | ... | June and December .. | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures ..... | 78 83 | 78 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American ..... x. | 52 55 | 52 55 | 5 14 0 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred ..... x 1 | 97 99 | 97 99 | 6 1 3 | ,, ,, | 99 | 97½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred ..... | 9½ 10 | 9½ 10½ | 2 8 9 | ,, ,, | 9⅞ | ... |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock ..... | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock ..... | 101 103 | 101 103 | 3 17 9 | ,, ,, | 102½ | 10 ⅜ |
| 15,000 | 10 | 4/0 | Cuba Submarine Ordinary ..... | 7 8 | 6½ 7½ | 5 12 6 | February and August | ... | ... |
| 5,000 | 10 | 10/0 | Do. Preference 10 per Cent. ..... | 14½ 15½ | 14½ 15½ | 6 9 0 | ,, ,, | ... | ... |
| 15,000 | 5 | 2/0 | Direct Spanish Ordinary ..... | 3 4 | 3 4 | 5 0 0 | April and October..... | ... | ... |
| 5,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference ... | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures ..... | 99⅞ 103⅞ | 99⅞ 103⅞ | 4 7 6 | January and July ..... | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable ..... xd & bonus | 10½ 11½ | 10½ 11½ | 5 13 1 | Jan., Apr., July, Oct. | ... | ... |
| £104,360 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. ) | 99 102 | 99 102 | 4 8 3 | June and December ... | ... | ... |
| £4,000,000 | Stock | £5/0 | Eastern Ordinary ..... [to 1,200) (red.) xd & bonus | 143 143 | 141 146 | 4 16 0 | Jan., Apr., July, Oct. | 144½ | 142 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock ..... | 92 95 | 92 95 | 3 13 8 | ,, ,, | 94½ | 95 |
| £1,732,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) ..... | 110 114 | 110 114 | 3 10 10 | May and November ... | ... | ... |
| 300,000 | 10 | 2/6 | Eastern Extension ..... | 13¾ 14½ | 13¾ 14½ | 4 15 0 | Jan., Apr., July, Oct. | 14⅜ | 14 |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock ..... xd | 110 115 | 110 115 | 3 19 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 ..... xd | 101 104 | 99 102 | 3 18 5 | February and August | 101½ | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) .. | 100⅞ 103⅞ | 100⅞ 103⅞ | 3 17 10 | May and November ... | ... | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen ..... | 31 32 | 31 33 | 4 10 11 | January and July ..... | ... | ... |
| £678,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos | 99 102 | 99 102 | 4 8 3 | June and December ... | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European ..... [1 to 1,200) (red. | 41 45 | 41 45 | 5 11 1 | May and November ... | 44 | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 ... | 103 106 | 103 106 | 5 13 2 | March and September ... | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) .... | 100 103 | 99 102 | 3 18 6 | June and December... | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) ..... | 99 102 | 101 104 | 4 18 0 | March and September | 103 | ... |
| 30,008 | 2½ | ... | West Coast of America ..... | ¾ ⅞ | ¾ ⅞ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures ..... | 99 102 | 99 102 | 3 18 6 | January and July ..... | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama ..... | ⅜ ⅝ | ½ ¾ | ... | May and November ... | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference ..... | 4½ 5½ | 4½ 5½ | ... | ,, ,, | 4⅞ | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference ..... | 3 5 | 3 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures ..... | 101 104 | 101 104 | 4 16 2 | January and July ..... | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) ..... | 13¾ 14½ | 13¾ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14⅜ | ... |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) ..... | 101 104 | 101 104 | 4 16 2 | June and December... | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) ..... | 100 103 | 100 103 | 3 17 8 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) ..... | 3¾ 4½ | 3¾ 4½ | 4 14 2 | August ..... | ... | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. ..... | 3/0 3/6 | 1/6 2/6 | 12 0 0 | April and October..... | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary ..... | ¼ ½ | ¼ ½ | 5 0 0 | November ..... | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference ..... | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National ..... | 3½ 3¾ | 3½ 3¾ | 7 17 2 | February and August | 3⅝ | 3 5/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference .. | 11 13 | 11 13 | 4 12 1 | ,, ,, | 12⅜ | 12 7/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference ... | 11 13 | 11 13 | 4 12 4 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. .. | 4½ 4⅝ | 4½ 4⅝ | 5 14 3 | ,, ,, | ... | ... |
| ‖£2000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) .... | 89 92 | 89 92 | 3 16 3 | June and December ... | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) ..... | 94 97 | 94 97 | 4 2 9 | ... | ... | ... |
| 171,504 | 1 | 0/8½ | Oriental ..... | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October..... | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate ..... | 5 5½ | 5 5½ | 6 7 3 | July ..... | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. ..... | 4½ 5½ | 4½ 5½ | 4 15 3 | June and December ... | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.)..... | 101 104 | 101 104 | 4 16 2 | June and December... | 105½ | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. ..... | ⅝ ¾ | ⅝ ¾ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary ..... | ... ... | ... ... | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference ..... | 1/16 1⅛ | ⅞ 1 | 8 0 0 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary ..... xd | 10 11 | 10 11 | 6 16 4 | July and February ... | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference ..... | 6 6½ | 6 6½ | 4 12 4 | January and July ..... | 6⅛ | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference ..... | 4½ 5 | 4½ 5 | 6 0 0 | ... | ... | ... |
| 90,000 | 2 | 2/0 | Brush Electrical Engineering ..... | 1⅝ 1⅞ | 1½ 1⅝ | 5 14 3 | September ..... | ... | ... |
| 16,731 | 2 | ... | Do. £1 paid ..... | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. ..... | 2 2½ | 2 2½ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid ..... | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock .. | 103 109 | 103 108 | 4 4 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock ..... | 99 102 | 99 102 | 4 8 3 | January and July ..... | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. ..... | 14 15 | 14 15 | 5 0 0 | ,, ,, | 14⅜ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference..... | 5½ 6 | 5½ 6 | 4 3 4 | ,, ,, | 5 5/16 | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.)..... | 107 111 | 107 111 | 4 1 0 | November and May ... | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) ..... | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) ..... xd | 92 96 | 94 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary ..... | ⅞ 1⅛ | ⅞ 1 | 5 10 0 | March ..... | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference ..... | ⅞ 1⅛ | ⅞ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) ..... | 3½ 4 | 3½ 4 | 5 12 7 | January and July ..... | 3½ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.) .. | 100 105 | 100 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. ..... | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) .. | ½ ¾ | ½ ¾ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) ..... | 1½ 2½ | 1½ 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) .. | 80 85 | 80 86 | 4 14 0 | June and December ... | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 88 92 | 85 90 | 5 11 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. ..... | 5½ 6 | 5¾ 6½ | 5 12 0 | Half-yearly ..... | 6 5/16 | 6 |
| 20,000 | 5 | 1.6½ | Do. 6% Cumulative Preference ..... | 5½ 6 | 5¾ 6 | 5 0 0 | ... | 6 1/16 | 5⅝ |
| £110,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) .... | 102 105 | 103 106 | 4 4 11 | ... | ... | ... |
| 112,100 | 5 | 1/7½ | Electric Construction Co. ..... | 1¾ 2 | 1¾ 2 | 6 0 0 | January and July ..... | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference ..... | 2½ 3 | 2½ 2¾ | 5 1 10 | July ..... | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ... | 98 102 | 98 102 | 3 18 5 | January and July ..... | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd, 5% Cum. Pref. ..... | 9¾ 11½ | 9¼ 10¼ | 4 17 7 | ... | 10⅛ | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures ..... | 99 102 | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary ..... | 15½ 16½ | 15½ 16½ | 6 1 3 | February and August | 16⅛ | 15 |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... | 5½ 6 | 5½ 6 | 3 15 0 | ,, ,, | 6⅛ | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) ... | 101 113 | 109 113 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works ..... | 21 22 | 21 22 | 4 13 0 | ,, ,, | 21½ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) ..... | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. ..... | 37 41 | 37 41 | 5 2 5 | March and July ..... | 3⅜ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 ..... | 101 104 | 101 104 | 3 17 0 | January and July ..... | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary ..... | 10½ 11½ | 10½ 11½ | 5 4 4 | ... | 11½ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference ..... | 5½ 16 | 5½ 6 | 4 3 4 | ... | 5⅝ | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary ..... | 10 11 | 10 11 | 5 9 0 | April and October ..... | 10 13/16 | 10½ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. ..... | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures . | 105 107 | 105 107 | 4 0 2 | May and November ... | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. .. | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,237 | 10 | 2/6 | Globe Telegraph and Trust ..... xd | 10 10½ | 10½ 10¾ | 24 17 8 | Jan., Apr., July, Oct. | 10½ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference ..... x 1 | 14¾ 15½ | 14¾ 15½ | 3 18 8 | ,, ,, | 15½ | ... |
| 11,839 | 8 | 4/0 | Reuter's ..... | 7 8 | 7 8 | 5 0 0 | April and October..... | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust ..... | 125 130 | 125 130 | 4 12 10 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,213. [No. 17. Vol. XLVII.] FRIDAY, AUGUST 16, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 3d., or 15 cents, or 30c., or 70f.


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## NOTES.

If Mr. Alexander Heyland succeeds in making an efficient three-phase induction motor with a power factor of unity, as foreshadowed in his article on page 627 of this issue, he will have made one of the greatest steps forward in dynamo and motor design during the last few years. The three-phase induction motor is already employed widely, but its popularity will be more than doubled if the power factor can be raised to nearly unity in such a simple manner as that indicated by Mr. Heyland, without seriously diminishing the efficiency. We look forward with interest to the results of the experiments which are being carried out.

We must congratulate the City of London Electric Lighting Co. on the facts disclosed in the interim report of the directors, printed in another column of this issue. What with the burden cast on the company by the financing operations at the start, the system of supply, which eventually proved to be not the most suitable, alternator coils which struck at overloads occasioned by fogs, contractors' delays in the delivery of steam-pipes, roofing and machinery, and, finally, the lamentable dispute with the Corporation of the City of London, the company has had hard times, and it is pleasant to read that a better result has been largely brought about by the economies which have been successfully effected by their engineer in connection with the new equipment of the station. Notwithstanding the approaching competition by the Charing Cross Company, a large number of additional lamps have been connected to the mains since last year, and in the middle of last month nearly 15,000 were awaiting connection on completion of the consumers' wiring; so that it seems that there will be ample room for both companies.

In commenting last week on the letter of Mr. Somers Clarke relating to the security of St. Paul's Cathedral we were unable, from want of sufficient data, to question his statement that the tubes of the Central London Railway had caused the steeple of Bow Church to overhang 1ft. 9in. We are glad that so great an authority as Sir Benjamin Baker has contradicted the statement in a letter to last Friday's *Times*. He says:—

> I have frequently heard that Bow Church steeple had been thrown 1ft. 9in. out of the perpendicular by the construction of the Central London Railway, but knowing from my own responsible personal inspections of the structure during and after the construction of the railway works that nothing of the kind had happened I paid little attention to the rumour. As the uncontradicted statement may, however, unnecessarily alarm frontagers on streets proposed to be occupied by tube railways, it may be well for me to state, on the basis of the experience gained in driving more than 20 miles of "tubes," that no such settlement ever has occurred or ever can occur with the cast-iron tube and shield construction carried out with the usual precautions. Bow Church steeple is 1ft. 9in. out of the perpendicular, not on account of the Central London Railway but because Wren ventured to build a tower over 200ft. high on no better foundation than an old Roman paved road, the stones of which, judging from a similar road which I came across in constructing the Metropolitan Railway, in all probability rested on consolidated mud with occasional layers of brushwood.

It is of interest to notice that Sir Benjamin Baker, with his 20 miles' experience of tube driving, completely corroborates our view that no settlement can occur in driving the tube with the usual precautions, and we now hope the fears of the public will have been set at rest.

In a recent issue of the *Electrical World* of New York, the results are published of an interesting investigation on the heating of field magnet coils. The coils were first heated when supported entirely in air; they were next experimented with on a table, and finally on a machine—first stationary and then running. The experiments appear to have been most carefully conducted by Messrs. Neu, Levine and Havill, but it is unfortunate that only two 115 volt bi-polar shunt motors were tested, one of a single horse-power and the other of only 5 H.P. The authors found that, with the four coils tested, the average ratio between the rise of temperature of the hottest point of the winding and the mean rise of temperature as measured by increase of resistance was, in air 1·135, on table 1·17, on machine 1·21, on machine running 1·12. The



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ratio of the rise of temperature as read by a thermometer to the rise as calculated by measuring the resistance was 60. We hope that these gentlemen will be able to continue their researches with a greater number and larger machines.

On previous occasions we have discussed the question of international technical dictionaries. The desirability of a thoroughly good dictionary of English, French, and German technical terms is indisputable, but the amount of skilled labour which the preparation of such a book would entail, if the compilation is to cover its ground completely, and its comparatively limited circulation, must deter any publisher from undertaking it on his own account. The Verein Deutscher Ingénieure has generously determined to provide engineers with such a lexicon; their propositions, which we have referred to in a previous issue, have now been adopted, and Dr. Hubert Jansen has been appointed editor-in-chief. The weak part of the arrangements, however, is the large amount of gratuitous work which the Verein expects to have done for it. The editor and his staff are, of course, to be paid, but a large number of outside contributors are expected to give their help gratuitously. We quote from the circular issued some little time ago:—

This co-operation we understand thus, that the societies, authorities, establishments, &c., give us the names of contributors qualified for our work from among their members or functionaries. These collaborators will have to bring our editor of the dictionary into communication with such scientific and industrial circles as are able to supply the technical expressions and denominations used in the different technical branches; besides, they will have to take part in noting down the technical words and phrases of their specialty, and finally, when the manuscript is ready for the press, they will have to read the proofs.

A further circular has now reached us describing more in detail the work that each of these collaborators is expected to perform, and it is apparent that if performed thoroughly these duties are by no means light. If, on the other hand, as is almost suggested in this second circular, each of these contributors only jots down from time to time a word that happens to force itself upon his attention, the compilation can never be complete, or at all events would take so long to make ready that by the time it is published it would be out of date. While giving the German society every credit for its public spirit in initiating this undertaking, we cannot but think that it is fore-doomed to failure unless an entirely different system is adopted. A technical dictionary which would require a decade in its preparation would be of little practical utility to those working in such a progressive industry as electrical engineering.

The International Telegraph Conference.—We are officially informed that the International Telegraph Conference will be held in London on February 10, 1902.

Cable Communications Committee.—This committee sat last week, and evidence was tendered by Mr. H. Cuthbert Hall, manager of Marconi's Wireless Telegraph Co.

International Association of Municipal Electricians.—The sixth annual convention of the above association of American engineers will be held at Niagara Falls on September 2nd, 3rd and 4th.

The Metropolitan and District Railways.—We learn that Mr. Philip Dawson has been retained by Mr. Yerkes to report on three-phase railway systems in connection with the arbitration between the District and Metropolitan railways next month.

The American Electro-Therapeutic Association.—This association will hold its eleventh annual convention in Buffalo on September 24th, 25th and 26th. Its headquarters will be at the Hotel Niagara. Particulars may be had from the secretary, Dr. Geo. E. Bill, Harrisburg, Pa.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Cadiz—Teneriffe | August 6, 1901 |
| Nase, Rinkin—Kelung, Formosa | August 2, 1901 |

Breakage of a Trolley Guard.—A rather amusing incident, showing the fear some people still have of broken trolley wires since the Liverpool accident, occurred at Leeds a few days ago. The guard above a trolley wire broke with a snap; the noise caused one man to jump off his trap, and two others rushed to the nearest insurance office for protection.

Cape-Australian Cable.—The Eastern and Eastern Extension Telegraph Companies notify that the ss. "Anglia" left the Thames on Saturday morning with the necessary cable to lay the sections between Mauritius, Rodriguez and Cocos. The ss. "Scotia" will leave next week with the Cocos-Perth section; and all these sections are expected to be laid and the line opened for traffic before the end of October.

The Birkenhead Tramways.—The formal opening of the Birkenhead tramway system took place on Wednesday last. Tramways on one route have been running for several months, and some particulars of the system were given in our issue of March 15th. Now traffic has been started on some of the new routes which were then in course of construction, and power is supplied from the new power house adjoining the electric lighting works.

Wireless Telegraphy at the Naval Manœuvres.—From the following report in the *Pall Mall Gazette* of yesterday evening, it will be seen that the syntonic system of wireless telegraphy is not yet being used in His Majesty's Navy.

When "war" was declared Vice-Admiral Wilson very cleverly turned to account his thorough grasp of the new method of signalling. To the signal staff of his flagship he gave orders that they should not work their own wireless instruments but should use these to read off the messages transmitted between the enemy's ships when the latter were near enough. . . . By thus using his wireless telegraphy instruments as ears instead of tongues, Vice-Admiral Wilson was enabled to gather a good deal of valuable information about his opponent. Sir Gerard Noel, the Commander-in-Chief of "B" fleet, it appears, adopted the ordinary Naval code for his war signals, with the slight alteration that instead of making only three letters he made five, two of which were dropped when deciphering the message. It did not take the quick-witted signalmen of "X" fleet long to get the key to "B" fleet's code sufficiently to read all of its messages that were picked up by their instruments. Vice-Admiral Wilson took good care to issue for his own fleet a code that could not be deciphered by the foe.

Insulating Efficiency of Electricians' Gloves.—We read in *Engineering* that the Central Electric Laboratory of Paris has recently carried out a series of experiments bearing on the degree of insulation of electricians' gloves. The tests were made both with low pressure and at high pressure. Without entering into the details of the experiments, our contemporary states that the practical conclusion arrived at was that insulating gloves cannot be considered to afford efficient protection against the dangers surrounding high-tension currents, that it would even be preferable to proscribe their use altogether rather than rely upon their efficiency in the contact with dangerous connections, and that it would be prudent only to consider them useful for working those parts already insulated from the lines, such, for instance, as non-metallic handles of switches. One glove which withstood a potential difference of 12,200 volts got pierced in one minute; another kind was pierced after three minutes with a potential difference of 1,000 volts only. No particulars are given as to the quality or thickness of the rubber employed.

A New Insulating Material.—A firm of mica manufacturers (Max Raphael, of Breslau) is bringing out a new insulating material which, it expects, will supersede micanite to a large extent for insulating purposes, especially for the construction of commutators and the manufacture of field magnet spools.

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It is cheaper than micanite, and being made solely of mica and asbestos has the additional advantage that it can stand much higher temperatures without softening. The process of manufacture is briefly as follows:—Moistened asbestos will adhere rigidly to mica so as to unite small pieces of the latter material, and the union thus produced remains even after the moisture has been removed. Small thin plates of mica are, therefore, mixed with asbestos, or laid upon it, and the whole is moistened with water. The mass is then subjected to pressure by means of which the greater proportion of the water is removed and the mica and asbestos are said to be left as rigidly bound together as the individual laminæ in natural mica. Any moisture still remaining is removed by further pressure, and simultaneous drying by the application of heat. The material can be made in the form of flat plates or sheets, or can be moulded into any shape required. The following tests, made by the Physickalisch-Technische Reichsanstalt on five pieces submitted to it, are of interest. The plates were placed between two brass electrodes each with a surface of 20 sq. cm., the upper electrode being weighted with two kilogrammes. Each plate was tested at two places:—

| Plate No. | Approximate thickness, mm. | Insulation resistance at a pressure of | | Sparking-through pressure. | |
|---|---|---|---|---|---|
| | | 500 volts. | 1,000 volts. | Continuous current. | Alternating current. |
| | | Megohms. | Megohms. | Volts. | Effect. volts. |
| 1 | 1·3 | 27·8<br>26·9 | 21·5 | 8,000 | 7,800 |
| 2 | 2·2 | 29·3<br>35·6 | 29·1<br>27·5 | Did not spark through up to 11,000 volts. | 12,600<br>12,900 |
| 3 | 2·4 | 70·0<br>63·4 | 58·8<br>33·7 | | 13,200<br>12,900 |
| 4 | 2·9 | 57·7<br>59·2 | 46·6<br>43·8 | | 13,500<br>14,100 |
| 5 | 3·7 | 91·2<br>73·4 | 69·8<br>74·3 | | 15,000<br>16,500 |

Telephonic Communication between England and Belgium.—An interesting article on the steps that are being taken to establish telephonic communication between England and Belgium is published in the *Transactions* of the Société Belge d'Electriciens. Up to the present there are only two submarine telephone connections of any appreciable length—viz., between Buenos Ayres and Monte Video and London and Paris. The former of these was established in 1899, and includes two distinct cables, each containing a single strand of copper wire. The cables themselves are 45km. long, and 4mm. overhead wires, 70km. and 187km. in length, are connected at each end of these, so that the total distance is 302km. The resistance of the cable is 8·8 ohms per kilometre, and its insulation and capacity 700 megohms per kilometre and 0·20 microfarads per kilometre respectively. The land-line has a resistance of 1·88 ohms per kilometre. The three telephone cables between Dover and Calais, the first of which was laid in March, 1891, each contain four conductors simply stranded, the go and return conductors for the same circuit being placed diagonally to one another. The length of the cable is 40km., the overhead wire to London 135km., and to Paris 325km., these two overhead wires being of copper, 4mm. and 5mm. diameter respectively. Thus the whole length is 515km., about a third of which is gutta-percha covered cable. Each of the four conductors is seven-strand, with a total diameter of 2·85mm. and a resistance of 7·56 ohms per knot. The total capacity after immersion is 5·52 microfarads, and the insulation resistance reduced to 24°C. about 2,000 megohms. The product KR is 5,500 for the Buenos Ayres–Monte Video circuit and 7,400 for the London–Paris line. Between London and Brussels the distance is 400km., the submarine part between Dover and La Panne being 90km. long, or 22½ per cent. of the whole. Arrangements are being made so that Birmingham, Manchester, Liverpool, Antwerp and Liège can make use of the line as well as the two capitals. Tests were originally made to see if it would be possible to establish communication between England and Belgium, via Lille and the Calais-Dover cable; but later, further experiments were made on the three Anglo-French telephone cables in series, which showed that it was quite possible to talk through 120km. of submarine cable. It was deemed advisable to make the overhead part of the line of copper weighing 800lb. per mile. The cable is a four-conductor one, *i.e.*, with two telephone circuits, and each of the conductors is 7-strand, weighing 39·12kg. per kilometre, and is covered with gutta-percha, weighing 78·35kg. per kilometre. It is expected that the maximum capacity of the core will not be greater than 0·1483 microfarads per kilometre. To protect the cable from the teredo, a brass tape is, as usual, interposed between the armouring and the core. The armouring consists of 16 galvanised iron wires. The article adds that not only is this the longest telephone cable which will have been laid, but the overhead parts will be the heaviest that have been employed up to the present, for hitherto the maximum diameter of telephone conductors has been 5mm. It is hoped that telephonic communication will be open before the end of the year.

Electric Lighting Provisional Orders.—The report by the Board of Trade respecting applications to and proceedings of the Board under the Electric Lighting Acts of 1882 to 1890 during the past year, shows that 108 applications in all were made, of which 69 were made by local authorities and 89 by companies or persons. Of these, five related to the County of London. A full list appeared in our issue of January 4th, page 402. Nine orders were refused. In the case of three of these (Macclesfield; Neath, Briton Ferry and Aberavon; Teddington, Hampton, Hampton Wick and Ham) an application was also received from the local authority, to which preference was given in accordance with the rules of the Board of Trade. The other orders were refused (Alfreton, Carnarvon and District, Stoke Newington, Pokesdown, Sittingbourne and Thornhill) owing to the promoters failing to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with. In three cases (Dorking, Deptford, Rhondda) the promoters decided not to proceed with the application. As to partial orders granted with the Ilkley order, the promoter failed to produce the consent of the local authority as regards the townships of Middleton and Denton, in the Wharfedale rural district. Two orders were granted for Lewisham and Penge, one in respect of part of the Metropolitan Borough of Lewisham, and one in respect of part of the urban district of Penge. The Midland Electric Corporation for Power Distribution had an order granted in respect of the urban district of Tettenhall, and the parish of Great Barr, in the Walsall rural district. Application was refused as regards other districts, but the most interesting cases of orders granted were Newbury and Marylebone. With the former the local authority refused to consent to the application. After consideration of the representations made to them, the Board of Trade, for the reasons stated in a special report made by them and presented to Parliament, decided to dispense with the consent of the local authority. The Corporation had, in fact, had an order since 1892, which was only revoked in August, 1900. In Marylebone both the Borough Council and the Marylebone Electric Supply Co. applied. The Board of Trade granted both orders with the view of giving Parliament the opportunity of deciding on the question whether any, and, if so, what supply should be authorised in Marylebone in competition with that already given by the Metropolitan Electric Supply Co. under powers conferred upon them in 1889. Arrangements were subsequently come to between the Metropolitan Co. and the Borough Council (see *The Electrician*, Vol. XLVII., p. 112.) There were no applications for licences, but the following transfers were effected:—

Allerton, Woolton, Childwall and Garston (1896) to Garston and District Electric Supply Co.; Brechin (1898) to Angus Electric Light and Power Co.; Durham (1899) to County of Durham Electrical Power Distribution Co.; East Stonehouse (1898) to Corporation of Devonport; Garston (1897) to Garston and District Electric Supply Co.; Glossop (1899) to Urban Electric Supply Co.; Harrow-on-the-Hill (1900) to Harrow Electric Light and Power Co.; Kingswinford (1898) to Midland Electric Corporation for Power Distribution; Montrose (1898) to Angus Electric Light and Power Co.; St. Helens (Isle of Wight) (1900) to St. Helens Electric Lighting Co.

Prior to the present session the Board of Trade had dealt with 861 applications for provisional orders, of which 646 were granted, 689 confirmed, and 119 since revoked or repealed.

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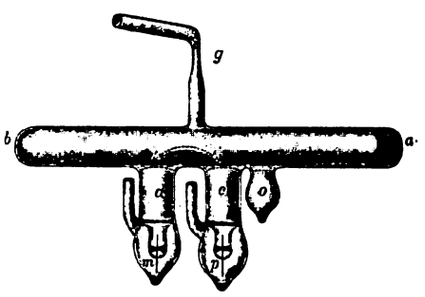
## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Mercury Lamp.*—The mercury arc lamp described by Arons gives an intense monochromatic light, and has the advantage of noiselessness over the Geissler tube. Such a lamp is of great value in polarimetric work, and more especially in the study of the Zeeman effect. But it has the disadvantage of being liable to burst, and its light is easily obscured by the condensation of mercury vapour. O. Lummer obviates these defects by cooling the lamp in running water and giving it the shape shown in the diagram. Only the mercury bulbs *d*, *e*, and *o* are submerged, the tube *ab* being free. The latter, therefore, remains at a higher temperature than the mercury, and does not condense the vapour. The arc plays in the direction of the arrow, and is seen end-on. The tube is ground, except over a circular area at the end *a*, through which the light is viewed. The author gives detailed instruc-




tions concerning the construction and mounting of the lamp. He made one pattern for magnetic work, in which the tube is enclosed in a narrow box which can be introduced between the poles of a magnet.

[O. Lummer, *Zeitschr. f. Instrumk.*, July, 1901.]

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*Velocity of Becquerel Rays.*—W. Kaufmann attempts to arrive at an accurate estimation of the ratio $e/m$ for Becquerel rays. This estimation is of great interest, as we have probably to deal in this case with velocities approaching the velocity of light, and the behaviour of electrons with such velocities is of special theoretical importance. The determination of both $v$ and $e/m$ requires at least two observations, such as the magnetic and the electric deflection. The heterogeneous character of the radiation here presents a difficulty, since the rays are drawn out in a continuous spectrum, and it is almost impossible to identify the beams subjected to definite magnetic and electric deflections. Another difficulty lies in the conductivity of the air produced by the rays, which reduces the deflecting electric field. The author avoids the latter difficulty by placing the whole apparatus in a vacuum, and the former by employing a method corresponding to Kundt's crossed spectra as used for the study of anomalous dispersion. The magnetic and electric fields were parallel, and the curve produced on a sensitive plate, mounted at right angles to the fields, was anything between a parabola and a straight line. The curves obtained so far approximate rather to the straight line, which would argue very high velocities; but before giving results the author intends to employ much stronger electric fields.

[W. Kaufmann, *Physikal. Zeitschr.*, July 13, 1901.]

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*Dielectric Cohesion.*—A gaseous mass placed in a uniform electric field allows the passage of an electric discharge as soon as the E.M.F. surpasses a critical value, below which the gas is a perfect insulator. E. Boutz tests whether the wall of the vessel in which the gas is contained has any effect upon the critical E.M.F., and answers the question in the negative. If the vessel containing the gas were strictly spherical and of uniform thickness, and if it were made of a perfect dielectric, the internal field would be uniform but slightly less intense than the external field. For instance, with a radius of 8cm., a thickness of 2mm. and a dielectric constant of 2·25, the interior field would be about 8 per cent. below the exterior field. The author carried out two measurements of the field, one with a glass bulb coated internally with a very thin film of paraffin, and another when enough paraffin was introduced to double the thickness of the wall. The result was a reduction of the interior field by 3 per cent. But no coating of the inner wall has any influence upon the critical E.M.F. Irregularities of shape give rise to local discharges which precede the general discharge, and are due to a lack of uniformity of the internal field.

[E. Boutz, *Comptus Rendus*, July 22, 1901.]

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*Uranium Radiation at very Low Temperatures.*—H. Becquerel has studied the radio-activity of uranium compounds at the temperature of liquid air. He shows that at that temperature the radiation is substantially the same as at ordinary temperatures. This supplements the fact that no variation is shown between the temperatures of −20deg. and +100deg. Uranium nitrate, when plunged into the liquid air, or, better still, into liquid hydrogen, becomes luminous, and so does the platinocyanide. This is an electric phenomenon due to molecular contraction. The luminosity only lasts while the crystal is cooling down, but it can be renewed by allowing it to regain the ordinary temperature, as the luminosity is seen both in heating and cooling. The phenomenon is, however, intermittent, and does not show the steadiness of thermo-luminescence. While the crystal is immersed in liquid air, it emits a luminescence as it impinges on the glass walls of the vessel similar to that of mercury when shaken up in a vacuum. Crystals of the double sulphate of uranium and potassium do not show any of these phenomena. The luminosity is, therefore, probably due to electric effects connected with compressions and cleavages in the nitrate, which becomes an insulator at the temperature of liquid air.

[H. Becquerel, *Comptes Rendus*, July 22, 1901.]

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*Photo-Electric Effects.*—The facilitation of discharge by the action of light, and more particularly ultra-violet light, has, since its discovery by Elster and Geitel, become of great theoretical importance. The absorption of light waves gives rise to intra-molecular forces which tend to separate a small negatively charged corpuscle from the rest of the neutral molecule. The maximum impulse so given to the negative particle may give it a velocity away from the surface sufficient to carry it beyond the range of molecular action, while the same outward impulse acting upon the much larger positive mass is not sufficient to take it beyond the influence of the attracting forces. Hence the impact of light only influences a negative discharge, while a positively-charged body remains practically unaffected. J. Zeleny has studied the effect of temperature upon the discharge from a platinum wire. He found that from a platinum wire the negative electricity is at first discharged more slowly as the temperature is increased; the rate of discharge reaches a minimum and then increases as far as the highest temperature employed (700deg.). The rate of the discharge produced by the light also depends upon the immediate previous history of the wire. On coming to certain temperatures from a higher one the rate of discharge is much greater than if a lower temperature had been used just before. For small ranges at least this effect appears to be independent of the electric intensity and of the intensity of the light. After the reduction of temperature the rate of discharge gradually becomes smaller with time, showing that the large conductivity at first is due partly at least to the fact that the wire reaches its steady state but slowly. The recovery is much faster at temperatures below a certain point than for those above, the change being fairly abrupt. From an iron wire the rate of discharge also appears to diminish at first with the temperature, but after reaching a minimum it finally becomes a great many times its value at room temperature. Heating the wire does not change the inactivity of the light for discharging positive electricity, even though the wire is raised to a temperature where, due to the heat alone, the positive electricity is being discharged.

[J. Zeleny, *Phys. Review*, June, 1901].

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## AN ASYNCHRONOUS INDUCTION MOTOR OR GENERATOR WITH A POWER-FACTOR OF UNITY.*

BY ALEXANDER HEYLAND.

The following article describes a method of producing the interesting and desirable result of eliminating the well-known phase difference between current and pressure in asynchronous induction motors, and thus at the same time doing away with the wattless magnetising and light load currents, and the consequences of the air-gap between the stator and rotor of these motors. This is attained by producing the rotatory field, not by the primary armature, but directly in the secondary armature,† by means of a simple arrangement which can be fitted to any type of motor without great difficulty.

The principle employed is as follows:—Let Fig. 1 represent a three-phase induction motor with a simple short-circuited armature—a so-called squirrel-cage armature. Let A be the stator or primary armature of the motor, and B the rotor or secondary short-circuited armature with copper bars distributed in holes or slots around the circumference, these bars being short-circuited at each end of the armature by a ring, K. Then, as is well known, a three-phase alternating current generates a rotatory field in the stator A, which traverses equally both armatures (the stator A and the rotor B), and sets up a turning moment between the stator winding and the closed armature winding of the rotor.

The field is generated in the stator, in distinction to that in the synchronous motor which would be obtained in this

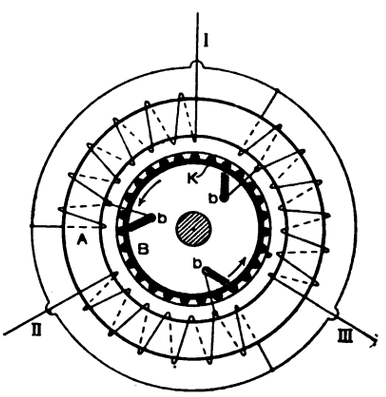


FIG. 1.

instance, for example, if the short-circuited armature were replaced by a magnet wheel. The exciting currents of the stator which generate the field are alternating currents of the full frequency, and therefore do not correspond, as in the case of continuous currents or alternating currents of lower frequency, to the necessary field excitation, but are considerably greater. As is well known, in circuits with high frequency a so-called counter E.M.F. of considerable magnitude is produced, and the magnetising current is produced by the small remainder after subtracting this counter E.M.F. from the pressure at the terminals. Owing to this, these currents differ considerably in phase from the pressure. On the other hand, the energy of these currents actually converted into heat in the copper is very small. As a rule, it is considerably less than 1 per cent. of its apparent value.

All this is prevented if we produce the rotatory field, not in the stator, but directly in the short-circuited armature. In the short-circuited secondary armature—*i.e.*, the rotor B—the back E.M.F. does not exist, or, if it does, only in a quite subordinate degree. The frequency of the variation in the field is here only very small, and is given directly by the slip of the motor. As is known, the armature rotates with the rotatory field. Its velocity with regard to this field differs only to a small extent (the slip), which just suffices to induce in the armature the current necessary for turning it. In distinction to the high E.M.F. of the stator, the E.M.F. of the rotor is, consequently, very small, and is only what is required to induce short-circuit currents which occasion the ohmic losses in the copper converted into heat. Now, if we send through the secondary armature, instead of through the primary armature, the magnetising currents necessary to produce the rotatory field common to both, we avoid the troublesome counter E.M.F.s which are set up in the stator. The whole pressure necessary for the magnetising currents drops to the small value which is necessary to cover the ohmic losses in the copper. The only problem before us is to convey the currents into the winding of the rotor, which is closed in itself, and to convey them in such a way that they have exactly the same direction and phase as the magnetising currents of the stator which they are to compensate.

The simplest way to do this is, as shown diagrammatically in the figure, by three brushes *bbb* which are in contact with the end of the ring K of the armature, and whose position with regard to the stator is so adjusted that the currents led to the armature have exactly the same direction as the magnetising currents of the stator had. The pressure of these currents need only be very small (even if one assumes approximately the same number of turns on the stator and rotor) and they can be taken from a few turns of the stator.

Thus a conversion of the current takes place from high frequency (primary armature) into low frequency (secondary armature), and yet we have not employed for this a commutator in the ordinary sense of the term, but have accomplished the conversion, as is seen in the diagram, by a continuous ring. In general one would not use the so-called squirrel cage armature, for the currents under the brushes would be too great. One can, for example, close a wound armature by a ring whose resistance bears a certain relation to the resistance of the winding. This has not any great effect on the efficiency. In the first place, the losses in this ring need only be small, and in the second place, one can reduce the losses in the winding by making the slots deeper and putting some more copper on the armature. The increase in the magnetic leakage thus caused is not important, as the phase difference is already avoided by the arrangement described. Besides, this is not necessary, as the following example will show.

The most remarkable thing about the motor is the commutation of the current by a commutator formed of a ring closed on itself. It is natural that such a commutator is not at all complicated, and works as simply and sparklessly as the usual slip rings on induction motors. A pertinent objection is that a part of the exciting current must be lost in the shunt which the ring forms to the winding. This is correct, but by the arrangement described the exciting current is already so reduced that this loss is without importance.

Assume that the copper loss in such an armature is 3 per cent.—2 per cent. in the winding and 1 per cent. in the ring, the resistance of the ring being thus half that of the winding. Let the magnetising current be one-third of the total current, the magnetising loss thus one-ninth of the total copper loss, *i.e.*, $\frac{2}{9}$ per cent. loss in the winding. To this must be added another $\frac{4}{9}$ per cent. lost in the shunt formed by the ring. Thus, altogether we have $\frac{6}{9} = \frac{2}{3}$ per cent. magnetising loss, and so, in spite of the shunt and the loss due to current in the ring, this is so little as to be unimportant.

One may find a certain analogy in continuous-current work in the replacement of copper brushes by carbon brushes. There, too, owing to the larger contact resistance at the brushes, the losses at one place are artificially increased, as a rule, to a much greater extent than here. Nevertheless, one accepts them willingly as they are well compensated by other advantages.

In the practical application of this system, it is advisable to employ a commutator instead of a single ring of resistance material, the sections of the commutator being connected

* From the *Elektrotechnische Zeitschrift* of August 8th.

† An endeavour to compensate the difference of phase has already been made by Leblanc. For this he uses an auxiliary motor which he switches into the circuit of the short-circuited armature. By adding such an auxiliary motor, however, the arrangements are very much complicated.



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together by electrical conductors of small resistance. In principle this changes nothing, of course, and in this case also the shunt prevents sparking at the brushes.

Finally, one can also employ at the same time a short-circuit winding and a second exciting winding with a commutator. The self-induction of the commutator winding will then be removed by the short-circuited winding, and there would again be no sparking at the brushes. In the case of motors with wound rotors and slip rings for starting, the exciting ring is best placed at the neutral point of the three armature phases.

The following then takes place in actual working:—The momentary position and synchronous rotation of the field with regard to the exciting armature is fixed by the position of the brushes (Fig. 1), and is independent of the speed of the armature. The current led through the brushes produces in the short-circuited armature a field rotating with the latter. If the armature is running synchronously at no load, the field in the armature is constant and the current is quite unchanged in direction and is a continuous current. When the armature is loaded, the reaction of the exciting armature will slowly rotate the field in the short-circuit armature, there is a slip, and working currents are thus induced in the closed winding of the short-circuit armature which tend to stop the field from rotating. Then the currents led in through the brushes constantly reproduce the field in each position, and the working currents induced by the slip tend with a certain force to retain the field in its momentary position and transmit the work or the turning moment from the exciting armature to the short-circuited armature. The same working or useful currents flow through the primary armature in an opposite direction to those in the short-circuited armatures, but no magnetising current flows.

In order to eliminate the phase-shifting entirely, the current passing to the brushes must, of course, be regulated. This is done by adjustable resistances placed in the leads. One can then go further, and finally, by over-excitation, produce a lead in the phase as with synchronous motors.

The advantages of compensating the phase lag in a motor need hardly be mentioned. The shifting of the phase is well-known as one detriment to the three-phase motor which is so excellent in every other respect. It prevents, as a rule, the direct connection of the motors to low-pressure lighting networks. In pure power-transmission it has the effect that, except at full load, the wattless currents are often greater than the actual useful currents. Even with an average power factor of $\cos \phi = 0{\cdot}7$, the wattless currents which are equal to $\sin \phi$ will be actually as great as the useful currents. Even with a fully-loaded motor, whose $\cos \phi$ may be 0·9, the wattless currents are half the useful current. In addition, it must be remembered that even this result is arrived at only with the help of what is recognised as the minimum air-gap that can be employed, while for mechanical reasons and security in working it would be preferable to employ larger air gaps between stator and rotor, as, for instance, in the continuous-current motor.

Further, the motor can run as a generator, and deliver current independently of other machines. It is self-exciting, just as a continuous-current dynamo, and there is no need of any exciter. The frequency is not, as in ordinary alternators, absolutely fixed by the speed, but it is somewhat less in relation to the speed of the rotor, according to the load. Its speed and frequency are asynchronous, the opposite case to that of ordinary alternating-current machines, and it can be connected in parallel with other generators without being previously brought up to synchronism. Switching in parallel and parallel running of such generators are just as simple as with continuous-current machines, and all the various difficulties known in connection with the parallel running of alternating-current machines, due to uneven turning moment of the engine, are eliminated. The system is therefore particularly suitable for the construction of large slow-speed machines, directly coupled to steam engines, the uneven turning moment of which throws great difficulties in the way of parallel running, and necessitates heavy flywheels.

It may be expected that the trials of the system will bring out further results. Probably it will be possible by a similar arrangement to compound this generator for constant pressure at variable loads as a compound continuous current machine, and finally to make it compensate phase lag in the network. At present various experimental motors are being constructed by the Allgemeine Elektricitäts-Gesellschaft and by Siemens and Halske, and I hope soon to be able to communicate the results of some experiments.

## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 558.*)

§ 18. Hick, Hargreaves–Lancashire Dynamo and Motor Co.'s Three-Phase Generator Set.—The solitary instance of the supply of current for lighting and power to the exhibition switchboard by means of a three-phase generator is afforded by the substantially-built generating set shown in Fig. 15. The engine was built by Messrs. Hick, Hargreaves & Co., and consists of a vertical enclosed cross-compound engine. The dynamo is a three-phase flywheel alternator, built by the Lancashire Dynamo and Motor Co. Dealing first with the engine, we may note that it is rated at 450 H.P., running at 150 revs, non-condensing, supplied with steam at 140lb. pressure. The cylinders are 16in. and 27in. diameter by 18in. stroke and are not jacketed. The valves consist, on the high-pressure side, of a piston valve, with a double port for steam and a single port for exhaust, and, on the low-pressure side, of an ordinary slide valve. The governor acts only on the high-pressure side and consists of a McLaren governor placed on the crank shaft with a handwheel for varying the speed about 10 revs. per min. The normal variation of speed between full and light load is 2 per cent. A feature of the engine is the perfect arrangement for automatic lubrication, there being oil circulation by means of a pump driven off the crosshead, forcing oil at 30lb. pressure to all the bearings.

With regard to the three-phase dynamo, this has a fixed armature and a rotating field, the field coils being of bare copper strip wound on edge and insulated by means of presspahn. The generator develops 200kw. at 5,000 volts and 50 ~ per second. The armature is star-wound. There are 40 poles, and the speed, as already stated, is 150 revs. The weight of the flywheel and field coils is about 11 tons. As shown in the illustration, a rope-driven exciter supplies the current to the field, this working at 80 volts, and supplying about 80 amperes. The exciter itself is separately excited. The collector rings of the alternator are carried through the flywheel boss by means of recessed bolts run in with an insulating compound. The stationary armature coils are former-wound and sunk in slots in the stampings. They are, of course, interchangeable in the same machine, but are also generally constructed so as to be interchangeable in machines of very widely different size. The exciter is built on the same lines as the enclosed motors manufactured by this company.

In order to supply continuous current at the ordinary supply pressure to the exhibition switchboard a motor generator built by the Lancashire Dynamo and Motor Co. is interposed between the generator and the board. This machine is shown in Fig. 16. It runs at 600 revolutions, and consists, on the high-pressure side, of a 130 H.P. synchronous motor, and on the low-pressure side of a six-pole continuous-current generator capable of developing 150 amperes at 500 volts. The synchronous motor has 10 poles, is star-wound, and has the same armature coils as are used on the dynamo shown in Fig. 15. The continuous-current generator is quadruple-wound, has spherical bearings and a shunt-wound field.

§ 19. Messrs. Hick, Hargreaves & Co.'s Exhibits.—In addition to the engine described in the previous section, Messrs. Hick, Hargreaves & Co. exhibit a large number of machines, many of which are of interest to electrical engineers. Among these may be mentioned their Corliss gear provided with two inde-

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pendent wrist-plates, one giving steam inlet with trip cut-off and positive steam pressure instead of the usual springs acting on the dash-pot. The gear is provided with a safety shut-down on the governor in the event of the governor running away. Another interesting exhibit is a superheater of the same type as that used at the Leeds electric supply station. This, however, is not in action.

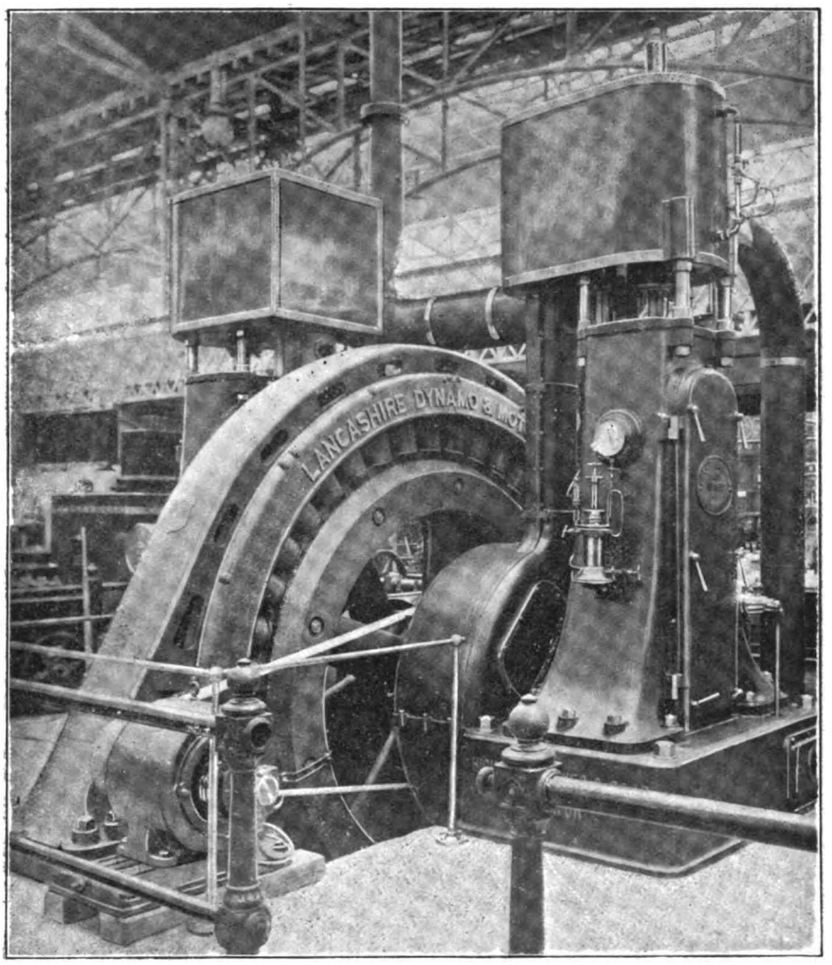


FIG. 15.—THREE-PHASE GENERATING SET, BUILT BY MESSRS. HICK, HARGREAVES AND CO. AND THE LANCASHIRE DYNAMO AND MOTOR CO.

§ 20. **The Lancashire Dynamo and Motor Co.'s Exhibits.**—Besides the large flywheel three-phase alternator illustrated in Fig. 15, this company have a number of other electrical exhibits, including motors, &c. The design of the motors is exceedingly compact; at the same time ample allowance has been made so that nothing inside the machine is unduly cramped, and all terminals, connections, &c., are accessible. Access to the brushes is obtained through two large doors, and the design is such that the brush holders, when drawn back, project through the doorways, enabling the carbons to be easily changed whilst the machine is working without any danger of shock, even if the frame of the motor is connected to earth. The bearings are so arranged that the motor can be readily adapted to bolt to the floor, wall, or ceiling. The field frame is of cast steel, circular in shape, and provided with circular or elliptical poles and laminated pole-pieces designed to prevent sparking and eliminate eddy currents. The field coils are former-wound, served with tape and then dipped in insulating compound and baked. Each coil is provided with its own terminals, so that no loose wires project, thus avoiding the danger of the latter being broken off. The coils are held in their places by brass clamps with wood strips at the back next the yoke, enabling the air to circulate freely both inside and outside the coil and ensuring cool running and absence from sweating. The bearings are of the swivel self-oiling type, provided with two brass oil rings which dip into the well below. The armatures are of relatively large diameter; they have but a small armature reaction, and are built up of thin varnished plates provided with slots to receive the windings. The armature is further ventilated to ensure cool running. The plates are securely keyed to a cast-iron sleeve extending from bearing to bearing inside, thus strengthening the shaft and allowing it to be readily replaced without interfering with the armature proper. The commutator is also carried on this cast-iron sleeve. The windings are of the cylindrical barrel type. Each coil is wound on a special former, afterwards taped up and then dipped in insulating compound and dried; a trough of insulation is then put into the slot and the coil slipped in position. After they are all in place wood strips are driven into the top of the slots, and steel bands wound tightly on and soldered up. The bands are carried in recesses in the core, so that in case the armature touches the fields it is not damaged. The commutators are built up under hydraulic pressure, and are made of hard drawn copper bars insulated with amber mica. Micanite is used for insulating the commutator from the end rings. All motors are designed to stand heavy overloads, and will carry 50 per cent. overload for a quarter of an hour, and 20 per cent. for two hours, without undue heating or sparking. The moderate and slow speed motors are capable of regulation by weakening the field, and are thereby adapted for separate driving, as the speed may be increased 100 per cent without sparking. The multipolar generators and motors of open type have field magnets with the yokes, of cast iron or steel, circular in shape, and provided with steel poles of circular or elliptical section, and a special form of pole-piece to reduce sparking. The fields are split across the horizontal diameter, to enable the armature to be readily inspected and repaired. The yoke is provided with brackets lined with white metal to support the brush ring. The field coils are former-wound, insulated with presspahn, served with tape, and then dipped in an insulating compound and thoroughly baked.

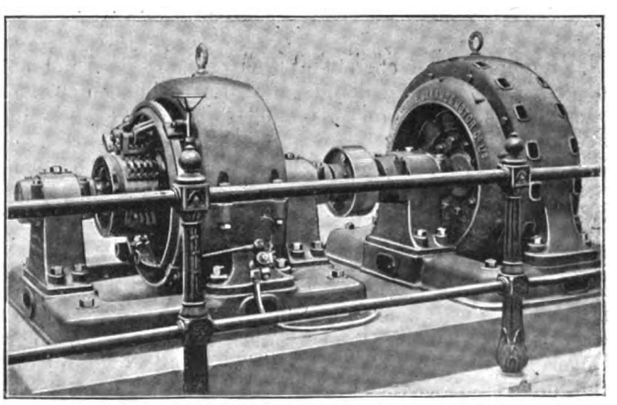

FIG. 16.—THREE-PHASE MOTOR-GENERATOR, BUILT BY THE LANCASHIRE DYNAMO AND MOTOR CO.

*(To be continued.)*

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## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 597.*)

### EXPERIMENTAL ELECTRIC RAILWAYS.

One of the most interesting things inspected during the Institution's German tour was the extra high-pressure electric railway experiments which were being conducted by Messrs. Siemens and Halske at Gross-Lichterfelde, near Berlin. If in the future ordinary heavy traffic is to be carried on electric railways at fast speeds, large powers will have to be conveyed to the trains, and it is evident that if current can be led to the train or locomotive at high pressure, considerable saving will be effected. If the employment of extra high pressure for the overhead line itself and the collection by the locomotive or motor-car of current at this pressure does not entail too great expense and danger, in comparison with stationary transformers along the line and trolley wires at a lower pressure, it is evident that it is the thing to use. Even with stationary transformers at frequent intervals, a low or medium pressure trolley wire would have to be of considerable size, and great difficulties are introduced in collecting the large currents necessary for the propulsion of heavy trains.

Thus the first part of the problem attacked by Messrs. Siemens and Halske was to find whether an extra high-pressure overhead wire for supplying current directly to the locomotive was feasible, and was not attended with too great danger, and then to contrive the most practical arrangements on the locomotive or motor-car to deal with this pressure. Hence the experiments at Gross-Lichterfelde.

A voltage of 10,000 volts three-phase was chosen, and this is delivered directly to the locomotive, on which the current is transformed down to a lower pressure and fed to the motors. Fig. 30 shows the detail of the current collectors. It is seen that they are sliding bars, but vertical instead of horizontal. Thus the overhead line can be placed to one side of the track, and there is room for a guard net below it to prevent accident in case of a broken wire. The three vertical spindles supporting the sliding bars press the latter against the wire by means of the spiral springs seen in the figure, which allow for the necessary lateral motion of the collectors, while the up-and-down motion is controlled in each case by a spiral spring around the horizontal spindle on which the collector arm is fixed. The bar itself is of aluminium. On the roof are three Siemens horn-shaped lightning protectors.

The method of supporting the line is seen in Fig. 31. The three high-pressure wires are mounted 1 metre apart, one below the other, on brackets fastened to iron lattice poles, the three-lip insulators to which the wires are actually fixed being mounted on a flexible wire suspension so contrived that the insulator slants forwards slightly. The distance of the lowest wire from the track is $5\frac{1}{2}$ metres.

Figs. 31 and 32 give a good idea of the construction of the locomotive. Running on standard gauge, its wheel-base is 2·8 metres, the length and width 4 metres and 2·2 metres respectively and the diameter of the wheels 1 metre. Its total weight, including equipment is 16 tons. The frame is built up of iron in the usual way. The electrical arrangements are, however, most interesting. The 10,000-volt 50~ three-phase current is led in from the collectors by conductors passing through an iron tube to the main high-voltage switch in one of the transformer chambers. There are two three-phase transformers, one at each end of the locomotive. Fig. 31 shows one of these chambers open. The transformers transform down to 750 volts, and there are two asynchronous motors rated at 80 H.P. normally and with a maximum permissible output of 120 H.P. The maximum speed of the locomotive is 60km. per hour, and the gear ratio is 1 : 3·15. To regulate the speed a controller is provided which is externally of the usual shape, but internally quite different. The variations in the speed are effected by changing the connections of the transformer secondaries. For full speed under ordinary conditions they are connected in star, for a large tractive effort in mesh, and for half speed one of the secondary phases is left open. The contacts are provided with magnetic blow-out devices. Rheostats for putting resistance in series with the rotor on starting are, of course, also provided. One of these

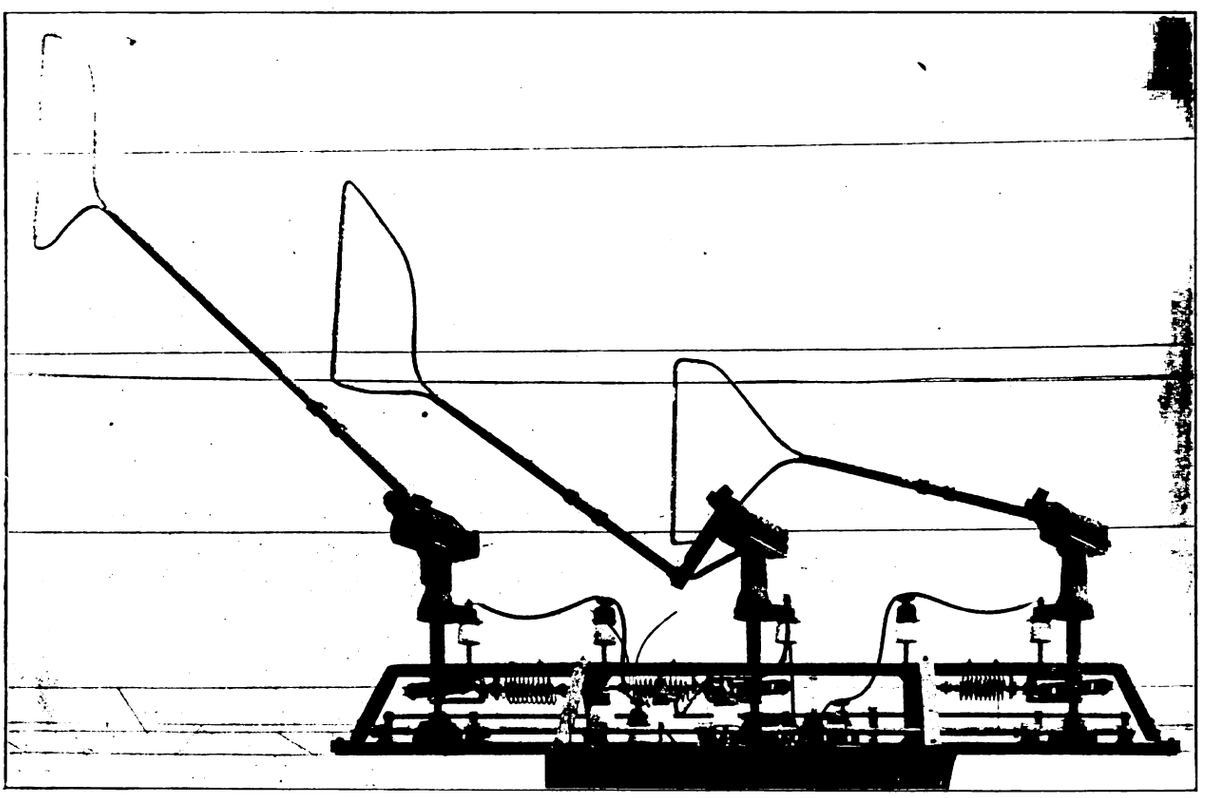

FIG. 30.—DETAIL OF CURRENT COLLECTOR.

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is seen in Fig. 31. They are worked from the controller handle through chain gearing, and the resistances are of the sheet-iron pattern, fixed in sheet-iron cases beneath the flooring of the locomotive.

The success of this experimental line has demonstrated the possibility of employing very high pressures, and the experiments with extra high speeds have still to be made. To this end the Studiengesellschaft für Elektrische Schnellbahnen, a company formed by Messrs. Siemens and Halske and the A.E.G. for the purpose of studying these problems, have ordered a car from each of the above two firms, and a trial line is to be built for a speed of 200km. per hour. The overhead equipment and collecting devices for 10,000 volts will not differ materially from that already described, but there are considerable points of difference in the design of the remainder of the car equipment. In the car Messrs. Siemens and Halske are building the three conductors coming from the line are first branched to a small auxiliary transformer with a ratio of 1 : 10, which furnishes the current for two air-compressors, used not only for the brake but also to operate the switches. After this the current passes through the two high-pressure switches (one on each end of the car) which are connected up in such a way that the direction of running is determined by them, only one of them being switched on when running. They are arranged in iron troughs on the top of the car, the contacts alone projecting above the car, and they are actuated by air cylinders disposed behind the seats. Switching-on is effected by letting in the compressed air, switching off by exhausting. The switches are of the tube type. The arc, interrupted in two places simultaneously, is drawn into a narrow insulating tube, the extinguishing effect of which is further increased by metal cooling rings. The main fuses are in two iron-lined spaces inside the car, which also contains the wires leading to the transformers beneath the car floor. They consist of fusible strips in narrow insulating tubes open at both ends.

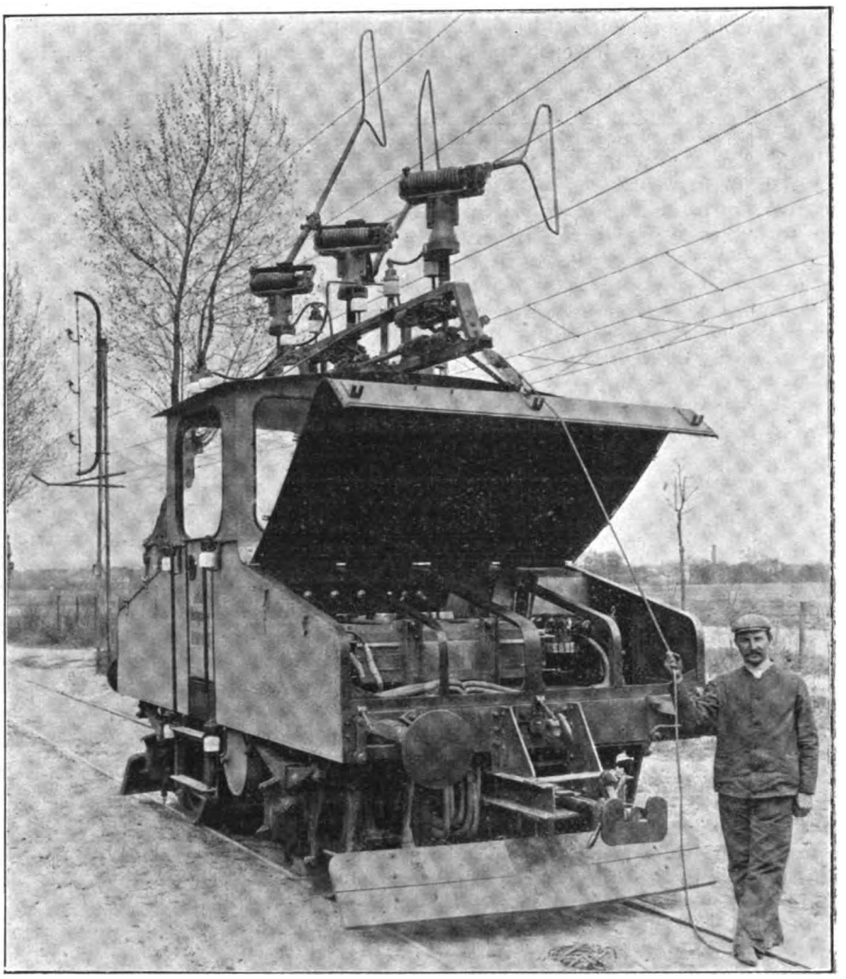

FIG. 31.—VIEW OF HIGH-PRESSURE LINE AND LOCOMOTIVE WITH TRANSFORMER BOX OPEN.

FIG. 32.—GENERAL VIEW OF HIGH-PRESSURE LOCOMOTIVE.

The transformers, one for each truck, have a ratio of 1 : 5. Their cores are arranged in a horizontal plane and connected by double yokes. They are pierced by longitudinal slots with a waterproof and dust-proof lining. Being situated in the longitudinal axis of the car, these slots provide for an excellent cooling of the transformers by the natural draught of air produced when the car is running. The transformers are enclosed in a sheet iron case suspended on the car beams. The primary windings are permanently star-connected, and the secondary windings, as in the previous case, are led out to separate switches by which they may be grouped either in star (2,000 volts between motor terminals for starting) or in mesh (1,150 volts for ordinary running). The switches for this, together with the motor switches and fuses are contained in two separate boxes arranged beneath the floor adjacent to the transformer cases. These lower pressure switches and fuses

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are of the same type as those for the high pressure, the switches being also driven by pneumatic pressure.

The motors, two for each truck, have each a normal output of one controller and a single controlling line running right through the train the six motors can be simultaneously cut in and out. A Westinghouse brake is adopted, the com-

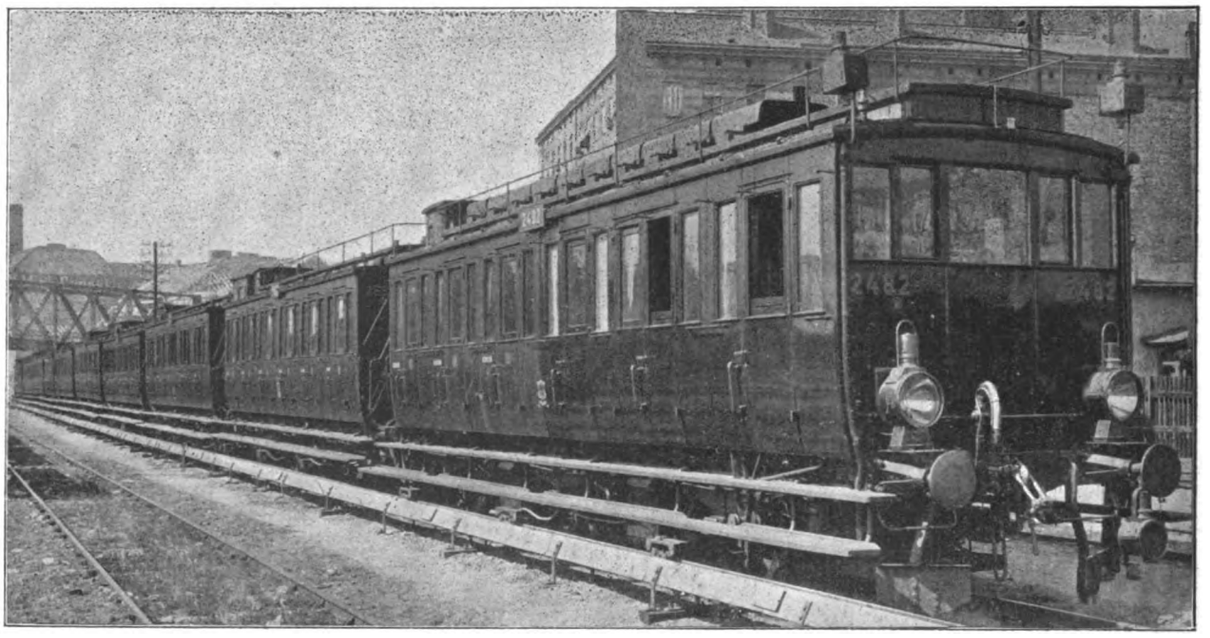

FIG. 33.—GENERAL VIEW OF EXPERIMENTAL TRAIN ON THE WANNSEE LINE.

of 250 H.P., and are able to stand an overload of 1,000 H.P. for a short time. Their speed is 880 revs. per min., with a frequency of 45 ~ per sec. They differ from the usual type of induction motor by the fact that their primary rotates, being provided with three slip-rings, and the secondary is stationary. The induced current is led from the latter to the starting devices. The starting device for one motor consists of three drums mounted on a common axle, these drums representing the neutral point of the low-pressure system. They are rotated by a step-by-step gear, gradually cutting out resistances in the three circuits. The starting device is driven partly by air cylinders, partly by hand. The resistances are composed of strips of "Kruppin," and are assembled in flat boxes fastened to both sides of the car beneath the windows; and the starting gear is arranged immediately below the resistances. The motor-man's switch table contains four handles for the air-cocks (forward-backward, star-mesh, motors and air pump), besides these there is a hand-wheel for controlling and aiding the movement of the air-driven starting device. The compressed air is furnished by two air-pumps geared to induction motors of 3 H.P. each.

The A.E.G. truck, inspected at the AE.G. works, offered several points of interest, especially with regard to the motor suspension and the connection between the motor shaft and the wheel axles; but, at the company's request, I am not giving any particulars of its construction at present.

Another experimental train, by which the Institution party travelled after having inspected the extra high-pressure line, is a line erected by Messrs. Siemens and Halske for the Prussian Railway Administration to run experimentally to time-table between Berlin and Wannsee. This train has been running since August 1, 1900. The system employed is continuous current at 750 volts, in order to allow for the use of storage batteries. The train is composed of 10 ordinary suburban train cars of the Prussian State railways, the first and last of which cars were adapted and fitted as motor cars. The weight of the train empty is 193 tons. Each of the six axles of the two motor cars is coupled to a motor, and the adhesion is, therefore, due to the weight of the two motor cars together—viz., 64 tons. The controlling of the two motor cars is effected from the cab of the motor car at the head of the train for the time being in such a way that by means

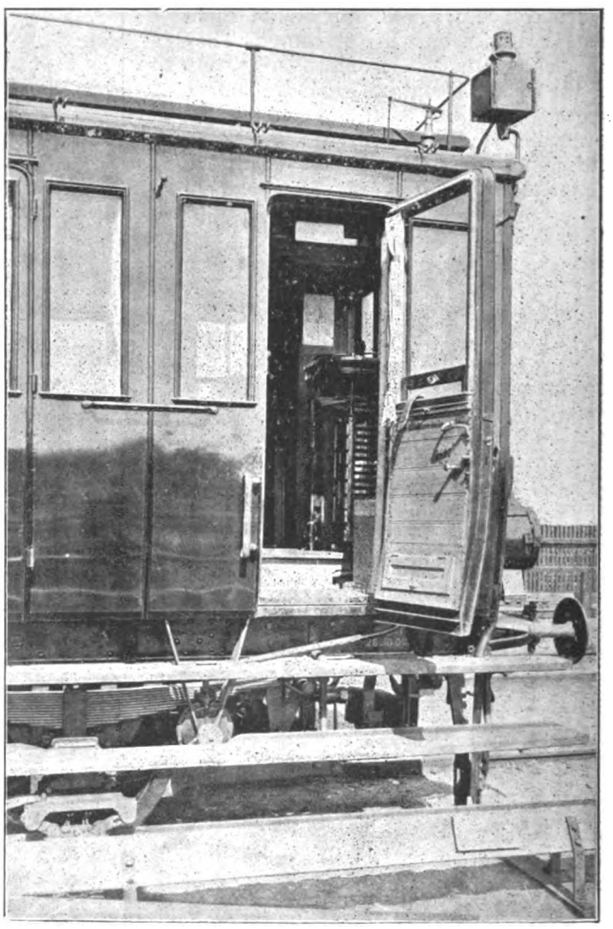

FIG. 34.—END OF WANNSEE RAILWAY MOTOR-CAR, SHOWING EQUIPMENT OF CAR AND COLLECTOR SHOE.

pressed air being generated by two electrically-worked compressors, one of which is installed in each motor car.

Current is led to the motor cars by means of a third

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rail by the side of the track, and returns by the track rails. It is taken up from the third rail by means of a number of sliding shoes fixed to the axle boxes of the motor-car axles and sliding along the top of the conduct rail.

The current used is generated in the power station of the Gross-Lichterfelde electric tramways, and is led to the line by means of overhead wires suspended from wooden masts. It is provided by a compound engine, running condensing, coupled to a Siemens and Halske dynamo of the external armature pattern. As the consumption of current varies between 0 and 1,200 amperes, equalising batteries were required, and these were installed at both ends of the line—viz., at Zehlendorf and Berlin.

The experimental train has been running without hitch since the opening day, and the equipments under trial, especially the method of switching the motor cars and the collection of the heavy currents, have proved a complete success.

## THE INTERPOLAR INDUCTION AND DISTRIBUTION OF COPPER IN THE ARMATURE OF A SIEMENS 12-POLE ALTERNATOR.

BY PROF. ERNEST WILSON AND WILLIAM MARDEN.

In the original Paper by Drs. J. and E. Hopkinson on "Dynamo Electric Machinery," * it was shown that the theoretical characteristic curve of a dynamo agreed with the curve obtained from the completed machine when corrections were made for leakage, and for the fringing of the lines of force in the air-space between the armature and the pole-pieces. It was shown how to measure the leakage by experiment, and by allowing a certain extension of the area of the field as geometrically defined by the polar-arc and mean radius of the air-space, theory was brought into agreement with practice. In dynamos with a small length of air-space as compared with the area, a considerable variation in the correction for extension of air-space due to fringing can be made

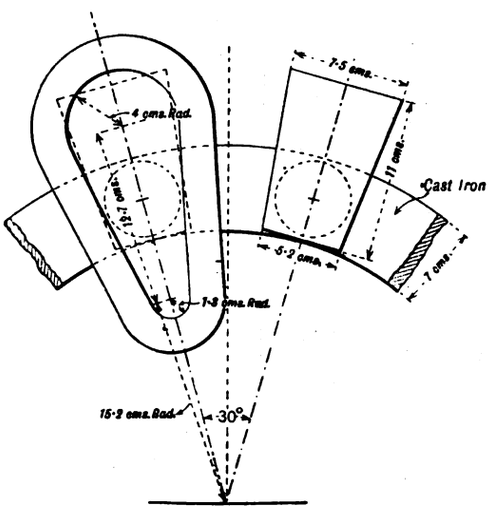


FIG. 1.

without seriously affecting the results, but with air-spaces whose length is great as compared with the area the subject of this correction presents considerable difficulty. Especially is this the case in alternators of the Siemens type in which the armature has no iron for its core and rotates between an even number of poles separated by a considerable air-gap as compared with the area of the pole-pieces.

In a Paper on "Dynamo Electric Machinery," † curves are given which show the distribution of induction between the smooth core of a direct current dynamo and the pole-pieces.

* *Phil. Trans.* Roy. Soc., 1886.
† Hopkinson and Wilson, *Proc.* Roy. Soc., Vol. LI., p. 49.

In this machine the radial length of the air-gap space is 1·4cm. and the estimated effective area is 906 sq. cm.; the extension in this case was taken to be equal to a strip, all round the pole face, equal in width to the air space length—1·4cm. If the figures in this Paper be examined it will be seen that the intensity of induction begins to diminish before the edge of the pole-piece is reached. The induction density begins to fall off about 1cm. from the edge of the pole face. This is called attention to by Messrs. C. C. Hawkins

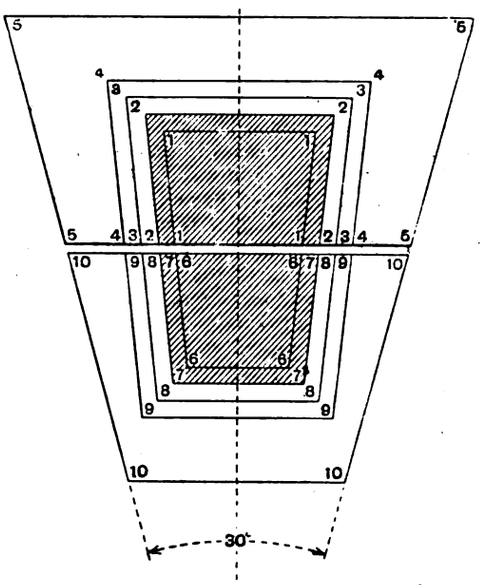


FIG. 3.

and R. Wightman* in a Paper dealing with this subject. Another Paper is that by F. W. Carter,† in which the same subject is dealt with theoretically. A Paper dealing with the E.M.F. of alternators, in which the effect of fringing and

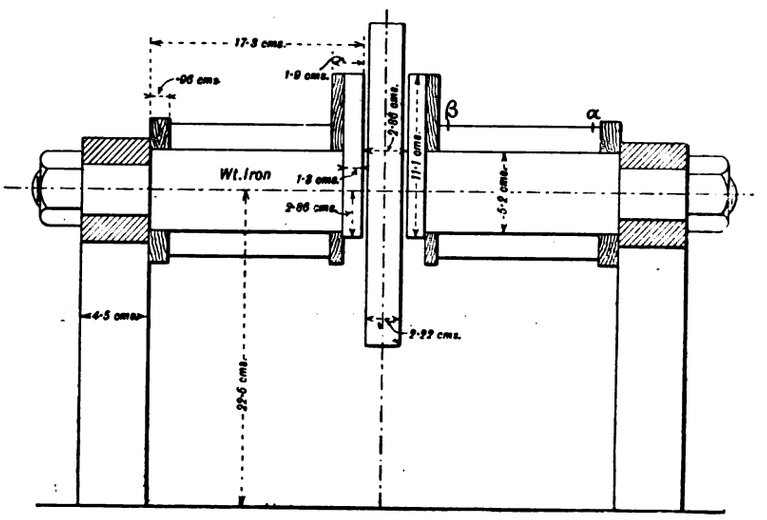


FIG. 2.

relative variation of pole-pitch and pole-arc are discussed, was written by C. C. Hawkins.‡

The object of the experiments described in this Paper, and made at King's College, London, was, first, to find the distribution of induction between the two opposing pole-pieces in a given machine when the air space length was varied and the exciting current kept constant; second, to examine the effect of variation of air-space length upon leakage for a given exciting current; and, third, to find the most economical distribution

* *Journal* Inst. Elec. Eng., Vol. XXIX., p. 436.
† *Journal* Inst. Elec. Eng., Vol. XXIX., p. 925.
‡ *Electrical Review*, Vol. XLVII., p. 655.

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of copper in an armature bobbin with the given air space and distribution of induction. A complete investigation would deal with the variation in the ratio of pole-pitch to pole-arc, the length and diameter of magnet core for given pole-piece, &c. This is not attempted in this Paper, as such quantities are kept fixed. The only variables are the magnetising current and air-space length, with their consequent effects upon leakage and distribution of induction.

The machine experimented on has already been the subject of experiment.* The dimensions of the iron pole-pieces, cores, &c., are given in Figs. 1 and 2. There are 12 pole-pieces on each side of the armature, *i.e.*, six periods per revolution.

The armature was taken out of the machine, and opposite one pole-piece was fixed a piece of wood ½in. thick, in which were bedded exploring coils. The shapes of these coils are shown in Fig. 3 (1 to 10 inclusive) in one set of experiments, and in Fig. 4 (*a* to *p* inclusive) in a second set of experiments. In Fig. 3 coils 2 and 7 together have the same area as, and are placed over, a pole-piece. The fringing in the first set of experiments (Fig. 3) is that taken all round the pole-piece. In the second set of experiments (Fig. 4) the fringing is that between adjacent pole-pieces on the same side of the armature, and in this case coils *e* and *m* together have the same area as and are placed over a pole-piece.

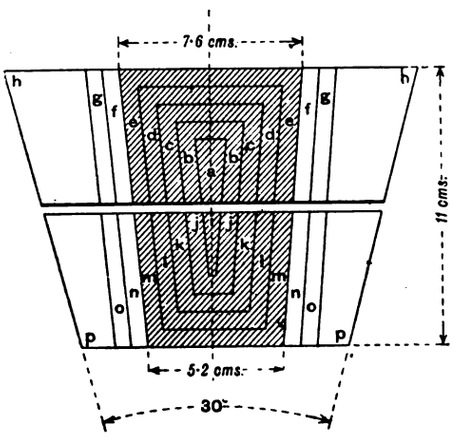


FIG. 4.

The method of experiment was to reverse a certain magnetising current passing through the 24 magnet windings, and to observe the resulting kick on a ballistic galvanometer placed successively in each exploring coil. The length of the air-space in the machine, as constructed with armature in position, is 1⅛in., and this was the first air-space dealt with. The magnets were then placed nearer together with a ½in. air-space, and experiments again made. Kicks were also taken from exploring coils wound round the magnet limb at positions $\alpha$, $\beta$ (Fig. 2), for the purpose of obtaining the leakage before the pole-pieces are reached.

In Fig. 3 we had to be content with the average over coils 1 and 6. In Fig. 4 an attempt was made to find the distribution of induction over the interior of coils 1 and 6. The result was not satisfactory, as the areas became so small and were difficult to measure accurately. We contemplated attacking the subject by means of a revolving contact-maker and coil embracing a known area of the armature, but this would have involved serious structural alterations with the ½in. air-space, and was not resorted to.

The exploring coils were in a plane parallel to and approximately ¼in. away from a pole-face in all the experiments.

In Figs. 5 and 6 the results of the experiments are shown by curves, which give the intensity of induction in C.G.S. units per square centimetre vertically and quarter space period horizontally. In each figure two curves are given: the upper one gives the intensity over the lower portion of the pole-piece, as shown in Figs. 1 and 2, showing the effect of the iron core which supports the pole-piece. In Fig. 5 the air-space length is ½in., in Fig. 6 it is 1⅛in. The curve is not materially altered in shape whether the results obtained from Fig. 3 or Fig. 4 be

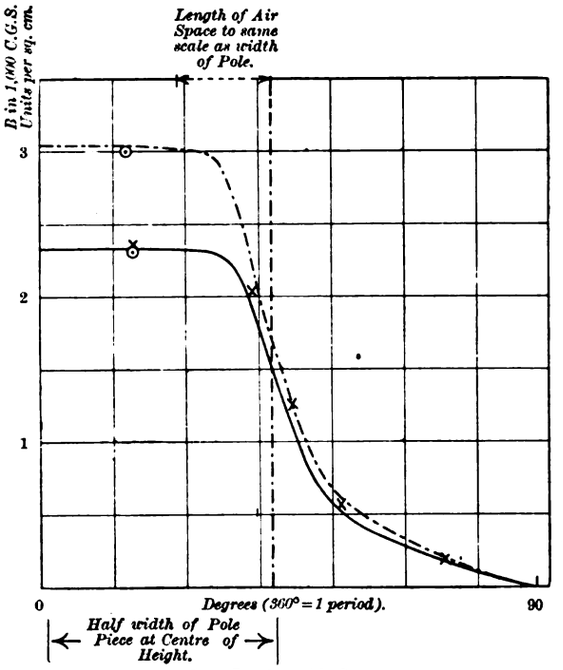
Length of Air Space to same scale as width of Pole.
B in 1,000 C.G.S. Units per sq. cm.
3
2
1
0
Degrees (360° = 1 period).
90
Half width of Pole Piece at Centre of Height.

FIG. 5.—½in. Air Space.

plotted. The magnetising current in each of the above cases was 13·5 amperes, and this corresponds to a total line integral of 5,940 C.G.S. units for two opposing magnet limbs, where

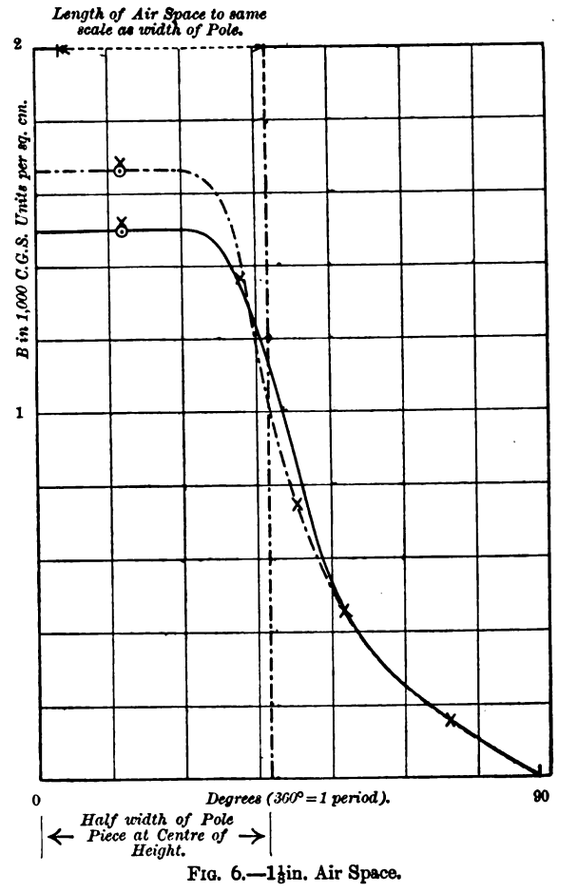
Length of Air Space to same scale as width of Pole.
B in 1,000 C.G.S. Units per sq. cm.
2
1
0
Degrees (360° = 1 period).
90
Half width of Pole Piece at Centre of Height.

FIG. 6.—1⅛in. Air Space.

the turns are 350. The curves obtained when the current was 7·2 amperes show practically the same distribution as in Figs. 5 and 6.

* For description, see *Phil. Trans.* Roy. Soc., Vol. CLXXXVII. (1896) A, pp. 229—252.

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Table I.

| Amperes in magnet winding | | 7·2 | | 14·5 (coils as in Fig. 3). | | 13·5 (coils as in Fig. 4). | |
|---|---|---|---|---|---|---|---|
| Air space length | | ½in. | 1⅛in. | ½in. | 1⅛in. | ½in. | 1⅛in. |
| Induced magnetism near ring $\alpha$, Fig. 2 | Total | 240,300 | 197,700 | 343,000 | 306,600 | 341,500 | 306,000 |
| | B per square centimetre | 11,100 | 9,200 | 15,900 | 14,200 | 15,830 | 14,200 |
| Induced magnetism near pole piece $\beta$, Fig. 2 | Total | 198,600 | 146,300 | 283,500 | 225,400 | 278,000 | 220,000 |
| | B per square centimetre | 9,200 | 6,800 | 13,150 | 10,450 | 12,900 | 10,200 |
| Leakage coefficient between total induced magnetism and that passing through coils | $\beta$, Fig 2 | 1·21 | 1·35 | 1·21 | 1·36 | 1·23 | 1·39 |
| | 5 and 10 (Fig. 3) together | 1·43 | 1·92 | 1·39 | 1·84 | — | — |
| | $h$ and $p$ (Fig. 4) together | — | — | — | — | 1·56 | 2·05 |
| | 2 and 7 (Fig. 3) together | 1·87 | 2·94 | 1·85 | 2·74 | — | — |
| | $e$ and $m$ (Fig. 4) together | — | — | — | — | 1·86 | 2·72 |

Table I. gives the induction per square centimetre at the two points $\alpha$, $\beta$ (Fig. 2) for the ½in. and 1⅛in. air spaces, each with two magnetising currents. The effect of diminution of air-space upon leakage is very marked. The ratio of the total induced magnetism to the magnetism which gets across between the pole-pieces varies from 1·9 to 1·4. The total induced magnetism is increased 21·5 and 11·9 per cent. on the value with 1⅛in. air space, with magnetising currents of 7·2 and 14 amperes respectively.

(*To be concluded.*)

## THE MECHANISM OF THE ELECTRIC ARC.

BY MRS. HERTHA AYRTON.*

The object of the Paper is to show that, by applying the ordinary laws of resistance, of heating and cooling and of burning to the arc, considered as a gap in a circuit furnishing its own conductor by the volatilisation of its own material, all its principal phenomena can be accounted for, without the aid of a large back E.M.F., or of a "negative resistance," or of any other unusual attribute.

*The apparent large Back E.M.F.*—It is shown how volatilisation may begin, even without the self-induction to which the starting of an arc, when a circuit is broken, is usually attributed; and it is pointed out that, when the carbons are once separated, all the material in the gap cannot retain its high temperature. The air must cool some of it into carbon *mist* or *fog*, just as the steam issuing from a kettle is cooled into water mist at a short distance from its mouth. The dissimilar action of the poles common to so many electric phenomena displays itself in the arc at this point. Instead of *both* poles volatilising, the *positive* pole alone does. It is considered, therefore, that the arc consists of (1) a thin layer of carbon vapour issuing from the end of the positive carbon, (2) a bulb of carbon mist joining this to the negative carbon, and (3) a sheath of burning gases, formed by the burning of the mist and the hot ends of the carbons, and surrounding both. The vapour appears to be indicated in images of the arc by a sort of gap between the arc and the positive carbon, the mist by a purple bulb, and the gases by a green flame.

The flame is found to be practically insulating, so that nearly the whole of the current flows through the vapour and mist alone. It is suggested that the vapour has a high specific resistance compared with that of the mist, and that it is to the great resistance of this vapour film that the high temperature of the crater is due, and not to any large back E.M.F. of which it is the seat. Volatilisation can only take place at the surface of contact between the vapour film and the positive carbon. When that surface is smaller than the cross-section of the end of the carbon it must dig down into the solid carbon and make a pit. The sides of the pit, however, must be hot enough to burn away where the air reaches them, hence there is a race between the volatilisation of the centre of the carbon and the burning of its sides that determines the shape of the carbon. When the arc is short, the air cannot get so easily to the sides of the pit, hence it remains concave. When the arc is long, the burning of the sides gains over the volatilisation of the centre, and the surface of volatilisation becomes flat, or even slightly convex.

The peculiar shaping of the negative carbon is shown to be due to its tip being protected from the air by the mist, and its sides being burnt away under the double action of radiation from the vapour film and conduction from the mist, to a greater or less distance, according to the length of the arc and the cross-section of the vapour film. It is shown that if the crater be defined as being that part of the positive carbon that is far brighter than the rest, then the crater must be larger, with the same current, the longer the arc, although the area of the volatilising surface is *constant* for a constant current. By considering how the cross-section of the vapour film must vary with the current and the length of the arc, it is found that its resistance $f$ must be given by the formula

$$f=\frac{h}{A}+\frac{k+ml}{A^2},$$

where $h$, $k$, and $m$ are constants, $l$ is the length of the arc, and A the current. This is the same form as was found by measuring the P.D. between the positive carbon and the arc, by means of an exploring carbon, and dividing the results by the corresponding currents. Hence the existence of a thin film of high resisting vapour in contact with the crater would not only cause a large fall of potential between the positive carpon and the arc, exactly as if the crater were the seat of a large back E.M.F., but it would cause that P.D. to vary with the current and the length of the arc exactly as it has been found to vary by actual measurement.

*The apparent "Negative Resistance."*—As nearly all the current flows through the vapour and mist, the surrounding flame being practically an insulator, the resistance of a solid carbon arc, apart from that of the vapour, must depend entirely on the cross-section of the mist. To see how this varies with the current, images of an arc of 2mm. were drawn, with the purple part—the mist—very carefully defined, for currents of 4, 6, 8, 10, 12 and 14 amperes. The mean cross-section of the mist was found to increase more rapidly than the current, consequently its resistance diminishes more rapidly than the current increases. As the formula for the resistance of the vapour film shows that it, too, diminishes faster than the current increases, it follows that the whole resistance of the arc does the same, and that consequently the P.D. must diminish as the current increases. Hence if $\delta V$ and $\delta A$ be corresponding increments of P.D., and current $\delta V/\delta A$ must be negative, although the resistanc of the arc is positive.

It is found, from the above measurements of the cross-sections of the mist, that the connection between $m$, the resistance of the mist, and the current, is of the form,

$$m=\frac{a}{A}+\frac{\beta}{A^2}.$$

If $m$ varies directly with the length of the arc, then

$$m=\left(\frac{a}{A}+\frac{\beta}{A^2}\right)l.$$

Adding this equation to (1), we get

$$f+m=r=\frac{p+ql}{A}+\frac{s+tl}{A^2}$$

for the whole resistance of the arc, which is exactly the form that was found by dividing direct measurements of the P.D. between the carbons by the corresponding currents. Hence there is no reason why this ratio should not represent the *true* resistance of the arc.

*Under what circumstances $\delta V/\delta A$ measures the True Resistance of the Arc.*—When the current is changed it takes some time for the vapour film to alter its area to its fullest extent, and still more time for the carbon ends to change their shapes. All the time these changes are going on the resistance of the arc, and, consequently, the P.D. between the carbons must be altering also. Both these, therefore, depend not only on the current and the length of the arc, but also, till everything has become steady again, *i.e.*, till the arc is "normal" again, on how lately a change has been made in either. At the first instant after a change of current, before the volatilising area has had time to alter at all, $\delta V$ and $\delta A$ must have the same sign, just as they would if the arc were a wire, but as the volatilising surface alters, the sign of $\delta V$ changes. If, therefore, a small alternating current is applied to the direct current of an arc, it will depend on the frequency of that current whether $\delta V/\delta A$ is positive or negative. When the frequency is so high that the volatilising surface never changes at all, $\delta V/\delta A$ will measure the true resistance of the arc unless it has a back E.M.F. which varies with the alternating current.

The measurements of the true resistance of the arc made in this way by various experimenters have given very various results, because probably the frequency of the alternating currents employed has been too low not to alter the resistance of the arc. A curve is

* Abstract of a Paper read before the Royal Society on June 20th.



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drawn showing how the value of $\delta V/\delta A$ with the same direct current and length of arc varies with the frequency of the alternating current, and it is pointed out that even if the arc has as large a back E.M F. as is usually supposed, the *true* resistance cannot be measured with an alternating current of lower frequency than 7,000 complete alternations per second. The exact conditions under which the *true* resistance of the arc can be measured in this way are examined, and the precautions that it is necessary to take to ensure the fulfilment of these conditions are enumerated.

*The Changes introduced into the Resistance of the Arc by the use of Cored Carbons.*—A core in either or both carbons has a great effect on both the P.D. between the carbons and the *change* of P.D. that accompanies a given *change* current. It lowers the first, and makes the second more positive, *i.e.*, gives it a smaller negative or larger positive value, as the case may be. It is pointed out that this might be due to the influence of cores either on the cross-section of the arc, or on its specific resistance, or on both. To see the effect on the cross-section, enlarged images were drawn of 2mm. arcs with currents increasing by 2 amperes from 2 to 14 amperes, between four pairs of carbons, + solid – solid, + solid – cored, + cored – solid, + cored – cored. Two sets of images were drawn with each pair of carbons —the one immediately after a change of current, to get the "non-normal" change, and the other after the arc had become normal again. The mean cross-section of the mist was calculated in each case, and its cross-section where it touched the crater was taken to be a rough measure of the cross-section of the vapour film.

It was found that the mean cross-section of the mist with a given current was largest when both carbons were solid, less when the negative carbon alone was cored, less still when the positive alone was cored, and least when both were cored. Coring either the positive carbon alone, or both carbons, had the same effect on the cross-section of the vapour film as on that of the mist, but coring the negative alone only diminished this cross-section immediately after a change of current, but not when the arc had become normal again. Hence it was deduced that if the cores altered the *cross-sections* of the arc only they would *increase* its resistance, and, consequently, the P.D. between the carbons. As they *lower* this, however, they must do it by lowering the specific resistance of the arc more than they increase its cross-section. The vapour and mist of the core must therefore have lower specific resistances than the vapour and mist of the solid carbon.

When it is the positive carbon that is cored, all the vapour and mist come from the *cored* carbon. When the negative, they come from the *uncored* carbon, and it is only because the metallic salts in the core have a lower temperature of volatilisation than carbon that the mist is able to volatilise these and so lower its own specific resistance. The effect of a core in either carbon, or in both, must depend on the current, because the larger the current the more solid carbon will the volatilising surface cover, and the less therefore will the specific resistances of the mist and vapour be lowered. The way in which the core acts in each case is traced, and the alterations in the specific resistances and cross-sections due to the core are shown to bring about changes in the P.D. exactly similar to those found by actual measurements of the P.D. between the carbons. It is shown, for instance, how these changes entirely account for the fact established by Prof. Ayrton* that, with a constant length of arc, while the P.D. diminishes continuously as the current increases, when both carbons are solid, it sometimes remains constant over a wide range of current, or even increases again, after having diminished, when the positive carbon is cored.

The alterations in the value of $\delta V/\delta A$ introduced by the cores are next discussed, and it is shown that the changes in the resistance of the arcs that *must* follow the observed changes in its cross-section, coupled with the alterations that must ensue from the lowering of its specific resistance, would modify $\delta V/\delta A$ just in the way that Messrs. Frith and Rodgers† found that it was modified by direct measurement. Thus all the principal phenomena of the arc, with cored and with solid carbons alike, may be attributable to such variations in the specific resistances of the materials in the gap as it has been shown *must* exist, together with the variations in the cross-sections of the arc that have been observed to take place. Hence it is superfluous to imagine either a large back E.M.F. or a "negative resistance."

* Electrical Congress at Chicago, 1893.

† "The Resistance of the Electric Arc," *Phil. Mag.*, 1896, Vol. XLII., p. 407.

## ELECTRICITY WORKS ACCOUNTS.

### Chester Municipal Electric Supply Works.

This undertaking continues to maintain the excellent results which have characterised it since the works were opened. As we feared they would be last year the cost figures for 1900-1 have been superficially marred by the high coal prices which have ruled. Making due allowance for the increase in this item it will be seen by our table that a fairly general reduction in the cost figures was effected.

As they now stand all the items, without exception, as well as the aggregate expenditure and revenue stand at values well below the average even considering the advantageous load factor of 16·9 per cent. which characterised the demand on the station.

The success of the undertaking is well shown up by the financial results attained in conjunction with the average total price.

With a low revenue of 8·52d. per unit from all sources, not less than 4·42 per cent. on the mean capital employed was put aside to the reserve and sinking funds after satisfying interest charges amounting to 2·82 per cent.

The year's output marks an increase of 26·4 per cent., and the lamp connections at the end of the year were higher by 15·4 per cent. than in the preceding year.

### Stafford Municipal Electric Supply Works.

There is evidence of quite a violent convulsion in the internal economy of this concern. Thus, with an increase in the fuel charge of no less than 0·54d. per unit the costs have been creditably reduced by nearly 0·44d. This result was effected chiefly by a reduction in the management and property charges, and partly also a lower expenditure per unit on wages and repairs at the station.

Again, the average load factor appears as 13·4 per cent. as against 8·54 per cent. in 1899-1900, while the year's output was more than double (or 131 per cent. higher than) that of the preceding year. The source of all this disturbance is to be found in the fact that of the 196,285 units sold to consumers 86,827 were sold by contract, and being sold at a low price had the further effect of reducing the average revenue from all sources from 4·9d. to 8d. per unit. It is not surprising, in the circumstances, that a deficit and, unfortunately, an increased one, has to be recorded as the net outcome of the year's operations.

The total equivalent lamp connections show an increase of 26·4 per cent.

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The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Ayr (Municipal) | Nov. 2, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bath (Municipal) | April 20, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leith (Municipal) | May 17, 1901 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | July 26, 1901 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | May 3, 1901 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Morley (Municipal) | June 14, 1901 |
| Bradford (Municipal) | July 12, 1901 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Brighton (Municipal) | May 10, 1901 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Bristol (Municipal) | Aug. 24, 1900 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bromley (Kent) (Co.) | June 15, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Norwich (Company) | Dec. 28, 1900 |
| Burnley (Municipal) | Nov. 30, 1900 | Notting Hill (Company) | Mar. 29, 1901 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Nottingham (Municipal) | Sept. 21, 1900 |
| Bury (Municipal) | Aug. 9, 1901 | Oldham (Municipal) | Feb. 1, 1901 |
| Cambridge (Company) | April 12, 1901 | Oxford (Company) | April 12, 1901 |
| Canterbury (Municipal) | Oct. 26, 1900 | Pontypool (Company) | May 3, 1901 |
| Cardiff (Municipal) | Jan. 11, 1901 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Charing Cross (Company) | Mar. 15, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Preston (Company) | Dec. 14, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Reading (Company) | Dec. 21, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Richmond (Company) | June 29, 1900 |
| City of London (Company) | July 26, 1901 | Salford (Municipal) | Feb. 23, 1900 |
| Clerkenwell (Company) | April 19, 1901 | Scarborough (Company) | July 13, 1900 |
| Coventry (Municipal) | Feb. 23, 1900 | St. Helens (Municipal) | Jan. 25, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Derby (Municipal) | Jan. 26, 1900 | St. Pancras (Municipal) | July 5, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dover (Company) | April 26, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dundee (Municipal) | Nov. 2, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Eastbourne (Company) | May 4, 1900 | South London (Company) | May 31, 1901 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Southampton (Municipal) | Feb. 8, 1901 |
| Folkestone (Company) | April 26, 1901 | Southport (Municipal) | July 7, 1899 |
| Glasgow (Municipal) | Sept. 14, 1900 | Stafford (Municipal) | Aug. 17, 1900 |
| Great Yarmouth (Mun.) | Dec. 28, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Guildford (Company) | Oct. 19, 1900 | Taunton (Municipal) | June 16, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Hammersmith (Vestry) | June 29, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hanley (Municipal) | Aug. 9, 1901 | Wandsworth (Company) | April 19, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Hast'gs & St. Leonards (Mun.) | July 12, 1901 | Winchester (Company) | May 17, 1901 |
| Hove (Company) | May 10, 1901 | Windsor and Eton (Co.) | July 19, 1901 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woking (Company) | Dec. 22, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Kens'gton & Knightsbr (Co.) | Mar. 16, 1900 | Woolwich (Company) | May 31, 1901 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Worcester (Municipal) | July 19, 1901 |
| Kingston-on-Thames (Mun.) | July 20, 1900 | | |

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| | CHESTER. | | STAFFORD. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Chester Town Council. | | Stafford Corporation. | |
| *Date of Commencement of Supply* | December, 1896. | | October, 1895. | |
| *System of Supply* | 3-wire continuous current with batteries. | | 3-wire continuous current with batteries. | |
| *Chief Engineer* | E. Thursfield. | | Hubert Pooley. | |
| **YEAR ENDED** | MAR. 25, **1900.** | MAR. 25, **1901.** | MAR. 31, **1900.** | MAR. 31, **1901.** |
| **QUANTITIES—** | | | | |
| Units generated | 763,154 | 944,857 | 118,341[a] | 261,599[d] |
| „ **SOLD (TOTAL)** | 617,792 | 780,567 | 86,780 | 200,271 |
| „ sold to consumers | 399,969 | 513,854 | 83,311 | 196,285 |
| „ sold for public lighting, &c. | 217,823 | 266,713 | 3,469 | 3,986 |
| „ used on works | 86,262[a] | 100,933[g] | 6,477 | 11,692 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 27·5 | 26·0 | 14·0 | 32·4 |
| Maximum supply demanded | 529 kilowatts | 527 kilowatts | 116 kilowatts | 171 kilowatts |
| Number of public lamps | 165 arc, 206 glow[b] | 165 arc, 313 glow[h] | 4 arc | 4 arc (10 amp.) |
| Number of consumers | 426 | 510 | — | 120 |
| Connections to mains in 8-c.p. lamps | 32,122 | 37,085 | 8,558 | 10,813 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 22,500 | 30,000 | 6,190 | 6,190 |
| **CAPACITY OF PLANT IN KILOWATTS** | 720 | 960 | 198 | 198 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £65,000 / £90·3 | £100,000 / £104 | £20,000 / £101 | £20,000 / £101 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 65,000 / 90·3 | 100,000 / 104 | 20,000 / 101 | 20,000 / 101 |
| **RECEIVED (TOTAL)** | 65,025 / 90·3 | 83,000 / 86·4 | 20,000 / 101 | 20,000 / 101 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 65,000 / 90·3 | 83,000 / 86·4 | 20,000 / 101 | 20,000 / 101 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | nil / — | 17,000 / 17·7 | — / — | nil / — |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | nil / — | 17,000 / 17·7 | — / — | nil / — |
| **REPAID (TOTAL)** | nil / — | nil / — | 2,463 / 12·4 | 3,085 / 15·6 |
| **RESERVE OR SINKING FUND** | 4,023 / 5·59 | 6,026 / 6·28 | — / — | — / — |
| **DEPRECIATION FUND** | 2,465 / 3·42 | 3,897 / 4·06 | — / — | — / — |
| **EXPENDED (TOTAL)** | 65,766 / 91·4 | 83,542 / 87·0 | 19,950 / 101 | 24,781 / 125 |
| Lands and buildings | 7,888 / 11·0 | 12,805 / 13·3 | 6,963 / 35·1 | 7,432 / 37·8 |
| Plant | 32,227 / 44·8 | 41,935[j] / 43·7 | 9,052 / 45·7 | 11,776 / 59·5 |
| Mains | 25,313 / 35·2 | 28,464 / 29·6 | 3,169 / 16·0 | 4,757 / 24·0 |
| Miscellaneous | 338 / 0·469 | 338 / 0·352 | 766 / 3·87 | 766 / 3·87 |
| **BALANCE OF CAPITAL ACCOUNT** | −741[c] / −1·03 | −542[c] / −0·565 | +50 / 0·25 | −4,781[e] / −24·1 |
| **REVENUE—** | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold |
| **TOTAL** | £9,501 / 3·693d. | £11,444 / 3·519d. | £1,770 / 4·900d. | £2,505 / 3·003d. |
| Revenue from supply | 6,670 / 2·592d. | 7,920 / 2·436d. | 1,571 / 4·346d. | 2,366 / 2·836d. |
| „ meters, &c. | 251 / 0·098d. | 310 / 0·095d. | 86 / 0·238d. | 3 / 0·004d. |
| „ public lighting | 2,532 / 0·984d. | 3,153 / 0·970d. | 90 / 0·249d. | 90 / 0·108d. |
| „ sale of lamps, &c. | 48 / 0·019d. | 32 / 0·010d. | — / — | 28 / 0·034d. |
| „ miscellaneous sources | — / — | 29 / 0·009d. | 23 / 0·064d. | 18 / 0·022d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £4,568 / 1·776d. | £6,038 / 1·857d. | £980 / 2·710d. | £1,897 / 2·274d. |
| **WORKS COSTS** | 3,425 / 1·331d. | 5,034 / 1·548d. | 749 / 2·073d. | 1,653 / 1·981d. |
| *Generation of electricity* | *2,752 / 1·069d.* | *3,974 / 1·222d.* | *612 / 1·693d.* | *1,473 / 1·765d.* |
| Fuel (including cartage, &c.) | 1,155 / 0·445d. | 2,043 / 0·628d. | 116 / 0·321d. | 719 / 0·862d. |
| Oil, waste, water, stores | 306 / 0·119d. | 370 / 0·114d. | 30 / 0·083d. | 67 / 0·080d. |
| Wages at station | 791 / 0·307d. | 1,084 / 0·333d. | 378 / 1·046d. | 570 / 0·683d. |
| Repairs and maintenance at station | 500 / 0·194d. | 478 / 0·147d. | 88 / 0·244d. | 117 / 0·140d. |
| *Distribution of electricity* | *39 / 0·015d.* | *84 / 0·026d.* | *126 / 0·349d.* | *154 / 0·185d.* |
| Wages, &c. | 39 / 0·015d. | 84 / 0·026d. | 126 / 0·349d. | 154 / 0·185d. |
| Repairs, renewals of mains, &c. | | | | |
| *Public lighting* | *634 / 0·246d.* | *976 / 0·300d.* | *11 / 0·030d.* | *26 / 0·031d.* |
| Attendance | 366 / 0·142d. | 512 / 0·158d. | 11 / 0·030d. | 26 / 0·031d. |
| Renewals | 268 / 0·104d. | 464 / 0·143d. | | |
| **MANAGEMENT AND PROPERTY CHARGES** | 1,143 / 0·444d. | 1,004 / 0·309d. | 229 / 0·634d. | 244 / 0·292d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *149 / 0·058d.* | *153 / 0·047d.* | *178 / 0·493d.* | *174 / 0·209d.* |
| *Management* | *994 / 0·386d.* | *851 / 0·262d.* | *51 / 0·141d.* | *70 / 0·084d.* |
| Salaries | 723 / 0·281d. | 526 / 0·162d. | 8 / 0·022d. | 18 / 0·022d. |
| Stationery, &c. | 72 / 0·028d. | 80 / 0·025d. | 7 / 0·019d. | 13 / 0·016d. |
| Establishment charges | 138 / 0·054d. | 139 / 0·043d. | 15 / 0·042d. | 18 / 0·022d. |
| Law charges, &c. | 61[d] / 0·024d. | 106[d] / 0·033d. | 21[b] / 0·058d. | 21[b] / 0·025d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £4,933 / 8·18% | £5,406 / 7·24% | £790 / 3·99% | £608 / 2·72% |
| Sum carried to Depreciation Fund | 1,140 / 1·89% | 1,400 / 1·87% | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 1,903 / 3·16% | 1,903 / 2·55% | 604 / 3·05% | 622 / 2·78% |
| Net interest on loans (incl. Debenture charges) | 1,889 / 3·14% | 2,103 / 2·82% | 560 / 2·83% | 532 / 2·38% |
| **BALANCE FROM LAST ACCOUNT** | — / — | — / — | −82 / 0·414% | −457 / 2·04% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — / — | — / — | — / — | — / — |
| *Deficit* | — / — | — / — | *457 / 2·31%* | *1,003 / 4·48%* |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 48·1% | 52·75% | 55·3% | 75·8% |
| Expenditure per kilowatt capacity | £6. 7s. 0d. | £6. 5s. 10d. | £4. 19s. 0d. | £9. 11s. 7d. |
| **REVENUE PER KILOWATT CAPACITY** | **£13. 4s. 0d.** | **£11. 18s. 6d.** | **£8. 18s. 10d.** | **£12. 13s. 0d.** |
| Expenditure per 8-c.p. lamp capacity | 4s. 0¾d. | 4s. 0½d. | 3s. 2d. | 6s. 1½d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | **8s. 5½d.** | **7s. 7½d.** | **5s. 8½d.** | **8s. 1½d.** |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | **5s. 11d.** | **6s. 2d.** | **4s. 1½d.** | **4s. 7½d.** |
| Price charged for lighting, per unit | 4½d.[e] | 4½d.[i] | 7d. to 3d.[c] | 7d. to 3d.[e] |
| Price charged for power, per unit | 2½d. to 1¼d.[f] [ann | 2½d. to 1¼d.[f] [glow lamps. | 3d. [ann. | 2½d. to 2d. [ann. |
| Price charged for public lighting | £18 & £14 per arc per | £21 & £14 arc; 3d. unit for | £22. 10s. per lamp per | £22. 10s. per lamp per |

**CHESTER.**—REMARKS—*a* Inclusive of 59,100 used in batteries, transformers, &c. *b* The glow lamps are of 8 c.p. *c* Over-expended. *d* To insurance *e* Less discounts up to 25 per cent. according to quantity sold. *f* By discounts according to quantity. *g* 63,257 used in batteries and transformers. *h* There are 96 10 ampere open type and 69 4 ampere enclosed arcs and 313 16 c.p. glow. *i* Less 5 per cent. discount for cash and discounts up to 15 per cent. according to quantity. *j* £9,363 on street lamps.

**STAFFORD.**—REMARKS—*a* Includes 98,748 units output of station. *b* Insurance. *c* Maximum demand system on 1-hour scale; or, alternatively, a uniform price of 5d. without meter fees. *d* Station output 235,905 units. *e* Over-expended.

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*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

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## LAMP EFFICIENCIES AND LAMP RENEWALS.

The old question of the most profitable efficiency at which to burn incandescent lamps forms the basis of a Paper read by Mr. FRANCIS W. WILLCOX at the recent meeting of the National Electric Light Association held at Niagara Falls. Although the conditions ruling on the other side of the Atlantic are in many ways far different from those prevailing on this side, there are yet some points which are evidently being discussed by the engineers of the United States that might well be considered in Great Britain. The two chief controversial points in Mr. WILLCOX's Paper relate to his recommendation of the general employment of incandescent lamps having an efficiency of 3·1 watts per candle, and to the adoption of free renewals for consumers by the central station authorities. In advocating the high efficiency lamp Mr. WILLCOX appears to look at the question from the lamp manufacturer's point of view rather than from that of the central station engineer, and his views will, in many instances not be shared by those whose business it is to supply electrical energy. For instance, after dealing with a case in which the use of a 3·5 watt lamp costs the consumer less than the 3·1 watt lamp, on account of the increased expense due to renewals in the latter instance, the author continues: "It must be noted, however, that this cost does not consider the value of the increased capacity of apparatus and lines resulting from the higher efficiency lamp," and therefore be still recommends that the higher efficiency lamp be employed, although its use is dearer in the end. Mr. WILLCOX forgets that the increased capacity of apparatus and lines is solely due to less current being supplied to the consumer, and consequently less revenue is being earned by the supply station. The supply station engineer supplies electrical energy, not light; and both his capital and revenue balance sheets are the same for a given number of kilowatts demand whether the lamps the consumer employs are on a basis of 29 or 32 lamps per kilowatt. A general increase in the efficiency of the lamps connected to his mains is simply a decrease in load, the revenue being diminished at the same time as the expenditure, and of course the reduction of standing charges would be in a smaller proportion than the reduction of load. We admit that, just as it is eventually to every tradesman's interest to increase the extent of his

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business as much as possible, the supply station manager should do all in his power to popularise the electric light. By all means then, let him encourage the use of high efficiency lamps so long as the net result is increased cheapness of light. But to use high-efficiency short-life lamps when the actual lighting bill is not diminished, does not tend to the greatest happiness of the greatest number, as although the lamp manufacturer will benefit by it the output from the station is diminished, less revenue is earned, and consequently the price of current must be raised. In reply to a question Mr. WILLCOX acknowledged that the limit of regulation for a 3·1 watt lamp should be 2 to 3 per cent. We doubt, therefore, if the majority of stations either in America or England regulate sufficiently well to meet Mr. WILLCOX's demands.

The reason for recommending this particular efficiency of 3·1 watts per candle is not given; but a calculation is made which shows that it is the most economical when the cost of electrical energy is above 3½ cents per kilowatt-hour, so, presumably, this is the highest efficiency lamp which the author considers satisfactory. This calculation is based on the assumption that the lamp is to be put out of use when it gives 80 per cent. of its original light, and on some figures for life which it may be presumed are laboratory tests at constant pressure. These are, for a 110 volt 16 c.p. lamp, 450 hours at 3·1 watts per candle, 800 hours at 3·5 watts per candle, and 1,600 hours at 4·0 watts per candle; but on ordinary supply mains the life of the lamps would be much shorter. This is borne out by other curves Mr. WILLCOX gives, from which it would appear that, taking an excess pressure of 4 per cent., the life of the lamp is abbreviated by more than 50 per cent. Theoretically, therefore, it would be very easy in every individual supply system to work out the best grade of lamp to use, but practically it is a very difficult problem. The custom of charging for current on the maximum demand system, which is becoming more and more prevalent, helps to complicate matters, as lamps which are used for long hours consume current at a cheaper rate than the lamps which are used for short periods. Obviously, it would appear to be better to instal lower efficiency lamps for those burning long hours than for the others which are only alight for short periods, more especially if this is during the peak of the load. It is thus a matter of equal benefit to supplier and consumer that the high efficiency lamp should be utilised in situations where it is only required at the maximum load. But yet another circumstance has to be taken into account, namely, that the long-burning lamps are also alight during the peak, and therefore the maximum demand would be further lessened by using the high efficiency lamp in these cases also. Practically, with the maximum demand system, it might be advantageous for different consumers to employ different grade lamps according to the average price per unit they have to pay; it would hardly be worth while, however, for a consumer to employ different lamps for long and short hours.

The custom of supplying incandescent lamps to consumers free of charge has been tried to a certain degree in England, but it has not been taken up to any great extent. Mr. WILLCOX remarks:—"Lighting results are directly dependent upon the lamp. All lamps lose in candle-power as they burn; some makes to a much greater extent than others. If lamps are not renewed, therefore, the lighting service must certainly deteriorate just as the lamp does. Extensive experience shows that few, if any, customers ever renew their lamps when charged therefor, except when they are burned out. We see, therefore, that as long as the central stations charge for lamps, deterioration in lighting service cannot be properly repaired." This is a grave indictment against the public. There is no doubt a certain class of consumers who do not trouble to change their lamps, but in England the vast majority of householders renew them when the futility of using old lamps has once been pointed out. The pioneer electricity supply works to introduce free supply in England was Bradford. In that instance, which we believe has formed the model for other towns in this country, the lamps were delivered to the consumer at the works in number according to the amount of energy he had used. This method treated the customer as a reasoning individual, and we feel sure Mr. WILLCOX's system—("the customer has only to turn the switch and pay the bill; all other details the station cares for")—would be impossible in Great Britain, where every man's house is his castle. It is almost a grievance that the meter man should have entry, and the new-lamps-for-old man would hardly be more welcome. Rather too much has always been made of the question of the wastefulness of old lamps. The difference between the actual watts consumed by an old lamp and a new one need not trouble the consumer. It is rational for him to assume that the consumption is the same in the two cases. He sees that he gets less light in his old lamp, consequently he realises that he pays the same money for less light, and he replaces the lamp by a new one which burns brighter. Electric lighting is not now such a novelty that a sensible consumer has not been taught this much. A free lamp system should either be based on the Bradford principle or on the still simpler one, suitable for smaller towns, of giving the consumer a new lamp if he brings a sufficiently old one in exchange for it.

## THE ELEMENTS OF THREE-PHASE THEORY.

BY ALEXANDER RUSSELL, M.A.

In the following articles several fundamental theorems in connection with three-phase theory have been discussed, and solutions have been arrived at without the necessity of making assumptions as to the shape of the E.M.F. waves generated by the machines. The infinite variety of these shapes and the fact that when a three-phaser is unsymmetrically loaded the waves of P.D. between pairs of terminals must all be of different shapes, makes the assumption of sine E.M.F.s quite inadmissible. There are several exact formulæ in three-phase theory familiar to practical men—for example, the formulæ for measuring power—but there are several containing $\sqrt{3}$ which they regard with suspicion. It is hoped that the following discussion may clear up some of those difficulties; and, although only elementary problems are considered, yet there are many obvious extensions of them which may prove useful in practice. As it is important that the foundations should be thoroughly examined before we begin to build on them, I have given mathematical proofs of the theorems in this Paper. The graphical constructions, however, can be understood by any engineer who knows the elementary theory of alternating currents and what a three-phase machine is supposed to do.*

The following is a list of the problems considered:—I. The magnitudes and the phase differences of the P.D.s between the mains in three-phase systems. II. The graphical representation of the voltages in the three arms of the load (star winding). III. The potentials to earth of the mains. IV. Diagram of the currents in a mesh winding. V. The measurement of power in three-phase circuits. VI. Miscellaneous theorems.

I. The Magnitudes and the Phase Differences between the Mains in Three-phase Systems.—Let $v_1$ = the potential of No. 1 main. Let $v_2$ = the potential of No. 2 main. Let $v_3$ = the potential of No. 3 main.

* See "Polyphase Electric Currents and Alternate-Current Motors," by Dr. Silvanus Thompson.

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Let also $v_{1\cdot2} = v_1 - v_2$ = the P.D. between mains 1 and 2,
$v_{2\cdot3} = v_2 - v_3$ = the P.D. between mains 2 and 3,
$v_{3\cdot1} = v_3 - v_1$ = the P.D. between mains 3 and 1.

Then, obviously,

$$v_{1\cdot2} + v_{2\cdot3} + v_{3\cdot1} = 0,$$
$$\therefore \quad v_{1\cdot2} = -v_{2\cdot3} - v_{3\cdot1},$$
$$\therefore \quad v^2_{1\cdot2} = v^2_{2\cdot3} + v^2_{3\cdot1} + 2v_{2\cdot3}v_{3\cdot1}.$$

If $V_{1\cdot2}$ equals the effective voltage between the mains 1 and 2, and $V_{2\cdot3}$ and $V_{3\cdot1}$ have corresponding values, then, by summation,

$$\left.\begin{aligned} &V^2_{1\cdot2} = V^2_{2\cdot3} + V^2_{3\cdot1} + 2V_{2\cdot3}V_{3\cdot1}\cos\alpha. \\ \text{Similarly,}\quad &V^2_{2\cdot3} = V^2_{3\cdot1} + V^2_{1\cdot2} + 2V_{3\cdot1}V_{1\cdot2}\cos\beta, \\ \text{and}\quad &V^2_{3\cdot1} = V^2_{1\cdot2} + V^2_{2\cdot3} + 2V_{1\cdot2}V_{2\cdot3}\cos\gamma, \end{aligned}\right\} \quad . \quad . \quad (1)$$

where $\alpha$ is the angle of phase difference between $V_{2\cdot3}$ and $V_{3\cdot1}$ and $\beta$ and $\gamma$ have corresponding meanings.

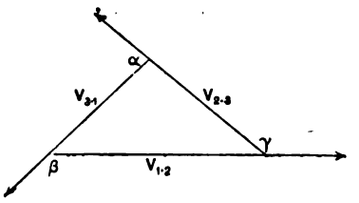


FIG. 1.

Now, if we construct a triangle (Fig. 1) whose sides are of lengths $V_{1\cdot2}$, $V_{2\cdot3}$, and $V_{3\cdot1}$ respectively, then by trigonometry we see that $\alpha$, $\beta$ and $\gamma$ are the exterior angles of this triangle which are opposite the sides $V_{1\cdot2}$, $V_{2\cdot3}$, and $V_{3\cdot1}$ respectively.

Given, then, the three P.D.s between the mains we get the phase differences by simply constructing a triangle whose sides are proportional to these three P.D.s respectively. All the formulæ for the trigonometry of a triangle can now be applied. For example:

$$\frac{V_{1\cdot2}}{\sin\alpha} = \frac{V_{2\cdot3}}{\sin\beta} = \frac{V_{3\cdot1}}{\sin\gamma}. \quad . \quad . \quad . \quad . \quad (2)$$

**II. The Graphical Representation of the Voltages in the Three Arms of the Load (Star-winding).**—Let 1, 2, and 3 be the

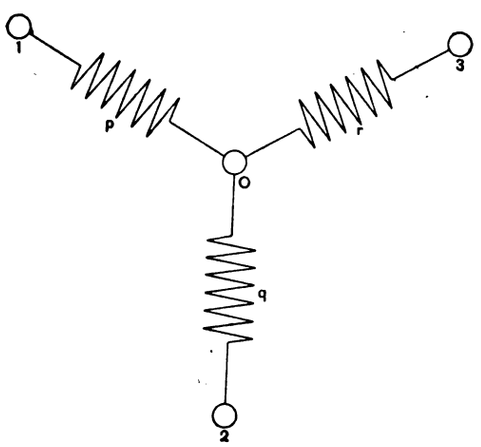


FIG. 2.

three mains, and let 0 be the centre of the star winding. If $p$, $q$, and $r$ be the resistances of the three arms (non-inductive) and $e_1$, $e_2$, and $e_3$ be the P.D.s across the arms, then, since by Kirchhoff's law the algebraical sum of the currents at 0 must be zero, we have

$$\frac{e_1}{p} + \frac{e_2}{q} + \frac{e_3}{r} = 0.$$

Hence, as before,

$$\frac{E^2_1}{p^2} = \frac{E^2_2}{q^2} + \frac{E^2_3}{r^2} + \frac{2E_2E_3}{qr}\cos\theta_{2\cdot3}, \quad . \quad . \quad . \quad (1)$$

and two similar equations where $E_1$ is the voltage across the arm 10, and $\theta_{2\cdot3}$ is the angle of phase difference between $e_2$ and $e_3$.

We see, as in the last theorem, that $E_1/p$, $E_2/q$, and $E_3/r$ form a triangle whose exterior angles are $\theta_{2\cdot3}$, $\theta_{3\cdot1}$, and $\theta_{1\cdot2}$ respectively. These angles can, therefore, be easily found when $E_1$, $E_2$, $E_3$, $p$, $q$, and $r$ are known.

It follows by geometry that

$$\theta_{1\cdot2} + \theta_{2\cdot3} + \theta_{3\cdot1} = 360°. \quad . \quad . \quad . \quad . \quad (2)$$

It also follows by the "rule of sines" in trigonometry that

$$\frac{E_1}{p\sin\theta_{2\cdot3}} = \frac{E_2}{q\sin\theta_{3\cdot1}} = \frac{E_3}{r\sin\theta_{1\cdot2}}. \quad . \quad . \quad . \quad (3)$$

From any point O (Fig. 3) draw OL equal to $E_1$. Make the angle LON equal to $\theta_{3\cdot1}$, and make ON equal to $E_3$. Make the angle NOM equal to $\theta_{2\cdot3}$, and OM equal to $E_2$. Then by (2) the angle LOM equals $\theta_{1\cdot2}$.

Now,
$$v_{1\cdot2} = v_1 - v_2 = e_1 - e_2,$$
$$\therefore V^2_{1\cdot2} = E^2_1 + E^2_2 - 2E_1E_2\cos\theta_{1\cdot2}. \quad . \quad . \quad (4)$$
$$= LM^2 \text{ in Fig. 3.}$$

Therefore LM equals $V_{1\cdot2}$. Similarly, MN and NL equal $V_{2\cdot3}$ and $V_{3\cdot1}$ respectively. Hence the triangle LMN is the voltage triangle already found (Fig. 1).

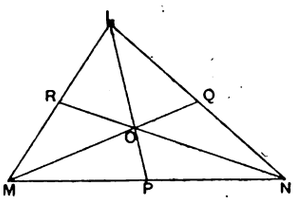


FIG. 3.

Produce LO, MO, and NO to cut the sides of the triangle in P, Q, and R respectively.*

Then,
$$\frac{MP}{PN} = \frac{OM\sin MOP}{ON\sin NOP},$$
$$= \frac{E_2\sin\theta_{1\cdot2}}{E_3\sin\theta_{3\cdot1}},$$
$$= \frac{q}{r} \text{ from (3).}$$

Similarly,
$$\frac{NQ}{QL} = \frac{r}{p} \text{ and } \frac{LR}{RM} = \frac{p}{q}.$$

It follows from these relations that O is the centre of gravity of three particles of masses $1/p$, $1/q$, and $1/r$ placed at L, M, and N respectively.

*Rule for finding the Voltages across the Arms of a Star-box when the Resistances of the Arms are given.*—Construct a triangle LMN the length of whose sides represent the voltages between the mains. Find the centre of gravity O of masses $1/p$, $1/q$, and $1/r$ placed at L, M, and N. Then OL equals $E_1$, the voltage across the terminals of $p$, OM equals $E_2$, and ON equals $E_3$. The angles LOM, MON, and NOL give the angles of phase difference between the various voltages, and, therefore, since the arms are non-inductive between the currents in the arms. The supplements of the angles of the triangle LMN give the angles of phase difference between the voltages represented by the sides of the triangle.

*Algebraical Formula for finding the Angles of the Voltage Triangle.*—In practice the voltages between the mains are nearly equal. In this case, if the voltages be V, $V + xV$ and $V + yV$, we can find the angles of the triangle in degrees by the formulæ $60 - 33(x + y)$; $60 + 33(2y - x)$; $60 + 33(2x - y)$.

*Example.*—Suppose the P.D.s between the mains are 2,000, 2,060 and 2,140 volts respectively. By the formulæ the angles of the voltage triangle are 56·7, 59·7 and 63·6deg. respectively. Their true values are 56·6, 59·6 and 63·8deg. The supplements of these angles will give the phase differences between the three voltages.

* See also a Paper on the equivalence of triangles and stars in conducting networks, by A. E. Kennelly. (*Electrical World and Engineer*, 34 pp., 413-414.)

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*The Voltages in a Star-box Adjust themselves so that the energy Expended in it is a Minimum.*—Since O (Fig. 3) is the centre of gravity of masses $1/p$, $1/q$ and $1/r$ placed at L, M and N, it follows that the moment of inertia of these masses about an axis through O perpendicular to the plane of the paper is less than their moment of inertia about any other parallel axis, hence

$$\frac{OL^2}{p}+\frac{OM^2}{q}+\frac{ON^2}{r}$$

is a minimum.

Since $p$, $q$ and $r$ are non-inductive, this expression represents the energy being expended in the star-box.

*Algebraical Relations between the various Voltages.*—Since

$$\frac{e_1}{p}+\frac{e_2}{q}+\frac{e_3}{r}=0,$$

$$\therefore\ e_1\left(\frac{1}{p}+\frac{1}{q}+\frac{1}{r}\right)=\frac{v_{1\cdot2}}{q}-\frac{v_{3\cdot1}}{r}.$$

Hence, squaring and adding,

$$E^2_1\left(\frac{1}{p}+\frac{1}{q}+\frac{1}{r}\right)^2=\frac{V^2_{1\cdot2}}{q^2}+\frac{V^2_{3\cdot1}}{r^2}-\frac{2V_{1\cdot2}V_{3\cdot1}\cos\beta}{qr}.$$

Therefore, by I. (1)

$$=\left(\frac{V^2_{1\cdot2}}{q}+\frac{V^2_{3\cdot1}}{r}\right)\left(\frac{1}{q}+\frac{1}{r}\right)-\frac{V^2_{2\cdot3}}{qr}. \quad . \quad (5)$$

We can write down two similar equations by symmetry. Similarly,

$$\frac{V^2_{1\cdot2}}{pq}=\left(\frac{E^2_1}{p}+\frac{E^2_2}{q}\right)\left(\frac{1}{p}+\frac{1}{q}\right)-\frac{E^2_3}{r^2}, \quad . \quad . \quad (6)$$

and two other symmetrical equations. Hence, also,

$$\left(\frac{E^2_1}{p}+\frac{E^2_2}{q}+\frac{E^2_3}{r}\right)\left(\frac{1}{p}+\frac{1}{q}+\frac{1}{r}\right)=\frac{V^2_{1\cdot2}}{pq}+\frac{V^2_{2\cdot3}}{qr}+\frac{V^2_{3\cdot1}}{rp}. \quad (7)$$

It follows that if $p$, $q$ and $r$ are all equal, then,

$$V^2_{1\cdot2}+V^2_{2\cdot3}+V^2_{3\cdot1}=3(E^2_1+E^2_2+E^2_3). \quad . \quad (8)$$

If, in addition, $V_{1\cdot2}=V_{2\cdot3}=V_{3\cdot1}$,

then, $$V_{1\cdot2}=\sqrt{3}E_1. \quad . \quad . \quad . \quad . \quad (9)$$

We here come across $\sqrt{3}$, and it is to be noted that no assumption has been made as to the shape of the waves of E.M.F.

**III. The Potentials to Earth of the Mains.**—Let $v_1$, $v_2$ and $v_3$ be the potentials of the three mains, and let $f_1$, $f_2$ and $f_3$ be their fault resistances to earth, then, since the sum of the currents to earth must be zero,

$$\frac{v_1}{f_1}+\frac{v_2}{f_2}+\frac{v_3}{f_3}=0.$$

Proceeding as before, we see that if O is the centre of gravity of masses $1/f_1$, $1/f_2$ and $1/f_3$, placed at the angles L, M and N of the voltage triangle, then OL, OM and ON represent $V_1$, $V_2$ and $V_3$ respectively in magnitude and phase.

*It follows, also, that if the fault resistances of the mains vary, then their potentials adjust themselves so that the energy expended in leakage currents is a minimum.*

*To find the Potential of the Centre of a Star-box.*—Let $p$, $q$ and $r$ be the resistances of the arms of a star-box, and let $x$ be the potential of the centre. Then

$$\frac{v_1-x}{p}+\frac{v_2-x}{q}+\frac{v_3-x}{r}=0.$$

$$\therefore\ x\left(\frac{1}{p}+\frac{1}{q}+\frac{1}{r}\right)=\frac{v_1}{p}+\frac{v_2}{q}+\frac{v_3}{r}.$$

Now, as the P.D. waves have different shapes a little consideration will show that the frequency of the alternating potential $x$ is an unknown quantity.

If V denote the effective value of $x$, then

$$V^2\left(\frac{1}{p}+\frac{1}{q}+\frac{1}{r}\right)^2=\frac{V^2_1}{p^2}+\ldots\ +2\frac{V_2V_3}{qr}\cos\phi_{2\,3}+\ldots \quad (1)$$

Also,

$$\frac{V^2_1}{f^2_1}=\frac{V^2_2}{f^2_2}+\frac{V^2_3}{f^2_3}+2\frac{V_2V_3}{f_2f_3}\cos\phi_{2\,3},$$

and two similar equations.

By means of these equations we can eliminate the cosines from (1), we get finally

$$V^2\left(\frac{1}{p}+\frac{1}{q}+\frac{1}{r}\right)^2=\frac{V^2_1}{f^2_1}\left(\frac{f_1}{p}-\frac{f_2}{q}\right)\left(\frac{f_1}{p}-\frac{f_3}{r}\right)+\frac{V^2_2}{f^2_2}\left(\frac{f_2}{q}-\frac{f_3}{r}\right)\left(\frac{f_2}{q}-\frac{f_1}{p}\right)+\frac{V^2_3}{f^2_3}\left(\frac{f_3}{r}-\frac{f_1}{p}\right)\left(\frac{f_3}{r}-\frac{f_2}{q}\right).$$

If $f_1/p=f_2/q=f_3/r$, $x$ is always zero and V is, of course, also always zero. Hence, if the centre of a star-box is at zero potential, the fault resistances of the mains are proportional to the resistances of the arms.

**IV. Diagram of the Currents in a Mesh Winding.**—Let $a_1$, $a_2$, and $a_3$ be the instantaneous values of the currents in the mains, and let $i_1$, $i_2$ and $i_3$ be the currents in the mesh windings. The arrow heads are drawn pointing round the same way, so

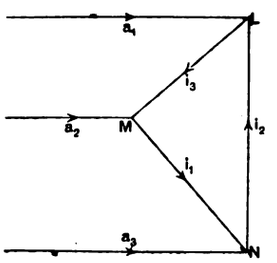


FIG. 4.

as to get algebraical symmetry in our equations. At any instant, however, one or two of the expressions $i_1$, $i_2$ and $i_3$ must be negative.

From the figure we see that

$$a_1=i_3-i_2,\quad a_2=i_1-i_3,\quad a_3=i_2-i_1. \quad . \quad . \quad (1)$$

Hence, $$a_1+a_2+a_3=0.$$

Proceeding exactly as in § I. we see that $A_1$, $A_2$ and $A_3$ form a triangle (Fig. 5), the exterior angles of which give the phase differences between the three vectors.

Again, if $r_1$, $r_2$ and $r_3$ be the resistances of the arms MN, NL and LM in Fig. 4, then, if they are non-inductive,

$$r_1i_1=v_2-v_3,$$
$$r_2i_2=v_3-v_1,$$
$$r_3i_3=v_1-v_2,$$
$$\therefore\ r_1i_1+r_2i_2+r_3i_3=0. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

We have supposed the three arms of the load non-inductive, but equation (2) is also true in other cases. Suppose, for

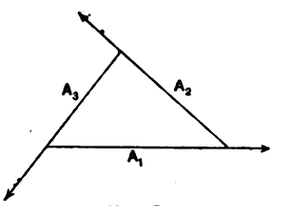


FIG. 5.

example, that the three arms of the load are the primary coils of a three-phase transformer, each of which contains the same number of turns $n$, then

$$r_1i_1+n\frac{dN_1}{dt}=v_2-v_3, \text{ \&c.},$$

where $N_1$ is the magnetic flux in the first limb of the transformer.

Then $$r_1i_1+r_2i_2+r_3i_3+n\frac{d}{dt}(N_1+N_2+N_3)=0.$$

If there be no magnetic leakage, $N_1+N_2+N_3$ must equal nothing, since the lines of induction are closed curves, therefore, as before, $$r_1i_1+r_2i_2+r_3i_3=0.$$

Hence, as in § I., $$\frac{r_1I_1}{\sin\theta_{2\cdot}}=\frac{r_2I_2}{\sin\theta_{3\cdot1}}=\frac{r_3I_3}{\sin\theta_{1\cdot2}}, \quad . \quad . \quad . \quad (3)$$

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where $\theta_{2\cdot3}$ is the angle of phase difference between $I_2$ and $I_3$. If $r_1I_1$, $r_2I_2$ and $r_3I_3$ represent forces acting at a point O equations (3) show that they will be in equilibrium.

Now it is known from statics that O is the centre of gravity of three equal masses placed at the extremities of $r_1I_1$, $r_2I_2$ and $r_3I_3$ respectively. Hence O will also be the centre of gravity of masses proportional to $r_1$, $r_2$ and $r_3$ placed at the extremities of lines equal in length to $I_1$, $I_2$ and $I_3$ respectively.

Now, from (1) $A^2_1 = I^2_3 + I^2_2 - 2I_3I_2\cos\theta_{2\cdot3}$.

If we draw, therefore, from O (Fig. 6) lines proportional to $I_1$, $I_2$ and $I_3$ and inclined to one another at angles $\theta_{2\cdot3}$, $\theta_{3\cdot1}$ and $\theta_{1\cdot2}$ we see that the lines joining the extremities of these lines give us $A_1$, $A_2$ and $A_3$ respectively. Hence the triangle is the same triangle as in Fig. 5.

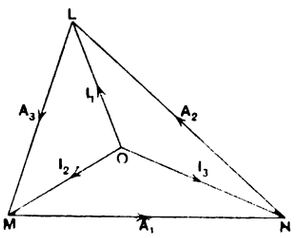


FIG. 6.

Knowing the currents in the mains and the resistances of the arms of the mesh winding we can find the currents in the arms by the following construction :—

*Make a triangle LMN whose sides are equal to $A_1$, $A_2$ and $A_3$ respectively. Find the centre of gravity O of masses $r_1$, $r_2$ and $r_3$ placed at L, M and N. Then OL will give $I_1$, OM will give $I_2$ and ON will give $I_3$.*

Again, if in Fig. 6 we produce OL to L', &c., so that $OL' = r_1 . OL$, $OM' = r_2 . OM$, and $ON' = r_3 . ON$, then if the resistances are non-inductive L'M'N' is the triangle giving the voltages between the mains, and OL', OM' and ON' give the voltages to the centre of the star winding.

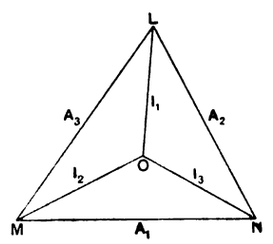


FIG. 7.

We can prove, as in § II., the following algebraical relations between the currents :

$$r_2r_3A^2_1 = (r_2I^2_2 + r_3I^2_3)(r_2 + r_3) - r^2_1I^2_1, \quad . \quad . \quad (4)$$

and two symmetrical equations. Similarly,

$$(r_1 + r_2 + r_3)^2I^2_1 = (r_2A^2_3 + r_3A^2_2)(r_2 + r_3) - r_2r_3A^2_1, \quad (5)$$

and two symmetrical equations. Hence, also

$$(I^2_1r_1 + I^2_2r_2 + I^2_3r_3)(r_1 + r_2 + r_3) = A^2_1r_2r_3 + A^2_2r_3r_1 + A^2_3r_1r_2. \quad . \quad (6)$$

The case when $r_1$, $r_2$ and $r_3$ are all equal is important. O (Fig. 7) is now the centre of gravity of the triangle LMN. Hence, from geometry or from equations (4) and (5) above,

$$A^2_1 = 2(I^2_2 + I^2_3) - I^2_1, \text{ &c.}, \quad . \quad . \quad . \quad (7)$$

$$9I^2_1 = 2(A^2_2 + A^2_3) - A^2_1, \text{ &c.} \quad . \quad . \quad . \quad (8)$$

Also, from (6),

$$A^2_1 + A^2_2 + A^2_3 = 3I^2_1 + 3I^2_2 + 3I^2_3. \quad . \quad . \quad . \quad . \quad . \quad (9)$$

And the curious theorem is also true, that

$$A^4_1 + A^4_2 + A^4_3 = (3I^2_1)^2 + (3I^2_2)^2 + (3I^2_3)^2. \quad . \quad . \quad (10)$$

When the currents in the mains are all equal,

$$A = \sqrt{3} . I. \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

It is to be noted that these formulæ are perfectly general, no assumptions having been made as to the shape of the wave.

When we have a star winding the currents in the branches are, of course, equal to the currents in the mains. Their phase differences can be got by constructing a triangle whose sides are proportional to the currents. The exterior angles of this triangle are the phase differences required.

If we have both a star and mesh winding the graphical representation of all the currents by a figure drawn in one plane is rarely possible.

**V. The Measurement of Power in Three-phase Circuits.**—Suppose that there is both a mesh and a star winding as in Fig. 8. Let $a_1$, $a_2$ and $a_3$; $i_1$, $i_2$ and $i_3$; $i_x$, $i_y$ and $i_z$ be the instantaneous values of the currents in the mains, in the mesh winding and in the star winding respectively.

Then
$$\left.\begin{aligned} a_1 &= i_3 - i_2 + i_x \\ a_2 &= i_1 - i_3 + i_y \\ a_3 &= i_2 - i_1 + i_z \end{aligned}\right\}$$

$$\therefore \quad a_1 + a_2 + a_3 = i_x + i_y + i_z = 0.$$

Let $w$ be the instantaneous value of the watts, then

$$w = v_{1\cdot2}i_3 + v_{2\cdot3}i_1 + v_{3\cdot1}i_2 + v_1i_x + v_2i_y + v_3i_z.$$

Now, $v_{3\cdot1} = -v_{1\cdot2} - v_{2\cdot3}$,

and $i_y = -i_x - i_z$;

also $v_1 - v_2 = v_{1\cdot3}$.

$$\therefore \quad w = v_{1\cdot2}(i_3 - i_3 + i_x) + v_{3\cdot2}(i_2 - i_1 + i_z)v_y \quad . \quad (1)$$

$$= v_{1\cdot2}a_1 + v_{3\cdot2}a_3$$

By symmetry $$= v_{2\cdot3}a_2 + v_{1\cdot3}a_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$= v_{3\cdot1}a_3 + v_{2\cdot1}a_2$$

Similarly, $$w = v_1a_1 + v_2a_2 + v_3a_3. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The formulæ (2) and (3) give the ordinary methods of measuring power in three-phase circuits.

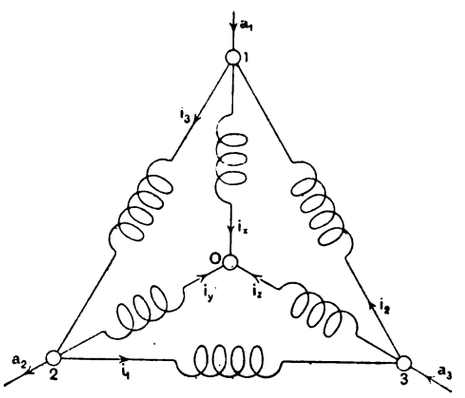


FIG. 8.

The first method is to use two wattmeters. The ampere coil of one of them is put in the main $a_1$ and the volt coil is connected across 1 and 2. The ampere coil of the other is put in the main $a_3$ and the volt coil is connected across 3 and 2. Suppose that $w_1$ is the reading on one meter and that $w_2$ is the reading on the other, and suppose that $w_1$ is greater than $w_2$. Then the watts given to the circuit are $w_1 \pm w_2$. If the phase difference between $a_3$ and $v_{3\cdot2}$ is less than 90deg., $w_2$ is positive, but if greater than 90deg. $w_2$ is negative. It is easy to find out experimentally whether $w_2$ is positive or negative.

The second method is to use three wattmeters, their ampere coils being put in the main circuits and their volt coils across 0 and 1, 0 and 2 and 0 and 3 respectively.

These methods also apply when the windings are as in Fig. 9, where 1, 2 and 3 are the terminals for the mains.

Let $e_1$, $e_2$ and $e_3$ denote the P.D.s between 1 and L, 2 and M and 3 and N respectively.

Then
$$w = e_1a_1 + e_2a_2 + e_3a_3 + v_{LM}a_1 + v_{NM}a_3,$$
$$= (e_1 - e_2 + v_{LM})a_1 + (e_3 - e_2 + v_{NM})a_3,$$
$$= v_{1\cdot2}a_1 + v_{3\cdot2}a_3 \text{ as before.}$$

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Similarly, $w = e_1a_1 + e_2a_2 + e_3a_3 + v_{LO}a_1 + v_{MO}a_2 + v_{NO}a_3,$
$= v_1a_1 + v_2a_2 + v_3a_3.$

It is to be noted that if all the mains are equally loaded, one meter is sufficient. If the volt coil be connected across two of the mains we multiply the reading by 2. If it be connected from one main to the centre of the system then the multiplying factor is 3.

An important case is when the volt coil of the meter forms one of the arms of a star-box. If the three arms are of equal resistance, the multiplying factor is 3. If, however,

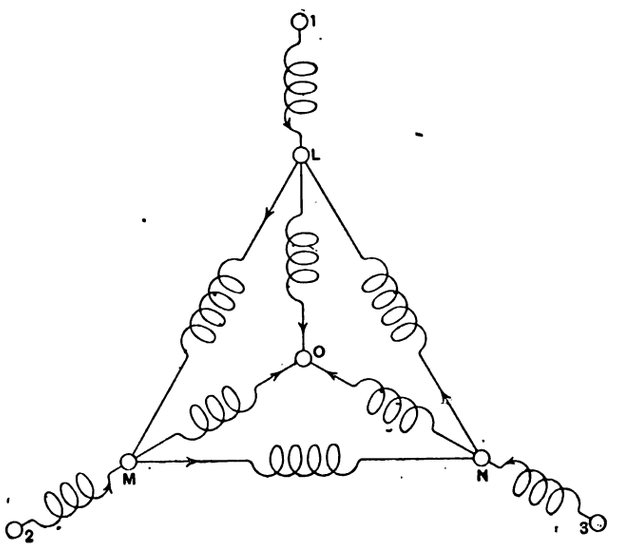


FIG. 9.

as is often the case in practice the resistance of the volt coil be different from that of the other two arms, then it is known that the multiplying factor is $2+\frac{r}{R}$ where R is the resistance of the volt coil and $r$ that of either of the other arms of the box.

This formula can be easily proved by means of §II. above. Let ABC (Fig. 10) be the voltage triangle. Then if O be the centre of gravity of masses $1/R$, $1/r$ and $1/r$ placed at A, B

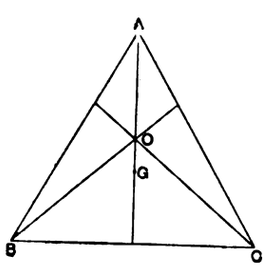


FIG. 10.

and C respectively, OA, OB and OC will be the three P.D.s to the centre of the star box.

Also by II. (5)

$$OA^2\left(\frac{1}{R}+\frac{1}{r}+\frac{1}{r}\right)^2=\left(\frac{CA^2}{r}+\frac{AB^2}{r}\right)\left(\frac{1}{r}+\frac{1}{r}\right)-\frac{BC^2}{r};$$

$$\therefore OA^2\left(2+\frac{r}{R}\right)^2=3\,.\,AB^2=9\,.\,GA^2,$$

where G is the centre of gravity of the triangle ABC;

$$\therefore\ 3\frac{GA}{OA}=2+\frac{r}{R}.$$

Now, if the arms had been equal GA would be the P.D. across the volt coil. Hence the required multiplying factor is $\frac{3GA}{OA}$, and this we have shown equals $2+\frac{r}{R}$.

VI. Miscellaneous Theorems.—It can be shown mathematically that if we take a point O within a triangle LMN (Fig. 11), then OL + OM + ON is a minimum when the angles LOM, MON and NOL are each equal to 120deg., provided, of course, that no angle of the triangle is equal to or greater than 120deg. If one angle of the triangle is equal to or greater than 120deg., then to make OL + OM + ON a minimum O must coincide with this angle. It follows, therefore, from Fig. 3, that the sum of the three voltages across the arms of a star box is a minimum when their phase differences are each equal to 120deg. In this case by the formula, II. (3) the currents in the arms are all equal to one another.

*To find the Resistances of the Arms of a Star-box in order to get Symmetrical Three-phase Currents.*—Describe the voltage triangle LMN. On each side describe a segment of a circle which will contain an angle of 120deg. Let O be the point of intersection of the three circles. Produce LO to cut MN in P, then the ratio of MP to PN will be the ratio of the resistances $q$ and $r$ in the desired box.

*To find the Ratio of the Resistances in the Star Winding in order that the Voltages to the centre may be equal.*

In this case $E_1 = E_2 = E_3$ and O is therefore the centre of the circumscribing circle. Let A, B and C be the angles of the voltage triangle, then

$$\theta_{2\cdot3} = 2A, \text{ \&c.}$$

Also, II. (3)

$$\frac{E_1}{p \sin \theta_{3\cdot3}} = \frac{E_2}{q \sin \theta_{3\cdot1}} = \frac{E_3}{r \sin \theta_{1\cdot2}}.$$

Hence $p \sin 2A = q \sin 2B = r \sin 2C.$

Fairly obvious extensions of the above theorems suggest themselves in many cases. It is hoped that some of them

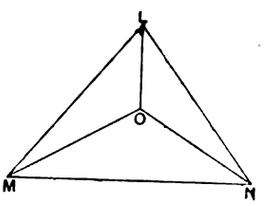


FIG 11.

may prove the stepping stones to improved methods of measurement or more efficient working arrangements. The author has found that the equations (V., 2 and 3) for the electrical methods of measuring power in three-phase circuits, when interpreted geometrically, give rise to numerous interesting and novel theorems connected with the trigonometry of a triangle. Some of these theorems, derived from obvious electrical considerations concerning the power wasted in ironless chokers, are exceedingly difficult to prove mathematically. Similarly, the equations for the measurement of power in a star connected two-phase system give rise to several curious theorems concerning the geometry of a tetrahedron.

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Long Telephone Wire Span.—According to the *Telephone Magazine* of Chicago the American Telephone and Telegraph Co. has erected across the Connecticut river 20 wires for its long-distance telephone service between New York and Boston. The span is 1,300ft. between towers on the two sides of the river. The wires are made of a composition called "phono-electric," possessing a tensile strength of 82,000lb. per sq. in. and conductivity of about 50 per cent. that of pure copper. In such a case strength is more important than a low resistance. The wires are placed 10 on an arm about 1ft. apart and are insulated by saddle-shaped insulators. It was necessary to string all these wires at equal tension to avoid their crossing in windy weather. To obtain this equal tension each wire is fastened to an iron bolt $\frac{5}{8}$in. in diameter and about 20in. long.



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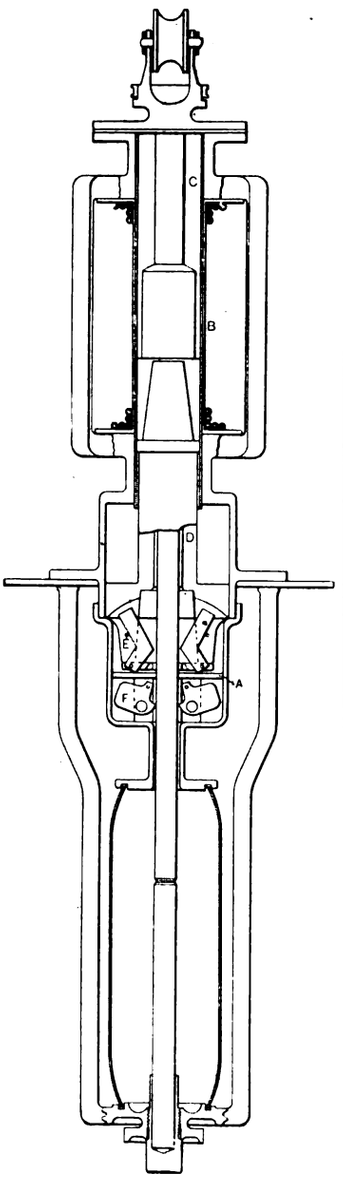
## THE "ARK" LAMP.

By the kindness of the makers, Messrs. Johnson and Phillips, we are enabled to give a short description of the construction of the "Ark" enclosed long-burning lamp, referred to recently in our description of the electric supply system at East Ham, which is one of the many places where it is employed. As will be seen from the figure there is no upper carbon holder, and contact is made directly on to the carbon. The contact device consists of four pieces of copper of special section, which are connected by pins to the contact frame (A). There are no springs or any similar contrivances, the contact pieces merely resting against the positive carbon by gravity.

On current passing through the solenoid (B), which is placed inside the lamp frame casting, which carries the fixed internal pole piece (C), the armature is raised slightly, causing the four clutch cams, which are connected to the armature (D) by the pins (E), to grip and raise the carbon, thus striking the arc. The armature descends as the carbon is consumed, thus releasing the grip of the clutch cams on the positive carbon, and allowing it to slide through and feed. The contact pieces (F) are placed inside and at the bottom of the dashpot, and when the carbons have burnt down to a certain point they automatically cut the lamp out of circuit. The body or frame of the lamp is in one piece, and great strength and rigidity is thereby secured. The whole lamp is of very solid and durable construction, with simplicity carried to a degree that can only be realised by an inspection of the lamp itself, and incidentally this feature enables the lamp to be produced cheaply. The trimming is very simply and easily performed.




THE "ARK" LAMP (¼ full size).

## COAL AND ASH CONVEYING GEAR.*

BY R. A. CHATTOCK.
(City Electrical Engineer, Bradford.)

The question of dealing with coal used in electric generating stations is one of the most important that presents itself to the electrical engineer, and of almost as much importance is the question of disposing of the ashes that are produced by the boilers. Taking the average of a number of works, the cost of the coal works out at 0·71d. per unit, and this represents 46·6 per cent. of the average works cost per unit. In a station producing 5,000,000 units per annum this means an expenditure of £14,791 per annum, or, at an average rate of 12s. per ton, a consumption of 24,652 tons per annum. The cost of conveying and handling this coal varies between very wide limits, according to the distance it has to be taken, the height to which it has to be raised, and the means at disposal. As a rule coal contracts are drawn up to include the cost of cartage into the generating station, and it is consequently somewhat difficult to give an exact figure for this item. A charge of 6d. per ton for cartage from an ordinary railway siding for a distance of half a mile is, however, a fair estimate. This represents an annual cost of about £616 on the above quantity of coal.

If it is possible to put in a conveying apparatus that will take the coal direct from a railway or water siding and deliver it to the generating station, and if the annual charge on this, represented by, say, 10 per cent. on the prime cost of the apparatus, does not exceed the above amount, it is certainly worth while to adopt this principle. If, however, the distance is great between the siding and the station, and the cost of the apparatus excessive, it is better to have the coal carted to the generating station and distributed in the coal bunkers by means of a local conveying apparatus. Horse traction for cartage purposes is a very unreliable means, especially in winter time when the frost is on the ground, and when it is very important that there should be no interference with deliveries, and on this account, and also that the cartage may be under the direct control of the station engineer, a more reliable means should be provided. This may be effected by means of motor-driven trolleys, each capable of holding about 5 tons, so constructed that they can be backed under the coal drops of a railway siding or under the cranes used to unload a barge, and arranged so that they can be tipped into convenient hoppers in the generating station. Such vehicles can travel at a speed of 8 miles an hour, and when not used for coaling purposes they can be utilised for conveying cable drums or other heavy gear about the town. They should be, preferably, steam-driven, and can be purchased for £500 or £600 each.

Once the coal has reached the station the question of the most convenient means of storage presents itself to the engineer. The minimum amount which should be stored in a station is 100 tons for every 1,000 I.H.P. installed, and this amount can be conveniently contained in overhead bunkers placed above the boilers. It is, however, desirable to store four or five times this amount if possible, and to effect this an auxiliary coal store is necessary. This must obviously be placed outside the boiler house. It should be near the ground level, and connected to the overhead store by means of conveying and elevating machinery. The coal store or bunkers, whether overhead or on the ground level, may be constructed of brick or iron work. The flooring should be sloped at an angle of 45deg. to points in the centre, from which distributing shoots can be taken either to supply the boilers or the conveying apparatus. The maximum depth of the coal stored in such bunkers should not exceed 10ft. If this is exceeded the coal is liable to become overheated and to catch fire. The construction of the bunkers, including the roof-work, should be entirely of non-combustible material, and fire hydrants should be placed in accessible positions. In an auxiliary coal store it is usual to have a conveyor running over the top of the store and returning underneath it. By means of this the coal can be collected from the points where it is discharged from the carts, and can be distributed in the store. If it it desired to draw coal from this store the return half of the conveyor, which runs beneath it, can then be fed by shoots, and arranged so that it will deliver to an elevating apparatus. The elevating apparatus should take the coal to the level of the coal bunkers over the boilers, and it should be possible to feed this either from the auxiliary coal store or direct from the carts. After the coal has been elevated to the desired height, it can then be distributed in the overhead bunkers by means of another conveying apparatus, and from these bunkers it should be fed to the boilers through shoots, which should be fitted with controlling valves. There are many forms of conveying apparatus, and I will endeavour to describe those most in use, and point out their advantages and defects.

The worm type of conveyor consists of a worm or screw which revolves in a semi-circular trough. The coal is fed into one end of this trough and is gradually pushed along by means of the worm; it is allowed to fall through doors in the bottom of the trough, which can be opened when necessary. This apparatus can only deal with small coal, and it is very liable to get out of order owing to lumps of coal becoming jammed between the worm and the trough. The power taken by this apparatus is also excessive owing to the friction between the worm and the coal, and between the coal and the sides of the trough.

The chain type of conveyor consists of a chain formed of lines of bar-iron riveted together; this is dragged along a flat bottomed trough having doors on the underside; the chain passes over a sprocket wheel which is driven by gearing, and is dragged along the trough pulling the coal with it. This conveyor is less liable to get out of order than the worm conveyor, but the friction between the chain and the trough, and the coal and the trough is excessive. Another objection that this conveyor has is the fact that the rivets in the chain, which form the pins on which the links turn, are buried in the coal, and in time these and the holes in the links become worn and cut away; the centres of the links consequently become elongated and the chain does not gear properly with the sprocket wheel. The life of such a chain is not more than from three to four years.

The push-plate type of conveyor was devised with the idea of keeping the chain itself out of the coal. The chain of this conveyor runs on rollers above the trough, and attached to it are a series of rectangular plates which dip down into the trough and push the coal

* Paper read before the Incorporated Municipal Electrical Association at Glasgow.

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along as the chain is dragged forward. This is a better form of conveyor than the last, but it has the same objection owing to the excessive power absorbed in the friction of the coal when being dragged along the trough.

The band type of conveyor consists of a broad endless indiarubber or fibre belt, from 18in. to 24in. in width, running over pulleys at either end, and supported by rollers throughout its length. These rollers are shaped or inclined so as to cause the belt to sag in the centre, and so prevent the coal from falling off. In order to discharge the coal from the belt, the latter can be tipped on one side at any desired point, and the coal will fall off the other side, or the coal may be scraped off by an inclined scraper placed at any point. This form of conveyor takes less power to drive, and there is no power absorbed in friction as described in the previous types. This type of conveyor has the advantage of being about the cheapest in first cost, and rubber belts such as these have been known to last from 10 to 12 years, and even then to be in a very fair condition. The working parts of the apparatus can be lubricated, preferably by means of grease.

The steel trough conveyor is composed of a number of steel plates, which are usually turned up at the edges, and which are fixed to the links of an endless chain. The chain may be run on rollers or may be fitted with small flanged wheels which run on a tramway. The plates are so arranged that when the chain is approximately in a straight line they form a continuous trough, which travels along. The coal, which may be of any size, is fed on to this trough and carried along by it to any desired point, where it can be discharged. It has the advantage that the working parts of the chain are kept away from the coal dust, and there is no power absorbed in friction, the coal being carried along bodily. The conveyor, is not, however, adapted for the convenient discharge of the coal at any point along its route. The return chain also is useless. All the above types of conveyors can only be used for conveying coal approximately horizontally, and if used for elevating they should not be run at a greater angle than 30deg. with the horizontal.

Another type of conveyor that is being extensively adopted now is one in which the coal is conveyed by means of buckets which are hung on an endless chain. These buckets always hang vertically, and in this way the conveyor can be used either for conveying horizontally or elevating vertically, or at any desired angle. The chain itself is fitted with small flanged wheels, which run on an ordinary tramway composed of T section rails. Where it is necessary to change the direction of the motion from conveying horizontally to elevating vertically, curved rails are fitted to effect this. The chain is a double-link chain on each side of the buckets, and the driving is effected by means of toothed wheels or pawls, which engage with distance blocks fixed between the double links. This conveyor can only run in a straight line when moving horizontally, but the direction of the motion may be changed to one at right angles if desired, where the chain is ascending or descending vertically, by allowing the chain to twist where it is hanging free. The buckets are filled by means of funnel shaped spouts which fit into them as they pass along, and each spout allows just sufficient coal to enter in order to fill the bucket. This conveyor takes very little power to drive it, as there is only the friction in the wheels to overcome and the dead weight of the coal to be raised. It is so free that the weight of the coal in the ascending buckets is enough to cause the chain to run backwards if the driving-power is taken off, and means have to be taken to prevent this by using some form of ratchet and pawl. The working parts are protected from contact with the coal or ash dust, and, in consequence, have a maximum life. The buckets can be tipped at any desired point by means of a lever engaging with a pin on the side of the bucket. This conveyar can be used both for coal and ashes if it is arranged to travel over the coal bunkers and under the ash pits of the boilers, and in this way the cost of installing two conveyors and special elevating gear is obviated.

Another type of conveyor and elevator that may be employed is as follows:—A long girder of H section is supported at any desired height by means of lattice framework and tie rods. On this is fitted a trolley which can be pulled backwards and forwards by a wire rope; on this rope is a pulley with a hook attached, and at certain points this hook can be lowered to the ground level, where a skip, holding about a ton of coal, can be attached to it. The skip is then raised, and when the hook is brought to a level of the girder it is gripped by the trolley, and the whole is travelled along; the skip can then be tipped at any desired point. The motion is then reversed, the skip brought back again, lowered, unhooked, and a fresh skip attached. In this method it is necessary to fill the skips by hand; they can, however, be emptied at any desired point. The working parts are kept free from coal and ash dust, and the apparatus does not take an excessive amount of power to drive.

Turning now to elevators as distinct from conveyors. The most usual type adopted is that having an endless chain, which passes over pulleys at the higher and lower level, and has buckets fixed to it. These buckets dig into the coal at the bottom end, in what is called the boot of the elevator; they carry the coal to the top, and as they turn over the top pulley they discharge the coal down a shoot, which, as a rule, feeds on to a conveyor. This form of elevator takes a considerable amount of power to drive it, and it has the disadvantage that the working parts of the chain come into contact with the coal or ash dust, and in consequence wear takes place. For unloading coal from a barge the best form of elevator is an automatic grab which can be attached to a crane. This, while open, can be dropped into the coal, and, as soon as the lifting chain begins to pull, the grab closes, digs into the coal and fills itself. It can then be lifted to any desired height and discharged into a hopper, from which the coal can be taken by the conveyor. If desired, each grab can be weighed and an automatic register kept of the weight. Conveying and elevating apparatus is peculiarly liable to breakdown, owing to the rough nature of the work it has to do, and in order to guard against the serious results which a breakdown may entail during the heavy winter loads, some duplicate means should be provided for getting coal into the station and for getting the ashes away from it. Owing to the high initial cost of good conveying plant it is not advisable to instal this in duplicate, unless the station be very large and the outlay be warranted. It would appear best to use some simple and effective means, such as a system of light tipping trucks, which can be run on a tramway in the boiler house and which can be filled by hand. Such an arrangement, of course, entails a considerable amount of labour; but, being only a stand-by and to be used only in an emergency, this item cannot amount to very much. In some cases means may be provided for taking the coal carts themselves into the boiler house and dumping the coal on to the floor.

With reference to ash conveying, the same type of apparatus can be used as is employed for coal conveying. The ashes should not be allowed to interfere with the handling of the coal in any way, and should, if possible, be dealt with in a cellar below the boiler house flooring. In a boiler house containing a large number of boilers, if the ashes are allowed to accumulate even for a couple of days, the whole place becomes so choked that it is impossible to work the boilers properly, and if there is a large space available below the floor the ashes can be allowed to accumulate here for several days if it is impossible to get rid of them. The ashes should be taken to an overhead bunker, preferably at the end of the boiler house furthest from that at which the coal enters, and from this bunker they may be fed into carts or trucks by means of shoots. It is most essential that they should not be allowed to accumulate, and it is quite as important to provide duplicate means for getting rid of them as it is for getting the coal into the station.

# PARLIAMENTARY INTELLIGENCE.

## PACIFIC CABLE BILL.

In the House of Commons, on Monday, on the order for the second reading of this bill, Mr. FLYNN said no reasons had been given why the colonies of Canada and Australia had induced the Government to wholly change the attitude taken up in April, 1899, and why this country should be committed to a capital expenditure of £2 000,000 and an annual expenditure of £25,000 or £30,000 for the cable. The Government were embarking upon that very uncertain enterprise in competition with the Eastern and Eastern Extension Telegraph Companies, who had invested millions of shareholders' money in the development of their cable system to the public satisfaction, and yet a little more than two years ago they laid down the principles that the cable was of more importance to Canada and Australia than to the United Kingdom, and that the responsibility of construction and maintenance should rest upon those colonies. The main motive of the Australian colonies was to get a reduction of tariff, and, that being so, they should themselves pay for it. He complained that the House had no information as to the opinion of the Colonial Office and the colonies with regard to the proposal of the Eastern Company, dated Sept. 28, 1899, providing for a progressive reduction of tariffs. The Australian colonies were by no means unanimous in favour of the scheme, which, he thought, was an unwarrantable interference with private enterprise by means of Government money.

Mr. H. HEATON supported the second reading, and he looked forward to the day when there would be sixpenny telegrams to India, shilling telegrams to Australia, and penny telegrams to America.

Mr. O'MARA held that, for the distance, the present charge of 4s. 9d. a word was the cheapest telegraph charge in the world. He opposed the bill and said that, looked at from the business point of view there was not sufficient remunerative business for two cables to Australia at the present rates.

Mr. AUSTEN CHAMBERLAIN said that for many years the Australian colonies had been complaining of high rates and of an insufficient service, and they, together with the Dominion of Canada, had been anxious for a further cable connection to be constructed between this country and Australia, via Canada, which would touch only on British soil. The object of the Government had been to secure an all-British cable, and they had attained that object. British employés would be engaged by the Pacific Cable Board, which, as it was not running a purely commercial business, did not require to be tied down in the same way as a commercial company would. As regarded Government messages, it would probably be convenient that they should go at half rates, as they did under most of



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their agreements with the cable companies. But that matter was of much less consequence when the cable was owned by the Government themselves, for the profits, instead of going to somebody else, as they did when they were dealing with a commercial company, would come back to them. He had also been asked what payments had already been made. Roughly they amounted to £290,000, due to the contractors, in accordance with the conditions named in the contract. His Majesty's Government held that the construction of the Pacific cable would be of material advantage to them in time of war, and they asked the House to ratify the agreement they had made and to carry out the undertaking which had already been ratified by every colonial Government concerned.

After Mr. Dillon had spoken in opposition the second reading was carried by 183 votes to 59.

On Tuesday the House went into Committee on the bill, when Mr. O'MARA moved an amendment that $\frac{5}{8}$ths only of the £2,000,000 required for the construction of the cable should be provided by this country.

Mr. AUSTEN CHAMBERLAIN said the original proposal of the Government was merely to subsidise the cable and to take no part in its construction or control; but then the Government would not have shared in the profits. That arrangement was not satisfactory to the colonies, and the Government agreed to take part in the construction of the cable, to be, in fact, joint owners with the colonies, and to be represented with the colonies on the board of control. The guarantee of the colonies to defray $\frac{3}{8}$ths of the expenses included all charges in connection with the raising of the necessary money, the construction, and the maintenance and repair of the cable.

Mr. DILLON said that, unless there were some secret understanding, the whole tendency of the proposed Pacific Cable Board would be to cut down rates without any regard to commercial considerations.

Mr. TULLY said he should resist the measure at every stage unless some pledge were given that if there was to be competition with the Eastern Extension Company it would be genuine competition.

The amendment was rejected.

Mr. O'MARA then objected to the handing over of a cable constructed by British capital to colonial management. The cable board was to consist of three Treasury representatives, two members representing Canada and three Australian colonies and New Zealand. The Treasury members would be in a minority, and the majority, consisting of colonial politicians, would work the line in colonial interests, keeping the rates as low as possible. On the other hand, if the Treasury controlled the working through an experienced manager, there would be some guarantee that the business would be conducted on sound economical principles. He therefore moved to substitute the Treasury as the controlling authority.

Mr. A. CHAMBERLAIN declined to accept the amendment. He entirely dissented from the view that the interests of this country and the colonies would always be in conflict. If the cable did not pay the colonies would make up $\frac{3}{8}$ths of the deficit. Traders at home, as well as in the colonies, would have the advantage of reduced rates, and if they were unduly reduced the greater proportion of the loss would fall on the colonies. There was no reason to suppose there would be any desire to work the cable at a permanent loss. At first possibly there would be a loss, but it was sometimes necessary to face present loss to secure ultimate gain.

The amendment was negatived.

Mr. O'MARA moved a new clause to the effect that the rates charged, either intermediate or through, should be approved by the Treasury.

Mr. A. CHAMBERLAIN would not accept the proposed clause, which was rejected.

The bill was then reported without amendments to the House, and was read a third time.

On Wednesday the bill was read a first time in the House of Lords.

## WEST AFRICAN TELEGRAPHS.

In the House of Commons on Tuesday Sir C. DILKE asked the Secretary for the Colonies whether, in consequence of the recent purchase by the French Government of certain submarine telegraph cables on the West Coast of Africa (the property of the West African Telegraph Co.), the lines previously worked by the company would be so deviated as to avoid Bathurst and Accra.

Mr. J. CHAMBERLAIN said the purchase by the French Government of the cables had not yet been completed, but arrangements had already been made that the cables to be transferred would be deviated from Bathurst and Accra, which places would continue to be connected telegraphically with the mother country by other British-owned cables.

## LONDON TELEPHONE SYSTEM.

In reply to Mr. Henniker Heaton, Mr. AUSTEN CHAMBERLAIN stated, in the House of Commons on Friday last, that negotiations were in progress between the Post Office and the National Telephone Co. with a view to secure the greatest possible facilities for telephone users in the London district, and, in particular, free inter-communication between subscribers on either system. These negotiations were not yet complete.

## LIGHT RAILWAYS (No. 2) BILL.

This bill, which provides for the appointment of another Light Railway Commissioner at £1,000 per annum, was read a second time in the House of Commons on Wednesday.

Mr. GERALD BALFOUR stated, in reply to some criticism on the Light Railways Act, that the act had been successful beyond expectation, and had led to a large increase of enterprise. It was necessary to appoint a qualified successor to Mr. Fitzgerald, one of the unpaid commissioners, who was retiring

# LEGAL INTELLIGENCE.

## Glynn v. Atherton and Others.

At Liverpool Assizes, on Thursday last week, this action came before Mr. Justice Bucknill and a special jury. Plaintiff, managing director of the Leyland steamship line, claimed compensation from defendants, directors of the British Electric Works Co. (Ltd.), for alleged misrepresentation in the prospectus inviting applications for capital. The defence was a denial of liability. Counsel engaged included Mr. Asquith, K.C., M.P., Mr. Horridge, K.C., Mr. Rotch, and Mr. Glynn for plaintiff; Sir E. Clarke, K.C., Mr. Pickford, K.C., Mr. Isaacs, K.C., and Mr. Rowlatt for defendants; and Mr. G. D. Keogh held a watching brief on behalf of Messrs. H. E. Abbott and W. C. Spencer, liquidators of the British Electric Works Co. (Ltd.).

Mr. ASQUITH said plaintiff was an original allottee of 500 preference and 500 ordinary shares in the British Electric Works Co., and defendants were promoters and directors of the company. Compensation was claimed in respect of misleading statements contained in a prospectus upon the faith of which plaintiff was induced to subscribe for shares. The company was formed in April, 1899, to acquire and carry on the business of R. F. Hall (Ltd.), and the question of defendants' liability, and of the truth or falsity of the statements in the prospectus of the Works Company depended to a large extent upon the character, value, and commercial possibilities and prospects of this Hall business which the new company was to acquire and work. Mr. Hall, one of the defendants, was the managing director of the British Electric Works Co., and his name appeared on the prospectus as one of the persons responsible for its issue. From 1877 he had been an engineer connected mainly, if not exclusively, with the cycling industry, and had taken out in connection with that industry a number of patents. Counsel proceeded to give a history of the Hall business, from which it appeared that Mr. Hall was a successful cycle manufacturer and established a good business. In 1897 this business was converted into a joint-stock enterprise with a capital of £125,000. Subsequently the Hooley collapse followed, and a receiver was appointed on behalf of the debenture holders. The receiver carried on the business from June, 1898, to February, 1899. During the continuance of the works, counsel said, an attempt had been made to put some electric lamp holders upon the market, but not with successful results, and the business of the Hall Company remained of the same character as before. In January, 1899, an extraordinary meeting of the shareholders decided to wind up the company voluntarily, and under the supervision of the Court a liquidator was appointed, who at once endeavoured to find a purchaser for the business, and was brought into communication with the defendant, Mr. J. B. Atherton, who ultimately became promoter of the British Electric Works Co. An agreement was entered into for the sale of the undertaking of R. F. Hall (Ltd.) to Mr. Atherton for £55,000, and Mr. Hall informed the Court that in his opinion this would be a good and adequate price. Two months later the same property was sold by Mr. Atherton to the British Electric Works Co. for £142,000. The debenture holders were paid in full, the unsecured creditors received 3s. 6d. in the pound, but the shareholders did not receive anything. On April 20, 1899, the British Electric Works Co. was registered, and an agreement entered into by Mr. Atherton as vendor and the company as purchasers. The new company got the benefit of three electrical inventions by Mr. Hall, but those proved practically worthless and incapable of commercial extension. The nominal capital was £135,000 (£50,000 preference and £80,000 ordinary), in £1 shares, and a debenture capital of £50,000, making in all £185,000. Of the £142,000 Mr. Atherton received £102,000 in cash and the remainder in ordinary shares. While in February, 1899, the goodwill had been valued at nil, and the patents at £250, in the following April the new company was paying £31,000 for goodwill and patents. The public were, in fact, invited to subscribe to a flourishing engineering and electrical business, when what they were really acquiring was an insolvent cycle business. Mr. J. B. Atherton was known as carrying on a successful business, whilst the names of the other directors (Mr. Marriner Brigg, Mr. Goffey, Mr. Jacob Atherton, and Mr. Hall) were such as might command confidence. £50,000 worth of the debenture issue were guaranteed by the Liverpool Mortgage Insurance Co. The statements in the prospectus (counsel continued) were such as to make the subscribing public believe that a large cycle, electrical, and general engineering business was being acquired ready to proceed with the execution of large orders already in hand. These statements were entirely unjustifiable. Things went on from bad to worse, and a receiver entered into possession in April last on behalf of the debenture holders; on May 2 a resolution was passed to wind up the company, and the company was so wound up. The undertaking has, however, now again been sold for £60,000, and £6,056 for the payment of trade creditors. If he was able to prove substantially what he had alleged then he submitted that plaintiff was entitled to compensation.

A mass of evidence having been given in support of the plaintiff's case,

Sir EDWARD CLARKE said he was glad the time had come when he could call the mind of the jury to the real question, which had, he thought, never yet been stated to them. Mr. Asquith had dealt with the circumstances of the construction of the company, and had referred repeatedly to "the misleading prospectus." The way in which the case had been opened had to some extent disguised the real gravity of the action. The plaintiff charged all the defendants with fraud. First it was alleged that defendants were guilty of fraud, but he did not think it had been clearly brought to the minds of the jury that this was one of the issues. There was an alternative case against the defendants, raised upon an Act of Parliament passed in 1890, which imposed upon those who became directors of a company and issued a prospectus upon which subscriptions were invited severe liabilities. But under the

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Directors' Liability Act of 1890 it was not necessary that personal fraud should be proved, and he was anxious that in this case the two issues should be kept apart. If they found a statement in a prospectus that was shown to be untrue then the directors or promoters of the company could defend themselves by showing that they had reasonable ground for believing that the statements made were true. When a prospectus showed, as this one did, a report made by a firm of valuers, so far as the statements in that report went the directors were clear of any responsibility for liability, unless it was shown that the person who made that report was not a person who could reasonably be accepted as competent to make it. With regard to the statements the directors made themselves, they had to show that they had reasonable belief in their truth. He would, therefore, ask the jury to steadily bear in mind the question of fraud as alleged against defendants, and also their liability under the Directors' Act. He hoped to satisfy them that there was no fraud whatever on the part of the directors, several of whom had lost personally more money than the plaintiff in the action, but that, on the other hand, they had good and reasonable ground to believe that the statements in the prospectus were true. He did not admit that there was a single statement in the prospectus that was not a true one. Counsel then briefly reviewed the history of the Hall Company and its successor, the British Electric Works Co. The whole position of R. F. Hall (Ltd.) having been placed before Mr. Atherton, that gentleman undertook to purchase outright and to pay £55,000. It was a bonâ fide contract, and when he made his agreement with the new company the only cash which, under that agreement, he could insist upon was £57,000. The shares were offered to the public and were taken up. Upon the face of the prospectus they had the names of the directors who took shares in this company, and there was not one of them whom the jury could imagine putting forward a fraudulent prospectus. The first name was Ald. Lloyd Higginbottom, who at the time the prospectus was sent out was chairman of the Electricity committee of the Manchester Corporation. He accepted the chairmanship of the new company, and, as chairman of the Electricity committee at Manchester, he knew something about electricity. He subscribed for and paid for 500 preference and 500 ordinary shares, the same as the plaintiff, who now suggested that Mr. Higginbottom, who had the same interest in the concern, was risking his own £1,000 on a fraudulent transaction or upon a fraudulent prospectus. Alderman Higginbottom's father-in-law took 100 shares and his brother-in-law 100 in the company, and counsel believed that not one of those shares had ever been parted with, although at one time during the existence of this company the shares were quoted at a little over par. Mr. Marriner Brigg took 500 preference and 500 ordinary shares, another member of the family taking 800 shares, and another member, a lady, 100 shares, so that the Brigg connection held 1,900 shares between them, and had sold none of those. Mr. Goffey took 2,000 preference and 1,000 ordinary shares, while a relative of his took another 1,000. He therefore contended that the directors all believed the prospectus to be true then and true now, and it was because they believed it to be true that they put their money into it. When the company got into difficulties they paid back a large proportion of the fees they had received.

Mr. PICKFORD, on behalf of Mr. Goffey, said his client believed at the time, and believed now, that every statement put before the public in the prospectus was honestly put before them and could be justified. Mr. Goffey joined the board of the British Electric Works Co. without any knowledge of the antecedents of the concern, beyond the statement of the valuers. He put £3,000 of his own into the company, and also recommended some member of his family to put £1,000 in, and although the shares were at one time at a premium he had never parted with a single share.

Evidence was then tendered for the defendants, and the witnesses included Mr. B. H. Jenkinson, M.I.E.E., Mr. F. Tremain (G.P.O.), Mr. A. R. Bennett, M.I.E.E., Prof. A. C. Elliott (University College, Cardiff), and other witnesses.

Mr. ROBERT F. HALL said that after having been connected with the Birmingham Small Arms Co. and the Abingdon Works, he, in 1890, established the business of R. F. Hall & Co., which was one of the most succesful businesses in Birmingham, nearly half their turnover being net profit. In 1894 this business was taken over by the Cycle Components Co., of which he became managing director. He resigned that position in 1896, and started business on his own account in Birmingham, and purchased automatic machines that could be adapted for various purposes in engineering work. He spent about £26,000 in machines, of which not more than £2,000 worth was exclusively for cycle manufacture. In 1897 R. F. Hall & Co. (Ltd.) was formed, the value at that time placed on the plant, machinery, and stock in trade by an expert being £23,500, and he had in hand £30,000 worth of orders. He sold the property for £10,000 in cash and £15,000 in shares. The new works at Cheston-road were completed in May, 1898, and were equipped with machinery which was all for other than the cycle trade except 12 machines. Up to that time about £40,000 was spent on machinery for the purpose of making these works suitable for light engineering and electric work. There was trouble with regard to the insufficiency of capital in 1898, and in June a receiver was appointed. The circulars issued as to the class of work they were prepared to do at the works represented a truthful state of things at that time. The business under the receivership declined until they were only paying £30 a week in wages, contrasted with £350 when the receiver entered. He knew nothing of Mr. Atherton until he was introduced to him by the firm's London representative early in 1899. Mr. Atherton made inquiries about the business with his electrical adviser, Mr. Nesbitt, who visited the works and examined the machinery. Two agreements were ultimately drawn up in February, 1899, one arranging for the purchase by Mr. Atherton of the works for £55,000, and the second with regard to the purchase by Mr. Atherton of witness's patents for 10,000 ordinary shares in a new company, 5,000 of which he was to keep so long as he continued to act as manager of the company. He understood the highest price the receiver had been offered for the works was £45,000. He (witness) approved the prospectus of the new company and the statements regarding the practical side of the business. 288,000 of the lamp-holders made under his patent had been manufactured and he thought about 200,000 had been sold. They had all the machinery to make roller bearings, and would not have had to spend a penny in new machinery for that purpose. He believed the price paid by the new company for the property and business a fair one, and that the works would prove a commercial success. The average value of the output from the factory rose from £400 per month in 1897 to £6,000 in February, 1901. The first difficulty of the British Electric Works Co. was the supply of porcelain, and eventually the company was obliged to purchase works of its own at Hanley. They also experienced considerable difficulty in obtaining experienced men to work the automatic machinery. It was not true that large sums of money were spent in adapting the machinery for electrical work as was stated by the chairman at the first meeting of the British Electric Works Co. He (witness) heard the chairman make that statement, and told him after the meeting that he did not agree with it. The statement was false that the arc lamps sent to the show in London would not burn. The agreement of February, 1899, as to the sale to Mr. Atherton for £55,000 put the value of the land, buildings, plant, and machinery at £46,000; loose plant, tools, furniture, &c., £8,750; patents, £250; goodwill and contracts, nil. Those figures were suggested by him. He was to be manager of the new company at a salary of £1,000 per annum, or double the amount he had received from R. F. Hall & Co. (Ltd.).

By Mr. ASQUITH: As to telephone appliances, had you ever sold a telephone to anybody?—No. We received a trial order from Glasgow, but had not completed it.

Then do you say it was fair to tell the investor that you had the machinery to turn out the telephone when you had not a pattern telephone there, and had not made one at this date?—I had nothing to do with the prospectus. The only electrical order we had was the one of the National Electric Wiring Co., the larger portion of which was cancelled. He still considered, in view of the progress the works were making, that the British Electric Works Co. would have succeeded if there had been sufficient capital.

Mr. J. B. ATHERTON said he was director and general manager of the British Insulated Wire Co., a very successful joint-stock undertaking. In January, 1899, he heard from his brother, Mr. J. Atherton, in London, that the works of Messrs. R. F. Hall (Ltd.) were in the market. He and his brother went to see if the works were suitable for manufacturing electrical goods. Both he and Mr. Nesbitt, who was connected with him, were satisfied with the works. He knew the works were in the hands of a receiver, but that made no difference. All he was concerned in was to buy as cheaply as possible. He saw at the Cheston-road works a number of machines similar to those they had at the British Insulated Wire Co.'s works, and which were the most profitable part of the Prescot works. He entered into the agreement of February, 1899, to purchase the Cheston-road works for £55,000, and contemplated forming a company to whom he could re-sell the works. His board of directors for the new company were all well known to him. By the agreement with the new company he was to receive £57,000 in cash, 40,000 ordinary £1 shares, and the balance (£45,000) making up the purchase-money either in shares or cash according to the discretion of the directors. The public applied for the full amount for which subscriptions were invited, and he received the £45,000 in cash. Had the shares not been taken up, he would have had to take the whole of the purchase-money, except £57,000, in shares, in which case he would have been out of pocket except for any shares that he might have been able to sell. He contended that the prospectus was an accurate description of the works, and the prospects of the business were very bright indeed. There was a market in the shares of the company for three or four weeks, and in February, 1900, they were a little above par, but he did not sell a single share. He sold the Hanley works to the British Electric Works Co. for the price he paid for them. From the time he joined the directorate (March, 1900) until the company was wound up he did his best for the interests of the company, and he believed it would be a success. He still believed it could have been made a success. We under-estimated the amount of the working capital. £52,000 was actually the amount that came to himself. Messrs. Davidson and Cookson got 1,250 preference and 1,250 ordinary shares for £2,500 in cash for placing the whole of the debentures. The issue was guaranteed by the Liverpool Mortgage Insurance Co. at 10 per cent.—a high figure, but he preferred to pay a little more in order to have the whole guaranteed by such a corporation. The reason he got paid in cash was because the public applied for all the shares. In reality, however, the total application was 169,000 shares short, and he took them over as one of the public.

By Mr. ASQUITH: Did you apply for those shares in your own name?—No, in the name of the Electric Extension Co. [All the 27,297 vendor's shares which came to him he still held.

By Mr. ISAACS: He fully believed that £130,000 had been spent on the works. He did not consider that he got £1 out of the shareholders of the British Electric Works Co. They got full value for the money they paid. The bulk of the shareholders were Liverpool men.

Mr. JACOB ATHERTON said he was London representative of the British Insulated Wire Co., and had had great experience in electrical matters. He considered his brother Mr. J. B. Atherton had made an excellent bargain in buying the machinery, plant, and buildings at Cheston-road Works, Birmingham, for £55,000. He believed the statements published in the prospectus were absolutely true.

By Mr. ASQUITH: You knew the works had been for a long time in the hands of a receiver?—A short time only before I met Mr. Hall.

You knew they had at the time the prospectus was issued?—I did.

You knew your brother only paid £55,000, and that he was asking the public £142,000?—Yes.

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Was there no obligation to disclose this fact to the public when inviting subscriptions?—I did not think it material to disclose that. As to the order for £3,000 worth of electrical fittings from the National Free Wiring Co. he thought that order was cancelled by the new manager. He did not think the directors had anything to do with it. There was certainly no foundation for the suggestion that it was not a genuine order.

Mr. LLOYD HIGGINBOTTOM said he carried on business in Manchester as an engineer and maker of cranes and hoists. His business brought him in contact with the electrical trade. In March, 1899, he was asked to join the British Electric Works Co., and went to Birmingham to see the works. He saw electrical fittings which had been manufactured, and also that the machines used were mostly automatic. He was of opinion that the works were well equipped and admirably suited for the purposes to which they were to be put. He saw machines at work on electrical accessories.

Did you hear Mr. Hall say in the box that the switches had never been manufactured under his patent?—They had been manufactured as samples.

By Mr. HORRIDGE: Had a single switch been sold?—I cannot say. I was more concerned with the capabilities of the machinery. I thought the company had every prospect of a large trade in electrical accessories, &c., and knowing the demand for electrical goods, thought there was every probability of a very extensive business being done on a profitable basis. I am still of the same opinion if certain steps had been taken.

Mr. W. MARRINER BRIGG said he had been chairman of the British Insulated Wire Co. for a number of years, and had known Mr. J. B. Atherton for a considerable period, and had the utmost confidence in him. In February, 1899, he was invited to join the British Electric Works Co., which he understood was to purchase well-equipped works for the manufacture of electrical fittings at a cheap rate. He knew the Hall Company had a receiver in possession, and he knew it had been largely a cycle works. His relatives took £5,000 worth of shares in the company, which showed his good faith in it, at any rate.

Mr. T. GOFFEY said in March, 1899, he was told of the formation of the British Electric Works Co., and he joined the board and invested £3,000 in it. He considered the prospectus that was issued a perfectly honest one. He did not hope to get anything out of the company except from its success. He had never attempted to sell a share, nor had any of his friends.

Mr. B. H. JENKINSON, recalled, said he was now manager of Hands Limited. The orders he had given, as manager of that firm, to the British Electric Works Co. for electrical fittings and appliances during 12 months numbered about 150, and were for lampholders, ceiling roses, switches, wall plugs, cutouts, &c., the value being about £5,000. Those orders were given by him on behalf of Hands Limited after he left the National Free Wiring Co.

Mr. G. H. NESBITT, engineer and manager of the British Insulated Wire Co., said he inspected the works at Cheston-road with Mr. Jacob Atherton. He considered they were admirably adapted for the work required of them, and he estimated it would cost £150,000 to build and equip works like them. He advised the Works Company to continue the business the factory had previously been engaged upon until a connection in electrical fittings was developed. He was aware reference was made in the prospectus to the manufacturing of telephonic apparatus, but he had advised that, until the Government itself seriously undertook telephone service, that department could be left alone, and he also advised that the question of motors should be left in abeyance.

Mr. J. BANKS, electrical engineer, said he was employed by the British Electric Works Co. when the company was formed. He was appointed assistant works manager, and had had no experience in cycle manufacture whatever.

By Mr. HORRIDGE: Did you report that there was no plant for making the heaviest motors?—Yes, for the heaviest motors. Only for motors up to 4 H.P.

Is that light electrical stuff?—It is, in my opinion, compared with the heaviest motors. He was with the Works Company up to May, 1901, and could swear the bulk of the electrical fittings, &c., which had been referred to had been manufactured by the company, and had not been made at the time the business was taken over.

Mr. J. B. ATHERTON was recalled by Sir Edward Clarke, and further evidence was tendered as to the valuers' certificate, after which

Sir EDWARD CLARKE submitted to the Court that the following questions were those which should be considered by the jury:—Whether any and which of the statements in the prospectus are untrue; whether plaintiff was induced to apply for shares by such statements, or any of them; had the defendants, or any and which of them, reasonable ground to believe that such statements were true; did the defendants, or any and which of them, so believe them to be true at the time of allotment; what loss or damage did plaintiff sustain by such untrue statements; did the defendants, or any and which of them, make the said untrue statements fraudulently and with intent to deceive; and, finally, whether the statements were honestly made. He said it was a question of fact with which the jury had to deal. They were dealing, not with one, but with five or six persons who were in different positions with regard to some of the matters which had to be dealt with. The serious charge was that the prospectus was issued fraudulently. With the exception of Mr. J. B. Atherton, the defendants were identifying themselves with the undertaking, risking their own money with regard to its success in the same way as any member of the public. And yet the jury were asked to say there was conspiracy to defraud. He considered there was no answer at all needed in regard to the other five defendants. As to the statements in the prospectus which were alleged to be untrue, Sir Edward contended that defendants were not bound to do exactly the things they said they intended to do in the prospectus, if so doing would not be effective and valuable. The directors in reality had come upon another branch of business which had proved important—the manufacture of shells for the Government, and of electric fuses. He contended, on behalf of all the defendants, that there was no pretence for suggesting that there was fraud in the issue of the prospectus.

Mr. PICKFORD having addressed the jury for Mr. Goffey,

Mr. ASQUITH, for the plaintiff, said undoubtedly the question the jury had to determine was whether the prospectus of the British Electric Works Co. (Ltd.) was a fair and honest one. He submitted there were in it misleading and untrue statements of fact; and that there were omissions most material to be known which made that which was stated not only incomplete but misleading. The defence really was that defendants were highly respectable men, and that if they had been conspiring to palm off on the public a thing which they knew to be worthless, could the jury suppose that they would have put their own money into it. His answer to that was that the moment they came to the public and asked them to go into partnership the public (as investors) were entitled to require the utmost good faith, and open disclosure of all that was known, and if they succeeded in getting money from the investors by partial and misleading statements they were no longer entitled to retain it, and as promoters and directors were liable to make the investor compensation. The plaintiff's contention was that the first statement in the prospectus issued to the public was misleading, and was a statement that the directors knew to be misleading. Still less true was it to state that a large portion of the plant was erected for the special purpose of manufacturing electric goods. Nor was there any ground for the statement that the patents mentioned in the prospectus were valuable patents. Nor was the machinery at the works capable of producing a telephone, and the same applied to electric motors. It was completely misleading to say that they had machinery that would produce motors. He asked the jury to find that the prospectus was an untrue and a misleading prospectus.

On Wednesday Mr. Justice BUCKNILL commenced his summing up and continued yesterday. The jury ultimately returned a verdict for the plaintiff on all the counts, and judgment was given for £950, and costs.

## Thrupp v. Robinson.

In the King's Bench Division, on Saturday, Mr. Justice Wills heard an action by Mr. Edgar Charles Thrupp against Prof. Henry Robinson for the recovery of £249 10s. 5d. for his salary for the quarter ended June 30, and for a quarter's salary in lieu of notice. Defendant paid £20 into court as balance of salary due to plaintiff, and denied that plaintiff had any claim to salary in lieu of notice. It appeared from the statement of counsel that in August, 1882, Mr. Thrupp, then 19 years of age, was articled to Prof. Robinson, and subsequently became his chief assistant at a salary of £300 a year, afterwards increased to £500 a year, payable quarterly. In his evidence plaintiff said that he continued in defendant's employ to June 27 last. On April 4 this year he had a conversation with defendant, who said he thought the time had come when it would be better for them both if they carried on business independently, his office to be still used by the plaintiff. He certainly did not agree to cancel his right to three months' notice, nor did defendant ask him to do so. When defendant told him his engagement had terminated on April 4 he was much surprised.

Prof. ROBINSON said there were slight disagreements between himself and plaintiff at the latter part of 1899 and the early part of 1900 on account of plaintiff having matters on his mind or being engaged in matters outside his employer's professional practice. The first time his attention was directed to this was when plaintiff referred to his patent for liquid air, when he said he did not earn anything except what he got from him. On April 3 plaintiff delivered him his account for the quarter, making certain deductions for time occupied in private business. The conversation which took place between them on April 4 was in reference to a matter which had been mooted months before. He said to plaintiff: "In the past you have credited me with the few days you have been engaged in private practice. In future you must charge me for any work you do for me, and the rest of your time will be your own." As plaintiff was silent he supposed that gave assent, and he acted upon it.

His LORDSHIP said it was an unfortunate dispute. It was evident that the parties did not come to a common understanding on April 4. It was, however, hardly likely that plaintiff would forego his right to three months' notice, and he would allow him a quarter's salary in lieu of same, but the amount paid into court would be sufficient payment for his services during the last quarter. There would, therefore, be judgment for plaintiff for £124. 10s. 5d.

## Re Central London Railway Bill, 1901.

Before Mr. Justice Byrne, in the Chancery Division, on Saturday, an application was made on behalf of the Central London Railway for an order for the payment out of Court of the statutory deposit of nearly £24,000 lodged in accordance with regulations in relation to the Central London Railway Bill, 1901. Counsel stated that it was the general practice of Parliament, when a bill was directed by resolution not to be proceeded with, to certify for the return of the deposit, and require fresh proceedings in the following session; but in the case of this particular bill an exception had been made, the resolution of the House being that the bill be not proceeded with "during this session," and the question for the Court to decide on the present motion was whether the addition of those words would affect the return of the deposit.

After hearing counsel's arguments, his lordship made the order as desired.

## National Electric Supply Co. v. Foster.

Last week, in the Chancery Court of Lancashire, before Mr. Vice-Chancellor Hall, the National Electric Supply Co. (Ltd.) claimed specific performance of agreements for the sale of certain cottages and land for extending their works at Preston, or alternatively for compensation for expenses incurred in connection with the purchase. After proceeding with

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the extensions for some time and carrying them to a height of 33ft. the plaintiffs were informed by the L. and N.W. Railway Co. that there were restrictive covenants as to building which affected the property, and that no building could be erected over the railway tunnel under the premises or within 25ft. thereof of a greater height than 25ft. Plaintiffs also said that the property, instead of being freehold as represented by defendant, was held on leases for 999 years, and the defendant had no title whatever to a small portion of the property agreed to be sold. Plaintiffs had spent about £5,000 in the erection of the extensions. Defendant denied all plaintiffs' contentions.

The VICE-CHANCELLOR found that there had been no fraudulent misrepresentation by defendant, but that plaintiffs were entitled to compensation owing to the property being leasehold and to there being restrictive covenants, on the ground that defendant knew the purpose for which the buildings were required. Plaintiffs should, however, have brought their action before commencing to build. He directed an inquiry to assess damages, and reserved the question of costs.

### Winding-up Petition.

Last week, in the Chancery of Lancashire, Vice-Chancellor Hall, K.C., heard a petition for the winding-up of English Industrials (Ltd.)

Mr. MABERLY said that the company's registered offices were at 55, Market-street, Manchester, and the petition was in respect of a solicitor's bill of costs.

Mr. GRANT, for the company, said his clients were willing to pay an agreed amount in settlement.

The petition was ordered to stand over until Aug. 12 on the company submitting to an order for the payment of £45 to the petitioners together with the taxed costs of the petition. This arrangement having been duly carried out the petition was withdrawn.

In connection with the above petition for the winding-up of English Industrials (Ltd.) the secretary writes us that the petition was filed against the company for what was regarded as an exorbitant bill of costs, the directors being of opinion that this was out of all proportion to the legal services rendered. The matter, as we understand, has been settled as recorded above on the basis of a considerable reduction in the bill.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of electrical engineer to the municipality of East London, Cape Colony. An advertisement contains further particulars, and applications must be received by the town clerk, East London, Cape Colony, by noon of Oct. 10.

Wimbledon Urban District Council require an assistant engineer. Applications to the electrical engineer (Mr. F. Barnes Spencer). The Broadway, Wimbledon, S.W., by 28th inst. See also advertisement.

Partick Town Council require a chief assistant at the electricity works. Applications to the burgh electrical engineer (Mr. H. B. Maxwell) by noon 31st inst. See advertisement.

An advertisement on another page announces that the Admiralty require able-bodied young men, with experience as fitters in electrical shops, as electricians in the Royal Navy. Applications to the Admiralty Recruiting Department, 22, Spring-gardens, London, S.W., or to any Royal Navy or Royal Marine recruiting officer in the United Kingdom.

Engineering assistants, with experience of underground dry-core cable and overhead construction, are required for Glasgow Corporation telephone department; also chief draughtsman and switchroom manager. Applications to the general manager (Mr. A. R. Bennett), Castle Chambers, Glasgow. See advertisement.

Foreman cable jointer is required by the Battersea Electric Lighting department. Applications to electrical engineer (Mr. H. R. F. Mackay), Municipal Buildings, Lavender Hill, London, S.W., by Aug. 21. See advertisement.

The Edison and Swan Company require a sales manager. Some particulars of the required qualifications will be found in an advertisement.

A jointer used to lead-covered paper cables and a fitter used to Willans' engines and Babcock-Wilcox boilers are wanted at the Wigan Corporation electricity works. See advertisement.

Two switchboard attendants are required for the Stafford electricity works. Applications to the engineer and manager (Mr. Hubert Pooley), by 21st inst. See advertisement.

Bedford Corporation require an electrical engineer to take charge of their electricity department. Applications to town clerk by Aug. 20.

Finchley District Council require a resident electrical engineer. Applications to Mr. C. Roberts, Ribbsworth House, Church End, by noon, Aug. 19.

The committee of University College, Nottingham, require a demonstrator in electrical engineering. Applications before Sept. 7.

An assistant lecturer and demonstrator in physics is required for University College of North Wales, Bangor. Applications by Oct. 12.

A professor of engineering is required by University College, Bristol. Applications to secretary by Aug. 31.

Mr. Arthur J. Wheatley, for some years chief engineer and manager of the Woking Electric Supply Co. (Ltd.), and latterly on the staff of Mr. Edward Dodd, consulting engineer, Birmingham, has accepted an appointment under the War Office to work out the details of a scheme for the electric lighting of the Royal Victoria Hospital, Netley. Mr. Wheatley has already assisted in carrying out a similar scheme at Inkerman Barracks, near Woking.

Mr. C. E. Hume, mains superintendent at Bristol, has been appointed resident electrical engineer and manager at the Twickenham electricity works.

Owing to the appointment of Mr. Hume as engineer and manager of the Twickenham Electric Supply Co., the Bristol Electrical committee have appointed Mr. H. Jenkins assistant mains engineer, and Mr. O. Wheeler, an improver at the Temple Back station, has been appointed an assistant engineer.

Mr. T. Bell has been appointed assistant engineer at the Whitehaven electricity works.

**Ashton-under-Lyne.**—A loan of £30,000 for electric tramways has been applied for.

**Asylum Lighting.**—Bucks County Lunatic Asylum is to be lighted electrically, and the Asylum Visiting committee have appointed Mr. A. A. Campbell Swinton consulting engineer.

**Austria-Hungary.**—There were exported from this country in 1900 500 dynamos of the estimated value of £34,000. Sixty machines were for the United Kingdom, 150 for Germany, and 125 for Russia.

**Associated Chambers of Commerce.**—A special meeting of the Association of Chambers of Commerce of the United Kingdom will be held at Nottingham on Sept. 3 and 4, under the presidency of Lord Avebury. The subjects to be discussed include: Imperial telegraphs, cheaper telegrams, the telephone trunk system, patent law amendment, trade marks, municipal representation for joint-stock companies, tare limit of motor waggons, rating of machinery, decimal system, &c.

**Aylesbury.**—Offers recently received for the supply of electric current in the district have been submitted to the consulting engineer (Mr. F. H. Medhurst) for report.

**Barbados.**—The telephone service of this island, worked by a private company, has an approximate length of 600 miles of lines.

**Barnes.**—A dispute has arisen between the Council and the County of London and Brush Co. in regard to the supply of electric current in the district by the company. The company are supplying current to the Ranelagh Club and the Manor House, within the Council's area, and the Council are advised that such supply is illegal. The company, on the other hand, maintain that in each case the supply is being given within the company's area of supply. The Council have decided to apply to the Attorney General for his fiat to commence proceedings for injunction and damages.

**Birkenhead.**—Three new electric tramway routes were opened for traffic on Wednesday.

**Blackpool.**—The terms of the engagement of the borough electrical engineer (Mr. R. C. Quin) have been revised. Recently Mr. Quin intimated his wish to resign his position as soon as possible in order to devote himself to consulting practice; but, as important electric tramway and lighting extensions are in progress, the Electric Lighting committee declined to accept the resignation, and we now learn that other satisfactory arrangements have been made. Instead of being only allowed two days per month for consulting work outside the town, Mr. Quin is to have four days a month up to March next, and, during the extra year he now consents to serve, seven days a month.

**Bohemia.**—In addition to the city of Prague, where electric lighting is in fairly general use both for public and private lighting, from a supply station which commenced working last year, there are already 16 towns lighted electrically. The greater portion of the electrical plant and apparatus required for these installations has been supplied from Vienna and Germany, there being only two manufacturers of electric generating machinery in Bohemia.

Telephonic communication is established between Prague and 79 Bohemian towns. There is also trunk communication with Vienna, Berlin, Dresden and Brunn, the charge for using these lines ranging from 10d. to 2s. 6d. per three minutes' conversation, according to distance.

In the Prague district a large cotton mill has just been erected and equipped with 656 looms, all electrically driven.

An electrical engineering firm in the Prague district has recently secured an order from Great Britain for two 800 H.P. dynamos for tramway working, and, in connection with the Middlesbrough electricity supply works, an order for a 500 H.P. machine.

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**Boston.**—In a report on electric lighting presented by the consulting engineer (Mr. A. C. Collins) the Council are advised to establish electricity works estimated to cost £28,500. The continuous-current three-wire system of distribution is advocated.

**Bradford.**—The Electricity committee recommend an increase in the salary of the borough electrical engineer (Mr. R. A. Chattock) from £500 to £600 per annum, with a further £100 in 12 months.

**Braila (Roumania).**—The concession for lighting the town of Braila by electricity was granted to the Helios Company, of Berlin, in March last, but it is not expected that the generating station will be in full working before the spring of 1902. Electric tramways are, however, running in all parts of the city, including a line to the docks.

**Cleckheaton.**—The Council has obtained sanction to borrow £24,900 for electric lighting and refuse destructor works.

**Cowdenbeath (Fifeshire).**—This burgh is to be lighted electrically by 320 16 c.p. incandescents. Messrs. Hunter and Jack have the contract.

**Cuba.**—The new Havana electric tramway system was inaugurated in April, when the whole 35 miles was open for traffic. The company owning the concession for this line possesses powers for considerable extensions. The line is constructed on the overhead system, all the machinery being American. The capital outlay to the present has reached nearly £1,200,000.

**Customs Duties.**—Under the new classification of the customs of New Zealand, dated June 5 last, electric blasting apparatus for mines is classified as electric machinery and appliances, and bears 10 per cent. ad val. duty.

**Dartford.**—The maximum demand system of charging for electric current has been adopted by the Council, the charge for the first hour being 8d. per unit and 2d. after.

**Derby.**—The salary of the superintendent of mains (Mr. T. K. Hugessen) has been increased from £100 to £125 per annum, with a further increase of £25 in 12 months. Various extensions of the electric lighting mains were authorised at the meeting of the Council last week.

**Dublin.**—The Commissioners for Public Works have advanced the Corporation a loan of £254,500 for electric lighting. Intimation has, however, been made that so long as the rates within the city remain at their present figure the Commissioners can hold out no prospect of further Government loans being made.

**East Grinstead.**—A report on electric lighting by Messrs. Medhurst and Lloyd is before the Council.

**Electrical Treatment of Bauxite in France.**—In connection with the bauxite industry of the Var district of France it is stated that recent discoveries in the methods of electrical treatment of these ores have cheapened and facilitated the process of the extrication of "alumine," and this will have the effect of bringing French bauxite on to the market in competition with those from Ireland and the United States. The alumine, from which aluminium is extracted, is regarded as a by-product, and is bought up readily by paper-makers, dyers, makers of certain brands of disinfectants, and manufacturers of varnish for certain kinds of pottery. The discovery of an effective solder for aluminium would greatly increase the value of this French bauxite and lead to a considerable installation of electrical machinery and apparatus for bauxite treatment.

**Electricians in the Naval Service.**—Of the 100 electricians who are to be entered in the Navy under the new rating, Portsmouth will enter 34, and Chatham and Devonport 33 each. Until a torpedo depôt is established at Chatham, electricians entered at that port will undergo their qualifying course, extending over four months, on board the "Vernon" at Portsmouth.

**Frankfort-on-Main.**—Amongst the principal increases in the exports from this important German city may be mentioned telegraph cable, the export figures for 1899 reaching the value of M1,523,000 compared with M82,000 in 1898, and M19,000 in 1897.

**Hampstead (London).**—For the midsummer quarter the receipts of the Electricity department were £4,438. 5s. 7d., against £3,914. 11s. 8d. last year. At the meeting of the Borough Council last week the chairman of the Lighting committee (Ald. Pritchard) said that up to March 31 their capital expenditure on electric lighting was £236,000. On the first year's working there was a loss of £3,000, in the second year a slight profit, in the third year the whole of the £3,000 lost in the first year was repaid, and in the fourth and fifth years the total profit was £27,000 after deducting expenses and interest, but not including repayment of capital. The whole £27,000 had been set aside for depreciation, and was equal to 5¼ per cent. per annum on the capital invested for each year since the commencement of the undertaking. The profit for the sixth year was not so large, owing mainly to the price of current being reduced by about 20 per cent. He thought the Council would agree that the undertaking was a sound financial one.

**Hebburn.**—A seven years' agreement has been entered into by the Council with the Northern Counties Electricity Supply Co. for supplying electric current for public and private lighting. The Council's provisional order will be transferred to the company, but at first public lighting will be restricted to the compulsory area.

**Ipswich.**—The Council on Wednesday decided to adopt the site known as "Seven Acre Fields" for electricity and refuse destructor works, in place of Canham's Marsh, which had previously been selected. Notice has been given to the Ipswich Tramways Co. of intention to acquire their undertaking,

**Leicester.**—The County Council are considering a proposal to construct a system of light electric railways in the district, and to connect up with the electric tramways of the Town Council. The lengths of the proposed light railways would vary from 1 to 3 miles. The committee hope to be able to submit a scheme for the approval of the County Council in November.

**Light Railways.**—The Welshpool and Llanfair Light Railway (Amendment) order has been submitted to the Board of Trade for confirmation. Objections Sept. 4.

The whole of the Southend-on-Sea municipal light railway system has now been certified by the Board of Trade for public traffic.

**Lincoln.**—The Council have decided to supply current for power at a uniform rate of 2½d. per unit or 4d. per unit for the first hour and 1d. after. Motors are to be supplied on hire at an annual rental of 12½ per cent. of cost price of motor and cost of fixing. Of this 12½ per cent. 10 per cent. is to be allowed for depreciation and 2½ for interest on capital.

**London Underground Railways.**—The Joint Committee on London Underground Railways, in their recent report referred in favourable terms to 11 of the bills, and on the 2nd inst. the House of Lords resolved to give the promoters leave to suspend further proceedings in order to proceed with the bills next session, provided notice of intention to do so was given within a certain time. This notice has already been lodged for the whole of the bills, viz.:—Brompton and Piccadilly Circus Railway, Central London Railway, Charing Cross, Euston and Hampstead Railway (Nos. 1 and 2), Charing Cross, Hammersmith and District Electric Railway, City and North-East Suburban Electric Railway, North-East London Railway, Islington and Euston Railway, King's-road Railway, Piccadilly and City Railway, and West and South London Junction Railway.

**Lowestoft.**—Sanction to a further loan of £20,000 for electric lighting has been obtained. On Aug. 2 there were 145 customers of the electricity department, representing an equivalent of 7,325 8 c.p. lamps connected, and 55 applications for 2,000 8 c.p. lamps awaited connection.

**Lyons.**—A feature of the application of electricity to industrial purposes in this district is the large increase in the number of motors installed for driving household looms in place of hand-power. Very few factories in the district are using electric driving, but the smaller machinery is driven electrically to a large extent.

**Margate.**—A discussion on recent tramway accidents took place at the meeting of the Council on Tuesday, and the opinion was expressed that the Fort-road and King-street tramway route should be abandoned and a double line constructed in Paradise-street. A conference of committees of the Margate, Ramsgate and Broadstairs Councils is to be held to-day (Friday) in reference to the general working of the tramways.

**Marseilles.**—In a recently-issued report on the trade of Marseilles for 1900 Mr. Consul-General Gurney writes as follows:—"As an instance of the initiative now at work here, I may refer to a proposal which has already received ministerial sanction, and will soon be put into execution. The present difficulties of local traffic will be met by an ingenious plan. A contract has been made between the new electric tramway company and Messrs. Waller Frères, of Marseilles, whereby the company's lines, in full operation since the spring of last year, will be used for the electric traction of goods between the docks and the warehouses and factories during the night hours, when passenger traffic has ceased. The plan is sure to succeed. The tramlines cover practically the whole city, and extend to all the suburbs. It will be boon to the innumerable factories and workshops that encircle the town, and will also be an improvement to the town itself, relieving its congested traffic."

**Municipal Telephony.**—The proposal to constitute a joint telephone board for the Manchester district was further discussed at Manchester on Friday by the joint sub-committee of local authorities. The draft scheme formulated in May last was discussed at great length, and it is reported that a working basis was practically agreed upon. This is to be laid before the various authorities in the area, who have been requested to send representatives to a conference to further consider the question next month.

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**Newcastle-under-Lyme.**—The consulting engineers to the Corporation (Messrs. Lacey, Clirehugh and Sillar) have presented a report on electric lighting. The continuous current three-wire system, with a pressure from 440 to 480 volts between the outers, is recommended. The estimated capital expenditure is put at £10,389 if steam-driven plant, and £8,365 if gas engines are employed, and the annual working expenses are put at £1,487 and £1,381 respectively. A revenue of £1,500 per annum is anticipated. The report is under consideration.

**New Acts.**—On Friday last the Royal Assent was given to the following Acts of Parliament :—

Electric Lighting Orders Confirmation (Nos. 7, 8, 9, 11, and 12) Act, 1901.
Glasgow Corporation (Tramways and General) Order Confirmation Act, 1901.
Tramways Orders Confirmation (Nos. 2, 3, and 4) Acts, 1901.
Wigan Corporation Act, 1901.
Worcester Tramways Act, 1901.
Chester Corporation Act, 1901.
Manchester Corporation Act, 1901.
Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board Act, 1901.
Bradford Corporation Act, 1901.
Central London Railway Act, 1901.
Barrow-in-Furness Corporation Act, 1901.
Metropolitan District Railway Act, 1901.
Blackburn Corporation Act, 1901.
Brighton Corporation Act, 1901.
Clyde Valley Electrical Power Act, 1901.
Metropolitan Electric Supply Co.'s Act, 1901.
City of Birmingham Tramways Act, 1901.
Tyneside Tramways and Tramroad Act, 1901.
South Staffordshire Mond Gas (Power and Heating) Co.'s Act, 1901.
Dover Corporation Act, 1901.
Smethwick Corporation Act, 1901.
Lowestoft Corporation Act, 1901.

**Personal.**—The Glasgow Town Council have decided to confer the freedom of the city on Mr. R. W. Hanbury, M.P., late Financial Secretary to the Treasury, for services rendered in connection with the obtaining of a licence to establish the municipal telephone service at Glasgow.

**Provisional Order Transfer.**—Birkdale District Council propose to transfer their electric lighting order (1898) to the Birkdale District Electric Supply Co. (Ltd.) for £700. The right to purchase at the end of 14 or any subsequent seven years is reserved.

Our advertisement columns contain particulars of a provisional order which is for disposal.

**Rome**—The employés of the electric tramways, numbering about 1,200, have gone out on strike, and the service is almost entirely suspended.

**St. Malo.**—Considerable tramway and light railway extensions are being made in St. Malo and the surrounding district. Most of these lines are, however, steam driven, although the success of the electric tramways at Boulogne and elsewhere in France has called attention to the special suitability of electric traction for the St. Malo and district tramways, which are branching out in all directions.

**San Diego (U.S A.).**—This city is lighted by electricity on the masthead and low-arm system, with which, it will be remembered, the early experiments in electric lighting in the City of London were effected. There are 12 masts in all, 10 125ft. in height and two 75ft., casting their light over wide areas. Each mast is supplied with six 2,000 c.p. arc lights. The streets are lighted by arcs placed on low arm supports at the principal corners.

**Scarborough.**—By 10 votes to 9 the Council have decided not to apply for powers to construct tramways in the district. One of the schemes submitted by a private company will be supported.

**Sheffield.**—Application has been made for sanction to borrow £83,257. 10s. 4d. in connection with the electric lighting undertaking to June 30, and to borrow £500,000, the estimated capital expenditure on the mains and extensions for the year euding June 30, 1902.

**Southport.**—The cars for the new electric system of the Southport Tramways Co., which was opened for traffic last week, were manufactured by the Brush Co. They are of the four-wheel top-seated type with reversed staircases, and screens in front to protect the driver. These handsomely-fitted cars seat 22 inside and 34 outside. The motors are of a special kind, and have been designed to the requirements of Mr. Raworth (chairman of the Southport Co.) to meet the case of a tramcar running on a perfectly flat line and fitted with roller bearings. The controllers are of the series parallel type with an electrical emergency stop. By means of this brake the car can be pulled up in less than one-half its length. The trolley heads are made of aluminium, which, being so much lighter than gunmetal, allows the trolley poles to be of more slender dimensions, and enables surer contact to be made with the trolley wire. The trucks are of the standard four-wheeled pattern adopted by the Brush Co., who are proud of the fact that they now produce trucks to fill every possible requirement of tramways, light railways, and heavy railways. They claim to be the only firm in this country who manufacture complete electric cars.

**Stourport.**—Before carrying out the proposal to transfer their order to the Kidderminster Electric Light Co. it has been decided to consult an expert as to the cost of erecting and maintaining municipal electricity works.

**Suez Canal.**—3,441 vessels, with 282,194 passengers, passed through the Suez Canal in 1900, the total net tonnage of the vessels being 9,738,152 tons. 2,407 vessels were merchant ships, 773 mail steamers and 261 naval vessels. The percentage of ships passing through using the electric light during transit was 91·2 against 90 7 in 1899.

**Sunderland.**—The Grangetown electric tramway route was officially inspected on Monday.

**The Telephone at Frankfort.**—In this city the telephone is progressing in public favour. A report giving the number of communications by telephone in 1899 shows that 574,000,000 messages were sent over the wires, an increase of 51,000,000, or 9·8 per cent. over 1898. The receipts reached the considerable total of 10,405,661 marks, an increase of 17·1 per cent. for the year. It is anticipated that when the figures for 1900 are available, the introduction of automatic telephone machines will be found to have greatly facilitated the use of the instrument. By these machines the payment of 10pf. gives the right to a local conversation of three minutes, 20pf. provides for connection with the suburbs.

Between Berlin and Cologne a system has been started by which conversations can be arranged during night hours at reduced subscriptions. These conversations are limited to between 6 and 12 minutes, and the rate charged is half that of the day rates for equally long conversations.

**Tramway and Railway Competition**—At the meeting of the London and North Western Railway Co. on Tuesday the chairman (Lord Stalbridge) said the main feature of the half-year's traffic as compared with the corresponding period was the tendency to increase in the average rate per passenger. The principal cause of that was the loss of short-distance traffic on their system in the neighbourhood of large towns, particularly in London and Liverpool, through the installation of electric tramways and railways all over the country. In some instances the electric lines acted as feeders, but in the short suburban traffic they undoubtedly abstracted traffic from the company. In the discussion which followed one shareholder said it was monstrous that they should sit still and see their traffics depleted by local electric lines, for which powers were granted without compensation to existing railways. It was slow theft to thus attack the railway properties and take away their traffic, compelling them to reduce their rates without giving them any remedy. In reply, Lord Stalbridge said he deprecated the action of Parliament in having sanctioned a line between Liverpool and Manchester, where three railway companies had spent an enormous amount of money in constructing the best possible lines.

The chairman of the Great Northern Railway Co. (Mr. W. L. Jackson, M.P.) at a recent meeting stated that the company had carried 300,000 fewer passengers in Yorkshire than in the previous half-year. That was due almost entirely to the competition of electric tramways in Halifax, Bradford, and the Leeds districts, and there was a growing tendency on the part of municipalities, who promoted those tramlines, to impose on railway companies additional burdens whenever they went to Parliament for any works. He believed that the amount paid by railway companies for local rates and taxes was about £3,500,000 per annum, while the amount distributed by the companies in ordinary dividend was a little over £14,000,000. What he desired to make clear was that the increasing competition of the electric tramways would go on, and they were promoted in the main by municipalities, who had shown a growing tendency to be unreasonable in their demand on railway companies.

At the Great Western Railway meeting yesterday (Thursday) the chairman (the Earl of Cawdor) had a similar complaint to make in regard to the competition of electric tramways and railways, which was, he said, responsible for a great decline in the number of short-distance passengers.

**Tramway Strike at Bristol.**—The Bristol Tramways Co. announced on Tuesday that they had appointed all the drivers required to fill the vacancies caused by the recent discharge of 400 employés. The usual service of cars has now been resumed.

**Tynemouth**—On Wednesday the Council resolved to apply for a further loan of £23,000 for extensions to the electricity works.

**Warrington.**—Application has been made to the Board of Trade for further time to construct the Council's authorised tramways.

**Whitehaven.**—From Oct. 1 electric current consumers will have the option of taking current at £12 per annum and 2d. per unit, or at a level rate of 6d. per unit. The Board of Trade have approved the increase of pressure from 210 to 420 volts.

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# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Darlington* Corporation invite tenders for the supply and erection of Lancashire boiler, 350 H.P. engine coupled to a continuous-current dynamo, and extension of steam, drain and feed pipes. Specification, &c, from the town clerk (Mr. H. G. Steavenson), and can also be seen at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to Mr. Steavenson by Aug. 22. See advertisement.

*Manchester* Tramways committee require electrical repairing stores, electrical fitters' tools, tram-car truck accessories, and oil and grease. Specifications from the general manager (Mr. J. M. McElroy), tramway department, 55, Piccadilly, and tenders (addressed to chairman) must be in by 1 p.m. 24th inst. See also advertisement.

*Aston Manor* District Council invite tenders for pipework, fitters' shop and cables. Specifications from the offices of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W., and tenders (addressed Chairman of the Electric Lighting and Tramways committee) to the Council offices, Aston Manor, by noon of Sept. 4. See also advertisement.

*Aston Manor* Council also require water-tube boilers, stokers and economiser, two 500kw. and one 200kw. steam dynamos and motor balancer, switchboard, travelling crane and arc lamps. Tenders to chairman of committee by noon Sept. 4.

The Guardians of the *St. George's Union*, London, W., invite tenders for the electric lighting of the chapel at Fulham-road Workhouse. Particulars from Mr. Edwin T. Hall, F.R.I.B.A., 54, Bedford-square, W.C., and tenders to the clerk (Mr. Thomas Worlock), St. George's Town Hall, Mount-street, W., by 28th inst. See advertisement.

*Glasgow* Corporation invite tenders for the supply, delivery and erection of the overhead trolley constructional work required for the extension of their tramway system. Specification from the general manager (Mr. John Young), 88, Renfield-street, and tenders to town clerk (Sir J. D. Marwick), City-chambers, Glasgow, by 5 p.m. 30th inst. See advertisement.

Tenders are invited by the *Postal Telegraph Department* for the supply of Swedish, Norwegian or Finland red fir telegraph poles. Further particulars are set out in an advertisement. Forms of tender from the Controller of Stores (Mr. Charles E. Stuart), G.P.O., London, E.C. Tenders by 10 a.m. Sept. 30.

*Lowestoft* Corporation invite tenders for a 500kw. steam dynamo and switchboard panels. An advertisement gives further particulars. Specifications, &c., of the town clerk (Mr. R. Beattie Nicholson), 115, High-street, Lowestoft, after 19th inst. The works are to be carried out in accordance with the plans of Mr. W. C. C. Hawtayne, the consulting engineer 9, Queen-street-place, London, E.C., from whom further information can be obtained. Tenders to Mr. Nicholson by noon Sept. 9.

*Oldham* Corporation Electricity committee invite tenders for two electric overhead travelling cranes. Specifications, &c., can be had from Mr. Arthur Andrew, Gas and Water Offices, and specifications, &c., can be seen at, but not obtained from, the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W. Tenders to Mr. Andrew by Sept. 10. An advertisement contains further particulars.

*Bournemouth* Town Council invite tenders for water cooler and travelling crane. Further particulars and drawings of the consulting engineers (Messrs. Lacey, Clirchugh and Sillar), 2, Queen Anne's-gate, Westminster. Forms of tender and specification of the borough engineer (Mr. F. W. Lacey), and tenders to town clerk (Mr. J. Druitt, jun.), by noon Aug. 31. See advertisement.

*Bournemouth* Corporation require boilers, super-heaters, economiser, feed pumps, pipe work and accessories. Tenders to town clerk by noon 29th inst.

*Partick* Town Council invite tenders for 12 months' supply of arc lamp carbons, meters, demand indicators, and house fuse boxes. Full particulars from the burgh electrical engineer (Mr. H. B. Maxwell), 32, Clyde-street, Partick, N.B. See also advertisement.

*Batley* Corporation require tramway rails, points, crossings, bonds, &c. Tenders by Sept. 14.

*Dundee* Town Council invite tenders for permanent way construction of tramways, &c. Tenders by 23rd inst.

*Withington* Council invite tenders for telephonic communication between the town hall and the refuse destructor and sewage works. Particulars from the engineer.

*London County Council* invite tenders for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

*Worcester* Corporation require electrical plant. Tenders to town clerk by noon Aug. 23.

*Middlesbrough* Electric Lighting committee invite tenders for mechanical coal handling plant. Tenders to town clerk by Sept. 3.

*Mansfield* Electric Lighting committee require tenders for refuse destructors. Tenders to town clerk by Sept. 5.

*Edinburgh* Corporation invite tenders for the electric lighting installation, &c., of the second portion of the Colinton Mains Fever Hospital. Tenders to town clerk by Sept. 9.

*St. Anne's-on-the-Sea* District Council require a 180kw. steam dynamo. Tenders to Mr. P. J. S. Tiddeman by Aug. 23.

*Glamorgan* County Asylums committee invite tenders for electric lighting of Parcgwyllt asylum. Tenders to the offices, Bridgend, by 24th inst.

*Ilford* District Council invite tenders for the construction of about 11 miles of tramways. Tenders by 5 p.m. Aug. 31.

*Farnham* Urban District Council are open to contract with a responsible firm for the supply of electricity under their electric lighting order, 1900. Proposals to clerk by noon Aug. 27.

*Croydon* Lunacy Visiting committee invite tenders for wiring the Warlingham Asylum. Tenders by noon 26th inst.

*Brighton* Guardians invite tenders for the electric lighting of a portion of the workhouse premises. Tenders to clerk by 20th inst.

*Leigh* Electricity and Tramways committee invite tenders for steam dynamo. Tenders by 24th inst.

*Birkenhead* Corporation require steam dynamo. Tenders by 23rd inst.

*Walthamstow* Council require tenders for house wiring. Tenders to clerk by 5 p.m. Aug. 30.

*Watford* Council invite tenders for wiring the public library and technical school. Tenders by Aug. 21.

Tenders are invited for the erection of electricity works for public and private lighting at Fayoum (*Egypt*). Overhead wires will be permitted. Tenders, addressed to Minister of Public Works, Cairo, Egypt, by 11 a.m. Sept. 15.

Application having been made for a concession for the construction of an electric tramway between Vigo and Bayona (*Spain*), proposals will be received until Sept. 6.

The Spanish Directorate General of Posts and Telegraphs, *Madrid*, are calling for tenders for the repair of defects in submarine cables between Cadiz and Teneriffe, and between Teneriffe and the island of La Palma, Canaries, by 27th inst.

## TENDERS RECEIVED AND ACCEPTED.

Nearly 120 tenders were received by the Gravesend Town Council for the supply of electricity generating plant, and the following are recommended for acceptance :—

Babcock and Wilcox (boilers, including automatic stoker), £3,005.
Ditto (steam pipes), £1,729. 16s.
Lancashire Dynamo and Motor Co. (engines and dynamos), £6,245.
Brook, Hirst & Co. (switchboard, including carbon brakes with ornamental cast-iron frames fitted round switchboard), £867. 10s.
Western Electric Co. (cables and underground work, including 7 years' maintenance), £7,220.
Veritye Limited (Pritchett accumulators, including 2 years' maintenance, with additional £80 for 5 years' maintenance), £1,677.
James Carrick & Sons (travelling crane), £219.
Hughes and Stirling (dust destructor, overhead bunkers not being recommended), £1,250.
Isler & Co. (artesian well), £310, less £1. 2s. for every foot under 100ft. in depth.

Weston-super-Mare District Council have received the following tenders for wiring the new pavilion :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bryant & Sons (*accepted*) | £290 | 0 | 0 | W. J. Badman & Co. ... | £353 | 0 | 0 |
| Edwards and Armstrong | 970 | 5 | 0 | C. W. Clark ..... | 335 | 10 | 0 |
| Tyler and Duncan ..... | 484 | 0 | 0 | Natl. Elec. Wiring Co. | 312 | 0 | 0 |
| Weston-super-Mare Elec. Wiring Co. ..... | 372 | 6 | 5 | H. South & Co. ..... | 310 | 0 | 0 |
| | | | | J. P. Curtis ..... | 247 | 19 | 9 |

Cardiff Corporation have received the following tenders in connection with their electric tramways :—

*Contract No. 9.—Cars.*

| | Double deck bogie. | Single deck bogie. | Double deck four wheel. |
|---|---|---|---|
| Dick, Kerr & Co. (*accepted*) ..... | £650 0 | £610 0 | £540 0 |
| British Electric Car Co. ..... | 740 0 | 670 0 | 635 0 |
| British Westinghouse Co. ..... | 712 0 | 654 0 | 604 0* |
| Do. do. ..... | 652 0 | 628 0 | 554 0† |
| International Electric Co. ..... | 680 0 | 655 0 | 570 0 |
| R. W. Blackwell & Co. ..... | 677 0 | 650 0 | 575 0 |
| Witting Bros. ..... | 677 0 | 652 0 | 576 0 |
| G. F. Milnes & Co. ..... | 674 10 | 647 10 | 573 10‡ |
| Do. do. ..... | 668 10 | 641 10 | 565 0§ |
| British Thomson-Houston Co. ... | 666 10 | 639 10 | 564 0 |
| Brush Company ..... | 660 0 | 607 10 | 577 0 |
| Hiram Maxim Eng. & Export Co. | 635 0 | 658 0 | 580 13 |

* Brush Company's body. † G. F. Milnes' body. ‡ British Westinghouse equipments. § British Thomson-Houston equipments.

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*Contract No. 10.—Main Switchboard.*

| | | | |
|---|---|---|---|
| Ferranti Limited (*accepted*). | £3,186 | R. W. Blackwell & Co. ..... | £3,825 |
| Brush Co..... | 5,050 | Mechan & Sons ..... ..... | 3,775 |
| Electric Transmission Co. ... | 4,788 | Dick, Kerr & Co. ..... | 3,750 |
| Hands Limited ..... | 4,540 | British Thomson-Houston Co. | 3,729 |
| J. G. Statter ..... | 4,500 | Dorman and Smith..... | 3,713 |
| W. J. Fryer & Co. ..... | 3,985 | Cowans Limited ..... | 3,329 |
| Belshaw & Co. ..... | 3,976 | General Electric Co. ..... | 3,300 |
| Williamson and Joseph ..... | 3,953 | British Westinghouse Co. ... | 3,250 |
| Crompton & Co. ..... | 3,891 | S. H. Heywood ..... | 2,900 |
| Moon, Loughlin & Co. ..... | 3,865 | | |

Several of the tenders were not to specification. Messrs. Dick, Kerr & Co.'s tenders were the lowest for all types of cars, as the Brush Company quoted for their own instead of Brill trucks, and also for chilled cast-iron wheels instead of wheels with wrought-iron centres and renewable steel tyres. Their tender also omitted a quotation for the tools for each car as specified, making a difference in price of £23. 10s.

At the Doncaster Council meeting on Wednesday it was moved that the minutes of the Tramways committee be not confirmed. It appeared that the committee had accepted the tender of M. Gielgud for tramway rails at £6. 2s. 6d. per ton, subject to the same being centre-grooved and having splayed ends, but subsequently M. Gielgud asked for 6s. per ton extra. It was urged that no additional price should be given to a foreign firm without English firms having an opportunity of re-tendering. It was, however, subsequently explained that all who tendered in the first instance were asked to re-tender. If the additional 6s. had been added to the original tender it would still have been the lowest. The committee's minutes were therefore confirmed.

Woolwich Borough Council have accepted the tender of the Creek Street Engineering Co. for sinking a well at the electricity works for £682.

Rochdale Corporation have accepted the tender of Messrs. Macartney, McElroy & Co. for overhead line equipment, poles, section boxes, &c., and feeder and pilot cables for their electric tramways.

Kensington (London) Borough Council have accepted the tender of Messrs. Crompton & Co. for supply of arc lamp columns in connection with the lighting of a number of main thoroughfares of the district at £1,378. 15s., and for the supply of arc lamps and meters at £1,291. 3s.

Kirkcaldy Corporation have accepted the tender of Messrs. George Smith and Sons for the construction of the permanent way of their electric tramways, laying rails, construction of car sheds, &c.

The contract for the arc and incandescent street lighting at Mexborough has been obtained by the Prism Globe Co.

St. Anne's-on-the-Sea District Council have accepted the proposals of Messrs. F. Smith & Co., of Southport, for wiring premises in the district on the easy payment system.

Ilford District Council have accepted the tender of Mr. H. E. Ellis for wiring the town hall at £205.

## BUSINESS NOTICES.

Mr. James Calmon, manufacturer of electrical fittings and accessories, 23, Temple-row, Birmingham, has taken into partnership Mr. D. J. D. Morgan, late of the Electrical Trades Supply (Ltd.), and the firm will carry on business as Calmon and Morgan.

Messrs. George Hatch (Ltd.) have removed to Crown-buildings, 20 and 21, Queenhithe, London, E.C.

Messrs. W. J. Cooper and R. M. Power (trading as Cooper & Co.), electrical engineers, &c., Bromsgrove-street, Birmingham, have dissolved partnership. Debts by Mr. Cooper, who continues.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A second and final dividend (5d.) will be payable on 23rd inst., at 24, Railway Approach, London Bridge, in the bankruptcy of A. W. Hirst (trading as Hirst & Co.), electrical engineer, St. Michael's-road, West Croydon.

In the bankruptcy of Mr. Charles Bright, 14, Copthall-avenue, E.C., the first meeting of creditors will take place on 20th inst., and the public examination on Sept. 24, at Bankruptcy Buildings, London, W.C.

A meeting of the Tramways Constructions Co. will be held at 52, Moorgate-street, London, E.C., on Sept. 26 to receive an account of the winding-up.

A meeting of the Electrical Inventions and Manufacturing Co. (Ltd.) will be held at 3, Mount-street, Manchester, on Sept. 12 to receive an account of the winding-up.

A receiving order has been made against W. R. Beckton, electrical and general engineer, 13, Brownlow-street, London, W.C. The first meeting of creditors takes place on 21st inst., and the public examination on 24th inst., at Bankruptcy Buildings, London, W.C.

A receiving order has been made against Thos. Morley, electrical engineer, 16, Whalley-road, and Borough Engineering Works, Argyle-street, Accrington.

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**Fire.**—A fire occurred on Monday at the warehouse premises of Messrs. Joseph Bakewell & Co., electrical engineers and contractors, in Old Change, London, E.C. The firm's offices and main premises are in Queen Victoria-street, and the fire will in no way interfere with the business.

**British Thomson-Houston Co's Works at Rugby.**—We learn that the electrical works of the British Thomson-Houston Co. at Rugby will shortly be completed, and it is anticipated that work will be begun in the pattern shop in about two months' time, and in the machine shop by the end of November, the entire works to be in operation in six months. The site comprises 24½ acres, of which 8 acres will be covered by roads and buildings, the latter having a total floor space of 200,000 sq. ft., most of which is under cover. Both the London and North-Western and the Midland Railways are to be connected with the works by spur tracks, so that the facilities for handling material will be ample, the canal on the north-east furnishing additional facilities if found desirable to ship by water. The buildings at present completed, but not fully equipped with machinery, are the power house, steel stores and smithy, punch and annealing shop, office building, gate house, pattern shop and pattern stores. Those partly completed and more or less roofed in are the brass foundry, iron foundry, machine shop, stores and warehouses. The construction of these buildings is of steel and brick throughout, and they are practically fireproof. On all buildings requiring the maximum of overhead light glass roofs have been erected, while large windows in the sides of the buildings give ample side light. The artificial light will, of course, be by electric arc and incandescent lighting. All the buildings will be heated in winter by hot air, propelled by powerful blowers, which will, at the same time, provide the necessary ventilation. The lavatory accommodation for the operatives is designed on a scale to compare most favourably with the best works on the Continent or in America. All the machine tools, which are of the most modern and up-to-date English, American and Continental makes, are to be electrically driven, the large tools by direct connection to individual motors and the smaller tools, conveniently grouped, by short lines of shafting. The large 84in. planers will be operated by the B.T.H. magnetic clutch drive, which permits the motors to continuously rotate in one direction, the reversing of the machine being accomplished by the magnetic clutch. The buildings have been so arranged as to permit the work to pass in at one end and continue through the various operations progressively until it reaches the testing department as a finished article with the minimum of handling in its progression. Where heavy pieces of machinery are to be handled in the buildings, overhead electric travelling cranes, of which there are 11, are to be installed, with capacities of from 2 to 40 tons. These are distributed as follows:—Iron foundry, one 30 ton and two 2 ton cranes; machine shop, one 40 ton and three 5 ton cranes; stores and warehouse, each one 5 ton crane; steel stores, one 2 ton and one 3 ton cranes. In the annealing shop a new form of Siemens annealing furnace is erected, for which great economy is claimed.

**Ironmongery and Hardware Trades' Exhibition.**—The second annual exhibition and market of the ironmongery and hardware trades is being held at the Agricultural Hall, London, N., from 14th to 24th inst. inclusive. Among the exhibitors are the Berliner Telephone Manufacturing Co., Crossley Bros., W. F. Dennis & Co., Falk, Stadelmann & Co., Fuller-Wenstrom Electric Manufacturing Co., Gent & Co., Meyra Electric Co., Renewable Electric Lamp Co., and the Stewart Electrical Syndicate. Many of the exhibits are of more than general interest, and the show is worth a visit. The stand of the Stewart Syndicate displays the latest types of "Stewart" enclosed arc lamp and a small dynamo for sewing machines of special design, as well as a number of items for which the syndicate have a deserved reputation; the Renewable Lamp Co. show their lamps in course of manufacture; Messrs. W. F. Dennis & Co. display a large assortment of electric wires and cables for various uses, as well as a good show of wire for fencing of all kinds. The latest types of high-speed gas and oil engines are to be seen at Messrs. Crossley Bros.' stand.

**"Engineering Price List."**—We have received from Messrs. J. Truscott & Son, Suffolk-lane, Cannon-street, London, E.C., a copy of the summer issue of the "Engineering Price List," which has been issued for eight years past as a guide to shippers and exporters of machinery. The book can be used by such shippers as their own catalogue, and furnishes foreign buyers with a useful record of up-to-date engineering productions. The indices are given in English, Spanish and French.

**Electrical Appliances List.**—Messrs. Ward and Goldstone, 45, Dutton-street, Strangeways, Manchester, have just issued a new list of miscellaneous electrical supplies.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured

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electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 8 to 13, with the ports of destination :—

*Africa*—Alexandria, £450 (including £414 telegraph material) ; Cape Town, £312 ; Durban, £396. *Argentina*—Buenos Ayres, £375 (telegraph wire). *Australasia*—Adelaide, £456 (telegraph cable) ; Brisbane, £97 (including £51 telegraph wire) ; Fremantle, £235 ; Launceston, £341 ; Melbourne, £404 (including £375 telegraph wire) ; Otago, £60 ; Perth, £52 ; Sydney, ££2,662 ; Wellington, £660 (including £596 telegraph material). *Brazil*—Rio Janeiro, £6,734 (telegraph material). *British Guiana*—Demerara, £110. *Ceylon*—Colombo, £47. *China*—Tientsin, £654 (telegraph material). *Denmark*—Copenhagen, £2,729 (including £508 telegraph wire). *France*—Rouen, £198. *Germany*—Hamburg, £30 (telegraph material). *Holland*—Amsterdam, £135 ; Rotterdam, £20 (telegraph material). *India*—Bombay, £24 ; Calcutta, £146 ; Madras, £64. *Malta*—£500 (telegraph material). *Norway*—Christiania, £81 (telegraph wire). *Russia*—St. Petersburg, £100 (telegraph material). *Siam*—Bangkok, £43. *Sweden*—Stockholm, £97 (telegraph wire). Total (for six days), £18,212, against £13,556 for the corresponding six days last year (Aug. 9 to 14).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 12, 1901.

7,547. H. H. LAKE. London. Improvements relating to incandescence electric lamps. (C. D. Smithers, United States.)*

7,548. L. MAICHE. London. Improvements relating to dynamo-electric machines.

7,553. S. P. THOMPSON. London. Improvements in electric alternate-current motors.

7,557. W. N. STEWART. London. Improvements in electric cables.

7,558. W. N. STEWART. London. Improved means for insulating electric conductors.

7,565. E. ROTTER and T. H. JONES. London. Improvements in and relating to systems of electric power transmission by overhead conductors.

7,576. A. T. M. THOMSON and THE THOMSON-DAVIS TELEPHONE SYSTEM (LTD.). London. Improvements in electric signalling.*

7,578. J. Y. JOHNSON. London. Improvements in or connected with graphophones or talking machines. (The American Graphophone Co., United States.)*

April 13, 1901.

7,584. F. T. TROUTON. Dublin. Improved method of obtaining electrical vibrations.

7,601. C. E. KNOWLES. Manchester. Improvements in and relating to electric glow lamp holders.

7,617. C. O. BASTIAN and J. VAUGHAN-SHERRIN. London. Improvements in electric meters.

7,619. E. ROTTER and T. H. JONES. London. Improvements in signalling on electric traction systems.

7,629. I. CELESTRE and F. GONDRAND. London. Improvements in and relating to secondary batteries.*

7,641. W. F. SMITH. London. Improvements in and relating to telephone exchange systems.*

April 15, 1901.

7,676. H. HANCOCK and D. WALTERS. Swansea. Trolley connection guide for electric traction.

7,687. E. KINSMAN. London. Printing telegraphs.

7,701. P. D. MILLOY and INTERNATIONAL TROLLEY CONTROLLER CO. London. Improvements relating to means for controlling the trolley arms of electric tramcars driven from overhead wires.*

7,702. W. S. BOULT. London. Improvements in or relating to dynamo-electric machines.

7,708. H. C. BRAUN. London. Improvements in connection with records for use with phonographs and allied talking machines.

April 16, 1901.

7,750. W. L. KING. Glasgow. Improvements in and connected with electric safety cutouts.

7,783. THE BRITISH THOMSON-HOUSTON CO. (LTD.) London. Improvements in controllers for electric motors. (W. B. Potter, United States.)*

7,791. J. S. SUNDERLAND. London. Automatic clock switch.

7,796. C. D. ABEL. London. An improvement in commutators for electric meters and the like. (La Compagnie Anonyme Continentale pour la Fabrication des Compteurs à Gaz et Autres Appareils, France.)*

7,820. W. F. HAWKSLEY. Liverpool. Improvements in devices for enabling trolley leads to be placed or replaced on the wire or cable with facility.

7,834. K. T. BENNET and J. T. JOHANSSON. London. Improvements in insulators for electric conduits.*

7,848. P. SCHARF. London. Improvements in or relating to the manufacture of incandescent electric lamps.

7,855. O. T. BLATHY. London. Improvements in means or arrangements for regulating the excitation of alternating-current machines.*

April 17, 1901.

7,867. E. BAILEY. York. Electrical explosive gases.

7,863. A. CHARLESWORTH. Manchester. Improvements in safety devices or guards for use in connection with electric traction cars or the like.

7,873. H. H. BERRY, P. F. W. SIMON, and E. SKINNER. Birmingham. Improvements in electric switches.

7,884. W. DAWSON. Cheshire. Improvements in apparatus for cleaning and scrubbing electrotype plates.

7,885. L. PETICH. London. Improvements in electro-medical apparatus.

April 18, 1901.

7,935. G. J. GIBBS. Bradford. Improvements in or relating to the grids of secondary batteries.

7,953. J. HINES. Southport. Improvements in surface contact electric traction.

7,958. J. WILKINSON. London. Novel or improved means for working or controlling semaphore or other signalling or indicating apparatus in connection with electric tramway systems by means of the trolley pole, also applicable for other purposes.

7,959. E. BUSHE. London. Increasing the economical efficiency of electric incandescent lamps.*

7,966. E. R. HILL. London. Improvements in or relating to electro-pneumatic controlling systems. (Date applied for under Patents, &c., Act, 1883, sec. 103, September 20, 1900, being date of application in United States.)

8,015. J. LENDERYOU and T. S. M. WYATT. London. A direct-acting combined magnetic regulator and brake for electric arc lamps.*

April 19, 1901.

8,102. L. CEREBOTANI and C. MORADELLI. London. Improvements in switch systems for telephone circuits.*

8,110. H. T. HARRISON. London. Improvements in means for facilitating the installation and control of electric lighting and like apparatus.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

8,439. RICHARDSON and ELLIOTT. Intercommunication by means of electro-mechanical type writing or printing instruments.

10,638. THOMPSON (Fraser Electric Elevator Co.). Devices for starting electric motors.

10,703. THOMAS. Manufacture of filaments for electric incandescence lamps.

12,296. RUSSELL. Fan or air propeller driven electrically or by mechanical power.

12,392. CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.) and WARD. Clamps for holding the ends of electrical fuses, or links acting as electrical conductors.

12,598. CONTAL. Driving axles for electric and other vehicles. (Date applied for under International Convention, Jan. 6, 1900.)

12,874. BLANCK. Telephonic apparatus.

13,085. PARIETTI and DURANTE. Method of and means for sounding alarms on electric tram and motor cars.

13,820. MOY and BASTIE. Starting switches and automatic controllers of electro-motors.

13,860. PERKINS. Controllers for electric motors. (Date applied for under International Convention, Jan. 13, 1900.)

14,895. SIMMS. Electric ignition plugs for internal combustion engines.

19,900. SPÜHL. Electric punka motors.

20,214. BERGMANN. Electric lighting cane or walking stick.

21,304. LUX. Electric meters.

1901.

3,972. CLAREMONT and STRATTON. Machines or mechanism employed in the manufacture of pipes or tubes, or for covering telegraph or telephone cables and wires with lead or other metallic substances for electric purposes.

7,959. BUSHÉ. Increasing the economical efficiency of electric incandescent lamps.

8,803. ARCIONI. Safety devices for electrical measuring instruments.

8,920. SPAGNOLETTI. Electric switches.

8,965. PARKER. Skates or contact makers carried by cars for use in a surface contact system of electric traction.

8,967. PARKER. Method of forming armature coils for dynamos, and electric motors and apparatus for use therein.

9,056. CLAREMONT and BEAVER. Electric insulation of cotton-covered cables or wires.

9,211. LAKE (Hugerford). Insulation of electrical conductors and the like and to compounds therefor.

9,217. JOHNSON (D. and W. Fuse Co.). Electric fuses or cutouts.

9,295. HADDEN (Blathy). Means for preventing the oscillation of alternators connected in parallel.

9,388. HELIOS-UPTON CO. and SPENCER. Electric arc lamps.

9,512. HEANY. Solenoid and other electric coils.

9,527. JOHNSON. (D. and W. Fuse Co.) Electrical fuses.

9,610. LAKE. (Courtney). Electrical exercising machines.

9,616. RAUSCH. Electrical time switches.

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# COMPANIES' MEETINGS AND REPORTS.

## National Telephone Co. (Ltd.).

The twenty-eighth ordinary general meeting of this company was held yesterday, Mr. JAMES S. FORBES occupying the chair.

The SECRETARY (Mr. Albert Anns) read the notice calling the meeting.

The PRESIDENT said the business of the half-year had resulted in an income accrued of £775,482, an increase of £74,879 compared with that of the June half of 1900. Looking at the circumstances of the time and the possible arrest in the progress of their business during the past year by people waiting for the unknown, it seemed to the directors that that result was very satisfactory, combined as it was with a disruption of trade and a very serious commercial condition throughout the country. The working expenses had, of course, increased, but not to the extent of leaving the company without a very satisfactory margin of improvement, although they had had to deal with the question of snowstorms—one of those disturbing influences which, unfortunately, affected them from time to time. The working expenses for the six months, including the outlay of £17,673 on this special damage, had been £457,363, an increase over those of the corresponding period of the previous year of £53,835. The June half-year must be looked upon as a provisional period. From the income accrued, the enormous amount of £73,229 for the half-year had to be deducted for Post Office royalties, an increase of £4,764 compared with the amount deducted for the June half of 1900. This item accounted for the difference in the net balance shown between revenue and expenditure and the balance accrued to the shareholders for dividend. This gave the company a net income of £702,000, or £70,000 more than for June, 1900. The net result of the half-year's working, after deducting the Post Office royalties, was a profit balance of £244,888, an increase of £16,279. There had been a relatively large growth in the working expenses, which had increased from 60·22 per cent. in the June half of 1899, and from 63·83 per cent. in the same period of 1900, to 65·12 per cent. in the past half-year. From year to year they had large stocks on hand, and a great deal of machinery both movable and fixed, which from time to time did not lose its efficiency in some senses, but which got out of date, and, therefore, although it was quite effective machinery at present, it was not quite so effective looking to future requirements. They had, therefore, made up their minds gradually to write down and to dispose of apparatus of that kind. The balance-sheet showed that very large sums were locked up in stores and plant. This half-year they had written a considerable amount off plant, and, with the concurrence of the auditors—in fact, at the latters' suggestion—the directors had brought in one or two items in the nature of writings-down for depreciation on a more liberal scale than in the previous year. This was a wise policy if it did not trench too severely upon the dividend of the half-year and the balance carried to reserve. What they had done was consistent with their paying a dividend of 5 per cent. on the ordinary shares, and carrying forward a much larger sum to reserve. With a good deal of the unknown in the position it was wise to err on the side of prudence in building up a reserve. Debenture and other interest absorbed £65,631, or £10,000 odd more than in the corresponding period last year, because since then they had raised money on debentures which had been expended in the expansion of the business. The preference and ordinary dividends—if these were approved on the scale recommended—would absorb £114,000, and it was proposed to carry £65,000 to reserve, against £55,000 a year ago. They would carry forward £5,954, or practically the same amount as last year. He then moved the adoption of the report and the payment of the dividends recommended therein.

The Right Hon. Sir HENRY FOWLER, M.P., seconded.

Mr. KELLY said the accounts would be perfectly satisfactory provided the company were not to be subjected to the guillotine in 10 years. It seemed to him that if the company continued to be managed as at present they would shortly come to a deadlock. Capital would be wanted to carry on the business. The capital issued amounted to £7,000,000, but there had also been expended £1,421,997. The reserve amounted to £964,000, which it seemed to him was too low for a company which was to be defunct in a little more than 10 years. He suggested that if no agreement was come to with the Government new subscribers should find the capital that was required—that was the £40 each which appeared to him to be the amount of the ordinary capital that was expended on each fresh exchange installation. For the £40 they might be given eight ordinary shares in the company, bearing the same dividend as the other ordinary shares, and saleable on the market, but not to carry a vote, say, until two years before the end of the lease. They did not want to give the company away to new subscribers who, he maintained, ought to bear the brunt of any loss if there was to be a loss.

The PRESIDENT said Mr. Kelly's suggestion should be considered by the directors, but the matter was a little more complicated than he appeared to think. It was found extremely difficult to induce a subscriber to pay his annual subscription in advance, and, notwithstanding that theirs was a ready-money business, there were very large outstandings. He was afraid that if a difficulty presented itself when it was a question of finding £10 or £8 to secure a service for the year, it would be a great deal more difficult if it came to finding £40.

The motion having been carried, and Mr. Forbes having been re-elected a director,

The PRESIDENT observed that the company had gone through some ups and downs, and they had had their moments of depression and elation. He was afraid that if he told the shareholders all about what he thought as to the future of the company he might express himself in an unduly elated manner. He would simply say that he thoroughly believed in the company and its future.

Sir James Fergusson, Bart., M.P., Mr. E. Heyworth and Mr. Samuel H. Sands were re-elected directors, and the auditors, Messrs. Welton, Jones & Co. were re-appointed.

Mr. LEA-SMITH asked if the president could give the meeting any information regarding the future.

The PRESIDENT said the fact was public property that negotiations were pending with the Post Office, but pending negotiations were of small moment, and all that the directors could say was that they trusted the negotiations would issue in an agreement to work amicably with the Post Office in their own interest and in that of the public. Whether, however, they would or not result in an agreement he could not say, because such negotiations were extremely difficult; they must be prolonged; they involved many different and very serious points, and they depended vastly upon judgment and an appreciation of the future, which in some respects was not so clear as it might be. The shareholders might rely on the directors doing their best to make an agreement which would benefit the company (that being the first consideration with the board) and enable them to work in amity with the Post Office. This would conduce much more effectually to the interests of those concerned in telephone matters than if such an agreement were not come to.

A SHAREHOLDER inquired if the shareholders would be called together before any agreement was come to.

The PRESIDENT said if the matters were to be put to a general meeting he feared the Greek kalends would not be in it for a general settlement. Did the shareholders think that a general meeting was competent—and, if competent, likely—to settle a matter of the delicacy and the gravity which the directors had in hand? It was impossible. The world was carried on on one great principle—faith—and if the shareholders could not trust the directors they should turn them out. If, on the other hand, they did trust them, they put them under an imperious obligation to strain every effort to achieve what was in the company's interest. He thought that there were on the board men whose knowledge of this particular business, and of commercial business generally, would enable them to protect the interests of the shareholders as ably as any board they could possibly have. He said that because these were the considerations which induced confidence, and without the shareholders' confidence the directors would be helpless. The moment an agreement was come to it would be the duty of the directors to inform the shareholders about it, but a general meeting was not required for the purpose. The moment the directors thought that the company's interests were sufficiently secured to put the seal to any agreement, the shareholders would be informed. He hoped the agreement arrived at would be satisfactory, and—although in this remark he only pledged himself—he thought it would be very satisfactory.

A cordial vote of thanks to the president, directors, and staff, was carried unanimously.

The PRESIDENT acknowledged the vote on the part of his colleagues and himself, and afterwards cordially testified to the invaluable services rendered by Mr. Gaine (the general manager), the secretary, the engineer and the staff, especially to the lady members of it, upon whom the efficiency of the service so greatly depended.

The proceedings then terminated.

## British Electric Transformer Manufacturing Co. (Ltd).

The directors' report for the year ended June 30 states that the business continues to show satisfactory and steady increase. After paying all manufacturing costs and expenses of administration, and providing for repairs and depreciation, there is a net profit of £6,658. 9s. 6d., which (with £1,802. 5s. 5d. brought forward) makes available for distribution £8,460. 14s. 11d. A dividend at the rate of 10 per cent. per annum (one-half of which was paid as interim dividend on Feb. 4 last) for the year absorbs £4,000, £2,500 goes to reserve, and £1,960. 14s. 11d. is carried forward. Though the capital upon which dividend is paid has been doubled during the year (vendors' shares now ranking for dividend) the rate of dividend is the same. A plot of freehold land has been purchased at Hayes, Middlesex, and new works are being erected thereon, which it is hoped will be completed about October. The board have granted a licence to the Union Elektricitäts Gesellschaft, Berlin, to manufacture transformers in accordance with their letters patent in Germany.

**BAKER-STREET AND WATERLOO RAILWAY CO.**—At the meeting yesterday the chairman (Mr. T. J. Hare) said the capital expenditure during the past half-year amounted to £276,850, of which £146,208 had been spent in the purchase of land, including the site of the depôt and generating station. The negotiations for the transfer of the contracts were still proceeding. In the meantime the sub-contractors (Messrs. Perry & Co.) were carrying on the works under a special arrangement with the company. They were now engaged in boring the second tunnel through the gravel-bearing strata in the river. The results of the working of the Central London Railway must, he thought, be exceedingly satisfactory to everybody interested in electric railways in London, and he saw no reason for apprehending any objection to their system, when it was completed, on the score of vibration. That was the opinion of their engineers, who had advised them that there would be no difficulty in fulfilling the conditions indicated in the interim report of Lord Rayleigh's Committee.

**BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.).**—The ordinary general meeting was held on Monday, Mr. J. Horne-Payne, K.C., presiding, who said that in order to keep pace with the continuous increase of the company's business in all departments it would be necessary to acquire further rolling stock, electrical machinery and plant, and to double-track portions of their line. They regarded the increase in business as satisfactory, but regretted that owing to certain exceptional expenses, the full benefit of the increase had not been obtained. He congratulated the

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shareholders on the growing prosperity of the company, and pointed out that between Oct. 1, 1898, and March 31, 1901, the gross earnings had increased from £75,210 to £102,435, or over 36 per cent., while the advance in the net revenue had been from £27,870 to £41,082, an increase of 47·4 per cent. Fresh capital had been necessary, of course, to meet the expansion of business, but the new preference capital for which the shareholders had been asked had only cost £6,800 a year, less £3,600 previously paid to income bondholders. The new capital had, therefore, cost exactly £3,200 a year, and this had produced in net earnings an additional £13,212 a year. To keep pace with the constant increase in the traffic and in electric lighting, extra capital had had to be found, and the outlay in the past year had amounted to £38,513, in addition to special expenditure on plant, £4,180, of which latter amount one-third would be written off every year. The capital outlay would have to be continued, though not on the same scale, and the directors would have to be very careful in meeting the demands that might be made on the company. Under the circumstances the directors might find it advisable in the future to recommend the ordinary shareholders to reserve their large cash earnings to a greater extent. The directors' report was adopted, and a final dividend of 2 per cent. on the ordinary shares for the half-year ended March 31 last was declared, making 4 per cent. for the year, and the payment of the preference dividend at the rate of 5 per cent. per annum was also confirmed.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—The half-yearly interim report of the directors states that on July 17 there were 10,060 customers, representing an equivalent of 522,497 8 c.p. lamps connected, and 14,483 lamps awaiting connection. The revenue was £126,122, against £100,550 in the corresponding period last year, an increase of £25,572. After payment of interest on debentures and loans, the net revenue available for depreciation, reserve, dividends and special charges, &c., for the first six months of 1901 (including £11,342 from 1900), is estimated to be not less than £50,000, compared with £19,538 (which included £1,622 from 1899) for the corresponding period of 1900. This result has been largely brought about by the reduction in the price of coal and the economies which have been successfully effected by the company's engineer in connection with the new continuous-current plant. The debenture interest and an interim dividend on the preference shares for the six months ended June 30 have been paid. The directors state that they have not yet succeeded in making any satisfactory arrangement with the City Corporation with reference to street lighting under the two contracts which were declared void by the Court of Appeal in February. In March the directors proposed a conference, which was acceded to by the Corporation, but was subsequently postponed at their request. Pending the result of negotiations, the public lamps are being supplied on the same terms as heretofore. The company's appeal against the excessive assessment of the generating station proposed by the Southwark rating authorities has been successful.

**LIVERPOOL OVERHEAD RAILWAY CO.**—At the meeting on Tuesday the chairman (Mr. G. H. Robertson) regretted that, in common with almost all railways, the dividend showed a reduction compared with the corresponding period last year, chiefly caused by the increased price of coal and materials. There had been an increase of traffic of £3,340, but the expenditure was larger by £5,500. There had been an increase of passengers carried by rail and tram of 694,362, the actual number of passengers carried by the trams alone being 968,936. The extension of the Liverpool Corporation system of electric trams to Seaforth had interfered with the company's railway traffic, as the trams had in a great number of cases proved more convenient for workmen living in the streets running parallel to the docks. The railway had been singularly free from accidents, and 95 per cent. of their trains had run punctually. They had carried 4,473,288 passengers, with a train mileage of 398,802, whilst the value of each passenger was 1·94d. The company was much indebted to their engineer and general manager (Mr. S. B. Cottrell) for his good work in connection with the tramway extension to Crosby, and the directors fully appreciated his energy as a manager and great skill as an electrical engineer. The report was adopted.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**FERRANTI LIMITED.**—Reg. July 17, capital £400,000 in £1 shares (£200,000 6 per cent. cumulative preference), to acquire, continue and extend the business previously carried on by S. Z. de Ferranti (Ltd.), to acquire any other electrical, mechanical or general engineering businesses or any patents relating to electricity, and to carry on the business of electrical, manufacturing and general engineers, contractors for the erection and working of central stations for the supply of electricity for motive and other purposes, constructors of railways, tramways, &c. The subscribers are :—S. Z. de Ferranti, engineer; A. B. Anderson; C. Day, engineer: G. del Rivo, engineer, and A. E. Hadley, engineer (each with 1,000 shares), and W. D. Davidson and H. V. Ashworth. Minimum cash subscription £60,000. The first directors are—S. Z. de Ferranti, A. B. Anderson, C. Day, G. del Rivo and A. E. Hadley. This company's prospectus was advertised in our issue of July 19.

**LIVERPOOL ELECTRIC CABLE CO. (LTD.)**—Reg. Aug. 10, capital £10,000 in £1 shares, to adopt an agreement with Mr. R. Taylor and to carry on the business of manufacturers of and dealers in wires, cables and lines of all kinds, electricians, mechanical engineers and manufacturers of and dealers in electrical apparatus, &c. The subscribers are J. M. Wood, R. Taylor (electrical engineer), H. G. Tippet (rubber manufacturer), C. S. Watson, S. H. Follin, P. Lace and C. Collins. The first directors are G. Jaeger, J. M. Wood and R. Taylor.

**WITTING BROTHERS, ELECTRICAL ENGINEERS (LTD.)**—Reg. Aug. 1, capital £40,000, in £20 shares, to adopt an agreement with Witting Brothers (Ltd.), to carry on the business of electrical and general engineers, contractors and manufacturers of and dealers in electrical and other machinery and articles to or in connection with which electrical power or electrical process of any kind may be applied or used. The first directors are S. C. Witting, F. Charles and L. Wiese.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26 1/16d. per oz. (Aug. 15). Consols (2¾ per cent.) 94⅞—94⅞ for money, 94⅞—94⅞ for account; 2½ per cent. 94¼—94¾ (Aug. 15). Consols Pay Day, Sept. 2; Stocks and Shares Continuation Days, Aug. 27 and Sept. 10; Ticket Days, Aug. 28 and Sept. 11; Pay Day, Aug. 29; Mining Share Carry-over Days, Aug. 26 and Sept. 9.

**BRAZIL.**—The Compagnie d'Eclairage de Bahia has been formed in Brussels, with a capital of £40,000, to carry out electric and gas lighting in Bahia.

**BRITISH ELECTRIC TRACTION CO. (LTD.)**—The dividend on the 6 per cent. preference share capital for the half-year to Aug. 15 has been declared.

**ELECTRICITY IN RAILWAY WORKING.**—At the meeting of the Midland Railway Co., on Friday, the chairman (Sir Ernest Paget) stated, in reply to questions, that the company had sent two gentlemen to America to study railway methods there, particularly in the locomotive departments, and they would especially study the use of electricity in place of steam and hydraulic power.

**IMPERIAL TRAMWAYS CO. (LTD.)**—An interim dividend for the June half-year at the rate of 8½ per cent. per annum has been declared, against 7½ per cent. last year.

**METROPOLITAN DISTRICT RAILWAY CO.**—The total receipts for the June half-year amounted to £200,747. 15s., against £224,429. 2s. 2d. for the corresponding half of 1900, and the profit amounted to £87,552. 4s. 9d., against £115,560. 16s. 3d. The number of passengers carried was 19,564,846, against 20,864,482. The directors' report states that the result of the half-year's working reveals the serious consequences to the company of the competition of the Central London Railway already experienced in the December half-year, and now aggravated by the effect upon the traffic of the extension of the electric tramway system on roads running parallel to the western extension lines. To cope with this severe competition there has been a revision of fares, which has already tended to diminish the possibility of further loss of passengers. The company's bill for confirming the agreement with the Metropolitan District Electric Traction Co. (Ltd.) for the conversion of the company's lines to electric traction has received the Royal assent.

**STOCK EXCHANGE NOTICES.**—Application has been made to the Stock Exchange committee to allow the further issue of 30,000 six per cent. cumulative preference £10 fully-paid shares (Nos. 160,001 to 190,000) of the *British Electric Traction Co. (Ltd.)*, and 160,000 six per cent. cumulative preference £1 fully-paid shares (Nos. 1 to 160,000) of *John I. Thornycroft & Co. (Ltd.)* to be quoted in the official list.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Aug. 10 | 898 | +93 | 10 | 8,735 | +997 |
| *Birmingham Tramways. | ,, 10 | 5,174 | + 772 | 5 | 24,533 | + 1,536 |
| *Blackburn Corporation.. | ,, 9 | 524 | + 27 | †32 | 15,316 | + 1,303 |
| Blackpool Corporation... | ,, 8 | 2,218 | + 844 | †19 | 18,841 | + 4,754 |
| Blackpool and Fleetwood | ,, 10 | 2,143 | + 239 | 6 | 7,684 | - 103 |
| Bolton Corporation ..... | ,, 11 | 1,457 | + 15 | 19 | 28,975 | + 2,998 |
| Bradford Corporation... | ,, 11 | 1 317 | + 814 | 19 | 20,227 | +10,721 |
| Brisbane Trams ..... | June 26 | 1,817 | + 145 | ... | ... | ... |
| *Bristol Trams & Carriage | Aug. 9 | 3,373 | - 688 | 5 | 22,009 | + 3.743 |
| *Buenos Ayres & Belgrano | July 14 | 2,744 | + 368 | 2 | 5,328 | + 726 |
| Calcutta Trams. Co. ... | Aug. 10 | R21,826 | +R1,726 | 6 | R 22,631 | + R6,357 |
| Carlisle Trams. Co. ..... | ,, 10 | 208 | + 4 | 6 | 1,340 | + 57 |
| Central London Railway | ,, 10 | 5,825 | + 782 | 6 | 35,902 | ... |
| City & South London Ry. | ,, 11 | 1,781 | + 226 | 6 | 11,049 | + 2,048 |
| Cork Elec. Trams ..... | ,, 8 | 614 | + 92 | 31 | 14,579 | + 1,917 |
| Dover Corporation ..... | ,, 10 | 373 | + 57 | 19 | 4,608 | + 321 |
| Dublin & Lucan Rly. ... | ,, 11 | 171 | + 64 | 6 | 892 | + 183 |
| Dublin United ..... | ,, 9 | 4,427 | + 669 | ‡6 | 23,707 | + 1,957 |
| Dublin Southern Dist.... | ,, 9 | 1,352 | + 363 | ‡6 | 6,903 | |
| *Dundee Corporation ... | ,, 7 | 669 | + 221 | 6 | 4,359 | + 1,484 |
| *Glasgow Corporation ... | ,, 10 | 12,042 | +3,215 | 10 | 118,893 | +26 038 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ..... | ,, 10 | 1,855 | + 499 | 6 | 10,691 | + 2,615 |
| Liverpool Corporation... | ,, 3 | 9,807 | +1,211 | 31 | 271,504 | +37,862 |
| *Liverpool Overhead Rly. | ,, 11 | 1,917 | + 41 | 6 | 10,572 | + 197 |
| *Manchester Corporation | ,, 10 | 2,377 | ... | §9 | 16,829 | + 63 |
| Perth (W.A.) Elec. Trams | ,, 9 | 800 | + 422 | ‡6 | 5,767 | + 3,606 |
| Portsmouth Corporation | ,, 10 | 1,334 | + 33 | ... | ... | ... |
| *Sheffield Tramways ..... | ,, 11 | 4,001 | +1,456 | 6 | 22,829 | + 7,259 |
| Southampton Corporat'n | ,, 8 | 1,237 | + 539 | 6 | 5,788 | + 2,084 |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 7: | | Price Wednesday, Aug. 14: | | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending Aug. 14. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ½ | ½ | ½ | ½ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅜ | 8½ | 7⅜ | 8½ | 3 12 9 | ... | ... | ... |
| 13,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¼ | 8⅝ | 8¼ | 8⅝ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅜ | 8 | 7⅜ | 8 | 2 3 9 | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 5⅝ | 5¼ | 5⅝ | 3 18 3 | ,, ,, | 5 11/16 | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 103 | 105 | 103 | 105 | ... | ... | 104½ | 10 ½ |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5⅜ | 6 | 5½ | 6 | 4 11 8 | March | 5⅝ | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 107 | 110 | 107 | 110 | 4 2 0 | June and December | ... | ... |
| 70,579 | 10 | 3/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8⅝ | 8½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 | 13 | 11½ | 12½ | 4 16 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 120 | 125 | 120 | 125 | 4 0 0 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 99 | 101 | 99 | 100 | 4 9 7 | ... | 100 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 4 4 3 | ... | 8⅝ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 13 4 | March and September | 12⅝ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | 105 | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5½ | 5⅝ | 5½ | 5⅝ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅞ | 7 | 6⅞ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Knigtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13 | 14 | 4 5 9 | April and October | 13⅛ | 13⅜ |
| 13,769 | 10 | 9d. | Do. (85,001 to 98,769) | 13 | 14 | 13 | 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 108 | 111 | 109 | 112 | 4 0 9 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 94 | 97 | 94 | 97 | 3 12 0 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15 | 16 | 4 7 6 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6⅜ | 5⅝ | 6⅜ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 400,000 | 1 | 1/0 | Rand Electric | 1/16 | 1/8 | 60 1/16 | 70 1/16 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 68 | 75 | 60 1/16 | 70 1/16 | ... | January and July | ... | ... |
| £115,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 6 2 | April and October | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | 15 | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9⅜ | 8½ | 9⅜ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2⅜ | 2½ | 2⅜ | 2½ | ... | ... | 3 1/16 | 3 |
| 109,518 | 5 | 5/6 | Westminster Electric Supply Ordinary | 11⅜ | 12 | 11⅜ | 12 | 4 7 6 | March and September | 12 1/16 | 12 |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4½ | 3⅞ | 4⅛ | 4 17 0 | April and October | ... | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 124 | 129 | 4 13 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 10 | 8 | 9 | 2 4 5 | ... | 8⅛ | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £50,900 | 100 | 5% | Do. 5% Debentures | 95 | 100 | 95 | 100 | 5 0 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams, Investment Ord. | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ | 4⅝ | 4½ | 4⅝ | ... | ... | ... | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 101 | 103 | 102 | 104 | 4 7 0 | ... | 103½ | 10 ½ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 21½ | 22½ | 21⅜ | 22⅝ | 3 15 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 | 115 | 112 | 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6¾ | 7 | 6¾ | 7 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9¼ | 9⅝ | 9¼ | 9⅝ | 5 2 7 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅞ | 102⅞ | 100⅞ | 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 13⅜ | 14⅜ | 13⅜ | 14⅜ | 7 0 4 | ... | ... | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 12⅝ | 12 | 12⅝ | 4 16 0 | February and August | 12 7/16 | 12½ |
| £250,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 122 | 125 | 122 | 125 | 4 0 10 | ... | ... | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅜ | 1⅞ | 1⅜ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5⅝ | 5¼ | 5⅝ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5¼ | 5⅝ | 5¼ | 5⅝ | 2 3 6 | ... | 5⅝ | ... |
| £220,000 | Stock | 5% | Do. 5 per Cent. Debentures | 103 | 105 | 102 | 105 | 4 15 3 | ... | 104 | 103 |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11½ | 12½ | 11½ | 12½ | 2 8 0 | ... | 12½ | 11½ |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 103 | 105 | 104 | 106 | 4 5 6 | ... | 105⅝ | 104⅜ |
| 400,000 | 1 | 1½ | Cape Electric Tramways Shares | 1⅜ | 1⅝ | 1⅜ | 2 | 3 0 0 | ... | ... | ... |
| £1,969,800 | Stock | ... | Central London Ordinary Stock | 99 | 102 | 101 | 104 | ... | June and December | 104 | 9 ½ |
| £440,100 | Stock | ... | Do. 4% Preferred Stock | 102 | 105 | 103 | 103 | ... | ... | 105½ | 102 |
| £440,100 | Stock | ... | Do. Deferred Stock | 93 | 101 | 96 | 100 | ... | ... | 100 | 98 |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ | 5⅝ | 5¼ | 5⅝ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 100 | 103 | 103 | 105 | 3 17 1 | ... | 103½ | ... |
| £355,000 | Stock | 1½% | City and South London Railway Con. Ordinary xd | 52 | 54 | 52 | 54 | 2 15 7 | February and August | 53 | ... |
| 47,500 | 10 | 2/0 1/16 | Do. Ordinary (Nos. 22,501 to 70,000) | 5¼ | 5⅝ | 5¼ | 5⅝ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 | 134 | 129 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 133 | 137 | 133 | 137 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 112 | 117 | 112 | 117 | 3 8 6 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 11¼ | 11⅝ | 11¼ | 12⅛ | 4 0 0 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 102 | 98 | 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5⅛ | | 5⅛ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 22 | 22⅝ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 111 | 113 | 3 19 8 | January and July | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7⅛ | 7⅜ | 7⅛ | 7½ | 4 6 8 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 104 | 103 | 104 | 3 16 11 | January and July | ... | ... |
| £350,000 | Stock | 3⅛ | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | 106½ | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 7 9 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 100 | 102 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3⅛ | 3 | 3⅛ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 12,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 12 | 13 | 12 | 13 | 1 10 9 | ... | ... | ... |
| 26,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 9½ | 10½ | 4 15 [illegible] | February and August | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 105 | 108 | 105 | 108 | 4 3 4 | ... | 107 | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 8% | Waterloo and City Ordinary | 93 | 93 | 91 | 94 | 8 4 10 | June and December | 93 | 92½ |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 7. | Price Wednesday, Aug. 14. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Aug. 14. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 98 101 | 98 101 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ 4⅛ | 3⅜ 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 52 55 | 52 55 | 5 14 0 | Feb., May, Aug., Nov. | 51⅛ | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 97 99 | 97 99 | 6 1 3 | ,, ,, | 98 | 97 |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 9⅜ 10⅛ | 9⅜ 10 | 2 10 0 | ,, ,, | 9⅝ | 9⅜ |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 103 | 101 103 | 3 17 9 | ,, ,, | 103 | ... |
| 15,000 | 10 | 4/0 | Cuba Submarine Ordinary | 6⅛ 7⅛ | 6 7 | 6 8 7 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14⅜ 15½ | 14⅜ 15½ | 6 9 0 | ,, ,, | ... | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 99⅝ 103⅝ | 99⅝ 103⅝ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10⅛ 11⅛ | 10⅛ 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | ... | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 102 | 99 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 141 146 | 142 147 | 4 15 3 | Jan., Apr., July, Oct. | 145 | 142 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 92 95 | 94 97 | 3 12 4 | ,, ,, | 95 | 94½ |
| £1,132,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 114 | 112 116 | 3 9 7 | May and November | ... | ... |
| 300,000 | 10 | 2/6 | Eastern Extension | 13¾ 14¼ | 13¾ 14¼ | 4 15 0 | Jan., Apr., July, Oct. | 14⅛ | 13⅞ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 110 115 | 111 116 | 3 9 0 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 102 | 99 102 | 3 18 5 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 100% 103% | 100% 103% | 3 17 10 | May and November | ... | ... |
| 150,000 | 10 | 5 0 | Great Northern of Copenhagen | 31 33 | 31 33 | 4 10 11 | January and July | ... | ... |
| £678,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos | 99 102 | 99 102 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37 6 | Indo-European [1 to 1,200) (red. | 41 45 | 41 45 | 5 11 1 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 102 | 99 102 | 3 18 6 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 101 104 | 101 104 | 4 13 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ ⅜ | ¼ ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 102⅜ | 99 102⅜ | 3 18 6 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅛ ⅜ | ⅛ ⅜ | ... | May and November | ⅛ | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 4½ 5⅛ | 4½ 5⅛ | ... | ,, ,, | ... | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 16 2 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 13⅜ 14½ | 13⅜ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14⅞ | 13⅞ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| £343,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 100 103 | 100 103 | 3 17 8 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3⅜ 4⅛ | 3⅜ 4⅛ | 4 14 2 | August | ... | ... |
| 234,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 1/6 2/6 | 3/0 3/6 | 8 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ½ ⅝ | ½ ⅝ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| £90,000 | 5 | 2/6 | National | 3⅛ 3½ | 3⅛ 4 | 6 5 0 | February and August | 4⅛ | 3⅛ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 13 | 11 13 | 4 12 1 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 13 | 11 13 | 4 12 4 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ 4⅜ | 4⅛ 4⅜ | 5 14 3 | ,, ,, | 4⅛ | 4⅛ |
| £2000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 89 92 | 89 92 | 3 16 3 | June and December | 9 3/8 | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 94 97 | 94 97 | 4 2 9 | ... | 95⅛ | 95 |
| 171,504 | 1 | 0/8⅜ | Oriental | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5⅛ | 5 5⅛ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅝ 5⅛ | 4⅝ 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 16 2 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅝ ¾ | ⅝ ¾ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅝ ¾ | ⅝ ¾ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅝ ¾ | ⅝ ¾ | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10 11 | 9½ 10⅛ | 7 2 10 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6 6½ | 6 6½ | 4 12 4 | January and July | 6⅛ | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ 5 | 4½ 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1½ 1⅝ | 1⅛ 1⅜ | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2¼ | 2 2¼ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 4 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14 15 | 14½ 15⅛ | 4 13 9 | ,, ,, | 14 15/16 | 14⅞ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ 6 | 5⅛ 6⅛ | 4 0 0 | ,, ,, | 6 | 5⅛ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 107 111 | 107 111 | 4 1 0 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 95 | 92 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 5 10 0 | March | 1 1/16 | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 1/9⅜ | Crompton and Co. (Nos. 1 to 54,000) | 3⅜ 4 | 3⅜ 4 | 5 12 7 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.) | 100 105 | 100 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ½ 1 | ½ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ⅛ ⅛ | ⅛ ⅛ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ 2½ | 1½ 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 85 90 | 85 90 | 5 14 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5⅜ 6⅛ | 5⅛ 6⅛ | 5 12 0 | Half-yearly | 6⅛ | 6 |
| 20,000 | 5 | 1/6⅛ | Do. 6% Cumulative Preference | 5⅛ 6 | 5⅛ 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 106 | 103 106 | 4 4 11 | ... | 1 1/16 | 1⅛ |
| 112,100 | 5 | 1/5⅜ | Electric Construction Co. | 1⅛ 2 | 1⅛ 2 | 6 0 0 | January and July | ... | ... |
| 25,000 | 2 | 2/9⅜ | Do. 7 per Cent. Cumulative Preference | 2⅛ 2⅜ | 2⅛ 2⅜ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 102 | 98 102 | 3 18 5 | January and July | 100⅛ | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅛ 10⅛ | 9⅜ 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 102 | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15⅞ 16⅜ | 16 17 | 5 17 8 | February and August | 16⅜ | 1 7/16 |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 6 | 5⅛ 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 113 | 109 113 | 4 1 1 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 13 0 | ,, ,, | ... | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 37 41 | 37 41 | 5 2 5 | March and July | 40⅛ | 39 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 104 | 102 105 | 3 16 7 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10⅛ 11⅛ | 10⅛ 11⅛ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ 6 | 5⅛ 16 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | 10 13/16 | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | 7 | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,000 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 10⅛ 10⅜ | 10⅛ 10⅜ | 4 17 8 | Jan., Apr., July, Oct. | 10 5/16 | 10⅜ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14⅛ 15⅛ | 14⅛ 15⅛ | 3 18 8 | ,, ,, | 15 1/16 | 14⅛ |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 130 | 125 130 | 4 12 10 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee refuses to quote these

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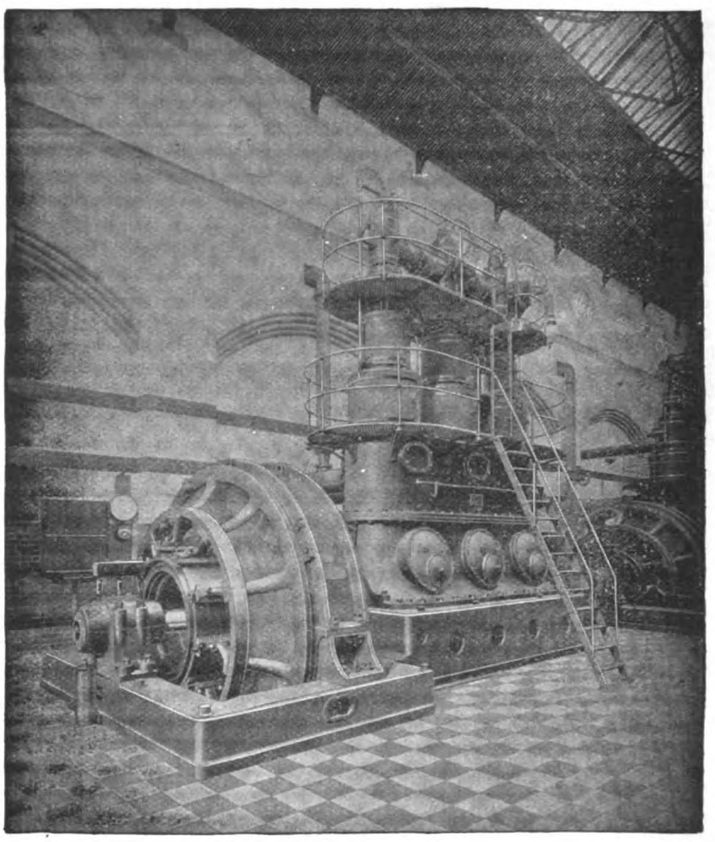

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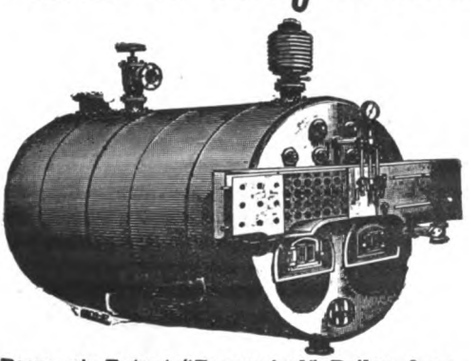

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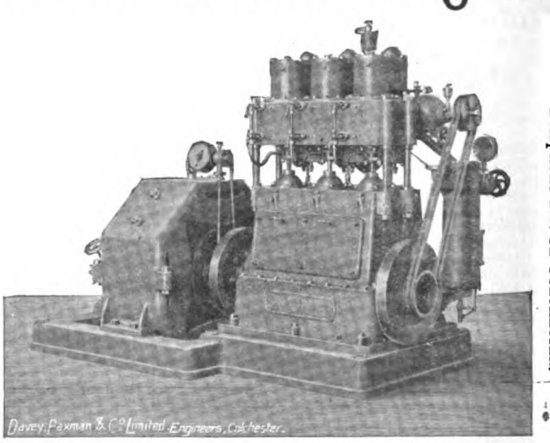


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ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,214. [No. 18. Vol. XLVII.] FRIDAY, AUGUST 23, 1901. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

MR. GEORGE WESTINGHOUSE, in a letter to *The Times* which we reprint elsewhere, deals with the question of both electric locomotion and electric supply. From the heading of the letter we must infer that Mr. WESTINGHOUSE's remarks are intended to be applicable to tramways as well as railways, though very little specific mention is otherwise made of them. The writer's panacea is the use of large dynamos driven by gas engines at one central supply station distributing current to carriages similar to those employed on the Central London Railway, but fitted with motors equipped with "unit control." No doubt there is considerable opening for large gas engine driven plant in particular cases, especially where such gas is a waste product, but we are afraid that, for electrical generating stations in London, it will not yet be found practical. As regards "unit control" systems, their extended use in the United States speaks for their fitness under the conditions prevalent in that country. In England we do not think their principal advantage—the ease of joining and separating trains—will be so apparent. With tramways we are convinced that the road authorities will never allow the use of tramcars coupled in trains. With the tube system of railways now being inaugurated, the change from one railway to another by footpath, as carried out at the Bank Station, between the City and South London Railway and the Central London Railway, presents less difficulties than the method of a large number of companies obtaining running powers over various lines. Take, for instance, the Inner Circle with its several branches; to utilise the "unit control" system to its fullest advantage almost every train would be made up of carriages each belonging to a separate company. The proposed subway lines of the London County Council alone remain; if the scheme is sufficiently comprehensive, the adoption in it of unit or multiple control might be advantageous.

HEBBURN, a small town on the right bank of the Tyne, made itself famous last year by its opposition, as vigorous as it was unreasonable, to two power supply companies which were desiring to obtain powers to supply electrical energy on a wholesale basis to this district among several others. The District Councils of Hebburn and of Felling, a neighbouring little town, had made up their minds each to supply electrical energy for themselves within their own districts, and, with the help of their consulting engineers, adduced marvellous figures to show how economically this could be done. So vigorous was the action of these two little towns that, although the Committee of the House of Commons saw no reason to omit them from the bill of the County of Durham Electric Power Supply Co., which was the one of the two competing power schemes which the Committee had selected for its approbation, the House of Lords was induced to strike out Hebburn and Felling from the supply area eventually granted to the company. In the case of Hebburn, at all events, this scheme for a most economical local generating station has fallen through, and, having now no "bulk" supply to fall back upon, the Hebburn Council has made up its mind to transfer its provisional order to the Northern Counties Electricity Supply Co., although it was almost pledged by its action in Parliament last year to build its own works and supply electricity both for lighting and motive power. We do not doubt that this company, which has gradually acquired a fairly large sphere of operation by means of provisional orders, will be able to furnish an efficient supply, although probably no cheaper or better than the County of Durham Company would have done; but the Hebburn District Council must have put its ratepayers to large and entirely unnecessary expense in opposing the latter company's bill, with the net result that they are, if anything, in a worse position than before, although they obtained what was sought. There is, of course, the possibility that the Board of Trade will not sanction the transfer. In contra-

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distinction to this method of procedure, we may mention that of the Stockton Rural District Council. This body has decided to apply to the Board of Trade for a provisional order empowering it to retail electrical energy in no less than 19 villages in the Stockton rural district, and proposes to take power wholesale either from the Stockton Corporation or the Cleveland and South Durham Electric Power Co.

It is surprising what ignorance still exists as to the precise legal power of a local authority under a provisional order. Thus the Board of Trade, we believe, will be quite in order in refusing the transfer of the Provisional Order referred to above. A case which has recently occurred at Ryde, and is reported in another column of this issue, is a parallel one in this respect, but it is seen how the difficulty can be evaded by substituting for a transfer of the provisional order a contract making the company sub-undertakers. A delightful example of an action whose legality is doubtful is that afforded by the Farnworth District Council, which is now supplying electrical energy free of charge to all consumers until the formal opening of its electricity works next Wednesday.

The dilute solution is probably the best explored medium in chemical physics. It shows some striking analogies to a perfect gas, and its intimate structure has been to a large extent laid bare by workers of the school of Ostwald and Nernst. The behaviour of the ions of a dilute solution is the key to the most profound problems of electrical science. Any researches which clear up obscure points in this domain are, therefore, of special value. One of these points is the influence of gravitation upon the motions of the ions. If they were particles of dimensions within the reach of the microscope, it would be safe to assume that gravitation would exert a very marked effect upon such motions. But even as it is a measurable effect may be looked for when the action of an electric current consists in transferring metal from one electrode to another against the force of gravity. For in this case definite mechanical work is done, which it would be quite feasible to measure in integers of foot-pounds with suitable apparatus. Researches dealing with this subject have already been made with varying success by Maxwell, Pirani, Colley and Gore, and these have now been supplemented by Miss Ramsey, who has succeeded in obtaining very consistent results, especially with cadmium electrolytes and electrodes. The effect observed amounts to a change in the E.M.F. of a few millivolts only, but there is every indication that it is a direct gravitational effect. The migration ratio is only 0·02, which shows that the anions are moving with a very small velocity in a direction opposed to the cations. The tendency in a concentrated solution would be for both ions to settle down to the lower end of the tube and produce a difference in concentration. The net result of the experiments is to show that our mechanical grip upon the carrier of "electricity" is steadily increasing.

In our issue of January 18th we described Prof. Slaby's "tuned" system of wireless telegraphy, indicating the theoretical principles on which it is based. More recently Prof. Slaby has delivered another lecture on his method, and we publish an extract of this in another column, with diagrams of the connections employed—and employed with complete success. The conclusion of his article, with its allusion to the present work of Mr. Tesla, comes as a considerable surprise. No one will deny that Mr. Tesla possesses genius—his valuable work in connection with polyphase methods alone demonstrates this. But from the soil of his genius have sprung up two varieties of dangerous weeds—a craving for notoriety and dreams of ultimate possibilities, and these have grown so thickly that it requires a skilful gardener indeed to discover the fruit. If Prof. Slaby has patience enough to do this it redounds to his credit; for otherwise if the illustration in the professor's lecture is a true picture of the condition of Mr. Tesla's laboratory, it seems probable that the ultimate result of the séances held by the wizard of the Rocky Mountains may be merely another wildly imaginative article such as that written by Mr. Tesla in the *Century Magazine* a year ago, or a description of an elaborate attempt to inspire an appreciative personal notice in the sensational press of the Martians.

Obituary.—We regret to announce the death of Mr. Charles A. Schott, who is well known for his researches in physical science, more especially in the region of terrestrial magnetism.

Opening of the Electricity Works at Penarth.—These works, which have been erected by the Electrical Power Distribution Co., are now completed, and the supply of current will be commenced in the course of a few days.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiros | April 21, 1901 |
| Nase, Rinkin—Kelung, Formosa | Aug. 2, 1901 |
| Cadiz—Teneriffe | Aug. 6, 1901 |
| Bolama—Bissao | Aug. 16, 1901 |

International Engineering Congress at Glasgow.—With reference to our note on page 550 of the present volume, we are now officially informed that on September 3rd, after the short introductory address by the President of the Institution of Electrical Engineers, Mr. W. B. Sayers will read a Paper, "Notes on some Electrical Exhibits in the Exhibition," followed by a short organised visit to the exhibition. Mr. A. R. Sennett's Paper will be omitted.

Interruption of Supply at Aberdeen.—One of those particularly annoying accidents to which three-phase systems are subject occurred on the Aberdeen mains last Friday. It appears that a fault developed on one of the outers, which caused a considerable rise in pressure on the other side of the network, and burst several lamps and blew some fuses on consumers' premises. To localise and remove the fault it was found necessary to cut off the supply in sections, but the interruption was not long in any instance.

Wireless Telegraphy.—As the Government has now established an installation of wireless telegraphy at Dover, and Lloyd's is also setting up an installation there, the Dover Chamber of Commerce on Wednesday decided to petition the Trinity House authorities to replace the wireless apparatus on the Goodwin lightship, which was removed about a year ago.——The "Lucania," which left Liverpool on the 10th inst. for New York, was spoken by wireless telegraphy at Nantucket Lightship shortly after six last Friday evening, 287 miles from Sandy Hook. On reaching port the officers of the "Lucania" reported that the messages from Nantucket were undecipherable aboard ship. One or two other vessels have communicated satisfactorily with the lightship.

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Experiments on the Central London Railway.—It is well known that experiments are being conducted on the Central London Railway with a view to reducing the vibration. These experiments are being made both to strengthen the permanent way by making the bed more rigid at the rail joint, and to diminish the dead weight of the locomotive. Besides this, a trial of the multiple unit system is being made in order to reduce still further the dead weight. Three locomotives with geared motors have been ordered, and one of these has been on trial for some time. In the new locomotive the two trucks weigh about 33½ tons against 42½ tons with the old gearless type. The dead weight is about 5 tons, four 150 H.P. motors are employed, the ratio of reduction is 3·3, and the distance between wheel centres on each truck is 6ft. We believe that the vibration has already been tested and found to be a tenth of that with the old locomotives whose motors are directly mounted on the axles. In the case of the multiple unit system, a train of eight carriages is being fitted. Two geared motors are placed on alternate carriages, each motor being rated at 80 H.P., the ratio of reduction being about 2·8. A successful trip with four carriages was made on Tuesday. The work in connection with both the geared locomotives and the multiple unit train has been carried out by the British Thomson-Houston Co.

Seventy-third Meeting of German Men of Science and Physicians.—*Nature* quotes from the programme of the seventy-third meeting of German Men of Science and Physicians, to be held at Hamburg on September 22nd to 28th. As there are eleven sections dealing with different departments of natural philosophy, and twenty-seven sections in the group of medical sciences, it is easy for all who are engaged in scientific work to find a section in which they are particularly interested. On September 23rd and 27th there will be general meetings at which lectures will be given. On the former date the lectures to be delivered will be on Hertz electric waves and their further development, by Dr. E. Lecher; the chemical properties of the cell, by Dr. F. Hofmeister; and the problem of fertilisation, by Prof. T. Boveri. On September 27th the lectures will be on medicine and maritime intercourse, by Prof. H. Curschmann; the significance of electrical methods and theories in chemistry, by Prof. W. Nernst; and on the natural energy of organisms, by Prof. J. Reinke. There will be a joint meeting on September 25th for the discussion on atoms, from the point of view of recent investigations and conclusions on ions and electrons. The president of the meeting is Prof. R. Hertwig, of Munich. Prof. van 't Hoff is the president of the group of natural philosophy sections, and Prof. Naunyn the president of the sections of medical sciences.

The "Hydroleum" System of Burning Liquid Fuel.—On Wednesday we visited Messrs. Muirhead & Co.'s works at Elmer's End, where we saw a 50 H.P. Hornsby water tube boiler and a motor car fitted on the "Hydroleum" system. The feeder for the liquid fuel has two passages through it, one passage being connected with the oil supply and the other being a steam connection from the boiler or elsewhere. The feeder is so constructed as to concentrate the issuing vapours instead of spreading them too abruptly; the oil is only at atmospheric pressure, and the reservoir from which the feeder takes its supply is slightly lower than the outlet nozzle of the feeder, thus preventing any flow of oil into the furnace when the feeder is not in action, and also allowing the feeder to suck its proper quantity of oil, no matter whether the combustion be fast or slow. The two passages through the feeder are arranged concentrically, the oil outlet being the central one and in advance of the steam one which surrounds it. This formation permits of a vacuum being formed in front of the oil orifice, which vacuum produces a suction of oil from the reservoir. The outflow of oil relatively to the volume of outcoming steam is regulated by a needle valve operating at the point of outlet. The makers state that no deposit of carbon occurs in the feeder, so that it never requires cleaning. The intimate mixture of vapour is directed on to a dash-brick, but it is essential, in order to produce complete combustion, that the dash-brick should be of a certain size, and located in a certain position, and that between it and the feeder nozzle should be an enveloping constricted passage of refractory material, the area of which bears a certain proportion to the size of the feeder employed. By these means every particle of vapour is kept together until it fires on the dash-brick, which, owing to the concentration of the vapours at that point, and its comparatively small area, rapidly becomes sufficiently heated to split up the vapour into its component gases. After leaving the brick the latter re-unite and give out heat in the main combustion chamber. The makers have made a test of the comparative power of water gas tar consumed in the boiler. The result was as follows:—Duration of test, two hours; mean temperature of feed water, 70°F.; mean pressure on boiler, 90lb.; pounds of water evaporated, 2,400; pounds of tar consumed, 211; pounds of water evaporated per pound of tar from and at 212°F., 13·47; price of tar, 19s. 0½d. per ton. We understand that this experiment does not allow for the steam used to suck the oil, and that this may amount to about 10 per cent. of the total water evaporated, which would reduce the useful weight of steam per pound of tar from 13·47 to 12·12lbs.

The Pacific Cable Debate in Parliament.—In the course of the debate in the House of Commons on the second reading of the Pacific Cable Bill, Mr. H. Heaton made a number of mis-statements regarding the early history of submarine cable laying between this country and Australasia. Among the statements made was one to the effect that in 1870 the Australian Government had been "jockeyed" into constructing an enormous landline, and had in this way considerably increased the cost of telegraphic communication; and, further, that the Eastern Extension Telegraph Co. and its predecessors, the British Australian Telegraph Co., notwithstanding the receipt from Government of large subsidies, charged excessive rates for cabling. A further statement was made by Mr. Heaton that it was only by the Australian Government promising a large subsidy that the rate was subsequently reduced to that at present charged. The true facts of the case have been set out in a letter from Mr. F. E. Hesse, manager of the Eastern Extension Company, which has appeared in the Press this week, as follows:—

With regard to the alleged "jockeying." When our predecessors, the British Australian Telegraph Co., arranged to establish cable communication between this country and Australia they proposed to land their cable at Port Darwin (northern territory of South Australia), thence extending it to Normanton (northern territory of Queensland), and constructing a landline from that point to Burketown, where it would join the Queensland Government telegraphs. But before the company's plans were definitely arranged the South Australian Government expressed a wish to have Port Darwin made the cable terminus, and voluntarily offered to establish, at their own cost, an efficient landline service between Port Darwin and Adelaide. As the company would thus be relieved of the construction and maintenance of a long and difficult landline through comparatively unknown country, the offer was accepted and the extension of the cable beyond Port Darwin abandoned. This change of route did not, however, "considerably increase the cost of cable communication," as the tariff would have been the same whether the telegrams had traversed the Queensland or South Australian Government landlines.

Now, as to the second point—that the company was "established by Government subsidies," and that "they charged enormous rates." The original cable to Australia was laid without the company receiving any Government subsidy or other privilege, and this at a time when cable enterprise was considered very risky, and the prospect of a remunerative traffic most remote.

The first tariff for messages between London and Australia was £9. 9s. for 20 words, that being the system in vogue over all international lines until a word rate was adopted by the International Telegraph Conference held at St. Petersburg in 1875. The tariff was then divided by 20—which worked out at about 9s. 6d.—and this was rounded up to 10s. 6d. per word; consequently, Mr. Heaton's assertion that the rate "on pressure being brought to bear was reduced to 10s. 6d. per word" is entirely fallacious, as is also the statement that "only by the Australian Government promising a large subsidy was the rate reduced to 4s. a word." The Eastern Extension Company has never received a subsidy for reduction of tariff. The reduction to 4s. was effected by a guarantee arrangement under which the company undertook to bear one-half of the loss resulting from such reduction, the Governments concerned bearing the other half.

The tariff is now 3s. 6d. per word, and if the "standard revenue" arranged between my company and certain of the Australian States is maintained, it will be further reduced on Jan. 1 next to 3s., and on Jan. 1, 1903, to 2s. 6d. per word. The existing rate (3s. 6d.), however, is one of the lowest in the world, and works out at 0·29d. per 100 miles of transmission—against 0·34 charged between London and New York, where an enormous traffic is transmitted and the keenest competition prevails.

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## CONTEMPORARY ELECTRICAL SCIENCE

[Compiled by E. E. Fournier D'Albe.]

*Metallic Conduction.*—E. Riecke attempts the question: Is metallic conduction attended by a transport of metallic ions? Such a transport of ions was suggested by the observed diffusion of metallic ions through solid metals, and was consistent with the author's electro-thermal theory. The apparatus used by the author consisted of three equal cylinders, two of them being of copper and the third of aluminium. They were firmly pressed together, with the aluminium cylinder in the centre, and provided with copper leads. The apparatus was kept in the closed circuit of a battery of accumulators for a whole year, during which time it was traversed by about 958 ampere-hours. In an electrolytic cell this would have meant the deposition of 1·14kg. of copper. But on weighing the cylinders at the end of the year it was found that, within experimental errors, their weight had not altered. The author, therefore, answers the above question in the negative, and concludes that in metallic conduction no electric charges are conveyed by positive metallic ions.

[E. Riecke, *Physikal. Zeitschr.*, August 3, 1901.]

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*Effect of Gravity and Pressure on E.M.F.*—When an electric current is passed through an electrolytic cell the anode is dissolved while the cathode is plated. If the cell is made in the form of a tube, with the electrodes in the ends, the law of the conservation of energy would require a greater consumption of energy when the current passes up through the tube than when the tube is horizontal or when the current passes down. This greater consumption of energy will express itself as a difference in the E.M.F. required for a given rate of deposit, and this difference may be regarded as a counter E.M.F. and detected as such. Some experiments in this direction have recently been made by Rolla R. Ramsey. Starting with the tube in horizontal position, the tube was turned to a vertical position and reversed repeatedly in unison with the galvanometer needle until a maximum deflection was obtained. Zinc or cadmium amalgams were used as electrodes, and the sulphates, either in solution or in paste, as electrolytes. The most consistent results were obtained with cadmium. The additional E.M.F. per centimetre height of a 10 per cent. solution was found to be $4{\cdot}78 \times 10^{-8}$ volts, with a migration ratio of 0·02. The authoress also measured the effect of pressure, and found that the E.M.F. increased in a linear manner with the pressure up to 300 atmospheres, and to a larger extent in a Clark cell than in a cadmium cell.

[R. R. Ramsey, *Phys. Review*, July, 1901].

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*The Braun Tube as an Electrometer.*—Braun's cathode-ray tube has been used with much success for studying the period of alternating currents. W. I. Milham has found it useful for measuring electrostatic fields, but in a somewhat indirect manner, for when the tube is placed between the electrodes, there is no deflection of the cathode beam; when, however, the field is suddenly commutated, the fluorescent spot jumps aside, and then returns to its normal position, quickly at first, and then more slowly. On repeating the commutation the throw is in the opposite direction, and the return is as before. The explanation is obvious. The field traverses the tube, but the cathode rays within the tube render the gas conducting, and the charges on the walls are thus neutralised. That this is the true explanation may be proved by interrupting the cathode rays during their returning motion by stopping the current. The luminuous spot then disappears, and when the beam is restored the spot re-appears, not in its normal position, but at the point it had reached when the rays were cut off. The speed of return is proportional to the throw, and the latter is proportional to the field. Under favourable conditions the author claims an accuracy to within 1 per cent. for the measurements.

[W. I. Milham, *Physikal. Zeitschr.*, August 3, 1901.]

## INDIARUBBER STRIP FOR INSULATION PURPOSES.

BY H. L. TERRY, F.I.C.

The pure rubber strip, which finds application either as the first coating of power and light cables, or which is used alone for jointing in house wiring, is of two distinct makes—viz., those which are respectively known in the rubber factory as "cut" or "spread," these terms being, it is hardly necessary to say, derived from the method of manufacture. With regard to the degree of favour which these two sorts find in the eyes of cable makers, it is noticeable that a change has come about in the course of the last few years. Whereas at one time cut sheet was more largely used than spread, the reverse is now the case, an altered condition of affairs which is undoubtedly traceable to motives of economy rather than to any predilection that spread strip is in any way more advantageous either as regards insulation or longevity than its congener. This increased use of the spread strip has considerably widened the field from which cable makers can draw their supplies, for although fine cut sheet is only manufactured by three or four firms in this country, for reasons which will be touched upon later, those who essay to produce spread sheet are by no means so limited in number, a state of affairs which in these competitive times is all in favour of the purchaser.

The raw material is the same in either case; it is only after the initial stages of washing and drying have been gone through that we come upon the parting of the ways. Suppose our objective is cut sheet, the primary object of attainment is the production of a homogeneous block of rubber from which sheets may be cut. This is effected by subjecting the dried rubber first to compression between revolving steel rollers and then for a considerable time to the action of a special machine known as the "pickle" or "masticator," a machine the principle of which it may be said has not seen any evolution since its first use by Hancock in the early days of the industry, though succeeding years have seen its dimensions grow and its power multiplied. The block of rubber on leaving this machine is next subjected to considerable hydraulic pressure; and then, after being frozen hard by chemical means, it is sent to the cutting room where, by the action of specially designed machinery, it is cut into sheets of the required degree of tenuity. Such is the outline of the process in vogue; it is hardly necessary to add that success depends upon the due observance of many matters of detail which could hardly be enumerated here much less commented upon in detail. Besides the matter of technical knowledge that of capital expenditure is one of great importance, the expense of the necessary machinery being far in excess of that which the manufacture of spread sheet entails.

To pass on now to the consideration of the latter body: The dried rubber is made into a paste technically called "dough" by the aid of a solvent, usually coal-tar naphtha, and is then spread by means of a machine such as is ordinarily used in the waterproof manufacture on to a length of cloth. In this process the naphtha is evaporated by passage over a steam chest, leaving a film of rubber on the cloth. A number of these films may be necessary in order to bring up the thickness to that required for any particular customer. Some difficulty was at first experienced in getting the sheet to that degree of uniformity required by cable makers, but by the exercise of care especially in the stripping of the rubber from the cloth, complaints on this head are now of great rarity. Strip of the required width is easily cut off the rolled-up sheet by means of a lathe. A variation in spreading is sometimes effected by what is termed rolling in calenders, but as space precludes further entry into details of manufacture its existence can only be indicated.

The reference that has already been made to the cost of the plant required in the manufacture of cut sheet will serve to explain the increase in the makers of spread sheet strip. And further than the cost of plant and the necessary technical knowledge, there has to be taken into consideration, in the case of cut sheet, that it is not always practicable to carry on the cutting process if the weather is at all sultry. This difficulty, which was at one time seriously felt, has now largely

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been overcome in England, but on the Continent, where the manufacture has been introduced of late years, the hot weather trouble has lost none of its acuteness. With regard to the Continental manufacture, which has not proved the success anticipated in every case, the time-honoured English process of using only fine Para rubber seems early to have been abandoned, the idea asserting itself that the adulterations which were customary in the bulk of rubber goods, might be introduced with advantage into fine cut sheet also. It is not suggested that anything fraudulent has taken place, because the sheet so made was and is sold as second or third quality; but the usual result in such cases followed—that is the necessity was entailed upon older houses in the trade to produce a lower class article in order to satisfy the demands of such of their customers who had become tainted with the craze for cheapness. In the light of what has happened in respect to other rubber goods, it is a fair surmise that the cut sheet trade is now in a state of transition, that is, the depths to which inferiority can attain have not yet been fathomed. When this degree has been reached, the inevitable reaction will set in, and buyers will recognise that the indulgence of a parsimonious spirit is not in the long run conducive to their best interests. It is not suggested that the electrical trades are responsible for the present condition of affairs; I write in ignorance of the extent to which anything but first quality rubber has effected a footing in the insulation business, if, indeed, it has obtained any footing at all.

I am not aware that any systematised tests have been made with a view to determining the electrical constants of first, second and third quality cut sheet; it may be that here we have a fruitful source of inquiry, and one on which much useful light might be thrown with the effect of clearing up obscure points. The failure in so many cases of the first coating of cut sheet in electric light cables to duly protect the core from the inroads of sulphur, has probably little or nothing to do with the quality of the rubber, the defect being attributable more to the degree of tenuity in which the rubber has been used, and to some extent no doubt to inequalities in the tinning of the copper. That the bad effects experienced are recognised as being difficult to obviate seem clear from the determination in certain quarters to abandon the use of rubber as a first coating, and to use in its stead cellulose in one of the protean forms in which this body is now available. Whether this means a serious reduction in the quantity of rubber strip hitherto used it is rather too early to speak with confidence, but the new departure certainly presages a diminished demand, and so may be viewed with some concern by the rubber manufacturer.

To turn now to a technical aspect, it is a rather moot point as to how far the mechanical treatment which the rubber undergoes in the cut sheet process affects its longevity. It has long been recognised that raw rubber as imported is practically imperishable when it is kept away from the insidious action of the solar rays, a fact to which a piece of unmanufactured rubber 70 years old, which I have in my possession, testifies. So long ago as 1865, Dr. W. A. Miller found that on exposure to sunlight masticated rubber was much more adversely affected than was unmasticated, though the exact cause of this does not seem to have engaged his attention. In 1891 Mr. William Thomson, on the result of a single experiment, expressed the opinion that over-mastication was not a source of injury to the rubber, though this hardly bears upon the case of masticated versus unmasticated rubber. The process which the spread strip goes through corresponds to some extent to mastication in the pickle, so the degree of deterioration may be considered approximately equal in both cases. As far as my own experiments in the matter have gone there seems no doubt that the less the rubber is exposed to mechanical action the greater is its longevity when exposed to the various deleterious influences with which it meets when put into use. Experience has taught me the lesson of caution in announcing results on the strength of single or even repeated experiments, and I shall, therefore, prefer to withhold details until my results have been substantiated beyond all possible doubt. The necessity of such reservation will be recognised by all those who have worked on rubber, and experienced how much effect slight differences of composition, of which in the present state of our knowledge we have little or no cognisance, have upon the obtaining of corroborative figures, a case in point being the widely differing figures published by various observers for the specific inductive capacity of rubber and gutta percha. The degree of precision which is attainable in experimenting with rubber and its compounds varies between almost as wide limits as is at present the case with regard to the analysis of rubber mixtures. Rubber analyses of a past age are still producible as weird relics of erroneous methods, and although modern research has done a great deal in the way of putting this branch of analysis on a sound footing, the amount of work which still remains to be done before finality is approached is yet very considerable.

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 633.*)

### THE A.E.G. CABLE WORKS.

The A.E.G. cable works are on the upper Spree at Oberschöneweide, a distance of about 7 miles from Berlin. The arrangement of the works, the site of which covers an area of 10,400 sq. metres, is shown in the plan Fig. 35, Fig. 36 being a general view of the buildings, which occupy about three-quarters of the available space. Besides the manufacture of cable and wire, the works undertake a certain amount of brass and bronze casting for commutator bars, switchboard bars, &c., and manufacture several classes of insulating material and mechanical rubber; and in addition there is a department for X-ray and wireless telegraphy apparatus. As can be judged from the plan, the transport facilities both for rail* and river are excellent, and the yard and wharf space is ample. On the wharf are stores for raw material and a fireproof building for the storage of benzine and naphtha, these inflammable spirits being led to various parts of the works by a system of pipes. For loading and unloading there is a 5-ton crane with a 6-metre jib, and it is worked by three three-phase motors. Two electrically-driven jib cranes of $4\frac{1}{2}$ tons capacity and 5-metre jib are used for loading the railway trucks, and there is an electric locomotive for shunting. In the central part of the yard, where there was a large number of drums of finished cable, it was pointed out to me that the high-pressure cable was distinguishable in the ground from low-pressure cable of similar size by extra threads of jute wrapped spirally round the Hessian tape or compounded serving which covers the armouring. I believe that the British Insulated Wire Co. has adopted a copper wire for the same purpose.

In the foundry there are 15 small furnaces, 10 stationary, and five of special design enabling the furnace to be raised and the metal poured directly into the ladle. The wire-rolling mills have already been referred to and illustrated in a previous issue of *The Electrician* (Vol. XLV., p. 698). The copper passes through the rolls 21 times, and the wire is rolled down to a diameter of 6mm. I was informed that the whole operation from rough to finishing rolls lasts about 40sec., and that the output of the rolling mills is 30 tons of 6mm. copper wire and 20 tons of bars of various metal in a 10-hour day. Yet the hands, on the day of our visit at any rate, did not seem so sharp as the average English wire-rolling mill hand. Both sets of rolls are electrically driven, the heavy rolls by a 200 H.P. motor at 500 volts, and the finishing rolls by a 600 H.P. motor at 1,000 volts.

* Since the visit of the Institution an electric railway for goods traffic has been opened connecting these works with the goods stations of the State railway at Rummelsburg and Nieder-Schöneweide. Two electric locomotives have been built for it by the A.E.G., who also supplied the other equipment. Three-phase current supplied from the Oberspree generating station is converted into continuous current in a sub-station at Ober-Schöneweide, and is led to the locomotive by means of the usual trolley. The line was put into operation on August 5th.

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The wire-drawing shop (Fig. 37) is a large one. Besides the machines of smaller size, there are 21 heavy machines and 10 multiple machines, in which the wire is drawn through seven rotating dies at a time. It was surprising to note that the "stringing up" was not done separately, so that these fast-speed machines were not being used to their greatest output, as they were naturally stationary for some time while the wire was first being fitted through the successive dies.

In the large cable shop, where the taping, serving and stranding of the heavier cables is carried out, the practice corresponds more or less accurately to our own. Among the minor points of difference was the extensive use of collapsible drums for quite large cable. The coils from these are largely sent out in Berlin, and when the cable is laid it is paid off from a hand-cart with a rotating top. An electric crane runs the whole length of this shop, serving all the machines mentioned, the impregnating tanks, and lead presses. Vacuum drying rooms are employed, and the vacuum impregnating tanks shown in Fig. 41. The lead presses, of which there are five—all in operation at the time of our visit—are of the Huber type, utilising hydraulic pressures of from 200 to 250 atmospheres. The lead is melted on the top of the press itself with the aid of petroleum fuel; this must be troublesome. On the other hand, one could not but contrast the motor-driven hauling-off gear for the lead presses with the older system, which employs two or three labourers to turn the drum, who must perforce stand idle every time the container is freshly charged.

The works are provided with a large boiler house, and, as current for driving the machines is derived from the adjoining Oberspree generating station of the Berliner Elektricitäts-werke, it supplies steam exclusively for heating and drying purposes and to the vulcanisers. Here are also the pumps which furnish the water supply to the whole factory, and which can provide sufficient water supply at a high pressure in case of fire. In view of the inflammable nature of the material handled, it has been wisely deemed advisable to take all precautions, and there is a volunteer fire brigade of 40 of the workmen under the direction of an inspector of the Berlin fire brigade, and all the necessary fire brigade appliances.

The part of the factory dedicated to lighter cable and insulated wire manufacture is quite as important as the portion

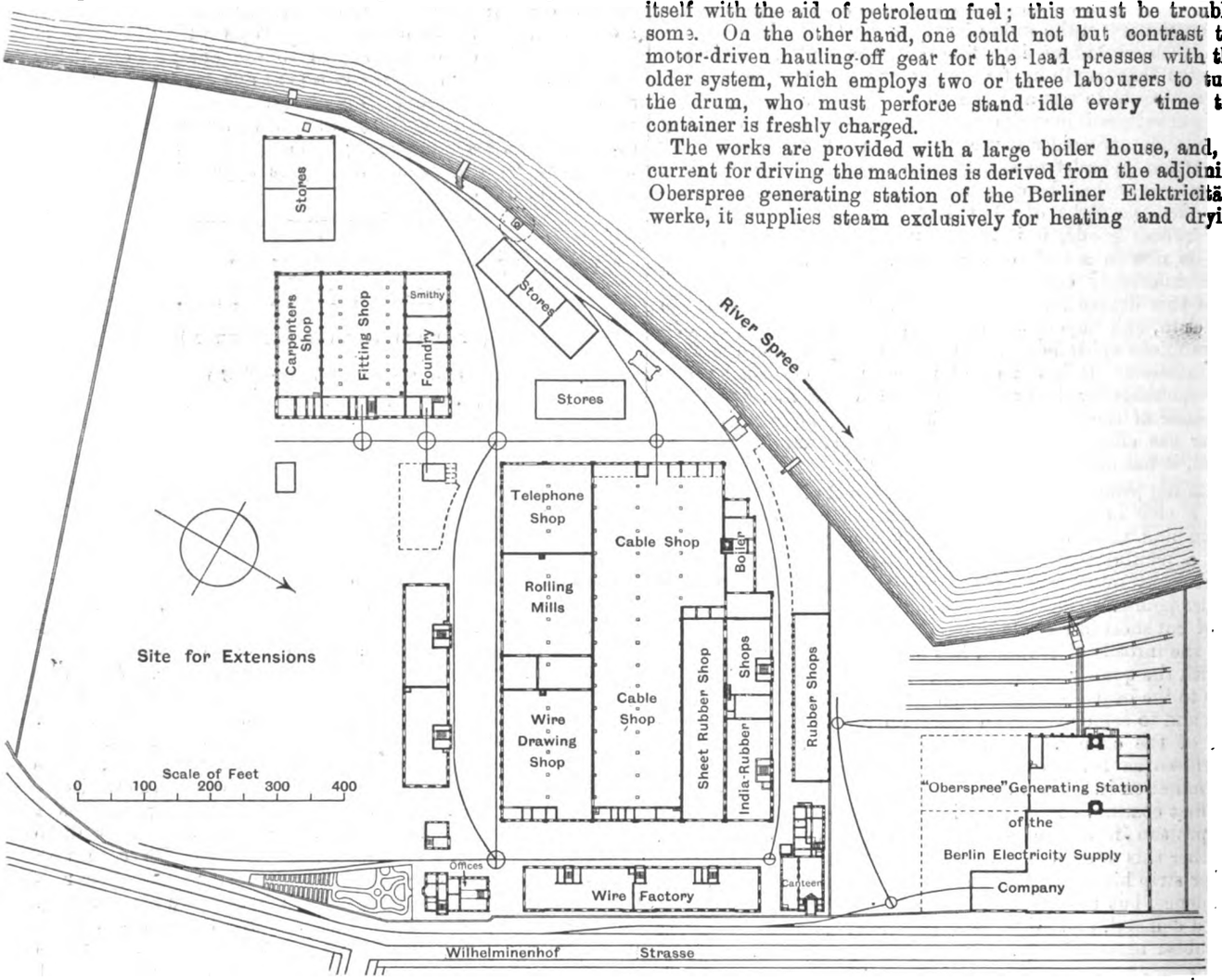


FIG. 35.—PLAN OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT CABLE WORKS AT OBERSPREE.

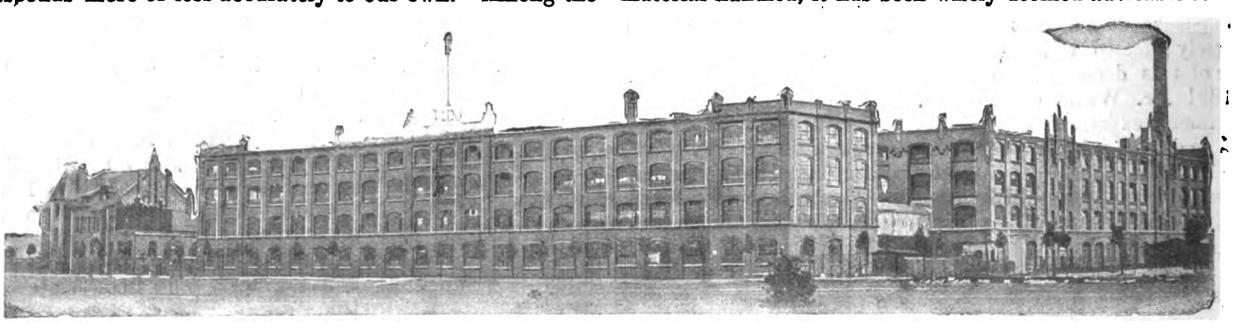

FIG. 36.—GENERAL VIEW OF THE WORKS.

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already described. To begin with there are about 100 machines, each with eight heads, for covering telephone wires with paper. Some of these are vertical taping machines, applying two laps (rather tighter than is customary in this country) and others are longitudinal paper coverers in which the paper tape passes through a conical die and is drawn off with the wire. The former class of cable is, I understood, specified by the German Post Office.

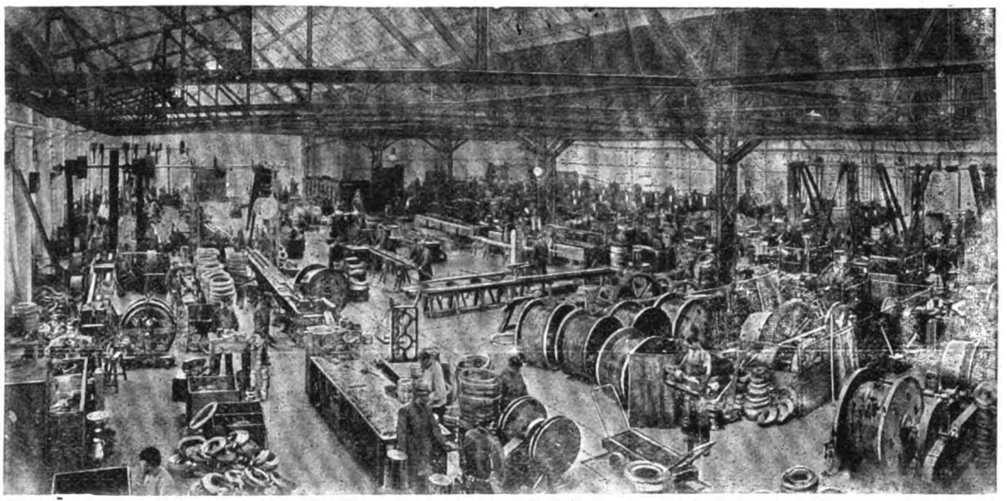

FIG. 37.—WIRE-DRAWING SHOP.

The braiding shops and the cotton, silk, and pure rubber lapping shops, as well as part of the rubber department and some of the machines for pairing and stranding insulated wires, are on the first, second and third floors. There are no less than 550 small braiding machines, and in some cases I noticed that one girl could serve as many as 14 of these. Two hundred of these light braiding machines are used exclusively for "flexible." The company appear also to do a large business in fine silk-covered wire for resistance coils, &c., as there are no less than 88 of these machines for fine lapping, some with 20, others with 40 heads running at 4,000 revs. per min.

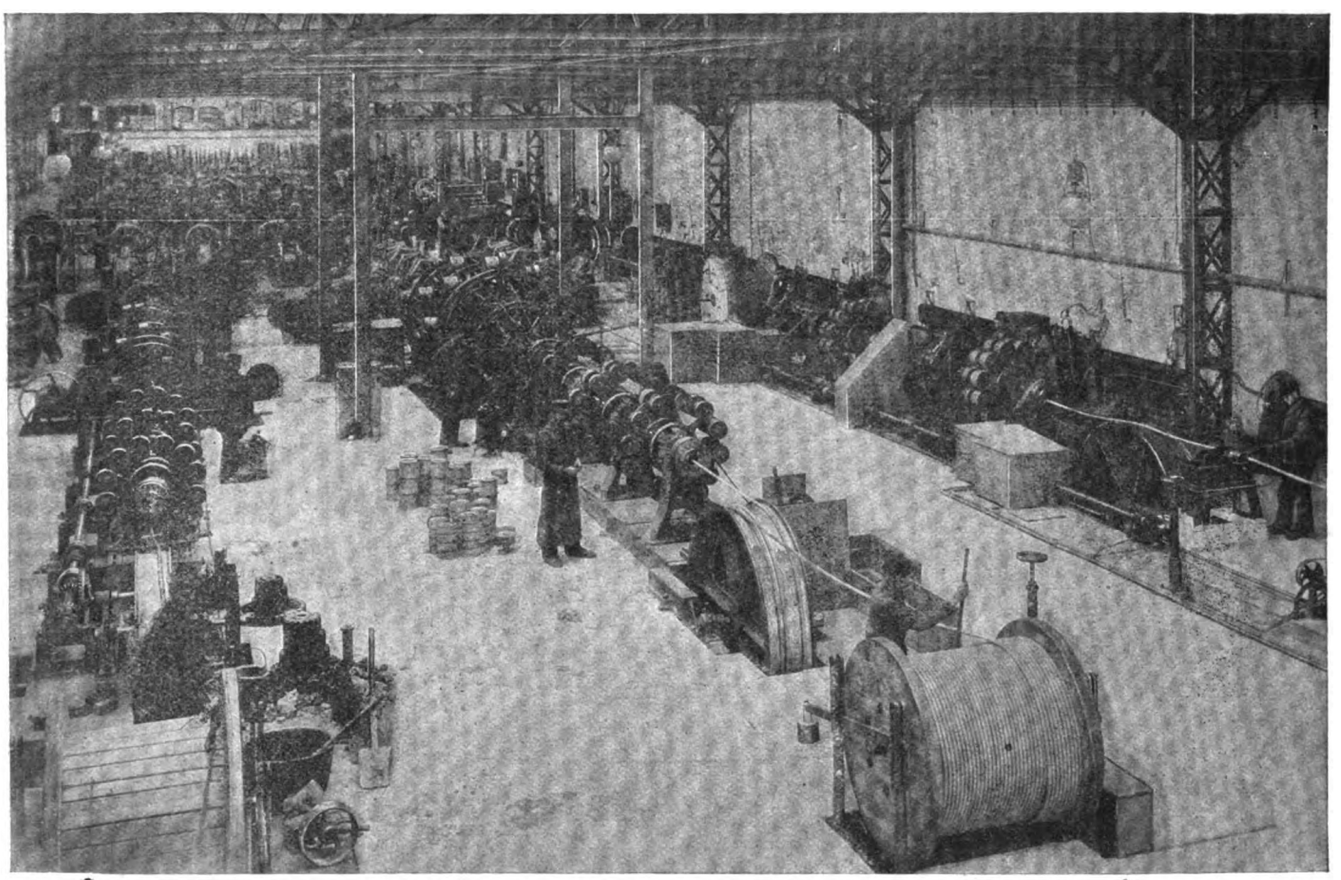

FIG. 38.—STRANDING MACHINES.

Fig. 40 is a view of one of the rubber shops. In the rubber-covering department both the longitudinal and "seamless" rubber-covering machines are employed. The process of manufacturing "stabilit," the new insulating material in



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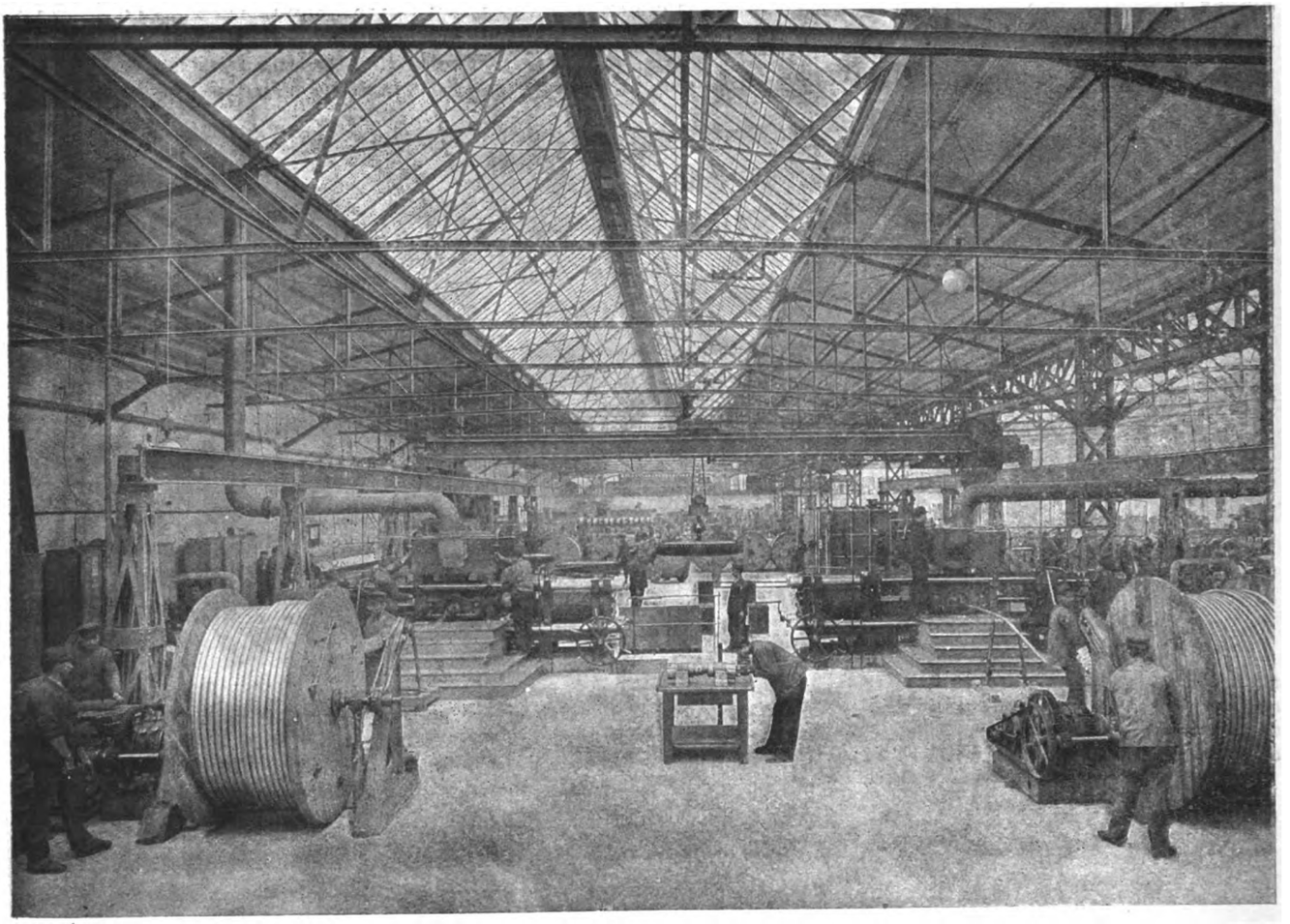

FIG. 39.—LEAD PRESSES.

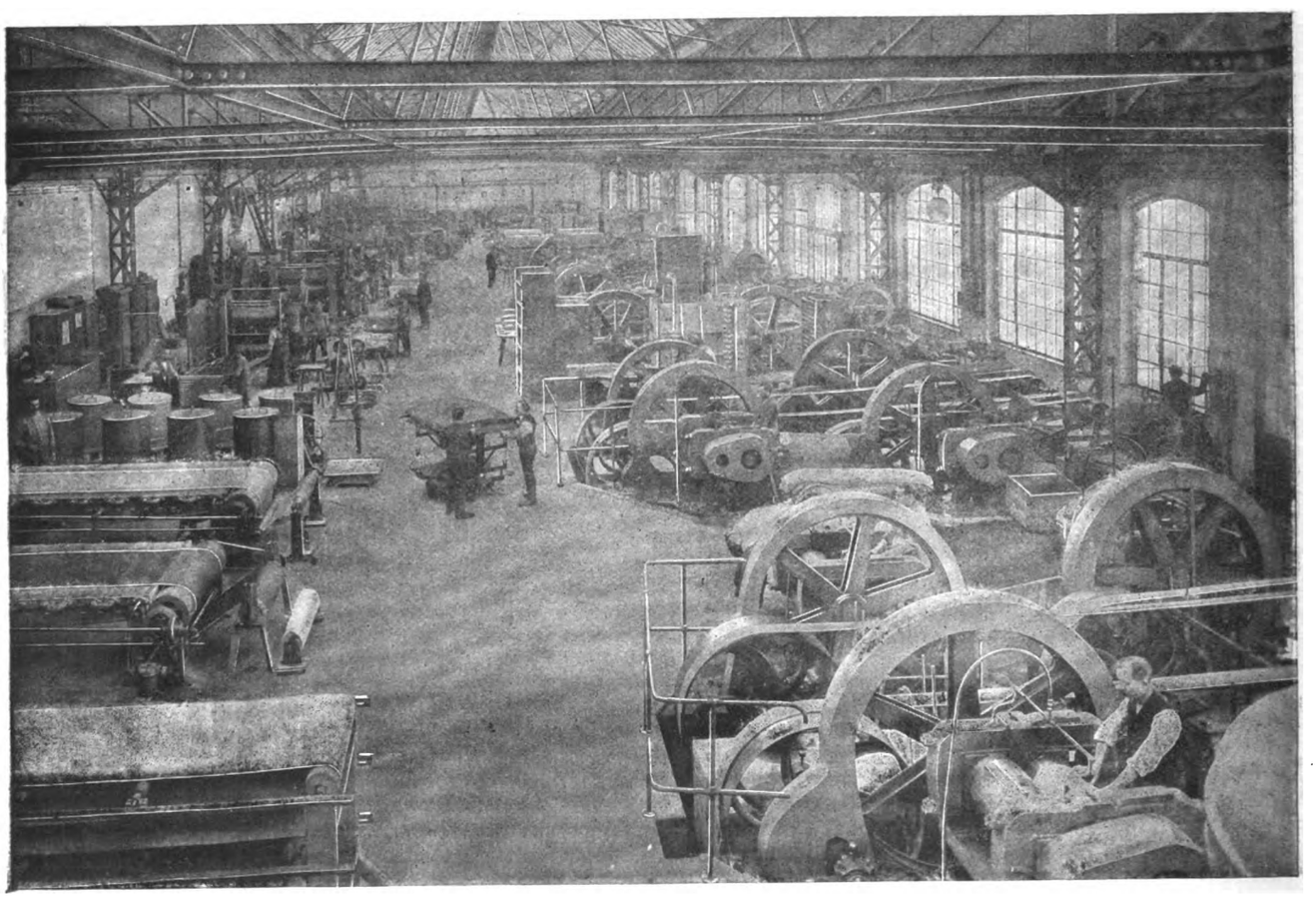

FIG. 40.—RUBBER CALENDERS.

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which the A. E. G. is interested, was not shown us; but we passed through the micanite shop in which the thin pieces of

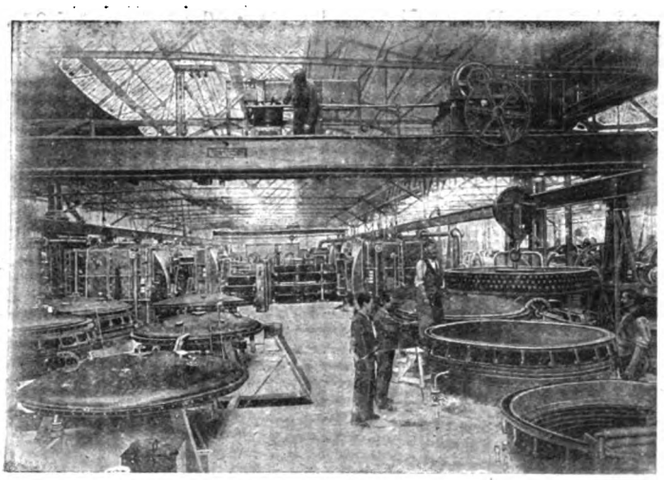

Fig. 41.—Vacuum Impregnating Tanks.

mica are spread out and united with shellac previously to being moulded and compressed.

The works have only been running since 1897, and in some respects, therefore, their equipment compares favourably with the older cable works in this country, although in the main the German cable works have followed our methods, and probably cannot turn out cable any better, cheaper or quicker than we can here. Yet what we gain by age and experience they make up for to some extent by their thorough "method," which extends even to matters of the smallest detail.

The machines are all motor-driven, and counter-shafting is almost entirely absent. Three-phase current is obtained from the 'bus bars of the neighbouring generating station at 6,000 volts, and is transformed down to 1,000, 500 and 200 volts in 16 three-phase transformers. There are also four 110kw. rotatory transformers supplying current at 200 volts for the locomotives, arc lamps and some of the cranes, the total capacity being 2,600kw. A battery is also provided for lighting the works in case of emergency. The lighting is largely done by means of inverted arcs.

The work-people are well taken care of. Allusion was made in a previous article to their fine dining hall. There is also a hall in which lectures are given once a week by the employés, and good baths and lavatories are provided. In the same building is a surgeon's room in which accident cases are dealt with, and a convalescent home or sanatorium has been erected in the woods. In all about 8,000 people are employed at the works.

## THE DUBLIN UNITED TRAMWAYS SYSTEM.

(*Continued from page 592.*)

Continuing our description of the power-station and its arrangements, we will now consider the plant erected for handling and storing coal and for distributing it to the boilers. Fig. 11 is a diagram of the conveyor and storage plant. The coal handling apparatus consists of a hoisting tower and grab driven by a steam hoist, the capacity of the shovel or grab being about 1½ tons. The hoisting engine has two 10in. cylinders, a stroke of 12in. and a speed of 150 revs. It is provided with a double winding drum. The apparatus is capable of handling 40 tons of coal per hour continuously. The coal is hoisted into a hopper on the tower from which it is emptied into a truck. The coal is first weighed and then conveyed along an elevated track running from the hoisting tower over a coal bunker of a storage capacity of 800 tons, the track being inclined towards the bunkers so that the skip or truck runs down and is made to discharge itself by means of a tripping device, the position of which is controlled from the hoisting tower. The empty truck, after being discharged, is then returned to the hoisting tower by means of a balance weight.

As will be seen by reference back to Fig. 8, the central portion of the boiler house carries overhead a series of coal bunkers of a total capacity of 1,500 tons. The coal is conveyed from the outside store to these bunkers by means of a gravity bucket conveyor. This conveyor is run in a tunnel underneath the outside bunkers and is filled by means of chutes and an automatic filler, a view of which is shown in Fig. 12. The conveyor consists of buckets each of 2 cubic ft. capacity, suspended between two link chains carried by

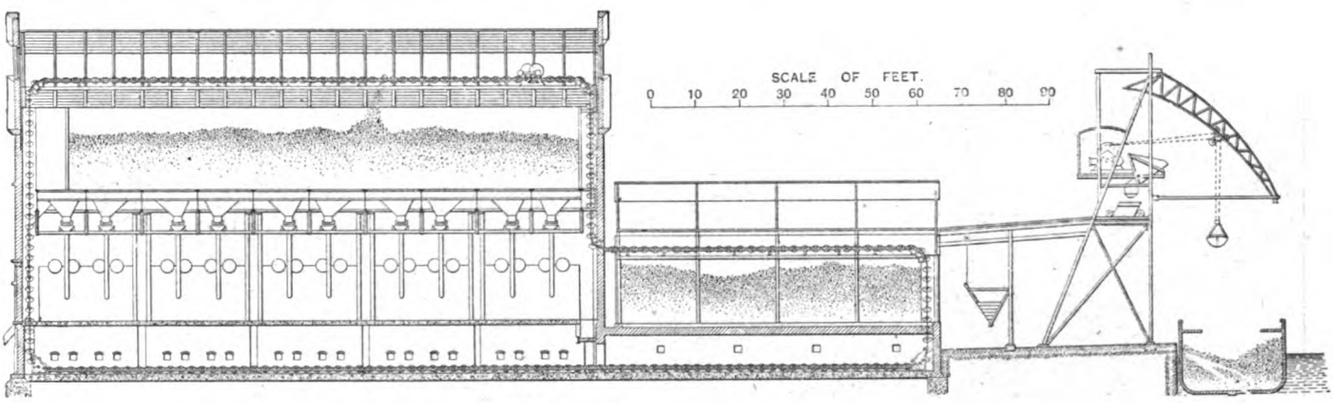


Fig. 11.—Coal Conveyor and Storage Department.

flanged wheels travelling on girder rails. There is a total of 220 buckets in the conveyor, which has a capacity of 50 tons per hour. The conveyor is driven through pawls from a 10 h.p. motor. A view of the driving apparatus at the end of the conveyor tunnel is shown in Fig. 13. The conveyor passes also underneath the central gangway between the two rows of boilers, conveying the ashes from the boilers and discharging them into an ash bunker overhead, this being located at the end of the building. From this bunker the ashes may be discharged by means of a chute passing through the walls of the building.

The overhead coal bunkers are fitted with valves and chutes, one for each boiler, the coal being first discharged into a hopper, where it is weighed, the weight being indicated on a dial attached to the hopper. A view of these hoppers and weighing arrangement is shown in Fig. 14. The coal handling apparatus was supplied by the C. W. Hunt Co., of New York.

The arrangement of plant in the boiler-room has been shown in Figs. 7 and 8, and a view from a photograph of the

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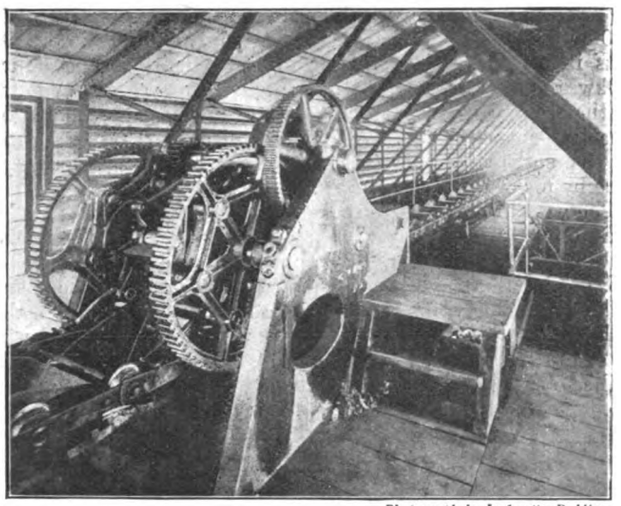
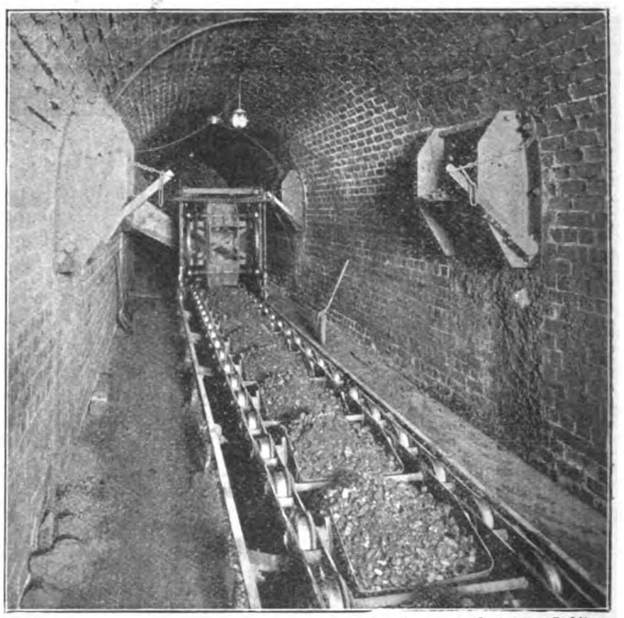
boiler-room is shown in Fig. 14. The boiler-room is designed for two rows of 10 boilers, arranged on each side of a central gangway, with the coal bunkers above and the conveyor race and ash-pits below the floor level. Each flue is connected through an economiser to a chimney, one for each flue. Each chimney consists of a steel shaft lined with fire-brick, and carried on an octagonal brick base supported on a block of concrete. The height of the chimney is 230ft., and the diameter inside the lining is 10ft. The steel shafts were supplied and erected by Messrs. the Riter-Conley Co., of Pittsburg. The Green's economisers are arranged in two groups of 192 tubes each, of standard size and type. A photograph of the economiser gear is shown in Fig. 15.

At the present time 12 boilers have been installed, six on each side, and foundations have been provided for the remaining eight future boilers. The boilers were supplied by Messrs. Babcock and Wilcox, and each boiler has a heating surface of 2,530 sq. ft. The boilers are fitted with Vicars' mechanical



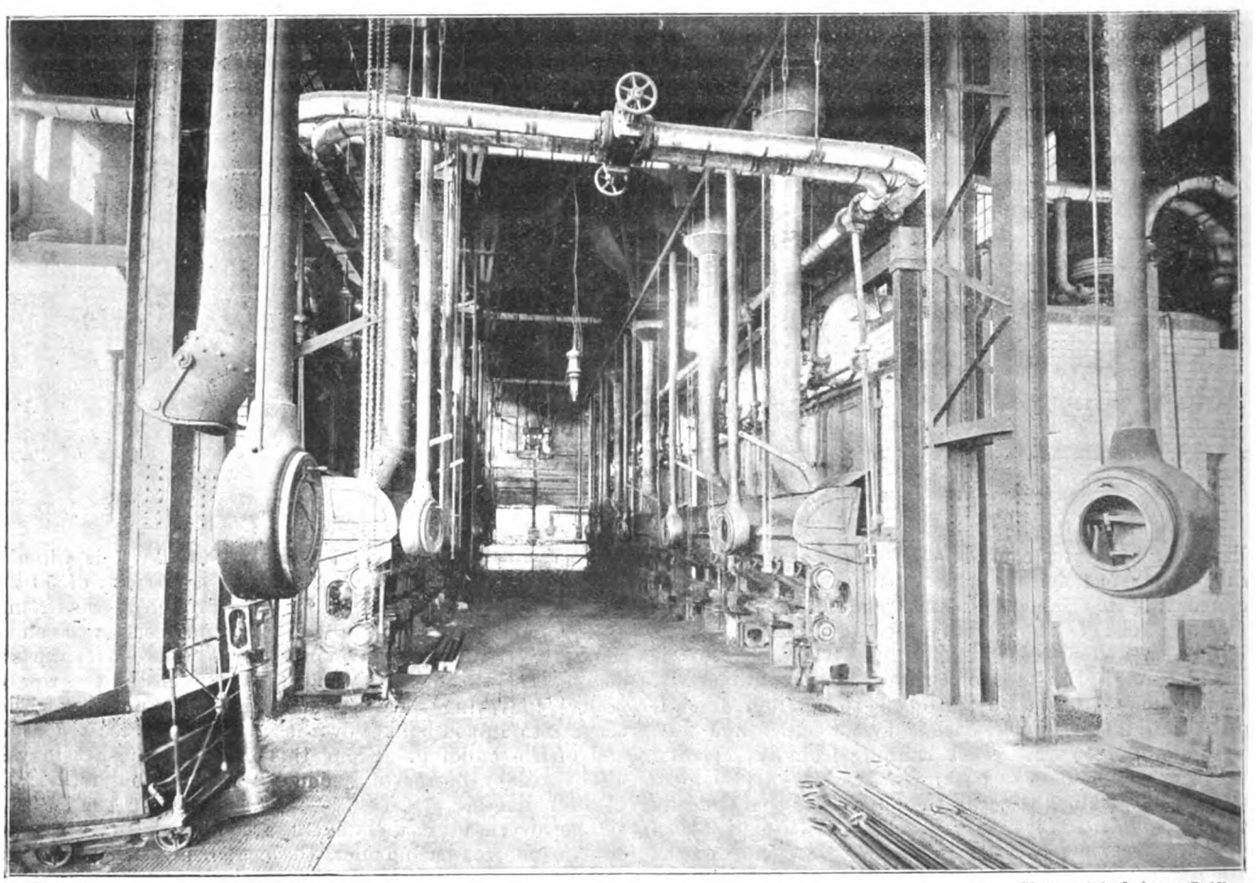
*Photograph by Lafayette, Dublin.*

FIG. 12.—COAL FILLER AT THE TOP OF THE POWER HOUSE.



*Photograph by Lafayette, Dublin.*

FIG. 13.—CONVEYOR AND DRIVING GEAR IN BASEMENT OF POWER HOUSE.



*Photograph by Lafayette, Dublin.*

FIG. 14.—GENERAL VIEW OF BOILER HOUSE AT THE RINGSEND POWER STATION.

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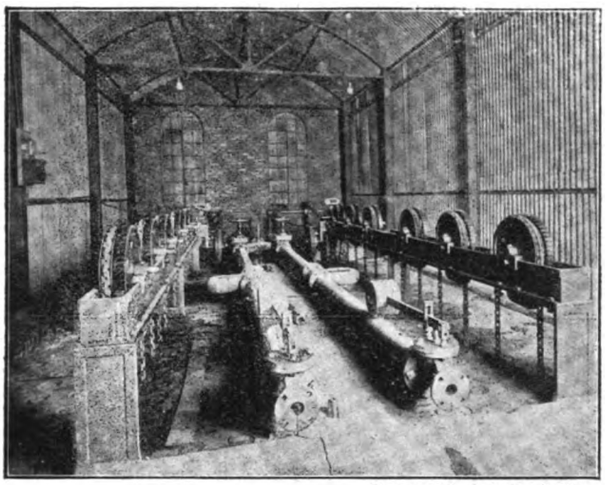
coking stokers, and are run from a pair of line shafts, driven by two Chandler high-speed compound engines.

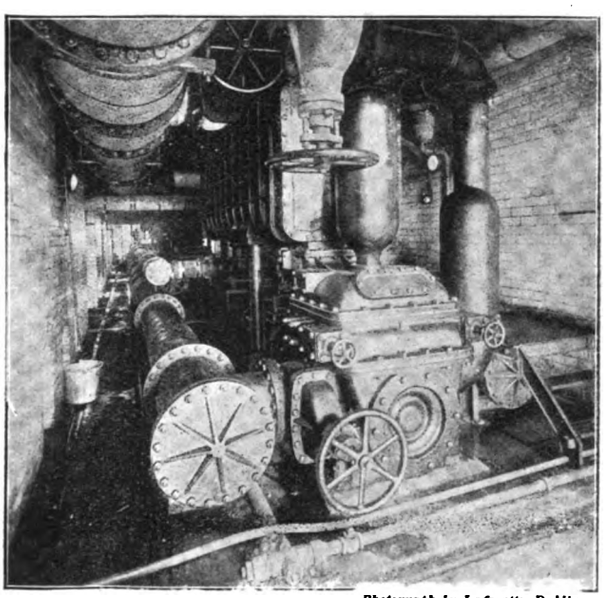
The main steam piping is arranged on the principle that two of the boilers, forming a battery, shall supply steam for one engine. The steam piping, however, is interconnected by means of a main header, so that any engine can be run from any of the pairs of boilers. The steam pipes from the main header to the engines dip down and are carried below the engine-room floor to each engine. A steam separator is



*Photograph by Lafayette, Dublin.*

FIG. 15.—VIEW OF ECONOMISER TOP.

fixed at the base of the vertical section of the steam pipes leading to the engines. The exhaust pipes from the engines are connected to a main exhaust header, 80in. diameter, located in the basement between the engine foundations. The main exhaust is connected through an automatic relief valve to an atmospheric exhaust pipe. The whole of the piping, steam, feed and exhaust, together with the valves, were supplied by the Crane Company.

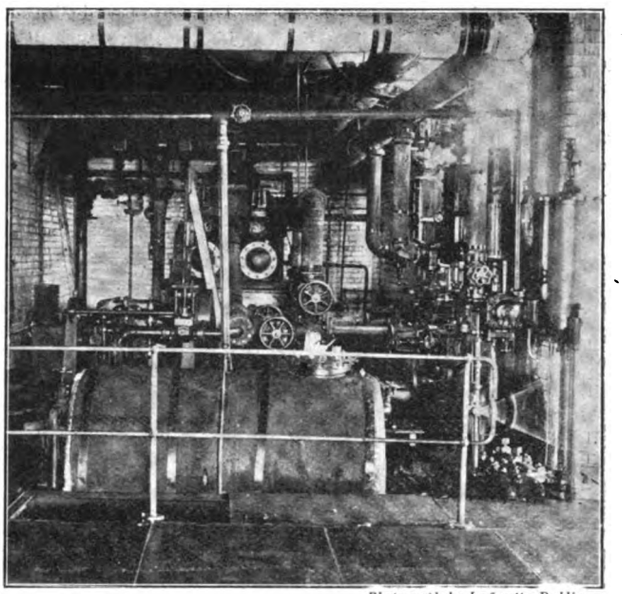


*Photograph by Lafayette, Dublin.*

FIG. 16.—VIEW OF CONDENSERS IN BASEMENT.

The condensing plant consists of three Wheeler surface condensers, each having 2,400 sq. ft. of heating surface, one condenser being provided for each pair of engines. Each condenser is provided with a steam-driven air and circulating pump, the steam cylinders being 7in. and 14in. in diameter, the diameter of the air-pump cylinder being 16in. and that of the circulating pump 18in. These condensers are placed in the basement with all of the auxiliary machinery and apparatus. A view of the condensing apparatus, as erected in the basement, is shown in Fig. 16.

There are three steam-driven boiler feed pumps. Two were manufactured by the Blake and Knowles Steam Pump Co.,

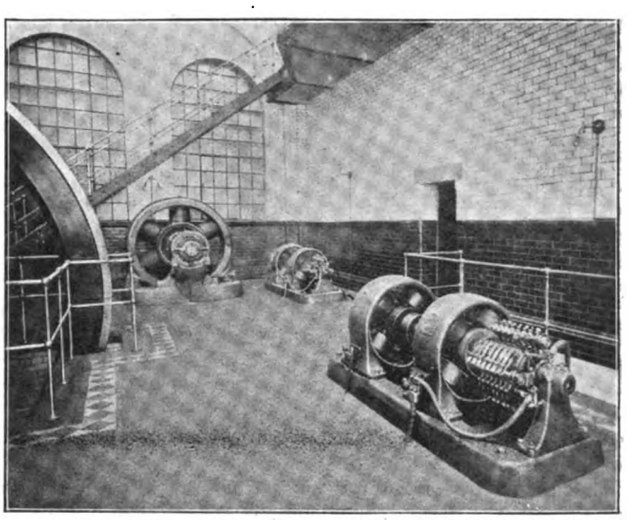


*Photograph by Lafayette, Dublin.*

FIG. 17.—VIEW OF FEED PUMPS IN BASEMENT.

and the third is a Weir pump. Each pump is capable of supplying feed water for the whole of the generating station against a boiler pressure of 200lb. per square inch. In Fig. 17 is given a photographic view of the pump department in the basement. The steam for all the auxiliary engines is passed through a feed water heater, made by the Wheeler Condenser and Engineering Co.

We now pass on to the spacious and admirably equipped machinery room, which is 180ft. by 80ft. internal measurement, and is 34ft. high from the floor to the roof truss. There is a basement 10ft. below the engine-room floor. One



*Photograph by Lafayette, Dublin.*

FIG. 21.—VIEW OF ROTATORY CONVERTERS AND BOOSTERS.

end of the building contains the stores and offices, leaving a clear space of 152ft. by 80ft. for machinery. A switchboard gallery is erected at the office end of the building and 16ft. above the engine-room floor. The engine room is designed for 10 units arranged in two rows, and of these six units are at present installed. Figs. 18, 19 and 20 give a general view of the engine room.

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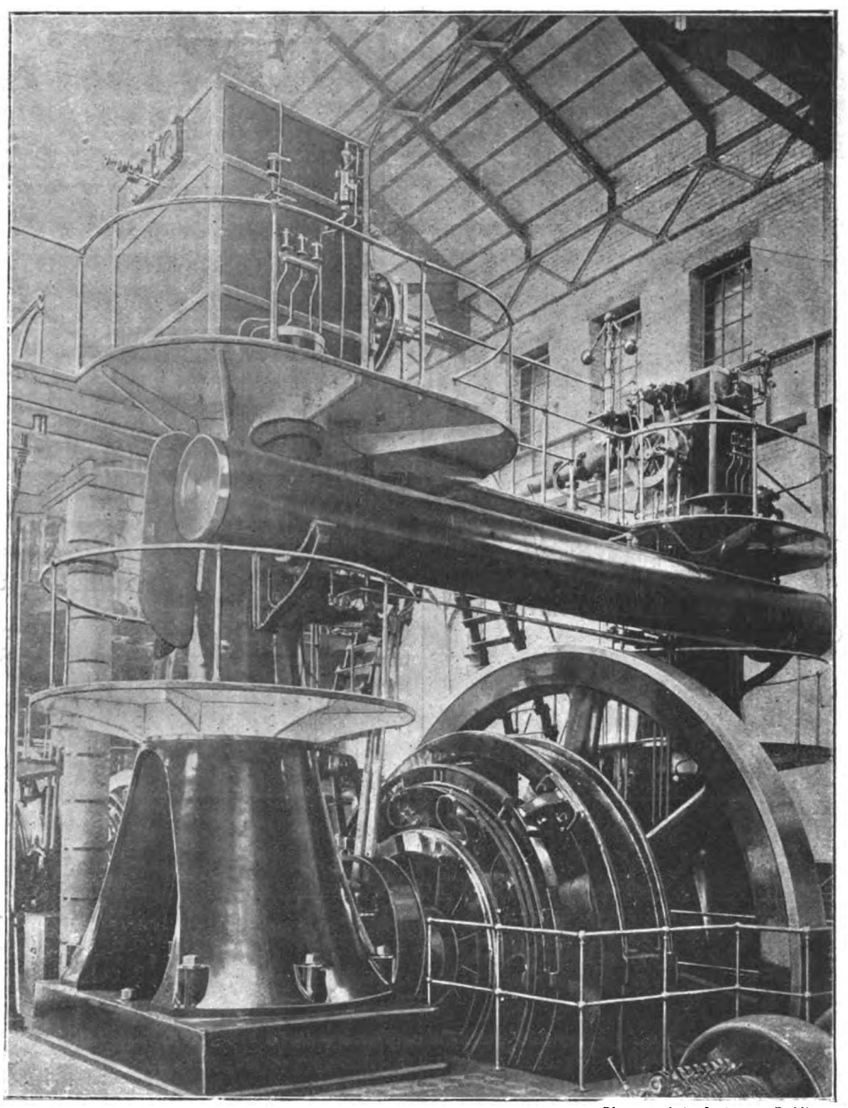
There are erected at present five cross-compound engines, each direct-coupled to a 500kw. direct-current generator, and one engine of the same type and capacity coupled to a 500kw. three-phase generator. The engines were made by the E. P. Allis Co., of Milwaukee, and are of the vertical cross-compound type with high-pressure cylinders 20in. diameter, low-pressure cylinders 40in. diameter, and a stroke of 42in., and are designed to run at 90 revs., the steam pressure being 150lb. The engines are fitted with Reynolds' Corliss valve gear, and are designed for normally yielding 650 B.H.P. with a vacuum of 27in. and with a steam consumption of 12½lb. per I.H.P. per hour. The governing arrangements are such that variation in speed does not exceed 1¾ per cent. when the engine is running at any range between minimum and maximum load. The engines are also provided with independent safety governors, which cut off the steam should the engine speed from any cause increase more than 5 per cent. above the normal. The engines are fitted with fly-wheels each weighing 19 tons and measuring 19ft. in diameter. The armatures of the direct-current generators are mounted on the shafts between the high and low-pressure cylinders.

The generators were supplied by the British Thomson-Houston Co., of London, and were made by the General Electric Co., of America. Five of these generators are of the multipolar direct-current type, each having 10 poles, and giving an output of 550kw. at 90 revs. They are constructed to stand an overload of 50 per cent. for an hour. The efficiency of these generators is 94½ per cent. at full load, 94½ per cent. at three-quarter load, and 94 per cent. at half load. The sixth engine is connected to a three-phase generator of the revolving field type, this generator having 32 poles and an output of 550kw. at 90 revs., at a potential difference of 2,500 volts. The armature winding is Y connected. The armature is 12ft. in diameter, has 192 slots and 192 coils, there being two coils per pole per phase. The efficiency of this generator, including all losses, is 95 per cent. at full load, 94·6 per cent. at three-quarter load, and 93½ per cent. at half load.

The two rotatory converters already mentioned were built by the General Electric Co. of America. They have six poles, and are designed for an output of 250kw. when delivering either alternating or direct current, and were designed to fulfil the following conditions specified by Mr. Parshall—namely, that when delivering alternating current the speed should be maintained constant within 3 per cent. under all conditions of load from no load to full load, and with any phase displacement up to 30deg. either lagging or leading. The efficiency of the rotatory converters, including all losses, is 95 per cent. at full load, 94 per cent. at three-quarter load, and 92 per cent. at half load. The armatures are of the drum type, having six circuits, with 72 turns in series per circuit. The field circuit is in series with the armature of a compensator, the principle of which has already been described. The compensator consists of a field ring with six laminated poles, with an armature direct connected to the end of the rotatory converter shaft. The windings of the armature are connected on one side to three collector rings, and on the



*Photograph by Lafayette, Dublin.*

FIG. 18.—DETAILED VIEW OF NO. 1 ENGINE SET.

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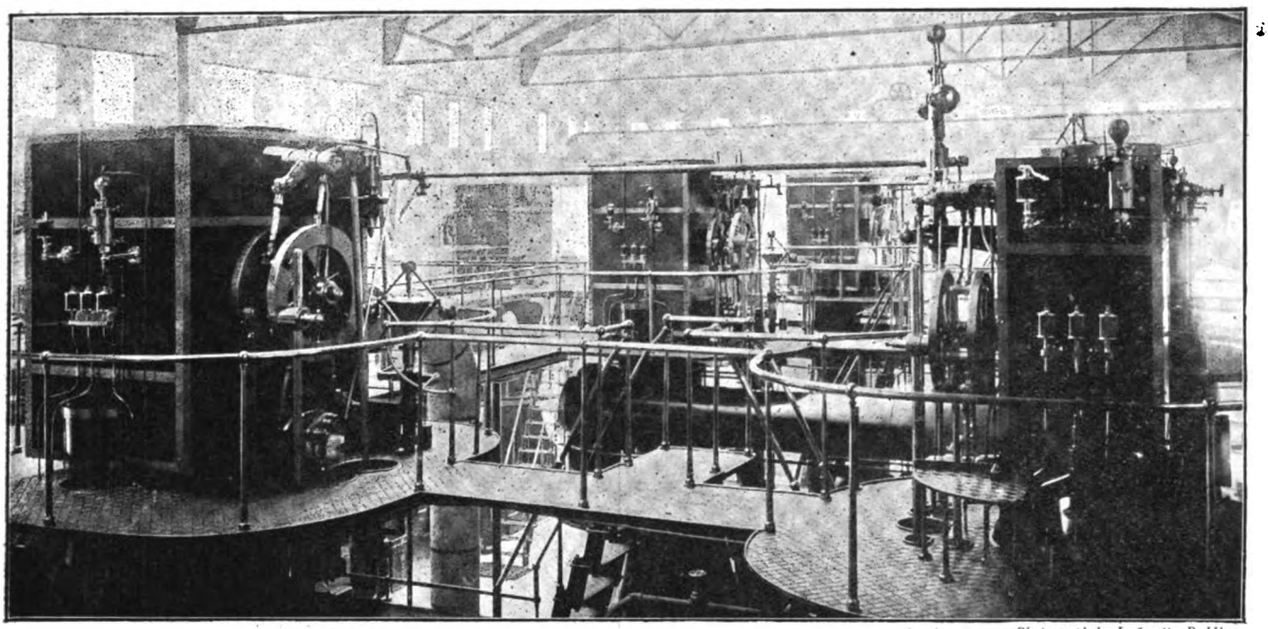
other side to a commutator. The actual capacity of the compensator is 0·75 of a kilowatt, or about $\frac{1}{3}$ per cent. of the capacity of the rotatory converter. In connection with each rotatory converter there are three transformers, each of 100kw., the windings being connected in delta and used for the purpose of transforming from the voltage on the collector rings to the high tension 'bus bar pressure of 2,500 volts. These transformers are located in a fireproof brick chamber at the end of the engine room, together with the series transformers used in connection with the compensators of the rotatory converters.

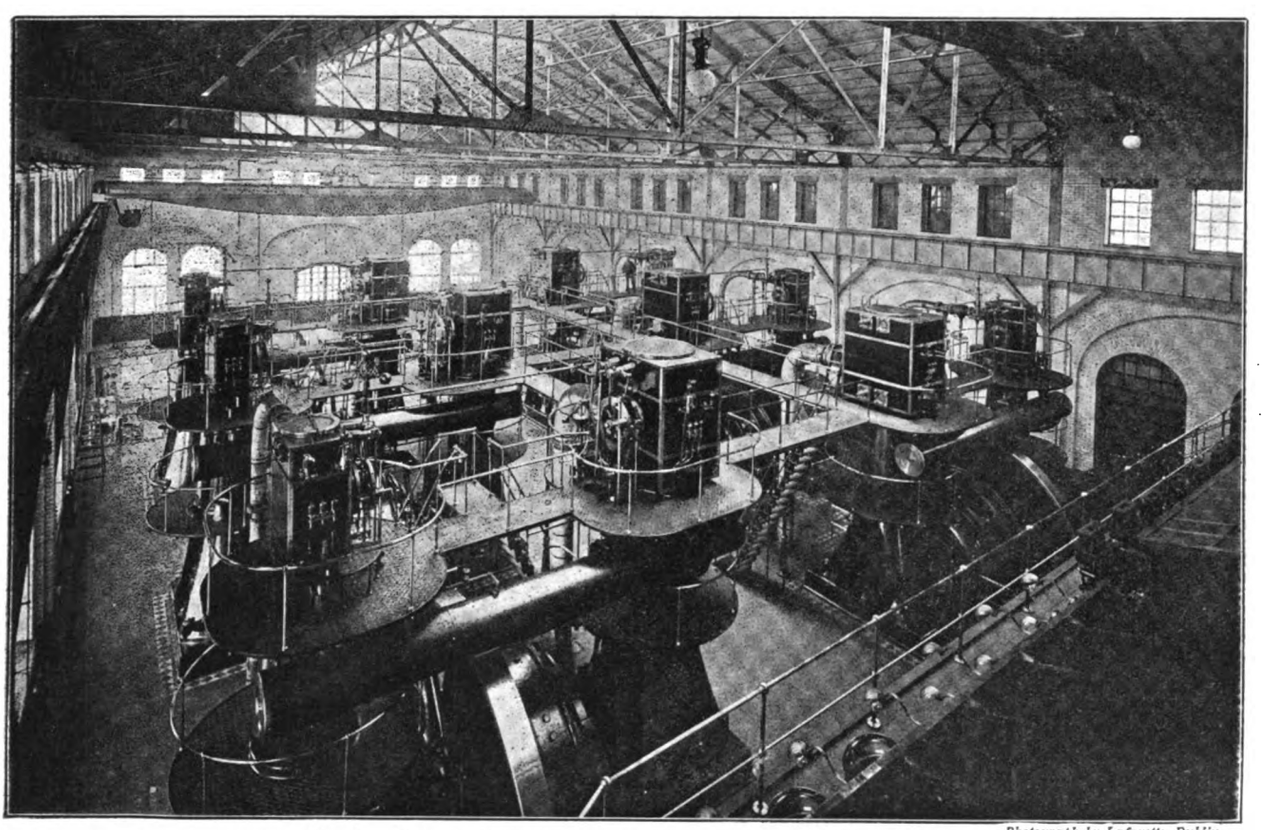
At one end of the engine room is located the four return boosters already mentioned and shown in Fig. 21. Each booster consists of a motor and a generator, the armature of the generator being in series with the return cable. The field of the generator can be put in series with any of the positive feeders according to the amount of current which it is found necessary to return through the cables. Three of the generators are constructed for a current of 800 amperes at 30 volts, and one for 500 amperes at 80 volts. The motors in each case are of the standard 500 volt, four-pole direct-current type.

*(To be concluded.)*



*Photograph by Lafayette, Dublin.*

FIG. 19.—VIEW OF ENGINE CYLINDERS AND VALVE GEARS FROM SWITCHBOARD GALLERY.



*Photograph by Lafayette, Dublin.*

FIG. 20.—GENERAL VIEW OF ENGINE ROOM FROM THE UPPER GALLERY.

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## THE LATEST PROGRESS IN SPARK TELEGRAPHY.*

BY PROF. A. SLABY.

The latest form of connections of the wireless telegraph apparatus made by the Allgemeine Elektricitäts Gesellschaft are as follows. The transmitter (Fig. 1) consists of wire fastened to the flagstaff of

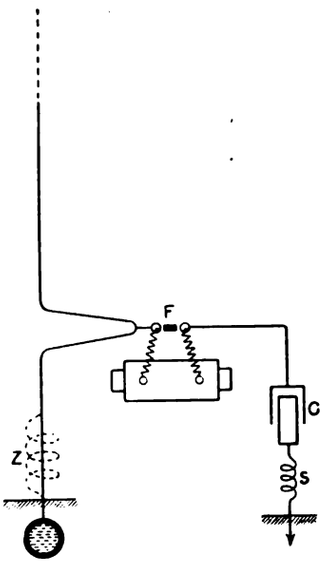


FIG. 1.

the building, which is led to earth and connected with the water main. A loop in this wire is led through the window into the room, and is connected to an induction coil, F, the other pole of whose secondary winding is connected to earth through a tuned condenser, C. If we wish to telegraph with a greater wave-length, it is only necessary to connect an additional coil, Z, in the earth wire, as shown by the dotted line. It corresponds to a certain equivalent length of wire by which we increase the quarter wave-length, and a whole set of such coils can be employed. In each case, however, it is necessary to tune the oscillation produced in the circuit closed by the earth connection to the oscillation of the wire, in order to obtain the greatest effect. This is done in the simplest manner by adjusting an adjustable self-induction, S, or the condenser C, which bear particular marks for this purpose.

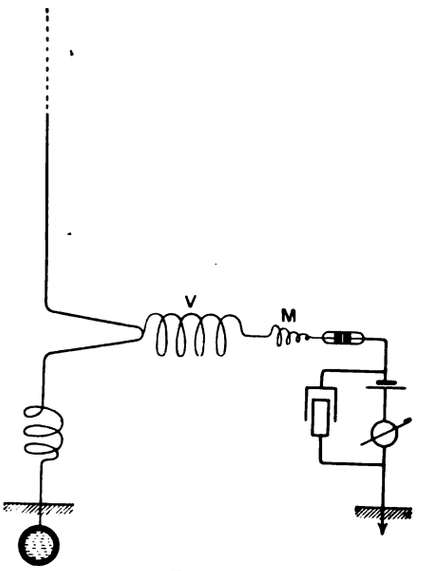


FIG. 2.

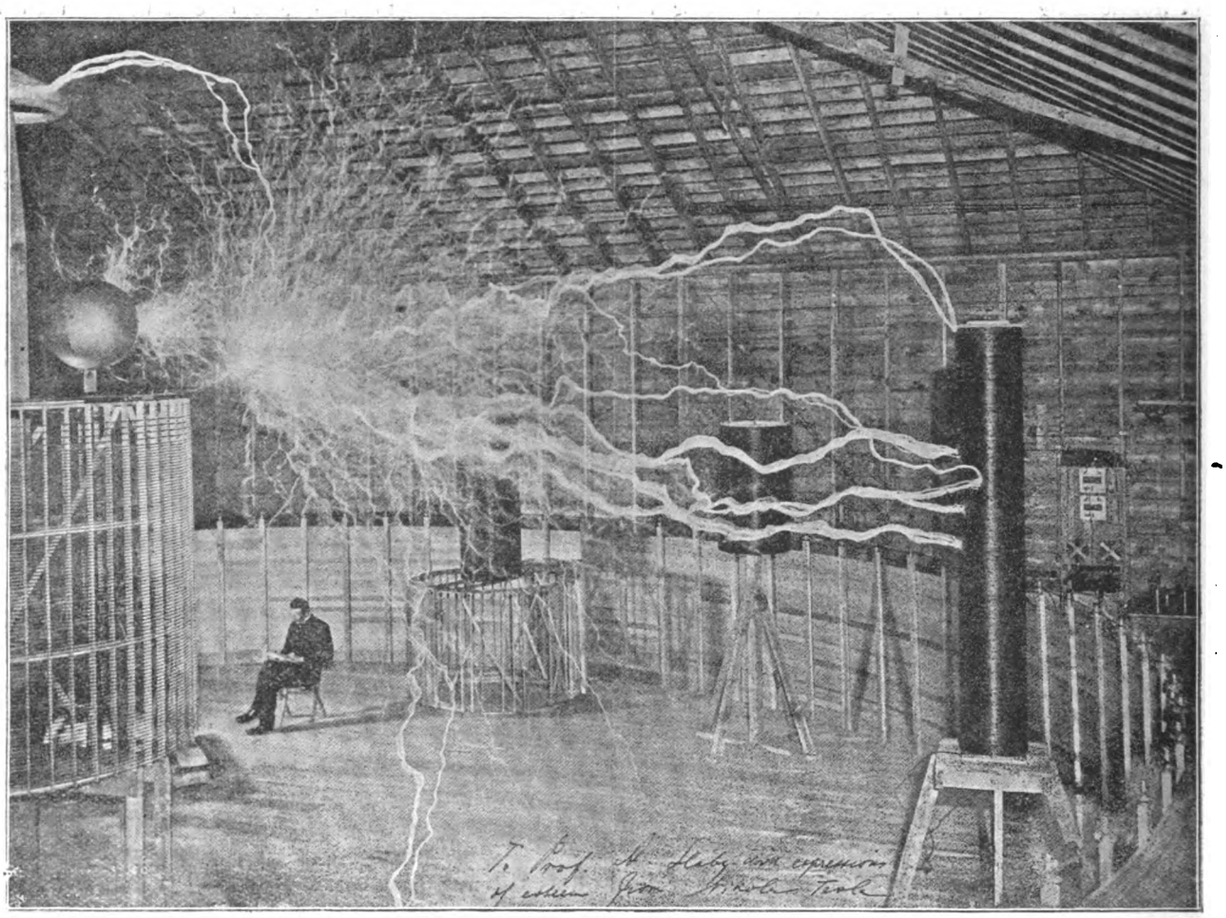

FIG. 3.

A similar wire serves as the receiver (Fig. 2), to which, also, an extension wire in the form of an equivalent coil, V, is connected by means of the loop. The pressure is at its maximum at the end of the latter, and is strengthened by a tuned intensifying coil M, which

* Extract from a lecture delivered at the forty-second general meeting of the Verein Deutscher Ingénieure, at Kiel.

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is connected directly to the coherer. It is also possible to replace the action of the two coils by a single coil with corresponding winding. The earth connection of the coherer contains the dry cell and the relay, which are bridged by a condenser in order not to disturb the oscillations. The Allgemeine Elektrictäts Gesellschaft guarantees with this arrangement a tuning to the required wave-length within certain limits, and a clear deciphering of signals at distances of 100km. on the sea with masts 50 metres high.

Spark telegraphy has now left the condition of tentative experiment and has developed into actual engineering to accomplish a definite object, and the active forces of the industry will soon do what is needful to extend its sphere of applicability. It will, in the first instance, become an indispensable means of communication on the coast and on the open sea, where the life and property of mankind is most endangered, and I do not think it will be long before every large ship will be equipped with this simple and useful apparatus. But spark telegraphy will also, in the future, replace cable in many cases for submarine communication, although in this respect we must not place our hopes too high. We can almost now see the limits, putting aside extravagant plans, as, for instance, elevating a wire 1,000 metres by means of balloons, which may be possible in an individual experiment, but is worthless in practice for reliable continuous working. We can scarcely expect a transmission of signals of more than a few hundred kilometres even with more perfect development of the means at present at hand.

The way open for further progress is also clear. The distance of transmission depends essentially on three things, the length of the parallel wires, the frequency of the pulsations, and the mean value of the current employed. The first two can hardly be increased, and also extending the length of the wire requires longer wave-lengths and consequently slower frequency; and, therefore, quite a new means would have to be found to make the wave-length independent of the length of wire employed. An increase of the induced current only remains therefore. This depends on two quantities, the capacity or receptive power of the wire, and the actual pressure of the spark. The higher we take the wire the smaller will be the capacity of the parts distant from the earth, and the longer it is the harder it will be to secure it in stormy weather. Thus I hope to have shown that the future of spark telegraphy lies exclusively in the direction of producing higher electrical pressures. What we have used in this direction hitherto is very modest if we compare it with what has been shown to only a few of the initiated, far from here on the other side of the ocean, on the high Rocky Mountains at the sources of the Colorado River, by an investigator who has shut himself off from the world—Nikola Tesla. I cannot report on it as an eye witness, but can only form my opinion from some photographs which he has most kindly sent me a few days ago. Here (Fig. 3) one sees him in his lonely house surrounded by artificially-produced spark discharges, which throw into the shade all that our most daring fancy has dreamt of. May his theoretical knowledge and his eminent technical ability soon be placed at the practical service of spark telegraphy.

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**Atmospheric Electricity.**—The *Meteorologische Zeitschrift* for July contains a very interesting and comprehensive article by Prof. H. Ebert, of Munich, on the phenomena of atmospheric electricity, considered from the standpoint of the theory of ions, or carriers of positive and negative electricity, generated by the medium of radiation. It is abstracted by *Nature* as follows:—The electrification of a gas has, especially since the discovery of the Röntgen rays, become a subject of fundamental importance, and has occupied the attention of several physicists, more particularly Messrs. Elster and Geitel, of Wolfenbüttel, and Mr. Wilson, of Cambridge, who have independently arrived at important and very similar results. They have also greatly improved the necessary apparatus and methods of measurement, by which means they have been able to show the connection between the electric conductibility of the air and artificially ionised gases. The following are some of the results deduced from the ionic theory. (1) The greater the solar radiation the less is the electric potential generally observed. (2) The ions generated at a great altitude are maintained for a certain time in the air and participate in its movements. (3) Dust, and especially aqueous vapour, obstruct the mobility of the ions, and therefore diminishes the conductibility of the air. (4) Negative ions move at a greater speed than the positive. (5) The ions form condensation nuclei which, in the case of supersaturated damp air, are exhibited as fog or cloud; hence the negative ions are more suitable for forming nuclei than the positive. The subject of the condensation properties of ionised air has been carefully investigated by Mr. Wilson, and some of the results have been published in the *Phil. Trans.* and other papers.

## ELECTRIC TRAMWAYS IN LONDON.

Under the above heading Mr. George Westinghouse, in a letter to *The Times* of the 19th inst., writes as follows:—

Mr. Balfour's terse statement—

"The questions of overcrowding and congestion might be stated in terms of time and expense; there would be no congestion if everyone could move quickly and at no expense to all parts of London"—

the admirable and concise illustrations in his speech at the opening of the West London electric tramways, and your editorial on the subject, prompt me to make some observations which may appear to you pertinent. The opportunity now afforded by the necessity for radical changes in the methods of transporting passengers upon the underground railways in London, coupled with a long and practical experience in every branch of mechanical and electrical engineering involved in the problem, have made the study of the London passenger traffic situation absorbing and attractive. Mr. Balfour, in concluding his remarks, said "he felt he was dealing not with a merely local or commercial concern, but with interests far beyond the profits of shareholders—the interests of the vast population of London."

He might have said with equal force that a wise solution of the London transportation problem would by its example have a national and even a world-wide effect. Most of the commerce of the world is carried on by people collected, and often crowded, into large cities or towns, and in all of these economy of time and decreased cost of living are as important as in London. Mr. Balfour, therefore, might have added that any serious mistake made in London in the beginning might prove as inconvenient as English railway tunnels, which, on account of their inadequate size, have prevented, and will for ever prevent, the use of capacious and truly comfortable railway carriages. The transportation methods of to-day have resulted from the accepted practice of converting coal into motive energy, and which method has, for economy and convenience, until now made the modern railway train composed of a locomotive and carriages running at infrequent intervals—the only practical way of transporting people over long and even short distances—a great source of discomfort arising from the heat, smoke, and cinders from the locomotive. The electric propulsion of vehicles, already well extended, admits, however, of such radical departure from the old way as to suggest that we may, by discarding many of our old ideas and methods, have a veritable revolution in the prevailing practice. This point is illustrated by the fact that an electric railway, upon which single cars are run at frequent intervals for a distance of about 45 miles, parallel to one of the standard railways in the United States, is, after being two years in operation, carrying 20 times as many passengers as were formerly carried by the steam railway between the same points.

In the first place, it appears to be a logical deduction that railways may with equal propriety contract for a supply of electric energy ready for use, quite as well as to purchase and instal electric plants and thereafter to buy coal, supplies and labour for the production of electricity. Such being the case, it follows that the judicious selection of sites and the erection of the highest types of electric generating stations for the purpose should result in great saving in capital expenditure as well as in great economies in the subsequent cost of operation. It seems certain that the Metropolitan and Metropolitan District Railways must, for their own protection, proceed with all diligence to the electric conversion of their lines, and that, therefore, the present is an opportune moment for the establishing of a "mutual electric supply and equipment company" upon a basis which will give to those companies, and subsequently to all other railways delivering traffic to the City over their lines, the most advantageous arrangement possible; it being almost self-evident that if each of the companies operating in London were to erect power stations and to electrically equip their lines upon dissimilar, or even similar, plans, the capital expenditure would, for a given service, be fully double that required by a company having appropriate contract relations with the different railway companies, and in which "mutual electric supply and equipment company" all such railway companies should obviously be financially interested and represented.

Such mutual supply company with appropriate powers could, in the first instance, contract with either or both the underground companies to furnish a complete electric plant, including new cars and the electric line and equipment, and to maintain and operate the power plant, sub-stations, electric feeder systems, and to deliver current to the collector rail for a long term of years; to supply all current needed for other power purposes, such as for the operation of moving stairs or lifts, lighting of stations, tunnels, &c., at a low rate per Board of Trade unit; to supply current for train power and lighting service of connecting or other railways, and to maintain a qualified corps of engineers and inspectors to assist in the inspection and maintenance of the electrical equipment; the railway companies to permit the use of their real estate for the location of stations or sub-stations; to secure or co-operate in securing all necessary parliamentary powers for the establishing of power plants on such real estate and for enabling the companies, if thought best, to maintain but one class of accommodation for passengers and with the right to establish a uniform rate or rates for distances within certain limits; to pay the contracting company, as a rental for the apparatus and car equipments furnished and for the current supplied, at a rate per passenger carried, the railway companies maintaining the car equipments and tracks, and to operate efficiently all departments of their service. Such contracts between a mutual electric supply and equipment company and the underground railways and those subsequently made with other companies would provide for an adequate supply of electric energy for all of the parties to the arrangement and for any additional car equipment which might be required to accommodate the larger traffic resulting from the substitution of the electric motor for the locomotive, and would thus bring the capital expenditures of the various companies to less



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than half of what they would be if each company were to establish its own plant and purchase its own new car equipments. In the struggle for very slight economies in the production of electric current, the ambitious electrical engineer has conceived that the best way to establish electric traction is by means of the erection of one enormous station from which high-tension alternating currents may be transmitted to various points, and there converted into continuous currents for local use. The electrical engineer has been encouraged and aided by the manufacturer, because this type of station has involved the use of the greatest amount of electrical apparatus. This plan necessarily involves the tearing up of roadways for the laying of cables required for carrying energy, and causes other inconveniences and risks. It is a fact that scarcely one of the great electric power stations heretofore built and operated is satisfactory in respect of cost of operation and other particulars to the owners of such plants.

The advantage of the current being generated by a mutual supply company cannot be over-estimated, because a minimum amount of apparatus would be used and the stations employed would be so distributed as to reduce to a minimum the inconvenience resulting to the public from the installation of such great undertakings. The foregoing suggestions involve the use of railway carriages similar to those employed upon the Central London, arranged in trains of three carriages each, two of such carriages being fitted with motors and controlling apparatus, the third being interposed. These carriages to be equipped with "unit control" and brake apparatus, and with coupling devices which will automatically unite them and the brake connections and the "unit control" electric connections at the same instant, without an appreciable loss of time. This provides for the joining together of two or more trains and the convenient operation of the entire equipment by a single motorman at the front end of the train.

Of great importance to those who invest capital in these undertakings are the facts with reference to the cheaper generation of electric energy—which means the cost of power—since the first outlay for a plant is of far less importance than the continued cost of operation. Having given continuous attention, during the past 10 years, to the development of gas engines of large power, and to suitable methods of producing a cheap gas for their operation, I may say, from a full knowledge of the subject, that the saving to be effected by the use of large gas engines supplied by producer gas—that is to say, a gas made in a very simple apparatus, preferably from hard coal or coke, or by the well-known Mond process from soft coal—will equal an amount which will represent an interest on about twice the estimated cost of a given power station of the modern type. The far-reaching effect of the cheap production of electricity can only be appreciated by going most carefully into the subject. Suffice it to say, however, that it is only by means of a much cheaper method of generating electricity than by the use of steam engines of even the best type, that one can hope to effect such economies as will justify the great railways in operating all of their suburban trains by electricity. Roughly stated, the expense for fuel and labour for the production of electricity by a gas-engine equipment will not be greatly above one-third of that of the highest type of steam plant, while, in comparison with the average steam plant, the fuel consumption and cost will not exceed one quarter. The decreased cost of production of electricity by means of gas engines, as compared with the present steam engine plants, would enable a Board of Trade unit to be sold at so low a figure as to justify a wide use of the electric current for cooking and heating purposes. In discussing the importance of the cheaper generation of electricity by means of gas engines and producer gas, one is met by much scepticism and frequently by the arguments of people having contrary interests. A sufficient answer to the sceptic and the interested party is the fact that apparatus will be supplied and results guaranteed. Representatives of large interests, ignoring what has heretofore taken place, have observed that to put in a large gas engine plant would be a great experiment; but on this point one may reply that it would be a much greater experiment to now establish a modern steam-engine alternating generating plant, and, in view of what can be accomplished with such economies with the gas engine, a far greater risk.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"A Handbook for the Electrical Laboratory and Testing Room." By Dr. J. A. Fleming, F.R.S. Vol. I. (London: "The Electrician" Printing and Publishing Co.) 12s. 6d.

"Die neuesten Fortschritte auf dem Gebiete der Funkentelegraphie." By Prof. A. Slaby. (Berlin: Julius Springer.) 80m.

"Annual Calendar of the McGill University, Montreal." Session 1901-1902. (Montreal: Gazette Printing Co)

## ELECTRICITY WORKS ACCOUNTS.

### Liverpool Overhead Railway.

The expenses per train mile on this line have again been slightly reduced. Had it not been for the inevitably higher coal bill and material increases in rents, rates and taxes and law costs the total expenditure out of revenue would have shown a diminution of 1·09d. instead of the 0·26d. per train mile actually arrived at. Unfortunately for the financial results, the receipts have fallen off by over 3d. per train mile, though to a great extent fair comparisons with former periods are impossible owing to the inclusion in the accounts of the traffic on the tramways owned by the company.

Owing to the relatively reduced receipts the ratio of total expenditure to revenue has dropped from 62·1 per cent. for the half-year to June 30, 1900, to 70·5 per cent. for last half-year. Out of the £11,723 net balance, £3,000 was paid in a 5 per cent. dividend on the preference shares and £5,000 in an ordinary dividend of 2 per cent. As compared with the corresponding period in 1900, the train mileage was 25·8 per cent. higher, and the passenger traffic nearly 15 per cent.

From the directors' report we learn that the extensions of the municipal tramways have not been without their effect on the traffic on the overhead railway in diminishing it, but that the traffic at Dingle station and on the Waterloo and Crosby tramways continues to be satisfactory.

In the table below figures are given showing the progress of the line:—

| Half-year ended | Passengers. | Train mileage. | Dividend per cent. | |
|---|---|---|---|---|
| | | | Pref. | Ord. |
| March 6 to June 30, 1893 | 1,370,742 | ... | ... | ... |
| June 30, 1894 ..... | 2,861,437 | ... | 5 | 1 |
| Do. 1895 ..... | 3,460,060 | 311,346 | 5 | 2¼ |
| Do. 1896 ..... | 3,739,575 | 313,010 | 5 | 2¾ |
| Do. 1897 ..... | 4,269,260 | 363,399 | 5 | 3 |
| Do. 1898 ..... | 4,472,941 | 362,690 | 5 | 3 |
| Do. 1899 ..... | 4,475,279 | 375,500 | 5 | 2½ |
| Do. 1900 ..... | 4,687,862 | 402,344 | 5 | 3 |
| Do. 1901 ..... | 5,382,224 | 506,174 | 5 | 2 |

### City and South London Railway.

The recently published accounts of this line bear unmistakable evidence of the improvement which is being wrought and which may be expected in the position of the concern by the extensions and connections which have been made. A glance at the table given below of the traffic over the line in corresponding former half-years will show how accelerated was the rate of progress last half-year compared with former periods. The train mileage marks an advance of 48·3 per cent., and the number of passengers carried was 41·2 per cent. higher than during the 1900 half-year. A further and a considerably greater impetus may fairly be expected when the Islington extension is opened in September, as promised.

The costs column in our analysis is little less encouraging than the traffic figures. The aggregate expenses per train mile have been reduced by 1·55d. There has been a considerable alteration and interchange among the costs. All the items under locomotive power or generating costs, including the coal item, have fallen in value to an aggregate of nearly a penny per train mile. The traffic expenses are also materially lower. It is the items of repairs and maintenance, not only of the permanent way and works, but also of the cars, which show to disadvantage among the costs by their increase. Rates and taxes, which in 1900 were £975, are down at £1,829 last half-year.

The loss of £8,034 by antiquation of plant at the generating station has forced the directors to see the necessity for a yearly allocation for depreciation. The original cost of four engines

| Half-year ended | No. of passengers. | Train mileage. | Receipts. | Ratio of expenditure to total rev. per cent. | Dividend per cent. | |
|---|---|---|---|---|---|---|
| | | | | | Pref. | Ord. |
| June 30, 1891... | 2,412,343 | ... | £19,403 | 79·0 | 5 | ... |
| Do. 1892 .. | 2,813,162 | ... | 20,931 | 70·0 | 5 | ¼ |
| Do. 1893... | 3,146,656 | ... | 22,458 | 64·6 | 5 | ¾ |
| Do. 1894... | 3,383,154 | ... | 23,565 | 61·7 | 5 | 1 |
| Do. 1895... | 3,113,199 | ... | 23,711 | 61·6 | 5 | 1¼ |
| Do. 1896... | 3,192,672 | 225,554 | 24,022 | 60·0 | 5 | 1½ |
| Do. 1897... | 3,437,810 | 232,703 | 26,403 | 57·6 | 5 | 1¾ |
| Do. 1898... | 3,478,977 | 235,342 | 26,357 | 56·7 | 5 | 2 |
| Do. 1899... | 3,540,098 | 235,254 | 26,749 | 56·4 | 5 | 2¼ |
| Do. 1900... | 4,169,717 | 299,723 | 33,608 | 59·4 | 5 | 1½ |
| Do. 1901... | 5,887,786 | 444,560 | 51,014 | 52·4 | 5 | 1¾ |

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is given at £5,500, and of eight boilers at £5,204. The proceeds of sale were £2,670, and the balance is being met by £1,000 from the reserve fund and £2,000 from the revenue account, leaving £5,034 to be met in the future. The £2,000 charged on the net revenue represents practically ½ per cent. in the dividend—an amount which would have raised it to 2¼ per cent.—the highest yet paid. On the other hand, the balance carried forward is £516 less than that received from the end of last year.

The following is a list of electric railway and tramway works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared :—

| | | | |
|---|---|---|---|
| Blackpool Corp. Trams. (Mun.) | Oct. 5, 1900 | Douglas Southern (Co.) | May 27, 1898 |
| Blackpool & Fleetwood (Co.) | Mar. 1, 1901 | Glasgow Corporation (Mun.) | Aug. 11, 1899 |
| Brighton & Rottingdean Seashore (Co.) | May 25, 1900 | Isle of Man (Co.) | May 27, 1898 |
| Bristol Tram & Carriage (Co.) | Feb. 17, 1899 | Leeds City (Mun.) | June 2, 1899 |
| Br'mpt'n & Pico'dilly Clr. (Co.) | July 8, 1893 | Liverpool Overhead (Co.) | Aug. 31, 1900 |
| Central London (Co.) | Mar. 1, 1901 | New General Traction (Co.) | May 27, 1898 |
| City & South London (Co.) | Mar. 1, 1901 | Oldham, Ashton & Hyde (Co.) | July 5, 1901 |
| | | Waterloo & City (Co.) | Mar. 1, 1901 |

| | LIVERPOOL OVERHEAD RAILWAY. | | | | CITY AND SOUTH LONDON RAILWAY. | | | |
|---|---|---|---|---|---|---|---|---|
| *Worked by* | The Liverpool Overhead Railway Co. | | | | The City and South London Railway Co. | | | |
| *Date of Commencement of Working* | March 6, 1893. | | | | December 20, 1890. | | | |
| *System* | Third-rail surface conductor at 500 volts. | | | | Third-rail surface conductor at 500 volts. | | | |
| *Chief Engineer* | S. B. Cottrell. | | | | P. V. McMahon. | | | |
| Half-year ended | June 30, 1900. | | June 30, 1901. | | June 30, 1900. | | June 30, 1901. | |
| **QUANTITIES.** | | | | | | | | |
| *Train mileage* | *402,344*[a] | | *506,174*[i] | | *299,723* | | *444,560* | |
| **Passengers Carried** | 4,687,862 | | 5,382,224 | | 4,169,717 | | 5,887,786 | |
| Length of railway authorised | 9 miles, 45 chains[b] | | 9 miles, 45 chains[b] | | 6 miles, 64·5 chains | | 6 miles, 70·75 chains | |
| Length of railway constructed | 7 miles, 65 chains[c] | | 9 miles, 17 chains[b] | | 5 miles, 42 chains | | 5 miles, 42 chains | |
| **Length of Railway Worked** | **7 miles, 65 chains**[c] | | **9 miles, 17 chains**[b] | | **4 miles, 60 chains** | | **4 miles, 60 chains** | |
| Length of railway under construction | 1 mile, 32 chains[d] | | nil | | 1 mile, 22·5 chains | | 1 mile, 28·75 chains | |
| Rolling stock, No. of cars | 7[e] | | 8[j] | | 84 | | 84 | |
| ,, No. of locos. | 44[e] | | 46[j] | | 30 | | 32 | |
| **CAPITAL.** | | | | | | | | |
| **Authorised (Total)** | £826,500 | | £906,500 | | £2,198,000 | | £2,598,000 | |
| Authorised (share) | 620,000 | | 680,000 | | 1,680,000 | | 1,980,000 | |
| Authorised (loan) | 260,500 | | 226,500 | | 518,000 | | 618,000 | |
| **Received (Total)** | 744,471 | | 790,000 | | 2,030,830[a] | | 2,165,098[c] | |
| Received (share) | 570,000 | | 620,000 | | 1,579,985 | | 1,680,000 | |
| Received (loan) | 174,471[f] | | 170,000 | | 413,593 | | 444,113 | |
| | Total. | Per mile of working railway. | Total. | Per mile of working railway. | Total. | Per mile of working railway. | Total. | Per mile of working railway. |
| **Expended (Total)** | £775,166 | £99.200 | £803,848 | £87,250 | £2,050,089[b] | £431,700 | £2,298,182[d] | £483,800 |
| On line open for traffic | 641,181[h] | 82,100 | 653,053[k] | 70,850 | 841,877 | 177,100 | 831,173 | 175,000 |
| On line in course of construction | — | — | — | — | 1,113,121 | 234,300 | 1,357,135 | 286,000 |
| On working stock, including power station | 133,985 | 17,150 | 150,795 | 16,360 | 80,787 | 17,000 | 97,370 | 20,500 |
| **Balance of Capital Account** | -30,694 | -3,930 | -13,848 | -1,502 | -19,260 | -4,053 | -133,083 | -27,990 |
| **Renewal Fund** | 16,200 | 2,073 | 19,200 | 2,083 | — | — | -5,034[e] | -1,059 |
| **Contingent Fund** | 1,000 | 128 | 1,200 | 130 | — | — | — | — |
| **REVENUE.** | Total. | Per train mile. | Total. | Per train mile. | Total. | Per train mile. | Total. | Per train mile. |
| **Total** | £38,023 | 22·68d. | £41.361 | 19·61d. | £35,145 | 28·15d. | £53,654 | 28·96d. |
| Passenger traffic | 37,404 | 22·32d. | 40,674 | 19·28d. | 33,608 | 26·92d. | 51,014 | 27·53d. |
| Parcels, rents, transfer fees, &c. | 618 | 0·369d. | 687 | 0·326d. | 1,537 | 1·231d. | 2,640 | 1·425d. |
| **EXPENDITURE.** | | | | | | | | |
| **Total** | £23,613 | 14·09d. | £29,158 | 13·83d. | £20,861 | 16·71d. | £28,096 | 15·16d. |
| *Maintenance of way, works and stations, less depreciation* | *2,493* | *1·496d.* | *2,873* | *1·362d.* | *723* | *0·579d.* | *1,390* | *0·751d.* |
| Maintenance of way | 922 | 0·550d. | 925 | 0·439d. | 535 | 0·428d. | 886 | 0·478d. |
| Repairs of structure, stations, &c. | 1,571 | 0·937d. | 1,948 | 0·924d. | 188 | 0·151d. | 505 | 0·273d. |
| *Locomotive power* | *7,189* | *4·290d.* | *8,818* | *4·180d.* | *7,459* | *5·970d.* | *9,139* | *4·935d.* |
| Coal and coke | 1,595 | 0·952d. | 2,908 | 1·379d. | 2,623 | 2·100d. | 2,784 | 1·503d. |
| Wages at power station | 3,061 | 1·826d. | 3,132 | 1·485d. | 2,966 | 2·375d. | 4,050 | 2·186d. |
| Oil and stores | 643 | 0·384d. | 789 | 0·374d. | 600 | 0·481d. | 586 | 0·316d. |
| Repairs and renewals | 1,890 | 1·128d. | 1,989 | 0·944d. | 1,269 | 1·017d. | 1,718 | 0·928d. |
| *Repairs and renewals of cars* | *444* | *0·265d.* | *389* | *0·184d.* | *609* | *0·488d.* | *1,354* | *0·731d.* |
| *Traffic expenses* | *9,277* | *5·536d.* | *11,363* | *5·390d.* | *8,965* | *7·180d.* | *11,866* | *6·410d.* |
| Salaries and wages | 6,035 | 3·600d. | 8,021 | 3·804d. | 5,480 | 4·390d. | 7,616 | 4·110d. |
| Other charges | 3,242 | 1·944d. | 3,342 | 1·584d. | 3,485[f] | 2·790d. | 4,250[g] | 2·294d. |
| *General charges* | *2,144* | *1·280d.* | *2,264* | *1·074d.* | *2,027* | *1·624d.* | *2,245* | *1·212d.* |
| Directors | 350 | 0·209d. | 350 | 0·166d. | 650 | 0·521d. | 650 | 0·351d. |
| Salaries of secretary, gen. manager and clerks | 1,071 | 0·639d. | 1,176 | 0·558d. | 533 | 0·427d. | 555 | 0 300d. |
| Other charges | 723[g] | 0·431d. | 738[l] | 0·350d. | 844 | 0·676d. | 1,040[h] | 0·562d. |
| Rents, rates, taxes, &c. | 1,905 | 1·136d. | 3,002 | 1·423d. | 975 | 0·781d. | 1,829 | 0·987d. |
| Miscellaneous items | 161 | 0·096d. | 448 | 0·212d. | 104 | 0·083d. | 273 | 0·147d. |
| **FINANCIAL RESULTS.** | Total. | Per cent. to mean capital expended. | Total. | Per cent. to mean capital expended. | Total. | Per cent. to mean capital expended. | Total. | Per cent. to mean capital expended. |
| **Working Profit for Half-year** | £14,409 | 1·885% | £12,203 | 1·526% | £14,284 | 0·760% | £25,558 | 1·136% |
| Sum carried to depreciation fund | 1,500 | 0·196% | 1,500 | 0·188% | — | — | 2,000 | 0 089% |
| Net interest on loans | 3,299 | 0·432% | 3,060 | 0·383% | 2,335 | 0·124% | 7,843 | 0·348% |
| Balance from last half-year's account | 4,592 | 0·601% | 4,080 | 0·511% | 1,267 | 0·067% | 1,249 | 0·056% |
| **Balance Available for Dividend** | 14,203 | 1·858% | 11,723 | 1·465% | 13,215 | 0·703% | 16,964 | 0·754% |
| **Ordinary Dividend paid at per cent. per ann.** | 3% | — | 2% | — | 1¼% | — | 1¾% | — |
| Percentage of total expenditure to revenue | 62·1% | — | 70·5% | — | 59·4% | — | 52·4% | — |
| **Revenue per Mile of Working Railway** | £4.870 | — | £4.490 | — | £7,400 | — | £11,290 | — |
| Expenditure per mile of working railway | £3,024 | — | £3,163 | — | £4,390 | — | £5,920 | — |
| **Revenue per Passenger** | 1·942d. | — | 1·844d. | — | 2·043d. | — | 2·190d. | — |

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

*All Editorial letters to be addressed to* The Editor.

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## THE PARLIAMENTARY SESSION.

The electrical industry is held by many to have been hampered by over-legislation. While it is still controlled in the main by the Telegraph Acts, the Electric Lighting Acts of 1882 and 1888, and the Tramways Act of 1870, fresh legislation has continually to be requisitioned to sanction its further development. Every new undertaking for the supply of electrical energy for lighting or power purposes is practically bound to obtain sanction from Parliament in some form or other, either by means of a Provisional Order granted by the Board of Trade and subsequently sanctioned by Parliament, or by means of a special Act. Electric traction is controlled by Parliament in more or less the same way, as a similar provisional order or special Act has to be the preliminary to the building of any electric tramway system. There are some exceptions, however, as the Light Railways Act affords an easier means of obtaining powers in certain instances of a special nature. Thus a review of the Parliamentary work of the session would be instructive even if there had been no new legislation on electrical matters affecting the electrical engineering profession generally. A few of the measures passed, however, possess more than local interest. Among the public bills which have become law we may mention the long-expected Pacific Cable Act, the Patents Act, 1901, and the new Factory Act. It is unnecessary to do more than mention the first of these; its scope is well known, and has already given rise to sufficient discussion. The Patent Laws Amendment Act is not concerned with the report of the Parliamentary Committee which recently considered the whole question of the working of the Patent Laws, but is merely a measure extending the time allowed to foreign inventors to lodge their applications for British patents, and *vice versa*, from seven to 12 months. The new Factory Act may or may not influence the electrical industry directly. If it does it will be by the power given to the Home Office and its inspectors to concern themselves with the inner working of electric generating stations, if these be classified as dangerous trades. Finally, the operation of the Light Railways Act has been prolonged for another year, and the bill to provide for the readjustment of the London electric lighting areas, to agree better with the boundaries fixed by the London Government Act of 1899, was abandoned.

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Several important private bills have been passed. Reference to those which have gone through as provisional electric lighting orders was made in our last issue, and this week we publish a list of all the public and private Acts of the session in which electrical engineering interests are involved. First among these should be placed the one relating to the Manchester-Liverpool Express Railway, which will be distinctly a landmark both in electrical and in railway engineering. Two examples of monorail lines already exist, but one combining the single-rail feature with extremely high rates of speed will be a new departure. A number of new electric power schemes have also been passed by Parliament—several of extreme industrial as well as electrical importance. One in the Shannon valley will open up a new industrial district, while the older districts in the North of England, the Midlands, and on the Clyde will be furnished with additional inducements to drive their works by electricity. The Mond Gas Act shows that our rivals, the gas engineers, are now intending to extend their competition to the transmission and distribution of power, and, whether the experiment it announces meets with success or failure, it will alike be watched with interest by our profession; possibly it will lead to renewed efforts in the direction of gas-driven electric supply stations. An experiment of a different nature is being attempted by the Corporations of Stalybridge, Hyde, and Mossley, and the District Council of Dukinfield, which will establish whether it is possible for four local authorities to join harmoniously in the business of electricity supply; while, in spite of what may have been said in directors' speeches to shareholders, the "electrification" of the Metropolitan and Metropolitan District Railways, dealt with to some extent in two other measures, need by no means be of an experimental nature. We must be thankful that the electrical equipment of the Inner Circle is to take place in the not too distant future, and that the dispute between the two companies will have, compulsorily, an early settlement. It is greatly to be regretted that the passing of all the new tube railway bills has been deferred until next session. The Committee appointed to inquire into the vibration in the neighbourhood of the Central London Railway reported quite early in the session that the vibration was not a necessary accessory to the working of a tube railway, and yet all these projected lines will have been delayed a year. Passing from railway to tramway bills, we will only refer to the Bexley tramways. These would have offered no points of unusual interest were it not for the electrolysis scare, which, we regret to say, was encouraged by the evidence of the then President and a past-president of the Institution of Electrical Engineers.

There is one class of legislation which affects considerably the electrical industry and yet often passes unnoticed by a large number of those whose interests are more or less directly involved. We refer to the clauses relating to electric supply which are packed away in the general powers bills of local authorities. If our professors would transfer their attention to an analysis of these omnibus bills, and leave the tramway bills alone, it would not be amiss. Under the ordinary provisional order, local authorities are bound to confine their trading in electrical matters to the supply of electrical energy, but every now and then, in special acts or in omnibus acts, they succeed in obtaining powers to sell and let out on hire electric fittings, motors, &c. These municipal authorities do not actually desire to compete with local tradesmen and electric wiring firms in selling fittings and wiring buildings, but their object is to have legal authority to supply consumers in some way or other on so-called "free," "easy payment" or hire-purchase wiring systems, to hire out motors and cooking and heating apparatus, and, in fact, employ every means to increase the load on their station to the benefit of their load factor. Such purely commercial business as "free wiring" is better undertaken by a company, but if no company can be found to supply such a system on reasonable terms, by all means let the local authority undertake it if it is clear that it fulfils a want and is advantageous both to the consumer and the supply undertaking. The same applies to the hire of motors and other expensive electrical appliances. There would appear to be an opening for an enterprising company or firm to establish itself for that purpose; but in the meantime the capital necessary for it will largely deter local firms from embarking on such a scheme, and it is left to the local authority to introduce it. Again, there is the supply of "free" lamp renewals, alluded to in our last issue. Whether the new lamps are given free or sold to the consumer, the latter pays for them—in the first instance, of course, by an enhanced price for electricity supply,—and it is a class of trading which is not provided for except under special acts.

In concluding, it will be of interest to quote the clause in question in some of the Acts. In the Wigan Corporation Tramways, &c., Act., and in the Lowestoft Corporation Act, 1901, the following clause is embodied:—

> The Corporation may provide sell let for hire and fix set up alter repair and remove (but shall not manufacture) lamps meters electric lines fittings apparatus and things for lighting and motive power and for all other purposes for which electrical energy can or may be used or otherwise necessary or proper for the supply distribution consumption or use of electrical energy and may provide all materials and do all work necessary or proper in that behalf and may require and take such remuneration in money or such rents and charges for and make such terms and conditions with respect to the sale letting fixing setting up altering repairing or removing of such lamps meters electric lines fittings apparatus and things as aforesaid and for securing their safety and return to the corporation as the corporation may think fit or as may be agreed upon between them and the person to or for whom the same are sold supplied let fixed set up altered repaired or removed.

This, it is seen, actually empowers the Corporation to do electric wiring, and leaves it to this authority to determine whether it shall do it itself or through contractors. Even though the Corporation at present in power may not intend to avail itself fully of this privilege, it would have been better if there were an express proviso that the Corporation is not authorised to fix electric wires or electric light fittings on consumers' premises. This is contained in the Brighton Corporation Act, which seems, however, not to contemplate free wiring, for it is expressly stated that the clause does not authorise the Corporation providing or fixing electric light fittings upon consumers' premises, and the powers would, therefore, seem limited to the sale and hiring out of electric motors, cooking, heating, ventilating, and other similar apparatus.

## EDISON'S ALKALINE STORAGE BATTERIES.*

BY E. J. WADE.

Edison's name has long been associated with that form of the zinc/copper-oxide combination known as the "Edison-Lelande," and constituting a primary cell capable of giving a large ampere-hour output at a low but constant E.M.F.; but quite recently he has described two new combinations with alkaline electrolytes which he considers are really reversible and not subject to the defects hitherto attendant upon this type of cell. The first of these, patented in 1900, is a cadmium/copper-oxide combination. In his specification he

* From a forthcoming work to be published by "The Electrician" Printing and Publishing Company.

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maintains that the copper-oxide passes into solution on recharging, because it is too dense and contains particles of imperfectly oxidised metal; and that if it is suitably prepared and sufficiently porous this vital fault will be entirely obviated. With this object in view, carbonate of copper is reduced by hydrogen at as low a temperature as possible, the finely-divided metal then moulded into thin blocks or slabs under slight pressure, converted into black oxide—cupric oxide, CuO—by heating for six to seven hours in a closed chamber at a temperature not exceeding 260°C, and then again reduced, but this time electrolytically, to the metallic state. The blocks are now ready for insertion in the pockets or recesses produced in a thin sheet of perforated nickel or nickel-plated iron by stamping it up. The electrode is shown in Fig. 1. There are no pockets on its other side, which is presumably covered in with a flat sheet of perforated metal and the two held together by the side ribs and rivets. On first charging, the active material is oxidised up to the red oxide—sub-oxide, $Cu_2O$—and is then ready for use.

The chief novelty of this cell lies, however, in its negative active material, consisting of finely divided metallic cadmium prepared by deposition upon a platinum wire from a solution of cadmium sulphate. After washing, it is packed into recesses in plates similar to those used for the positives.

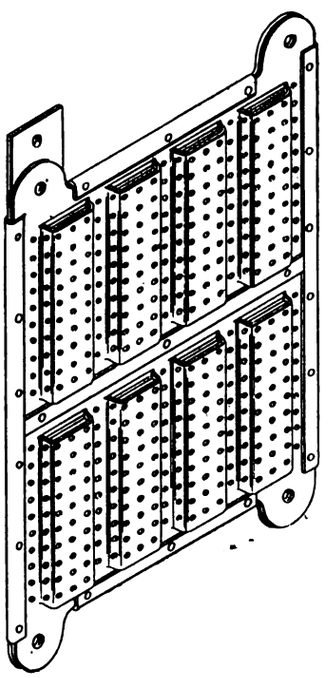

FIG. 1.

The metal oxidises upon discharge, but does not then dissolve in the electrolyte, so in this respect it behaves more like a lead negative in an acid solution than a zinc negative in an alkaline one. The electrolyte recommended is a 10 per cent. solution of sodic hydrate.

Early in 1901 Edison filed a second specification which relates to an iron/nickel-oxide combination. The positive active material may be an oxide of either nickel or cobalt, but the former is preferred on account of its lower cost. It is prepared by precipitating the hydrated oxide, which is then dried, powdered, mixed with nearly half its weight of flake graphite, moistened, and packed into a thin case of sheet nickel with perforated sides. The electrodes are now formed as positives for some considerable time, and the nickel-oxide is thereby carried to a higher stage of oxidisation and is ready for use. But in this cell, as in the other, it is more especially with regard to the negative active material that a new departure is made. It is prepared from monosulphide of iron mixed with one-fourth its weight of flake graphite, and packed into nickel electrodes similar to those used for the positives. The negatives are then formed in a solution of potassic hydrate by alternate oxidisations and reductions. Sulphur is eliminated as potassium sulphide, and ultimately nothing but finely divided metallic iron is left. Edison states that unless the iron is prepared in this way or from ferric hydrate which has been boiled with water for many hours, it is not susceptible to electrolytic reduction or oxidisation to any practical extent. Spongy iron reduced by hydrogen from various iron salts cannot be used on this account. The graphite mixed with the active materials does not take part in the reactions, but is used merely to improve the conductivity of the mass. On discharge the iron is oxidised, and the nickel oxide partially deoxidised, but only sufficiently to bring it to a lower stage of oxidisation, and not enough to reduce it to the metallic state; and as the ultimate reactions of discharge and recharge are simply the transference of oxygen backwards and forwards between the two electrodes, only sufficient electrolyte need be provided to form a conducting medium from one to the other.

So far the specifications. At present the only other source of information is the Paper read by Dr. A. E. Kennelly before the American Institute of Electrical Engineers in May last. In it no reference whatever is made to the cadmium/copper-oxide cell, so it may fairly be assumed either that it has not proved so satisfactory as was anticipated, or, at any rate, that it is distinctly inferior to the iron/nickel-oxide combination. Regarding the latter, the Paper supplies no further particulars as to the mode of preparation of the active materials or the precise compounds from which they are obtained. Indeed, it ignores the subject. The design and construction of the electrodes are, however, different to those described in the specification; but as the full details have already been given in the abstract of the Paper which appeared in *The Electrician* for June 7th last (p. 266) they need not be repeated here. Essentially, an electrode consists of a number of thin strips of consolidated active material, each enclosed in a very slight sheath of perforated nickelled steel, and held together by a grid stamped from a thin sheet of the same metal. The only difference between the positive and negative electrodes is in the nature of their active materials.

It is generally best to postpone criticism of the claims made for a new accumulator until the publication of figures obtained from electrodes and cells of the size and design that are going to be practically employed. As far as can be gathered from Dr. Kennelly's Paper, nothing beyond laboratory tests of small experimental cells have as yet been made, for the outputs given in the curves are not those of a cell actually weighing 21lb. but only of a smaller one "referred to" that size. Besides this, the data is very incomplete, and definite particulars regarding the charging and efficiency are altogether omitted.

Quite apart, however, from the commercial merits and possibilities of the cell, its nature is such as to suggest some interesting points, especially with regard to the use of iron as a storer of energy, which well deserve a little consideration.

Although iron is far cheaper than any other metal, and should yield, weight for weight, a watt-hour output about the same as that of zinc and many times greater than that of lead, it has not hitherto been found possible to employ it in a reversible cell. Its re-deposition from any acid electrolyte in which it is soluble is so uncertain, and its susceptibility to attack by local action so uncontrollable—in spite of its combining energy not being so great as that of zinc—that its use under such conditions seems quite out of the question. In an electrolyte containing free alkali these troubles disappear, for the iron can then only form insoluble compounds, and there is no local action. Edison has been subjected to some criticism for saying there can be no local action because iron cannot decompose water, but the remark appears to be substantially correct. According to the thermo-chemical figures, the E.M.F. due to the oxidisation of iron,

$$Fe + O = FeO,$$

is 1·47 volts, while the *minimum* E.M.F. required to electrolyse water is 1·48 volts, so it is hardly likely that iron will effect the transfer of the oxygen except in the presence of something which acts as a depolariser and combines with the liberated hydrogen. On discharge, this is furnished by the

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oxygen of the nickel-oxide at the positive electrode, but not, of course, on open circuit. It is improbable that the alkali itself reacts with the oxide of iron, or, if it does, the combination is such an exceedingly feeble one that it will contribute next to nothing to the E.M.F.

Because of its energetic union with the acid ions, iron reacts too readily with an acid electrolyte; but the difficulty in an alkaline electrolyte is to get the iron to react at all. Being insoluble in the solution, it must necessarily be used in some porous or finely divided form, and, as already stated, Edison finds that, when prepared by the usual known methods, it is practically unoxidisable. Kennelly further describes this by saying that "it assumes the well-known passive state," evidently alluding to the special conditions under which iron becomes insoluble in and remains unaffected by strong nitric acid; but it is questionable whether this is not to confuse two phenomena which, while superficially alike, are really of a different or even opposing nature, for it is generally believed that the metal is protected from the acid by a thin skin of oxide on its surface. That is to say, the "passive state" of iron is the result of oxidisation rather than of inability to oxidise.

The important fact, whose discovery is the essence of Edison's invention, is that, while most forms of iron cannot be oxidised and most salts of iron cannot be electrolytically reduced in an alkaline solution, there are a very few which will reduce to the metallic state and oxidise again with comparative facility. Indeed, he goes so far as to say that probably none other than the two he names can behave in this way. One of them, the monosulphide, has not been much studied, but the other possesses certain characteristics which long ago caused considerable attention to be devoted to it, and which now suggest the most probable explanation of its special behaviour in the cell. The substance in question is a curious modification of ferric monohydrate, $Fe_2O_3 + H_2O$, obtained by boiling ordinary precipitated ferric hydrate, $Fe_2O_3 + 3H_2O$ or $Fe(HO)_3$, for many hours. After that treatment it is no longer soluble in strong acids, and although dilute acids dissolve it, they do not form the usual iron compounds, for a gelatinous hydrate is re-precipitated on the addition of concentrated acids and certain salts which generally have no such effect. Moreover, when in solution it altogether fails to respond to some of the most distinctive tests for iron, as, for instance, those with ferrocyanides and sulphocyanides. Having regard to these and other properties, the opinion was formed that it must be an allotropic variety of the normal ferric hydrates, and Mendelejeff believes that it is a polymerised compound of very complex molecular structure.

The distinction between electrolytically active and passive (using the word in Kennelly's sense) materials or the active and passive states of the same material is by no means peculiar to iron and its compounds. In connection with the preparation of his positive active material, Edison speaks of its holding good for nickel and cobalt, and the ordinary lead accumulator affords some well-known examples of the contrast between the two conditions. The lead sulphate formed during the normal working of the cell and the white irreducible sulphate present the best case of this kind, and the spongy metallic lead of the negatives also appears to be capable of existing in either state.

The explanation of the difference is closely bound up with the question as to what is the nature of electrical conductivity in solid substances, and, until someone provides a theory which does for these what the dissociation theory has done for electrolytes, it will probably remain unsettled.

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Paris Exhibition Literature.—The seventh number of "l'Electricité à l'Exposition de 1900," compiled by MM. Hospitalier and Montpellier, and published by Dunod of Paris, has been sent us. It contains an excellent description by M. L. Montillot of the telegraphic instruments which were shown at the exhibition, telephony having been dealt with in a previous number, and wireless telegraphy being apparently reserved for a future issue.

## THE INTERPOLAR INDUCTION AND DISTRIBUTION OF COPPER IN THE ARMATURE OF A SIEMENS 12-POLE ALTERNATOR.

BY PROF. ERNEST WILSON AND WILLIAM MARDEN.

(*Concluded from page 635.*)

The quarter space period in Figs. 5 and 6 has been divided into 30 equal parts, and the area of each strip obtained. From these areas the E.M.F. of a single loop embracing arcs of 30, 60, 90, 120, 150, and 180deg. of a period of 360deg. has been obtained; these curves are numbered 1, 2, 3, 4, 5, 6, respectively, in Figs. 7 and 8. By adding together the ordinates of the curves in Figs. 7 and 8 respectively the average E.M.F.s for different arcs embraced by the width of the armature winding have been found; the

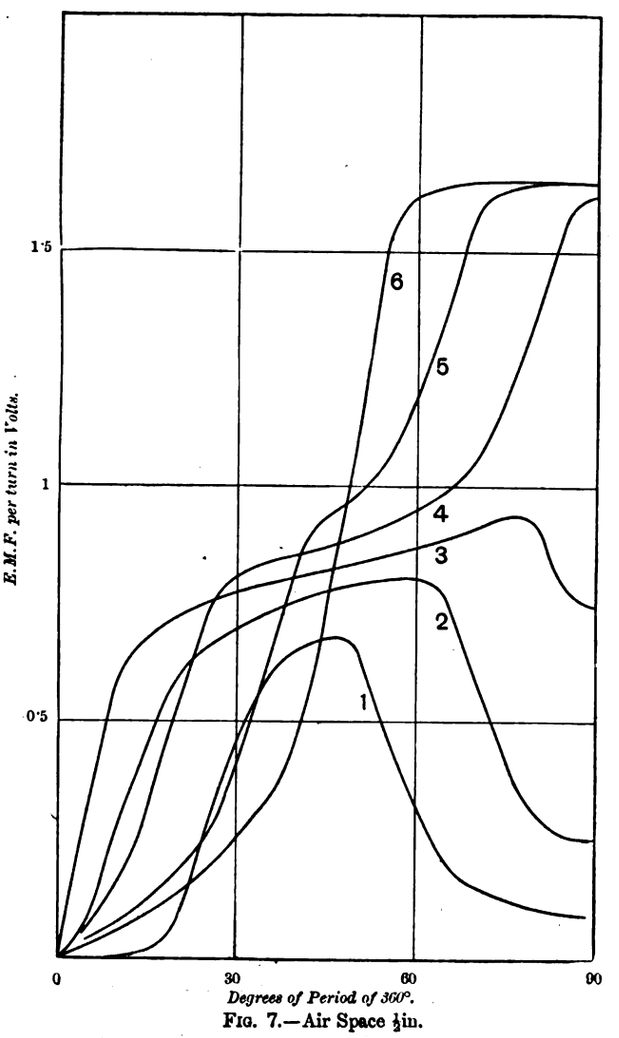


FIG. 7.—Air Space ½in.

total width of the armature coil always being equal to the pitch of the magnets. These are shown in Figs. 9 and 10, and are for width of armature winding embracing arcs of 15, 30, 45, 60, and 75deg., of a period of 360deg. They are numbered 1, 2, 3, 4, 5, respectively. Therefrom the form-factor, or coefficient with which the average E.M.F. has to be multiplied in order to obtain the $\sqrt{\text{mean}^2}$ value has been deduced.

The figures thus obtained are set forth in Table II., from which it will be seen that the ratios of E.M.F.s for the two air spaces for different arcs embraced by armature coil is practically constant at 1·61. An examination of the curves 1, 2 and 3 in Figs. 7 and 8 shows that the innermost turns of the armature contribute an E.M.F. with two maxima per half period. The arc embraced by the armature as constructed

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Table II.

| Number of curve in Figs. 9 and 10 | 1 | | 2 | | 3 | | 4 | | 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Degrees of period to width of armature winding | 15° | | 30° | | 45° | | 60° | | 75° | |
| Air space length | ⅛in. | 1⅛in. | ⅛in. | 1⅛in. | ⅛in. | 1⅛in. | ⅛in. | 1⅛in. | ⅛in. | 1⅛in |
| $\sqrt{\text{mean}^2}$ volts per turn at 100 frequency | 1·07 | 0·667 | 1·01 | 0·625 | 0·935 | 0·582 | 0·854 | 0 530 | 0·758 | 0·470 |
| Average E.M.F. per turn 100 frequency | 0·861 | 0·547 | 0·850 | 0·537 | 0·850 | 0·518 | 0·775 | 0 476 | 0·693 | 0·427 |
| Form factor $= \frac{\sqrt{\text{mean}^2} \text{ E.M.F.}}{\text{average E.M.F.}}$ | 1·24 | 1·22 | 1·19 | 1·16 | 1·10 | 1·12 | 1·10 | 1·11 | 1·09 | 1·10 |
| Ratio $\frac{\text{maximum ordinate}}{\sqrt{\text{mean}^2} \text{ ordinate}}$ | 1·56 | 1·46 | 1·62 | 1·55 | 1·51 | 1·49 | 1·39 | 1·40 | 1·32 | 1·34 |

is about 45deg., and the E.M.F. curve obtained from it corresponds to curve No. 3, Fig. 10. It may be mentioned that the figures obtained from this curve by calculation agree nearly with those obtained from the machine when running with the same excitation. The curves, No. 2, have the largest maximum ordinate for the same $\sqrt{\text{mean}^2}$ value of the E.M.F.

Suppose the E.M.F. of the machine is constant, and the total electrical energy of the armature is constant. This E.M.F. divided by the E.M.F. per turn for a given armature width gives the number of turns. Consider the armature constructed of strip of width equal to width of armature. This width cannot, of course, be equal to the length of air-space, as clearance must be allowed for; this may be taken as

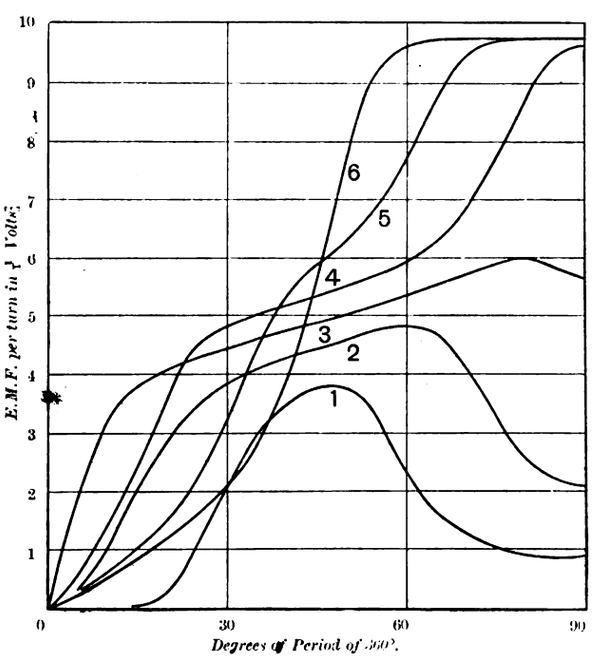


Fig. 8.—Air Space 1⅛in.

a constant, and will be large as compared with the short air-space. In the actual machine it is ⅛in. on either side of the armature.

Neglecting for the moment the effect upon the mean length per turn due to the semicircular ends of the armature bobbins, the length of the strip varies directly as the number of turns. The cross-sectional area of the strip will vary directly as the arc embraced by the width of armature winding, and inversely as the number of turns, if we neglect the variation in volume of the insulating material. The resistance of a bobbin will thus vary directly as the square of the number of turns, and inversely as the arc embraced by the width of the armature winding. Since the current is constant the loss in the armature varies directly as the resistance. Table III. shows that the loss falls to a minimum when the armature winding embraces 60deg.

The following figures show the variation of the mean length in terms of the armature width in this machine:—

| Armature width... | 15deg. | 30deg. | 45deg. | 60deg. | 75deg. |
|---|---|---|---|---|---|
| Mean length ..... | 1 | 0·95 | 0 90 | — | — |

In this type of machine the bolt which holds the bobbin in position against centrifugal force limits the arc embraced by the armature winding, unless the strip or conductors be widened

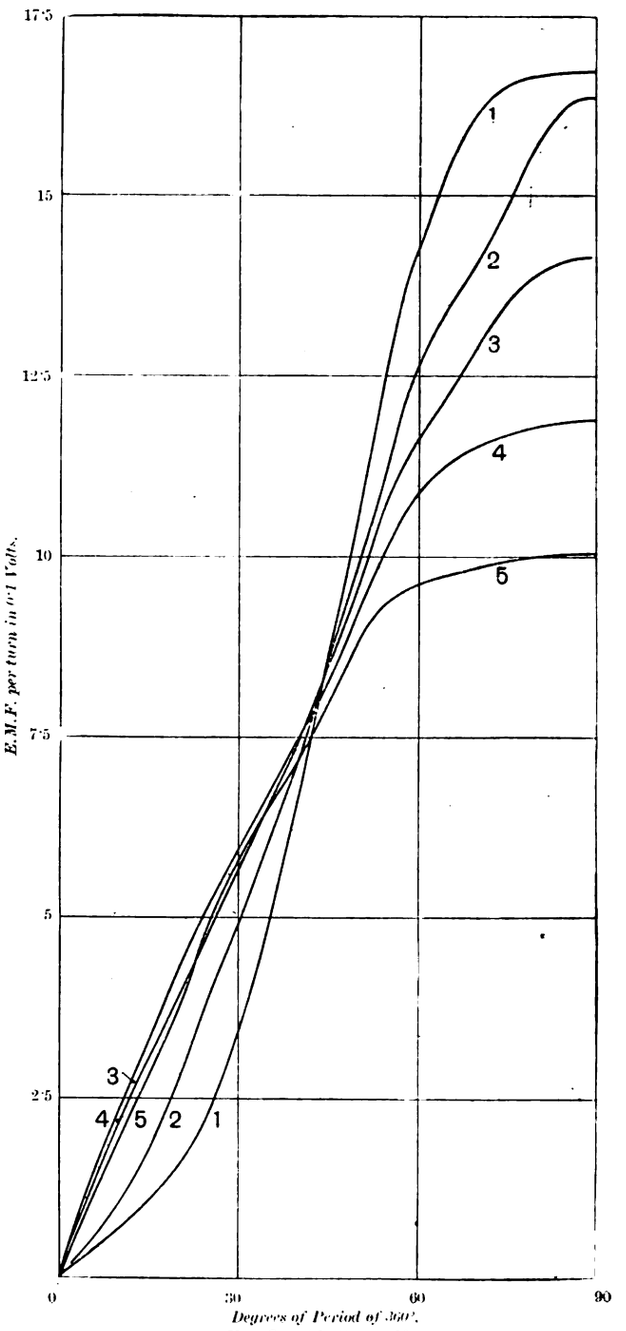


Fig. 9.—Air Space ⅛in.

at this position parallel with the axis of the armature. For 60 and 75deg. the mean length would be increased for the above reason and also on account of each turn having to cut the total field. This lengthening of the conductors might

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more than counteract the diminution of mean length due to the diminished radii of the inside turns at the two ends of the bobbin.

The foregoing remarks, so far as they relate to open-circuit conditions, may be taken to represent the facts very nearly in this machine. The subject of armature reaction is difficult to handle without further experiment. It has been dealt with in the case of the armature of this machine as actually constructed, embracing, as it does, 45deg. of a period.*

With such air-spaces we do not feel justified in drawing rigid conclusions as to what would happen with other armatures having different volumes of copper. Assuming the armature reaction the same in each of the two cases dealt with, the amature $C^2R$ loss is inversely proportional to $(\sqrt{\text{mean}^2}$ E.M.F. per turn$)^2 \times$ thickness of armature $\times$ arc embraced by width of armature winding. This gives the result in arbitrary units in Table III., that with the particular magnet circuit experimented on and $\frac{1}{8}$in. clearance on each side of armature, the loss is about a minimum, when the ratio of width of armature winding to pitch is about $\frac{1}{3}$. And this

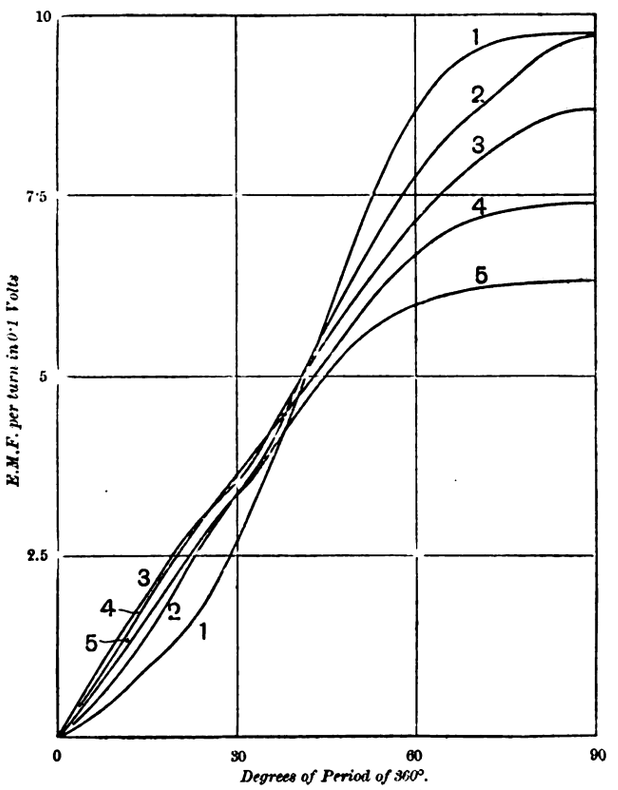


Fig. 10.—Air Space 1⅛in.

is in agreement with modern single-phase practice. The loss is in favour of the 1⅛in. air-space. If the clearance be reduced to $\frac{1}{16}$in. then the ⅛in. air-space is (so far as loss is concerned) equal to the 1⅛in. air space. In some of the largest alternators of this type the air-space length is not greater than in this small machine.

We wish to thank Mr. D. R. H. Browne for help given during these experiments.

Table III.

| Clearance between armature bobbin and pole face | | ⅛in. | | $\frac{1}{16}$in. | |
|---|---|---|---|---|---|
| Length of air space | | ⅛in. | 1⅛in. | ⅛in. | 1⅛in. |
| Arc embraced by width of armature winding period 360deg. | Ratio of width of armature winding to pitch of pole pieces. | ... | ... | ... | ... |
| 15deg. | $\frac{1}{12}$ | 291 | 214 | 194 | 187 |
| 30deg. | $\frac{1}{6}$ | 163 | 122 | 109 | 107 |
| 45deg. | $\frac{1}{4}$ | 127 | 94 | 84·7 | 82 |
| 60deg. | $\frac{1}{3}$ | 114 | 85 | 76 | 74 |
| 75deg. | $\frac{5}{12}$ | 116 | 86 | 77 | 75·4 |

* See *Phil. Trans.* Roy. Soc., Vol. CLXXXVII. (1896) A, pp. 229—252).

## COAL AND ASH CONVEYING GEAR.

The following is an abstract of the discussion which took place in connection with Mr. Chattock's Paper on the above subject, read before the Incorporated Municipal Electrical Association at Glasgow:

Mr. WORDINGHAM said that most of them were apt to over-estimate the money value of these labour-saving appliances, and to exaggerate the cost of hand labour. He did not think, however, that Mr. Chattock emphasized sufficiently at the beginning of his Paper the enormous cost of the double handling that was necessary if they had a separate coal store for their main reserve. There was practically no apparatus on the market that would take the coal from a given point, distribute it over a large area, and re-collect it from that large area and take it to another point. It could be done, but only at an enormous cost and by the use of an appalling number of conveyers. For this reason he thought it was desirable to go to the trouble of providing a very large storage capacity, because by that means they only got one handling. Then there was another thing that increased the cost of the double handling, and that was, that in order to make the conveying apparatus work they had to let the coal fall from a considerable height, and, therefore, it had all to be elevated practically twice over. Another important feature in connection with coal handling was the source from which they got the coal. One was very apt to think that water carriage was so very cheap, but in the matter of coal one found that railway carriage was incomparably better, particularly for a reason which had nothing whatever to do with coal handling, namely, that there were not usually a large number of collieries with connections with canals. Carriage by sea was a different matter altogether. He was speaking now of inland towns in England. They would find that they got a very much greater amount of competition if they took coal by rail as well as by canal, or by rail alone, than if they took it only by canal. Mr. Chattock said that for unloading coal from a barge the best form of elevator was an automatic grab which could be attached to a crane. That was all very well if they had a big Thames lighter, but if they had an ordinary narrow canal boat they would find that it made two bites at a cherry, and the rest had to be shovelled in by hand.

Mr. SNELL (Sunderland) said that for large stations there was no doubt they must make use of overhead bunkers. He urged the importance of large storage capacity. He pointed out that 35deg. was the angle below which coal refused to trim, and that entailed greater storage and large bunkers. With regard to the disposal of ashes, at the station in Glasgow they had seen a method which was exceedingly expensive, and one at Edinburgh which was much simpler and cheaper.

Mr. NEWINGTON (Edinburgh) said that the design of the conveyor must depend upon the site. The question of measuring the coal used was very important. He could not understand the arrangement they saw at the Pinkston (Glasgow) station. It seemed to him that the man pulled a string and the coal dropped into something and was weighed in some way but he thought that if the man held the string a little longer it would run through to the fire without being weighed at all. In Edinburgh they had a system of boxes capable of holding 5 cwt. with a sliding top and bottom. There was an interlocking arrangement so that the box could only be opened or closed when it contained the proper quantity; and there was a counting arrangement showing the number of times the slide had been opened and the box filled. The removal of ashes was a very difficult matter unless the station had been previously designed for the purpose.

Mr. BISHOP (Wigan) pointed out the advantages of the conveyer consisting of an endless chain of buckets for taking coal from one storage place to another. It could be used for carrying coal to boilers and also for carrying ashes away. It was necessary to have some means to get rid of the ashes without the fumes and dust from the hot ashes entering the boiler.

Mr. McCOWAN (Belfast) said that the subject of labour-saving machinery had a peculiar charm for engineers with electrical supply stations, but it was a question whether it was always commercially desirable to introduce it. He recently thought out a scheme for handling their coal and ashes; but he found that, while it would save about £70 in labour, the capital charges would amount to about £150, and so he had put it off for the present.

Mr. GRANGER, referring to the slope angle at which to tip coal, said it should not be more than 55deg.

Mr. BOOT (Tunbridge Wells) said that in the South of England the question of coal handling was a very difficult one, because they had to burn the very best coal, and the conveying appliances were not, as a rule, designed to convey the coal economically. Care should be taken that the cost of these conveying plants did not more than counterbalance the cost of a simple system of having their own works siding and running the rails up to a height which would be sufficient to discharge into coal storage above the boilers and thus save the whole of the labour. This system was largely employed in gas works, and he knew for a fact that it worked cheaply.

Mr. EDGCOME (Kingston-on-Thames) asked if Mr. Chattock had had any experience of the Zimmer conveyer. The coal was jerked along the conveyer. The Zimmer was used very largely for conveying grain and seeds.

Mr. MOUNTAIN (Huddersfield) said that so far as he could see it was much better to leave the conveyers alone when they were dealing with lighting only. But they must have coal stores in which coal could be put for emergencies, and it might remain for 10 years. The cost of storage would be very slight. A three months' supply was imperative for works that were not next door to a pit.

Mr. NEWINGTON (Edinburgh) said that they had had coal stored at Edinburgh for four years. They were using coal from it now, and they found to all appearance it was just as good as when put down.

Mr. ANDREWS (Hastings) asked what was the experience of engineers in the matter of storing Welsh coal for a long time. He found that it



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depreciated if kept a month or two. In the case of small coal the depreciation amounted to as much as 30 or 40 per cent. For that reason he did not store more than about a month's supply. With regard to measuring coal, he had an arrangement fitted with an electrical tell-tale which recorded every 4cwt. that went through.

Mr. CHATTOCK, in replying, said he thought the best place to quench ashes was certainly out of the boiler-house and below the boiler-house floor. If receptacles were provided in which the ashes could be stored for a day, or possibly two days, it would not be necessary to quench them, but simply to rake them out to the conveyor. In this way no fumes would be produced. With regard to storage, he had looked into the question rather closely, and he found that to store 200 or 300 tons per 1,000 H.P. meant a very heavy overhead construction. It also necessitated covering in the top of the boiler-house, resulting in shutting out light and ventilation. Any amount over 150 tons per 1,000 H.P. should be stored in an auxiliary store outside. He had fixed on 45deg. as the correct slope for the coal in store because it was occasionally stored in a wet condition, and might, in consequence, hang to the floor. He was sorry that he had never seen the conveyer which jerked the coal along; he had heard of it, and so far as he had heard it was satisfactory. But he should think that a motion such as had been described must entail rather heavy repairs—a sudden jerking motion would necessarily cost more for repairs than a steady motion. With regard to storage, he knew that Welsh coal depreciated very quickly. He had some in store for about four months, and when it was used the fires were only about half as good as they should have been, and as they were when the coal was used fresh.

## SOME EXPERIMENTS ON FILINGS COHERERS.*

BY W. H. ECCLES, D.SC.

*Preliminary.*

The investigation described in the following pages was commenced early in 1900 with the object of revising what was then known of the relative influences of oscillatory and of steady P.D.s in promoting coherence in filings coherers. It was hoped that evidence might be obtained which would decide definitely whether the action of electrical vibrations was in character different from or similar to that of steady E.M.F.s. The importance—from several points of view—of this discrimination is manifest; and that the difference, if any, has not, up to the present, been pointed out, nor, if non-existent, been proved so, is shown by an examination of the published records of the research on the subject.

Many observers have assumed or have suggested that the events leading to coherence among a mass of particles were identical in the two cases mentioned. They have often expressed this assumption implicitly by postulating electrostatic attractions between the particles. To go a long way back—in 1870—Varley, in describing to the British Association meeting his lightning protector for telegraphic apparatus, suggested that the bridging over of the gap resulted from the electrostatic attractions produced by large E.M.F.s among the particles of the conducting powder placed between the terminals. Even earlier, in 1850, Guitard made similar remarks regarding his experiments on dusty air. And since then other experimenters working on our or on kindred subjects have given similar vaguely-expressed views. Again, Branly, in his classical Paper,† having observed that the application of the E.M.F. of a battery of mercury sulphate cells produced conductivity in a mass of filings, and that the effects so produced were identical with those caused by the incidence of electric radiation on the filings, therefore asserted that the effect in both cases was one of E.M.F. merely. This view of the matter seems to have been accepted tacitly by many subsequent workers. But in no case has special care been taken by experimenters to avoid the creation in the coherer circuit of electrical disturbances of an oscillatory character. So that it is at present, to the author's knowledge, the opinion of several eminent authorities that the electrical surgings set up in the coherer circuit on the sudden establishment of a connection with a source of E.M.F.—as by any ordinary contact device used in conjunction with a battery—play an important part in the production of coherence. The exact function fulfilled by such electrical surgings has by no one been exactly outlined, but it is probably imagined by most to consist in a modifying of the mechanical arrangement of the particles. Such an action was broadly indicated by Lodge in the general case of a filings coherer submitted to electromagnetic radiation when he spoke in 1899‡ of the washing of the ether waves round the particles aiding their orientation.

With regard, merely, to this question of movements among the particles, considerable divergence of opinion has, apparently, always existed. Of course, the effect of tremors in assisting coherence and of shocks in destroying it has been noticed by all observers, and has by the majority been ascribed to actual relative motions among the particles. Calzecchi, in 1884, used a mass of filings heaped between two brass plates in series with a cell and galvanometer as a tremor detector, and noticed* that even sounds affected the conductivity of the mass. He calls the arrangement, indeed, a "microseismic indicator." On the other hand, Branly,† led by his experiments on compressed masses of filings and on filings embedded in blocks of resin, in introducing his theory postulates that motion of the particles is impossible. Pasquini‡ recommends the greatest possible freedom of motion for the particles. Arons§ finds that Canada balsam, which must of necessity greatly hinder the motion of the particles, did not interfere with the efficiency of the coherer's action. Several observers have investigated the effect on conductivity due to the agitation caused by sound waves. But Branly,‖ in 1898, still recommends compression in using filings coherers. Tommasina,¶ however, in 1899, and Sundorph** and Malagoli†† in the same year, demonstrated the formation of lines or chains of filings; and these lay stress on the occurrence of motion among the particles.

During the past year little has been added to our knowledge of the action of unidirectional E.M.F.s on filings coherers. In April, however, while the author was engaged on his experiments Blondel and Dobkevitch communicated‡‡ the results of their investigations. They had found that different coherers submitted in turn to gradually increased E.M.F.s cohered respectively at voltages which approximately indicated their sensitiveness. They called that P.D., which, steadily applied, produced coherence, the "critical voltage." They pointed out that for the purposes of wireless telegraphy the E.M.F. of the battery in the coherer-relay circuit (plus possible E.M.F.s due to the inductance of the circuit) must not exceed this critical value, and that the E.M.F. added by impinging waves should enable the critical value to be passed. The present writer, however, shows in this article that the coherers with which he worked—and they were of considerable number and variety—gave "critical voltages" which were very indefinite; these being dependent, as they seemed, on the tremors to which the coherer being examined was liable, even under the best working conditions. Moreover, it will also be here shown that there is no true "critical voltage"—the degree of coherence produced by even the smallest practicable E.M.F.s being perfectly measurable with an instrument of suitable sensitiveness. It will be seen that exact information on the various questions which arise in connection with the filings coherer is scanty in the extreme. Much more attention has been paid to the single-contact coherer. But as this article deals only with coherers made with filings, it is not necessary to revise the work which has been carried forward on the more carefully studied part of the subject.

The phenomenon of coherence, whatever it may consist in—whether it is, as Lodge affirms, a welding together of the two surfaces in pseudo-contact, a reaching of the forces of cohesion across the separating space; or whether it is, as Branly considers, a modification of the dielectric occupying the minute space between the conductors concerned; or, as Bose has proposed, an effect depending on allotropic change in the material of the conducting particles; or, as others believe, one depending on the existence of surface films of condensed gases or moisture—this phenomenon of pure coherence is, in all probability, greatly disguised and complicated in a filings coherer by the preliminary and purely mechanical actions of the particles. That the phenomenon of coherence proper, then, cannot be advantageously studied amid these probable complications need scarcely be pointed out. This view of the case seems also to the writer to account in a great measure for the extraordinary conflict of opinion which has obtained, since Branly's discovery, with regard to various qualities, such as the relative sensitiveness, of coherers made with filings of different metals. To cite only a few cases, it is notable that Marconi, in his patent specification of March, 1897, states that he uses a proportion of silver filings to increase the sensitiveness of his nickel coherers, and that the continued addition of silver greatly increases the sensitiveness; while Lodge,§§ in the same year, remarked that the noble metals are not suited for coherers. Dorn,‖‖ in 1898, confirmed Lodge, and with the noble metals placed nickel, adding that only oxidisable metals are sensitive. Branly¶¶ then announced that, on the contrary, the noble metals are extremely sensitive; and Blondel and Dobkevitch, in their Paper quoted above, seem to agree with Branly when they state that the less oxidisable metals give lower "critical voltages."

Such confusion has arisen, the writer believes, out of the great complexity of the numerous conditions which influence the mechanical and electrical behaviour of the filings in a coherer. These conditions may be seen to be dependent, broadly, on the state of rest or of motion of the particles and on their relative positions at the moment of coherence; on the nature, probably, of the material of which the

* Many of the tables accompanying this article were obtained from coherers forming part of the stock of the Marconi Company. It is only by the company's kind permission that the writer is now enabled to publish them.

† *La Lumière Electrique*, May and June, 1891.

‡ Royal Institution Lecture, February 24, 1899.

* *Nuovo Cimento*, September, 1897.

† *La Lumière Electrique*, June, 1891.

‡ *Nuovo Cimento*, March, 1898.

§ *Wied. Ann.*, No. 7, 1898.

‖ *Comptes Rendus*, December 26, 1898.

¶ *Ibid.*, May 15, 1899.

** *Wied. Ann.*, No. 7, 1899.

†† *Nuovo Cimento*, October, 1899.

‡‡ *Comptes Rendus*, April 23, 1900.

§§ *The Electrician*, Vol. XL., p. 87.

‖‖ *Wied. Ann.*, No. 9, 1898.

¶¶ *Comptes Rendus*, Dec. 26, 1898.

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filings consist; and on the size and shape of the filings. Evidently the size and shape of the particles each depend on the manner of production—that is, on the kind of file used and the mode of using it, and must also be, for different substances, to some extent dependent on the elasticities, the tenacity, and other properties of those substances. The mechanical circumstances alone are thus extremely involved. But to co-ordinate the experimental data accumulated by the author it was early found necessary to construct a working theory. This theory—which is sketched later—springs naturally from the results of the first few series of experiments. That these experiments were necessary for the framing of any hypothesis intended to correlate the movements of the particles with the E.M.F.s applied is evident. For, if oscillatory discharges were proved necessary for efficient coherence—that is, in the light of Tommasina's experiment for the formation of numerous chains of cohered particles—then the effect on the movements of the particles of displacement currents in the dielectric must be taken into account; while if, on the contrary, steady E.M.F.s were shown sufficient, then other electro-mechanical connections must be proposed.

*Experimental.*

To confirm or correct and to amplify the very meagre information available on the effects of steady E.M.Fs. on filings coherers the following experiments were projected during the spring of 1900. They were made possible by the kindness of Dr. J. Erskine-Murray, F.R.S.E., in whose laboratory they were commenced, and whose advice and assistance the writer had the good fortune to have always at call during the first phase of the work. The plan proposed was to submit to the influence of a steadily increased P.D. each of a large number of coherers of known degrees of sensitiveness, and to observe at what E.M.F. (if any any) coherence was produced. Through Dr. Murray's kindness the writer had access to a very large stock of coherers which had been tested by the use of signals received on an air-wire, and whose general character and whose sensitiveness were fairly well known.

These coherers were submitted to E.M.F.s supplied by a potentiometer arrangement. To avoid the possibility of abruptness in the changes of potential a copper-sulphate solution potentiometer was adopted. This consisted merely of a long graduated glass tube containing dilute copper-sulphate solution, with one movable and two fixed electrodes. The fixed electrodes were of copper, and introduced and led away respectively the main current supplied by a battery of 10 volts. The movable electrode was also of copper, but was exposed to the electrolyte only at its extremity, the shank by which it was moved being insulated. Its position was read on the graduations of the tube, the value of the graduations in volts being roughly found by a separate experiment. One of the fixed electrodes (earthed as a rule) and the movable electrode formed with the intervening electrolyte a portion of a circuit which also included a moving coil galvanometer, a resistance of 12,000 ohms, and the coherer which was to be examined. By this means could be applied to the coherer a gradually increased E.M.F., ranging from zero to 10 volts, and that in so gradual a manner that there arose no probability of the creation of electrical surgings in the circuit external to the coherer. It might be added that a very few preliminary experiments showed the advisability of including in the coherer circuit a high resistance; its inclusion prevented the passage of any current considerable enough to damage the coherer. The coherers used were all of one type, were made by the same man from the same materials, and consisted of nickel filings between silver electrodes about 0·3mm. apart, sealed in a vacuous glass tube.

In every case coherence was found to take place with suddenness. Immediately coherence was indicated by the violent throw of the galvanometer mirror the main current of the potentiometer was switched off and the position of the movable electrode read on the glass tube and recorded. Then the coherer was restored to its normal condition of high resistance by gentle tapping continued for a few seconds, and the experiment repeated. It was found that the E.M.F. required to cohere the same tube varied as much as from 20 to 60 per cent. on successive occasions. The movement of any occupant of the room below affected the value of the figure obtained appreciably, while gentle agitation of the tube usually ensured coherence at quite low voltages. The effect of rougher shocks was, as Branly and others had shown previously, very irregular, and as observation of the galvanometer mirror indicated sometimes took the form of a rapid succession of coherences and de-coherences. As regards the behaviour of different coherers all exposed to identical circumstances, it was found, even when the greatest efforts were made to protect the tube from mechanical disturbances, that no law could be proposed to connect the E.M.F. at which coherence occurred with the sensitiveness as ascertained by testing on an air wire—excepting in these two extreme cases in which the coherers were either extremely sensitive or extremely inert as regards signalling. In these two cases, indeed, low P.D.s for the one (from 0·1 to 0·5 volt) and high P.D.s for the other (from 6 to 10 or more volts) were the rule. In the case of very sensitive tubes the movements of the galvanometer mirror were extremely erratic at about the cohering voltage. No external cause could be definitely assigned to account for these vagaries, but they perhaps arose from mechanical disturbances originated at a distance and transmitted through the walls of the building to the apparatus table. A selection of the figures obtained is given in Table I. Each figure is the mean of three distinct observations obtained under circumstances as similar as possible. With these figures may be compared the results of independent tests made for commercial purposes on each coherer by examining its behaviour in receiving signals transmitted from a distant station.

**Table I.**

| Character of coherer by radiation test. | Cohering voltage. | |
|---|---|---|
| | Liquid potentiometer. | Wire potentiometer. |
| A. Too sensitive ..... | 0·05 | 0·15 |
| | 0·2 | 0·1 |
| B. Very sensitive ..... | 0·6 | 0·8 |
| | 2·0 | 1·2 |
| C. Moderate ..... | 0·4 | 1·2 |
| | 3·5 | 4·1 |
| | 1·1 | 0·7 |
| D. Hard ..... | 5·2 | 3·6 |
| | 0·3 | 0·5 |
| E. Very hard ..... | 4·2 | 5·0 |
| | 10+ | 10+ |
| F. Too hard ..... | 5 | 8 |

The liquid potentiometer was now discarded and a simple form of wire potentiometer installed in its place. The experiments outlined above were repeated on the same coherers, continuous contact between the slider and the potentiometer wire being purposely avoided. It will be seen from Table I. that figures were obtained which, allowing for the known aberrations, were for each coherer similar to those obtained with the electrolytic potentiometer.

So far, on the whole, mere confirmation of the results of other observers had been obtained. But now, it may be admitted, all doubts as to the possibility of coherence by the application of absolutely non-oscillatory E.M.F.s had, by the use of the liquid potentiometer, been removed. Moreover, it was now fairly well established that any electrical surgings produced by sudden connection with the source of E.M.F. had little or no influence in compelling coherence beyond that which their maximum voltage gives them. In other words, it appeared to be sufficiently demonstrated that coherence was an effect caused merely by P.D. It should be observed, however, that it is always possible, even when the applied P.D. increases slowly and continuously, that electrical surgings may be created by the first small discharge which takes place through the coherer along that line of particles which happens at the moment to offer the least resistance, and that the initial slight surgings so produced facilitate similar action along other lines of particles, till by a sort of cumulative process a large proportion of the whole mass of filings becomes involved in the process of coherence.

Unfortunately, the vagarious numerical results so far obtained indicated so little by their magnitude the characters of the coherers from which they were derived, that some statistical mode of attack seemed necessary to detect the relation which it must be presumed exists between sensitiveness and cohering voltage. The most obvious method was to obtain the cohering voltage of each coherer in a large number of successive trials and take the mean. This process was adopted to this extent: that 30 values were obtained from each of six coherers of medium sensitiveness. The circumstances of each test were made as identical as possible, and the decoherence preceding each test consisted of half a minute's tapping by a bell-trembler. The results of striking an average showed that there was a decided tendency for the figures to cling round a particular mean for each coherer, the values of these means lying all between 1 and 4 volts, but not agreeing strictly in their order with the known order of sensitiveness of the coherers used. No coherers that were extremely sensitive or extremely non-sensitive were submitted to this tedious method, for a single trial always picked out such tubes sufficiently definitely.

The laboriousness of this procedure prohibited its application to any large number of coherers. It therefore seemed necessary to vary the method of attack. Doubtful of finding any practicable mode of securing perfect freedom from mechanical disturbance, the writer next endeavoured to secure that the degree of mechanical disturbance should be uniform. This was more or less effectively managed by fixing the coherer to a framework kept in gentle agitation by an attached rapidly-vibrating bell-trembler. Unfortunately, another long series of measurements conducted on the same lines as before showed that little had been gained; the figures obtained from the same coherers, though being all smaller than by the previous method were as irregular in value, and, apparently, as little related to the behaviour of the coherers under receipt of radiation as those set out in Table I.

It now occurred to the writer to reduce the time of a single trial to the fraction of a second by allowing the hammer of a trembler to



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strike uninterruptedly the coherers under examination. During each quiescent stage between the blows coherence might take place and a current pass through the galvanometer. Decoherence would follow immediately and be succeeded by another coherence, and so on to any length of time. If uniformity in the vigour of the blows could be ensured each consecutive cycle of operations within the coherer would resemble accurately the preceding one; and the galvanometer would integrate the pulsating currents traversing it and give their mean value. It remained to be seen whether the time allowed between the blows was sufficient for the production of coherence. The trembler first used performed about 50 vibrations per second. The coherer selected was one of moderate sensitiveness. The following figures were immediately obtained by submitting the

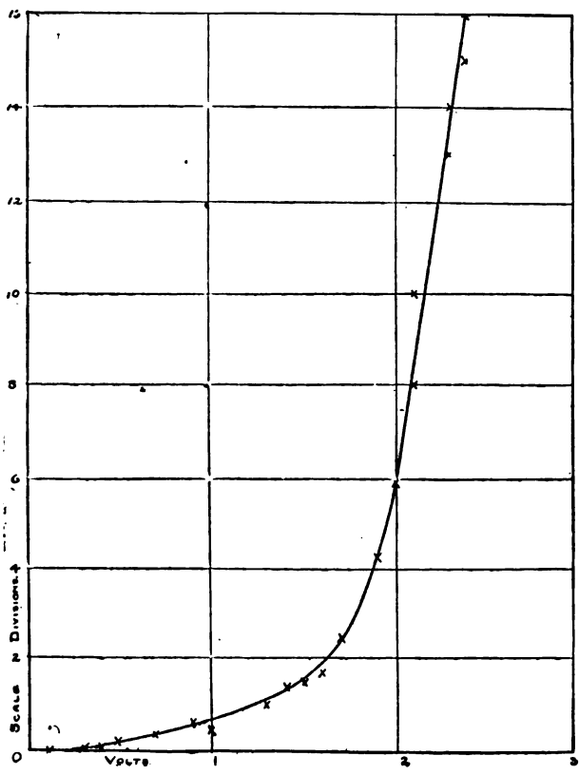


FIG. 1.

coherer, while being tapped, to known E.M.F.s taken from a wire potentiometer. Here the galvanometer deflections are left, as obtained, in scale divisions. Fig. 1 is plotted direct from this table.

**Table II.** (Fig. 1).

| Volts. | Deflection in scale divisions (1cm. corresponding to about 3 microamperes). | Volts. | Deflection in scale divisions (1cm. corresponding to about 3 microamperes). |
|---|---|---|---|
| 0 | 0 | 1·4 | 1·4 |
| 0·1 | 0 | 1·5 | 1·5 |
| 0·3 | 0·1 | 1·6 | 1·7 |
| 0·4 | 0·1 | 1·7 | 2·4 |
| 0·5 | 0·2 | 1·9 | 4·2 |
| 0·7 | 0·4 | 2·0 | 5·9 |
| 0·9 | 0·6 | 2·1 | 8 to 10 |
| 1·0 | 0·5 | 2·3 | 13 to 14 |
| 1·3 | 1·0 | 2·4 | 15 to 16 |

After the lengthy experience of coherers which had been gained by the writer, the steadiness of the galvanometer reading and the certainty with which increase of deflection followed the movement of the jockey along the potentiometer wire seemed almost incredible. Occasionally, however, there were rather violent throws which sent the spot of light off the scale, and there were also sudden lapses which allowed the spot to fall towards zero. A number of coherers were roughly tried over, and from them figures giving similar curves obtained. It was, therefore, decided to remodel the apparatus and to prosecute thoroughly the new method. It was noticeable that in every case a decided change occurred in the conductivity of the coherer at voltages much lower than the critical voltages obtained by previous processes from the same coherers.

The apparatus was wholly re-arranged. Continuity of sliding contact being of no importance, a potentiometer was made by winding about 100ft. of bare resistance wire on a long ebonite rod of circular section. When operated by six cells consecutive turns had a difference of potential of 0·02 volt very approximately. The contact piece moved parallel to the axis of the ebonite rod. A moving-coil mirror galvanometer was shunted till its sensitiveness was such that 1cm. on the scale corresponded to 3 microamperes. A bell-trembler especially capable of adjustment as to stroke and speed was obtained; and a non-inducive resistance of 10,000 ohms was placed in the coherer-galvanometer circuit. Suitable terminals were arranged for the quick interchanging of the coherers, and convenient switches were placed in the various circuits. A diagrammatic plan of the apparatus is given in Fig. 2. With this disposition of the apparatus the characteristic curves were plotted for a large number of tubes, the circumstances of each experiment being maintained for all invariable. A selection of the curves so obtained is

**Table III.** (Fig. 3).—*The letters have the same signification as those in Table II.*

| Volts. | A | B | C | C′ | D | E | F |
|---|---|---|---|---|---|---|---|
| | Microamperes. | | | | | | |
| 0 | 0 | ... | ... | ... | ... | ... | ... |
| 0·01 | 0·3 | ... | ... | ... | ... | ... | ... |
| 0·08 | 1·5 | ... | ... | ... | ... | ... | ... |
| 0·1 | 2·1 | ... | ... | ... | ... | ... | ... |
| 0·2 | 9·0 | 0·3 | ... | ... | ... | ... | ... |
| 0·3 | 21·2 | 0·6 | ... | ... | ... | ... | ... |
| 0·4 | 31·2 | 1·2 | 0·3 | ... | ... | ... | ... |
| 0·5 | 45·0 | 1·8 | ... | ... | ... | ... | ... |
| 0·8 | ... | 3·6 | 1·2 | ... | ... | ... | ... |
| 1·0 | ... | 5·7 | 1·8 | ... | ... | ... | ... |
| 1·2 | ... | 9·0 | 2·7 | ... | ... | ... | ... |
| 1·4 | ... | 14·7 | 4·2 | 0·3 | ... | ... | ... |
| 1·6 | ... | 21·5 | 7·5 | 0·3 | ... | ... | ... |
| 1·8 | ... | ... | 12·9 | 0·6 | ... | ... | ... |
| 2·0 | ... | 39·0 | 19·2 | 1·2 | ... | ... | ... |
| 2·2 | ... | 52·2 | 27·3 | 1·5 | ... | ... | ... |
| 2·4 | ... | ... | 40·8 | 2·1 | ... | ... | ... |
| 2·6 | ... | ... | 53·4 | 3·6 | ... | ... | ... |
| 2·8 | ... | ... | ... | 5·8 | ... | ... | ... |
| 3·0 | ... | ... | ... | 11·1 | ... | ... | ... |
| 3·2 | ... | ... | ... | 20·1 | 0·3 | ... | ... |
| 3·4 | ... | ... | ... | 31·2 | 0·3 | ... | ... |
| 3·6 | ... | ... | ... | 46·2 | 1·2 | ... | ... |
| 3·8 | ... | ... | ... | 63·0 | 1·8 | ... | ... |
| 4·0 | ... | ... | ... | ... | 3·0 | 0·3 | 0·0 |
| 4·2 | ... | ... | ... | ... | 3·9 | ... | 0·3 |
| 4·4 | ... | ... | ... | ... | 6·3 | ... | ... |
| 4·6 | ... | ... | ... | ... | 13·8 | ... | ... |
| 4·8 | ... | ... | ... | ... | 15·9 | 0·6 | ... |
| 5·0 | ... | ... | ... | ... | 22·8 | 1·2 | ... |
| 5·5 | ... | ... | ... | ... | 55·2 | 2·7 | ... |
| 6·0 | ... | ... | ... | ... | ... | 8·4 | 0·6 |
| 6·6 | ... | ... | ... | ... | ... | 22·5 | 1·2 |

**Table IV.** (Fig. 4).—*Moderately Sensitive Coherers under Low E.M.F.s.*

| Volts. | Microamperes. | | Volts. | Microamperes. | |
|---|---|---|---|---|---|
| | 1. | 2. | | 1. | 2. |
| 0·00 | 0·00 | 0·00 | 0·30 | 0·27 | 0·04 |
| 0·04 | 0·03 | ... | 0·44 | 0·44 | 0·06 |
| 0·08 | 0·06 | ... | 0·54 | 0·57 | 0·09 |
| 0·12 | ... | 0·02 | 0·60 | 0·68 | 0·10 |
| 0·16 | 0·13 | ... | 0·70 | 0·89 | 0·13 |
| 0·20 | 0·16 | 0·03 | 0·80 | 0·22 | 0·16 |

**Table V.** (Fig. 5).—*Non-sensitive Coherers.*

| 1. | | 2. | |
|---|---|---|---|
| Volts. | Microamperes. | Volts. | Microamperes. |
| 0 | 0 | 0 | 0 |
| 4·0 | 0·1 | 6·0 | 0·3 |
| 5·0 | 0·4 | 6·4 | 0·4 |
| 5·4 | 0·7 | 6·8 | 0·5 |
| 5·8 | 1·1 | 7·2 | 0·7 |
| 6·2 | 1·8 | 7·6 | 0·8 |
| 6·6 | 3·0 | 8·0 | 1·5 |
| 7·0 | 4·8 | 8·4 | 2·2 |
| 7·4 | 7·4 | 8·8 | 3·7 |
| 7·8 | 11·1 | 9·0 | 5·9 |
| 8·2 | 16·2 | ... | ... |
| 8·6 | 20·6 | ... | ... |
| 9·0 | 26·5 | ... | ... |

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given in Fig. 3. These are plotted from Table III., in which the scale readings of the galvanometer deflections have been converted to absolute values. From this selection will be seen what was merely emphasised by all the other curves obtained, that the general position of its curve on the chart indicates exactly the sensitiveness of a coherer as judged by the radiation test. It should be noticed that

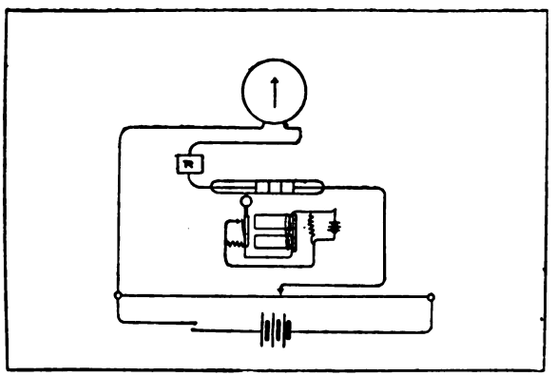

Fig. 2.

the occurrence of rapid coherence is on these curves indicated by their convexity towards the axis of E.M.F.—were the conductivity of the coherer constant the curves would degenerate into sloping straight lines passing through the origin. With all the coherers examined, excepting those of known and remarkable non-sensitiveness, some curvature was apparent under comparatively small E.M.F.s. Further, there was in no case, as the applied E.M.F. was increased, any sudden increase in the current; but, on the contrary, always a gradual growth in its value. Again, it will be noticed that when the applied E.M.F. becomes great enough the relation between current and E.M.F. becomes approximately linear—indicating that coherence is now increasing uniformly and slowly. In order to

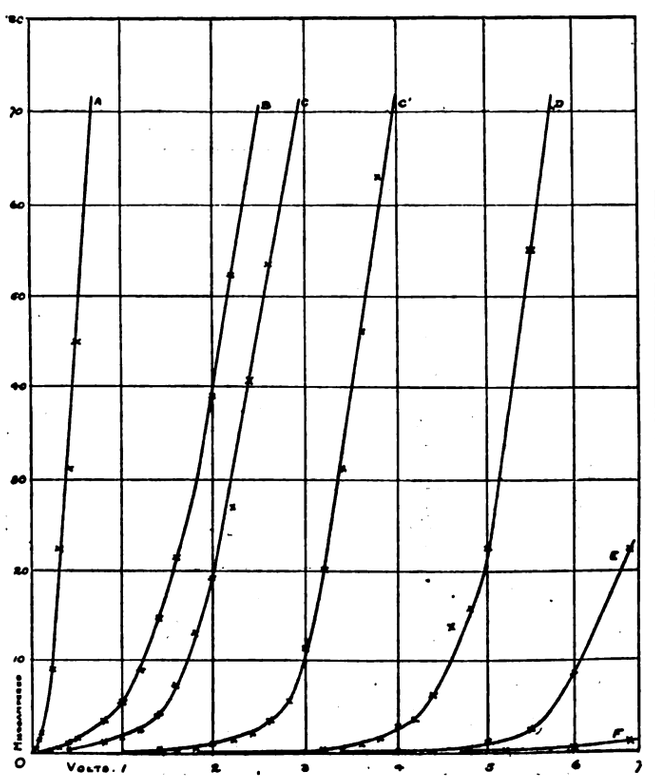


Fig. 3.

examine more closely whether coherence could be traced at rather low voltages the sensitiveness of the galvanometer was raised by changing the shunt, and two of the coherers whose curves are given in Fig. 3 submitted to low E.M.F.s, the frequency of the trembler being unaltered. Fig. 4 (Table IV.) gives the curves so obtained. They seem to indicate that the fall of resistance of a coherer commences very early, but, also, that no great change-rate is reached till a certain E.M.F. is applied which is different for each coherer. Another and similar trial on some very non-sensitive tubes, in which P.D.s up to 9 volts were used, showed that the linear portion of the

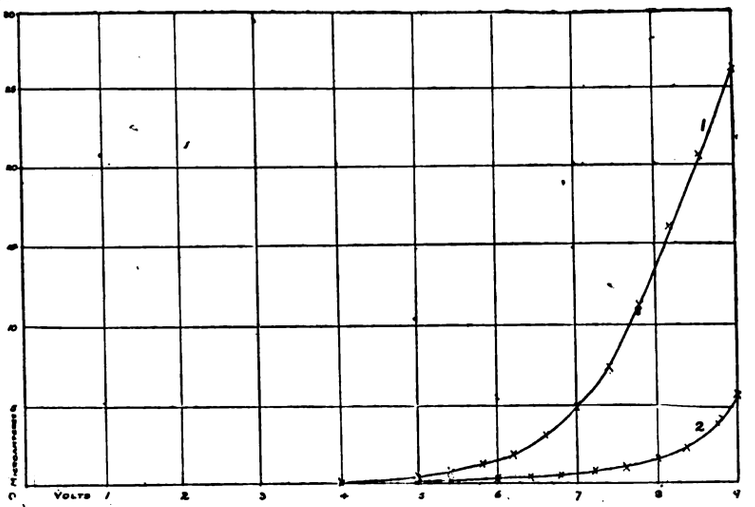


Fig. 5.

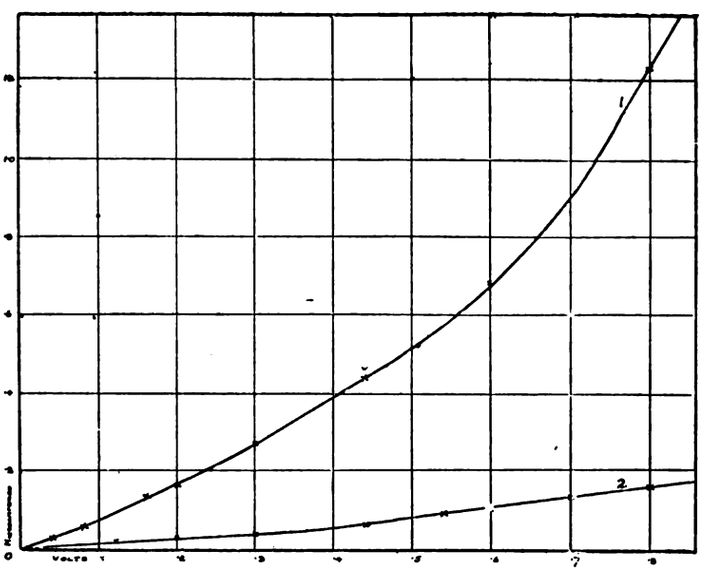


Fig. 4.

curve for most coherers could, if desired, be reached. Two of these curves, which are in every feature similar to those in Fig. 3, are given in Fig. 5.

*(To be concluded.)*

## PARLIAMENTARY RECORD FOR 1901.

Our readers will be interested to know the fate of the various bills (public and private) affecting electric lighting and power distribution, electric traction, &c., which were submitted to Parliament during the session just closed. The proceedings in Committee upon all the more important projects have been fully reported in *The Electrician*, and we give below a complete list of the bills. Of the public acts only very few affect electrical interests:—

*Public Acts.*

Factory and Workshop Acts Amendment and Consolidation Act.
Expiring Laws Continuance Act, including the Light Railways Act of 1896.
Pacific Cable Act.
Patent Law Amendment Act.

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The Electric Lighting (London) Bill, for the adjustment of the London electric lighting areas, and the Light Railway Bill, for the continuance and amendment of the Light Railways Act, were withdrawn.

*Provisional Order Confirmatory Acts.*

Electric Lighting Order (No. 1) Confirmation Act (Marylebone, two orders granted, but only that granted to the Corporation confirmed).

Electric Lighting Orders (No. 2) Confirmation Act (Abertillery, Aspull, Briton Ferry, Cannock, Ebbw Vale, Faversham, Llandaff and Dinas Powis, Llangollen, Neath (Borough) and Tredegar.

Electric Lighting Orders (No. 3) Confirmation Act (Birstall, Cheshunt, Dorchester, Felling, Frome, Lichfield, Mitcham, New Hunstanton, Northfleet, and Skipton.)

Electric Lighting Orders (No. 4) Confirmation Act (Atherton, Benwell and Fensham, Beverley, Burgess Bill, Chesham, East Cowes, Hindley, Honley, Standish-with-Langtree, and Stratford-upon-Avon).

Electric Lighting Orders (No. 5) Confirmation Act (Macclesfield, Ripon, Todmorden, Trowbridge, Ware, Wellingborough, (public purposes), Wellington (Salop), Widnes, Wisbech, and Workington).

Electric Lighting Orders (No. 6) Confirmation Act (Aberavon, Ashton-in-Makerfield, Hampton, Hoddesdon, Ince-in-Makerfield, Mountain Ash, Neath (Rural District), Pontypridd, Teddington, and Worsley).

Electric Lighting Orders (No. 7) Confirmation Act (Barry, Crompton, Foots Cray, Friern Barnet, Isle of Thanet (Rural), Newbury, Pudsey, Ross, Roundhay and Royton).

Electric Lighting Orders (No. 8) Confirmation Act (Clydebank, Crieff, Dalkeith, Dollar, Falkirk, Galashiels, Gourock, Jedburgh, Melrose and Oban).

Electric Lighting Orders (No. 9) Confirmation Act (Alnwick, Annfield Plain, Benfieldside, Consett, Handsworth, Norton Pickering, St. Austell, Shildon and East Thickley, and Whitley and Monkseaton).

Electric Lighting Orders (No. 10) Confirmation Act (Blackrock, Dungannon, Kildare and Waterford).

Electric Lighting Orders (No. 11) Confirmation Act (Bromsgrove, Goole, Ilkley, Lyndhurst (extension of area of supply of Midland Electric Corporation for Power Distribution), Northwood and Ruislip, Rickmansworth, Rishton, Great Harwood and Clayton-le-Moors and Warwick).

Electric Lighting Orders (No. 12) Confirmation Act (Lewisham and Penge).

Tramways Orders (No. 1) Confirmation Act (Ashton-under-Lyne, Denton, Devonport, Liverpool, Northampton and Pontypridd).

Tramways Orders (No. 2) Confirmation Act (Birkdale, Crompton, Leamington, Royton, Swinton and Wrexham).

Tramways Orders (No. 3) Confirmation Act (Cheriton, Colchester, Hyde, Littleborough and Middleton and Chadderton).

Tramways Orders (No. 4) Confirmation Act (Coatbridge, Folkestone, Glossop, Hopeman, Weston-super-Mare and West Riding).

In addition to the above, confirmation bills under the Private Legislation Procedure (Scotland) Act, 1899, have been passed in the following cases :—Clydebank Burgh Tramways, Dundee Corporation, Falkirk and District Tramways, Glasgow Corporation (Tramways and General) and the Paisley District Tramways Orders. The bills lodged for powers for the construction of tube railways in London have been suspended until next session. A list of these lines appeared in our last issue. The bill of the District Messenger and Theatre Ticket Co. was withdrawn, while the Hendon Tramways and Shields Bridge schemes were rejected in committee.

*Private Bills.*

(In many cases only one or two clauses in an omnibus bill deal with electrical matters )

Barrow-in-Furness Corporation.
Bexley Tramways.
Birmingham (City) Tramways.
Blackburn Corporation.
Blackpool Improvement.
Bolton Corporation.
Bournemouth Corporation.
Bradford Corporation.
Brighton Corporation.
Burton-upon-Trent Corporation.
Bury Corporation Tramways.
Central London Railway (No. 2 Bill).
Chester Corporation Tramways.
City and Brixton Railway.
City and South London Railway.
Cleveland and Durham County Electric Power.
Clyde Valley Electrical Power.
Cork, Blackrock & Passage Railway.
Derby Corporation.
Derbyshire and Nottinghamshire Electric Power.
Dover Corporation.
Dublin St. James' Gate ewery Tramways.
Eccles Corporation.
Folkestone Corporation.
Gateshead and District Tramways.
Handsworth District Council.
King's Norton & Northfield Trmwys.
Kingston-upon-Hull Corporation.
Leeds Corporation.
Loch Leven Water Power.
London C.C. (General Powers).
London C.C. (Tramways and Street Widenings).
London United Tramways.
Lowestoft Corporation.
Manchester and Liverpool Electric Express Railway.
Manchester Corporation.
Mansfield Corporation.
Metropolitan District Railway.
Metropolitan Railway.
Metropolitan Electric Supply.
Mond Gas.
Notting Hill Electric Lighting.
Pembroke (Dublin) District Council.
Portmadoc, Beddgelert and South Snowdon Railway.
Richmond Gas.
Shannon Water and Electric Power.
Sheffield Corporation.
Shipley Improvements.
Smethwick Corporation.
South Lancashire Tramways.
South-Western and Isle of Wight Junction Railway.
South Yorkshire Electric Power.
Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.
Tyneside Tramways and Tramroads.
Watford and District Tramways.
West Cumberland Electric Trmwys.
Wigan Corporation Tramways.
Worcester Tramways.
Yorkshire Electric Power.

# PARLIAMENTARY INTELLIGENCE.

## PATENT LAW AMENDMENT.

In the House of Commons last week Mr. J. LAWRENCE asked the President of the Board of Trade whether he was aware of the conditions existing between this country and Germany and France in respect of the Patent Laws, and whether the Government would next session take steps to assimilate the law ; also, what steps the Government intended to take to carry into effect the recommendations of the report of the Board of Trade Committee on the working of the Patent Acts.

Mr. G. BALFOUR said the proposal to introduce a condition for forfeiture of patents for non-working in this country was considered by the Board of Trade Committee, but was rejected in favour of other proposals having a similar object. The bill passed this year was intended to give effect to one recommendation of the Committee. The other recommendations were under consideration. He hoped it might be found possible to deal with the amendment of the Patent Laws before long, but he was not in a position to give any pledge on the subject.

# LEGAL INTELLIGENCE.

## Glasgow Corporation v. National Telephone Co.

At Glasgow, on Monday, counsel for Glasgow Corporation applied, before Mr. Sheriff Fyfe, for interim interdict against the National Telephone Co. opening or cutting up or making any excavations in or otherwise interfering with the surface and solum of Argyle-street and the Trongate, or laying any pipes, ducts, cables, &c., without the Corporation's consent. The petition had been granted on Saturday by Mr. Sheriff Scott-Moncrieff, and was now argued on behalf of the defenders.

Mr. Andrews, W.S., said the National Telephone Co. obtained permission from the proprietor of subjects at the corner of Wellington and Argyle streets, running westwards, to erect an exchange on the roof of the building, and from the Caledonian Railway Co. to lay a cable inside their tunnel running along Argyle-street. In consequence of these arrangements the company had opened up the pavement and cut a hole between the wall of the tunnel and the building in order to carry the telephone cable to the roof. A very important legal point was involved (urged counsel) as to what harm the Corporation had suffered by the existence of the hole. He submitted that there was no case for interdict.

Mr. J. LINDSAY (for the Corporation) said the hole was made between Saturday night and Sunday morning, and there was some difficulty in discovering who had opened up the street. The proprietor of the property even, he contended, was not entitled to open up the footpath without the permission of the Corporation.

The interim interdict was continued till Tuesday next.

## P. R. Jackson & Co. v. Glengarnock Iron and Steel Co.

In the Court of Session Edinburgh, on Tuesday, plaintiffs sought to recover a balance of £519. 10s. 3d. for plant supplied and work done. It appeared that in 1897 defendants contracted with plaintiffs for the supply and erection of electric pumping plant at defendants' No. 5 pit, Auchenharvie Colliery, for £2,600. The plant was supplied and erected, and some extra work executed for which payment was claimed, the sum sued for being balance of whole account. Defendants pleaded that the contract stipulated that the whole work should be in accordance with specifications and with the plaintiffs' estimate, but subject to defendants' approval of plaintiffs' working plans. Alterations were made from time to time by plaintiffs with a view of rendering it conformable to contract. It was not till February, 1900, that plaintiffs succeeded in putting the plant into a condition to perform the work it was guaranteed to do in a satisfactory and efficient manner. From Nov. 1, 1897, to Feb. 1, 1900, defendants were deprived of the use of the pumping plant owing to alleged failure of plaintiffs to have the same erected within contract time.

Lord PEARSON found that through plaintiffs' undue delay in fulfilling the contract, defendants sustained loss and damage to an amount exceeding the claims made in the action, and judgment would, therefore, be for defendants, with costs.

**Memorial to the late Peter von Tunner.**—It has been decided to erect in Leoben, Austria, a statue of Peter Ritter von Tunner, to commemorate his great services to the metallurgy of iron. An influential committee has been formed with Mr. Ignaz Prandstetter (Leoben) as president, and at a recent meeting of Council of the Iron and Steel Institute the matter was considered. As a contribution to the memorial could not be voted from the funds of the Institute, the members of Council present decided to contribute two guineas each, and Mr. Bennett H. Brough, the secretary, now informs us that he has forwarded to the committee in Leoben contributions of that amount from 26 gentlemen.

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Dewsbury Corporation require an electrical engineer to take charge of their electricity works. Further particulars appear in an advertisement. Applications to the town clerk (Mr. G. Trevelyan Lee) by 31st inst.

Applications are invited for the position of electrical engineer to the municipality of East London, Cape Colony. An advertisement contains further particulars, and applications must be received by the town clerk, East London, Cape Colony, by noon of Oct. 10.

An assistant is required in the electrical engineering department of the City and Guilds Central Technical College, Exhibition-road, S.W. Applications to Prof. Ayrton. See advertisement.

An advertisement on another page announces that the Admiralty require able-bodied young men, with experience as fitters in electrical shops, as electricians in the Royal Navy. Applications to the Admiralty Recruiting Department, 22, Spring-gardens, London, S.W., or to any Royal Navy or Royal Marine recruiting officer in the United Kingdom.

Motherwell Burgh require a switchboard attendant at their electricity works. Applications to the electrical engineer (Mr. S. E. Britton) by Sept. 2. See advertisement.

Islington (London) Lighting committee have a vacancy for a meter tester. Applications to the town clerk (Mr. W. F. Dewey), Town Hall, Upper-street, N., by 27th inst. See advertisement.

Wimbledon Urban District Council require an assistant engineer. Applications to Mr. F. Barnes Spencer, The Broadway, Wimbledon, S.W., by 28th inst.

Partick Town Council require a chief assistant at the electricity works. Applications to Mr. H. B. Maxwell by noon 31st inst.

The committee of University College, Nottingham, require a demonstrator in electrical engineering. Applications before Sept. 7.

An assistant lecturer and demonstrator in physics is required for University College of North Wales, Bangor. Applications by Oct. 12.

A professor of engineering is required by University College, Bristol. Applications to secretary by Aug. 31.

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Mr. Brewin-Noble has been appointed mains superintendent at Hastings.

Mr. J. Dennis Coales, B.Sc., has been appointed assistant lecturer and demonstrator of physics and electrical engineering at the Hartley College, Southampton.

Mr. C. H. Klyne has been appointed assistant engineer at King's Lynn electricity works.

Mr. J. Trevor Owen, M.A., has been appointed principal of the Swansea Intermediate and Technical College and School of Mines.

Mr. Cecil W. Kennaway has been appointed resident electrical engineer at Whitby.

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**Barnstaple.**—At a special meeting of the Council on Saturday Mr. C. E. R. Chanter was to have moved a resolution that it was not desirable to proceed with the application to borrow £27,000 for electric lighting, but the mayor (Mr. S. H. T. Brown) asked if there were any members of the Council present who held shares in the Barnstaple Gas Co. It appearing that several members (including Mr. Chanter) held such shares, the mayor ruled that the resolution could not be moved.

**Belgium.**—The Government are considering a proposal to construct an electric railway between Knocke and La Panne, at the two extreme points of the Belgian coast.

**Bredbury and Romily.**—This Council have authorised Mr. C. L. Turner, consulting engineer, of Manchester, to prepare an electric lighting and tramway scheme.

**Bristol.**—Further extensions of the public arc lighting are projected. The electrical committee have offered to fix 365 additional lamps at £14. 10s. per lamp per annum, including cost of installation, supply of current, maintenance and repairs, and if this proposed extension be carried out to reduce the charge on the existing 306 arc lamps to £21 per lamp per annum.

**Cape-Australian Cable.**—The Eastern Extension Telegraph Company notify that the ss. "Scotia" left the Thames on Saturday morning with the necessary cable to lay the Cocos-Perth section, which is expected to be completed and the line opened for traffic before the end of October.

**Chipping Norton.**—Proposals for the formation of a company to establish electricity supply for public and private lighting have been submitted by Mr. Popham, and will be discussed at the next meeting of the Council.

**Companies Struck off Register.**—The following companies have been struck off the register :—

Davy Improved Arc Lamp Syndicate.
District Electric Supply Co.
Electrical Industries.
Electric Light Railways.
Electro-Metallurgical Co.
Folkestone District Electric Railways Co.
Rochester, Chatham, Gillingham and District Electric Railways Co.
Tyne Acetylene and Carbide Co.

**Dunstable.**—Mr. Albion T. Snell has been called in by the Electric Lighting committee to prepare a report on electric lighting and tramways.

**Electrical Enterprise in Germany.**—In his report on German trade for 1900, Mr. Consul-General Schwabach says :—

No branch of industry during the last decade has shown such marvellous development as electricity. German electrical undertakings have considerably enlarged their works, and about 700,000,000 marks (£34,100,000) is invested in this industry. The increased exports relate chiefly to electrical appliances. An enormous field of work is opening before the electro technical industry in the construction of railways. At present there is only a modest experimental railway at Wannsee connecting Berlin with that suburb. This is working as far as Zehlendorf, and the results are at present favourable. The Allgemeine Electricitäts Gesellschaft and Messrs. Siemens and Halske have taken the enterprise into their own hands, and with financial assistance have called into existence a German Studien Gesellschaft for electric high-speed railways. Soon after the formation of this society, the Prussian Minister for War placed at its disposal the military railway, Berlin-Zossen (20 miles). The fast steam-driven trains at present average a speed of 40 to 45 miles per hour, occasionally reaching 50 to 60 miles. It is hoped, by the electric system to be adopted, to achieve a speed of 125 to 150 miles per hour.

Much attention is directed to the plan of Messrs. Philippi and Griebel for connecting Berlin and Hamburg with a high-speed electric railway of an estimated cost of £7,000,000. The projected working is as follows :—The carriages are to start at 6 a.m. from both termini, and run at 10-minute intervals till 9 a.m. Then a pause of three hours takes place ; traffic resumes at noon, and continues till 3 p.m. ; after a further stoppage the working is resumed from 6 p.m. till 12 midnight. Later on, an 8-minute, and even a 5-minute interval is proposed. Each carriage is to carry 60 passengers, so that by 10-minute intervals 360 passengers can be transported, and in 16 hours 5,760 persons daily in each direction, together 11,520 persons ; with 8-minute intervals 144,000 passengers can be carried. Three waggons, working at 5-minute intervals, can carry 69,000 persons. Two classes are proposed, and the fare will be 7s. 6d. first class, and 5s. second. Fast electric train riding by second class will thus be cheaper than the fourth class of the ordinary steam railway.

**Electrical Progress in Italy.**—There are 49,983 metres of electric tramway lines open in Genoa and its suburbs, and over these lines 70 cars are run daily. During 1900 the cars on these lines covered 898,876 journeys, a distance of 3,172,882 metres, and carried 15,100,504 passengers. At Genoa the system of connecting up the shipping with the city exchange telephone system has been extended, and is increasing in popularity. Electric lighting is available at all times on the nine wharves, and at various other points of the docks, and, in addition, the cranes available at these nine wharves are worked electrically, the maximum lift of the cranes being 1½ tons each. There are, in addition, seven fixed electric cranes of similar capacity. The docks are also provided with four electric capstans of a haulage capacity of 150ft. per minute when fully loaded. The whole port is now lighted electrically by 125 10 ampere arc lamps ; 80 of this number are kept alight by night, and 40 are extinguished at midnight. The port of Genoa is, with these up-to-date accessories, a favourite one with importers and exporters.

The electric tramway at Spezia has now been completed, and is expected to be open for traffic very shortly. The extension of the electric lighting mains for private lighting is making good progress. The town is becoming additionally attractive as a winter resort, and this has led to an extension of the telephone system to the neighbouring towns of San Terenzo, Lerici, and Portovenere.

The electric tramways which are being constructed between Bordighera and Ventimiglia are approaching completion, but will not be opened for traffic until the end of the year.

At San Remo the business of the British Continental Electricity Co. (Ltd.) shows satisfactory increase, and during 1900 the equivalent of over 3,000 8 c.p. lamps was added to the company's connections. An Anglo-Swiss degenerating set of 130 H.P. has been added to the station. The company, in addition to the payment of its 5½ per cent. preference dividend, distributed 2 per cent. on the ordinary shares for 1900.

On the extensive factory premises of the Vesuvius Ironworks at Naples, employing many hundreds of men, a number of electric motors have been installed in the new steel works which have recently been started by the company and are now working.

At Bari a spirited attempt has been made to introduce electric lighting in the principal streets, but an onerous agreement with the Tuscan Gas Co. has prevented the fulfilment of this enterprise. This

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is a case where the smaller communes of the district have the advantages of the electric light while the town itself is unable to enjoy the benefits of improved illumination owing to the gas contract, which does not, however, impede the installation of electricity for private lighting. The local telephone company in this district has 200 subscribers at £6 per annum out of a population of 84,000.

For some time past a scheme has been on foot to bring the waters of the river Tusciano into the town of Salerno for town water supply and for the generation of electric current for lighting in the district. A concession was, in fact, promised by the Government and a local company formed, but the absence of adequate subscription to its capital led to the abandonment of the scheme.

**Electricity in Mining.**—In a recently issued report on the coal trade of the United States reference is made to the increased use of electricity in the coal mines of the Union. In the anthracite mines in 1900 there were 60 dynamo machines at work, an increase of 15 over 1899; and for haulage purposes 38 electric locomotives, an increase of nine for the year. In the Pennsylvania bituminous coal mines 17 electric locomotives were employed, against 13 in 1899; and 196 dynamo machines were installed, compared with 156. The largely increased use of coal-mining machinery in the bituminous mines in the United States is a feature of present-day working, the amount of coal mined by machinery having risen from 6·66 per cent. in 1891 to 23 per cent. in 1899. In this work there are employed 450 chain-breast Jeffrey electric coal-cutting machines. This is the largest number of any type of chain-breast machine used in this industry. In many of the bituminous mines of the Pennsylvania district electricity is the only power employed for haulage, pump-driving, coal-cutting and lighting.

**Exhibition at Osaka (Japan).**—There is to be an exhibition held at Osaka from March 1 to July 31, 1903. The exhibits will be articles collected, produced, or manufactured by subjects of the Empire or by foreigners resident in Japan. The cost of the exhibition is to be met by payments from the Imperial Japanese treasury, exhibitors bearing the expense of their exhibits only. A display is to be given of mining, industrial, mechanical, educational, scientific and other general exhibits.

**Farnworth.**—The formal opening of the electricity works takes place on 28th inst. In the meantime the Council are supplying current free of charge.

**Greenock.**—There are at present 216 consumers of electric current, representing an equivalent of 16,971 8 c.p. lamps connected. A report by the burgh electrical engineer (Mr. W. M. Nelson) on extensions will be considered at the next meeting of the Council.

**Hexham.**—In a report on electric lighting by Messrs. Lacey, Clirehugh and Sillar, it is stated that, though the town has only a population of 7,000, electricity works can be established on a remunerative basis. It is estimated that within a short period a demand for the equivalent of 6,000 8 c.p. lamps will arise. The report is unfavourable to the proposal to utilise a fall on the river Tyne for the generation of current, and steam-driven plant is recommended.

**Hoylake and West Kirby.**—Sanction to a loan of £13,500 for electric lighting has been obtained.

**Huddersfield.**—The borough surveyor (Mr. K. Campbell) has been authorised to prepare plans and specifications for the conversion of the remaining portion of the tramway system from steam to electric traction.

**Hungary.**—It appears that subsidies are granted by the Austro-Hungarian Government (in similar manner to those granted by the Governments of Servia and Roumania) to persons starting industrial enterprises. Included in these ventures are the establishment of factories for making articles in lead, zinc or tin by electricity.

**Japan.**—The imports into Japan for 1900 included submarine telegraph cable to the value of £71,014, these supplies being provided from Great Britain, France and Germany.

**Leigh.**—The Council have decided to obtain powers to construct and work seven lengths of electric tramways. The total capital expenditure is estimated at £93,368. 19s. 1d.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Tickhill light railway order.

The East Sussex, the Mitcham and the Lyndhurst light railway orders have been submitted to the Board of Trade for confirmation. Objections to the two former by Sept. 7, and to the latter by Sept. 11.

The Cheltenham and District Light Electric Railway was opened for traffic on Saturday.

**Loftus (Yorks.).**—The Council has rejected the proposals of the Cleveland and South Durham Electric Co. to supply current, and application is to be made for a provisional order.

**Mansfield.**—The following scale of charges for the supply of electric current has been adopted:—Quarterly payment: For first 100 hours' use per quarter of maximum demand, 6d. per unit for private lighting and 2d. after; 4d. per unit for motive power and 1d. after. Monthly payment: 6d. for the first 30 hours and 2d. after; for motive power, 4d. and 1d.

**Margate.**—A Board of Trade inquiry will be held next week into recent accidents on the electric tramways.

**Mexico.**—A feature of recent industrial development in this thriving country is the installation of electrical plants in the chief cities of the Republic. For tramways electricity is becoming the chief motive power, supplanting both mule-driven and steam lines. The City of Mexico Tramways Co. commenced running their electric cars in February 1900, on the overhead trolley system, and this electric service has been extended since that date to the principal suburbs of the city, several extensions being still in hand. The power house is situate to the south of the city, and a continuous service is given from 5:30 a.m. to 11 p.m. In regard to lighting, in the City of Mexico, until a comparatively recent date, overhead cables were permitted, but the terms of the contracts have since been modified, and all cables are now placed underground. Great advances have been made in the construction of railway lines throughout Mexico, accompanied by extension in telegraphic and telephonic facilities. The telephone, in particular, has come into very general use, the longest line being from the city of Mexico to Toluca, a distance of 45 miles by railway. A charge of 25c. is made for five minutes' conversation.

**Morecambe.**—A further loan of £2,000 for electric lighting extensions is to be taken up by the Council.

**Municipal Telephony.**—High Wycombe Corporation have appointed a committee to report upon the advisability of establishing a municipal telephone service.

Further progress has been made with the municipal telephone scheme for *Manchester* district. The draft scheme provides for the formation of a joint board, consisting of representatives appointed by the Councils within the local telephone area, viz.:—Manchester 10 members, Salford five, and Eccles three. Capital is to be provided in the following proportions:—Manchester, two-thirds; Salford, one-third, any deficiency in revenue to be met in the same proportions, and profits not exceeding 5 per cent. per annum on capital expenditure to be divided in the same proportion. When the undertaking shows a net profit exceeding 5 per cent. it is to go in reduction of telephone charges. The Councils agree to grant all necessary wayleaves, and the "Telephone" board is to consider at the end of 10 years the advisability of revising the terms generally. The scheme is still under the consideration of the various authorities, more particularly those clauses relating to the financial contributions of the outside authorities.

**North Berwick.**—The result of a recent plebiscite is in favour of electric lighting being handed over to a company, and the Council have, therefore, conditionally sanctioned Messrs. Crompton & Co.'s scheme.

**Pemberton.**—The Board of Trade have informed the Council that they have no power to authorise the borrowing of money for wiring premises, and that they will not in future sanction loans for the execution of work beyond consumers' terminals or for the supply of meters in houses.

**Personal.**—Mr. James Paxman, senior partner of Messrs. Davey, Paxman & Co., of Colchester and London, is visiting the United States, and sails on the ss. "Campania" on 24th inst., accompanied by Mr. T. H. Harrison, the London manager.

**Plymouth.**—It was reported last week that the actual cost of the first year's working of the electricity undertaking amounted to £5,642, compared with an estimated expenditure of £3,815. The capital charges amounted to £3,097, against an estimated £2,497. On the other hand, the estimated revenue had been exceeded by £500, leaving a deficiency of £1,900.

**Proposed New Duties on Electrical Imports into Germany.**—Under the existing commercial treaty between this country and Germany comparatively little trade is possible with British electrical manufactures. This treaty expires on Dec. 31, 1903, and proposals are before the German Reichsrath which will considerably raise the import duties on this class of goods. The net weight is to be taken as the basis of the new imposts. The duty on dynamos, motors, transformers, armatures and commutators is to range from 6 marks to 9 marks per 100kg (about 2 cwt.). The lowest duty will be charged on the heaviest plant (that exceeding 60 cwt. in weight), the second duty on plant from 10 cwt. to 60 cwt., and the highest duty on plant weighing up to 10 cwt. The present duties range from 2½ marks to 8 marks. Storage batteries and electrodes will be liable to a duty of from 6 marks to 14 marks. Land and submarine cables remain at 6 marks. Arc lamps will pay 40 marks, search-lights and reflectors 20 marks, and electric glow lamps 120 marks (compared with the present 24 marks duty). These dues are per double centner. Telegraphic apparatus, telephones, and electrical appliances for lighting and transmission of power, electrolysis, and medical purposes, also measuring and registering instruments, switches and shunt resistances, dry, galvanic and primary batteries, and other electrical apparatus and parts of same are to bear a duty of 60 marks per double centner. Quality and description of material used in

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manufacture will not affect the rate. Steam engines, turbines and pumps coupled direct to dynamos or motors are to be increased for duty from the present 2½ marks to 8 marks to 3½ marks to 100 marks per double centner, according to weight.

The duty into Hamburg of strips of sheet brass used for encasing paper insulating tubes for electric wires now have to pay duty as sheet metal at the rate of 12 marks per 100kg. (equal to 6s. 1d. per cwt.).

**Ryde (Isle of Wight).**—On Tuesday the Council discussed an important report of the Electric Lighting committee on the proposal that the Council should contract for the erection and equipment of electricity works for the district. A municipal scheme was originally proposed, but after the November elections the subject had to be reconsidered. The committee now reported that they had been in communication with the Board of Trade in order to ascertain whether power to transfer their electric lighting order of 1899 could be obtained. The Board intimated that they were advised that they had no power to consent to such a transfer, as there was no transfer clause in the Council's order. The Board referred to sec. 11 of the Electric Lighting Act, 1882, under which the Council appeared to have power to contract for the execution and maintenance of works and for the supply of energy, but not to divest themselves of their legal powers and liabilities. Thereupon the committee applied for and obtained an extension of time to comply with the terms of the order, and several companies were approached in order to ascertain the terms on which electric supply works could be constructed and maintained. Offers were submitted by Edmundson's Electricity Corporation, the West London and Provincial Electric Supply Co., the Brush Company, Crompton & Co., the United Kingdom Tramway, Light Railway and Electrical Syndicate, and the British Insulated Wire Co., but it was considered that the proposals offered by Edmundson's Electricity Corporation on behalf of the Isle of Wight Electric Light and Power Co. were most favourable. Under a special agreement drawn up to fit the peculiar circumstances of the case, the committee consider the best possible terms have been obtained for the town. A free-wiring agreement between the company and consumers had also been prepared, with the hope that this would facilitate the use of electric current. Terms were discussed and arranged with one exception—viz., that should the Corporation eventually purchase the undertaking, apart from free-wiring installations, which they were advised they had no power to purchase, then the Corporation were asked to guarantee to the company 1s. 6d. per lamp, instead of 1s., which the company would at that time be receiving from the consumer for ordinary lamps. The increased payment the committee could not advise, as being outside the powers of the order, and as the company declined to give way the free-wiring agreement had to be abandoned. The terms of the agreement were discussed at considerable length by the Council, and eventually it was decided to approve the proposed arrangement and to affix the corporate seal. The agreed sum of £500 was ordered to be paid to Messrs. Kincaid, Waller & Manville in discharge of their claim against the Council in connection with the provisional order.

**South Bank (Yorks.).**—The Council will apply for a provisional order "in order to exclude a proposed application by the Cleveland and South Durham Electric Power Co."

**Stamford.**—Edmundson's Electricity Corporation are proceeding with the scheme for the erection of electricity works, and the plans submitted by the company have been referred to Mr. F. J. Warden-Stevens for report.

**Stockport.**—The first section of the electric tramways (Mersey-square to Woodley Village) will be officially inspected on Saturday.

**Swinton and Pendlebury.**—Application has been made to the Board of Trade for an extension of three years to carry out the terms of the provisional order. Negotiations are in progress between the Council and the Salford Corporation for the supply of current in bulk.

**Taunton.**—Official inspection of the electric tramways takes place to-day (Friday).

**Telephone Trunk Line Extension.**—The trunk telephone system of the country has been extended to Penrith.

**Village Lighting.**—Elinton and Creswell Parish Council have accepted the offer of the Bolsover Colliery Co. to supply electric current for lighting the village.

Stockton Rural Council have decided to apply for a provisional electric lighting order. It is not proposed to erect a generating station, but to take current in bulk from either Stockton Corporation or the Cleveland and South Durham Electric Power Co. Current will also be distributed, under the order, by the Council, in the adjoining villages of Eaglescliffe, Norton, Billingham, Hartburn, Aislaby, Carlton, Cowpen, Bewley, Elton, Long Newton, Newsham, Newton Bewley, Preston-on-Tees, Redmarshall, Thorpe, Wynyard, Whitton and Wolviston.

**Woodford.**—The Metropolitan Tramway and Omnibus Co. have dropped the Woodford and Wanstead section of their electric tramway scheme.

**Woking.**—The dispute with the Woking Electric Supply Co. has been settled by the payment of £63 by the Council as damages for their breach of contract. The failure of the Council to give proper notice of termination has resulted in the streets being left in darkness for several days.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

### TENDERS INVITED.

*Oldham* Corporation Electricity committee invite tenders for two electric overhead travelling cranes. Specifications, &c., can be had from Mr. Arthur Andrew, Gas and Water Offices, and specifications, &c., can be seen at, but not obtained from, the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W. Tenders to Mr. Andrew by Sept. 10. An advertisement contains further particulars.

*Southend-on-Sea* Corporation invite tenders for supplying and laying electric lighting cables (solid system). Specifications (after 28th inst.) from the borough electrical engineer (Mr. D. F. Adamson), and tenders to the town clerk (Mr. W. H. Snow) by Sept. 7. See advertisement.

*Kirkcaldy* Corporation invite tenders for the supply of overhead construction for electric tramways. Specifications from the town clerk (Mr. Wm. Macindoe), and specifications and drawings can be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. An advertisement contains further particulars. Tenders to Mr. Macindoe by 10 a.m. Sept. 13.

*Doncaster* Corporation require a tramway switchboard. Specification, &c., from the borough electrical engineer (Mr. C. A. L. Prusmann), and tenders to the chairman of the Tramways committee, electricity works, Grey Friars-road, Doncaster, by noon, 31st inst. See advertisement.

*Dundee* Town Council invite tenders for the overhead equipment of the Constitution-road and Victoria-road and Ferrymuir tramway routes. Specifications, &c., from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope, Crescent-road, and tenders to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Sept. 14. See advertisement.

*Bournemouth* Town Council invite tenders for steel-grooved girder rails, &c., permanent way construction and rail bonding, and wood-block, tar, macadam and granite sett paving. Further particulars are given in an advertisement. Forms of tender and specification of the borough engineer (Mr. F. W. Lacey, M.I.C.E.), and tenders to the town clerk (Mr. J. Druitt, jun.) by 10 a.m. Sept. 16.

*Bournemouth* Corporation require boilers, super-heaters, economiser, feed pumps, pipe work and accessories. Tenders to town clerk by noon 29th inst.

*Bournemouth* Corporation also invite tenders for water cooler and travelling crane. Tenders to town clerk by 31st inst.

*Partick* Council invite tenders for 12 months' supply of arc lamp carbons, meters, demand indicators and fuse boxes. Particulars from burgh electrical engineer (Mr. H. B. Maxwell), 32, Clyde-street, Partick, N.B.

*Aston Manor* District Council invite tenders for pipework, fitters' shop and cables. Tenders to Chairman Electric Lighting and Tramways committee by noon Sept. 4.

*Aston Manor* Council also require water-tube boilers, stokers and economiser, two 500kw. and one 200kw. steam dynamos and motor balancer, switchboard, crane and arc lamps. Tenders by noon Sept. 4.

*Glasgow* Corporation invite tenders for the overhead trolley constructional work required for the extension of their tramway system. Tenders to town clerk by 5 p.m. 30th inst.

*Edinburgh* Corporation invite tenders for electric lighting of second portion of Colinton Mains Fever Hospital. Tenders to town clerk by Sept. 9.

*Belfast* Gas and Electric committee require tenders for cast-iron frames and covers, cast-iron pipes and bell-mouth ends. Tenders to town clerk by Aug. 30.

*Lowestoft* Corporation invite tenders for a 500kw. steam dynamo and switchboard panels. Tenders to town clerk by noon Sept. 9.

*Batley* Corporation require tramway rails, points, crossings, bonds &c. Tenders by Sept. 14.

*London County Council* invite tenders for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

*Middlesbrough* Electric Lighting committee invite tenders for mechanical coal handling plant. Tenders to town clerk by Sept. 3.

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*Mansfield* Electric Lighting committee require tenders for refuse destructors. Tenders to town clerk by Sept. 5.

*Ilford* District Council invite tenders for the construction of about 11 miles of tramways. Tenders by 5 p.m. Aug. 31.

*Walthamstow* Council require tenders for house wiring. Tenders to clerk by 5 p.m. Aug. 30.

Tenders are required for wiring the stores depôt, *Derby*. Tenders by 27th inst.

*Newport* (*Mon.*) Guardians require tenders for installing telephones, electric bells, &c., at the workhouse. Tenders by Sept. 4.

Tenders are invited by 30th inst. for wiring the new Hylton-road station, *Sunderland*.

Tenders are invited by the *Postal Telegraph Department* for Swedish, Norwegian or Finland red fir telegraph poles. Forms of tender from Controller of Stores, G.P.O., London, E.C. Tenders by 10 a.m. Sept. 30.

The Ministry of Public Works, *Madrid*, invite tenders for a concession for establishing and working an electric tramway from Linares to Minas (Jaen) for 60 years. Tenders by Oct. 17.

*French* Postal Telegraph authorities, 103, Rue de Grenelle, Paris, invite tenders until 30th inst. for the supply of 42,000 porcelain insulators.

Tenders are invited for about 5,000 tons of grooved rails, &c., and also for tramcars for the *Amsterdam* electric tramways. Tenders by Sept. 2.

## TENDERS RECEIVED AND ACCEPTED.

The following tenders were on Friday last accepted by the Mansfield Town Council in connection with their electric lighting scheme, advertised in *The Electrician* on June 14th :—

| | | | |
|---|---|---|---|
| J. Musgrave & Sons (boiler house plant) | £3,162 | 0 | 0 |
| Thos. Parker (Ltd.) (engine house plant) | 6,180 | 0 | 0 |
| Johnson and Phillips (condensing apparatus) | 725 | 0 | 0 |
| Bertram Thomas (switchboard) | 1,462 | 14 | 3 |
| Tudor Accumulator Co. (accumulators) | 2,967 | 0 | 0 |
| Carrick and Ritchie (overhead crane) | 316 | 0 | 0 |
| Western Electric Co. (mains) | 8,595 | 11 | 11 |
| Gilbert Arc Lamp Co. (public lighting) | 428 | 14 | 0 |
| Chamberlain and Hookham (meters) | 765 | 15 | 0 |
| Britannia Co. (workshop equipment) | 336 | 3 | 11 |

Grays Thurrock District Council have accepted the tender of Messrs. Venner & Co. for Hookham meters, and that of the Reason Manufacturing Co. for Wright demand indicators.

West Ham Lighting and Tramways Committee have accepted the tender of Messrs. Babcock and Wilcox for 11 water-tube boilers at £14,720.

The Tyne Improvement Commissioners have let the contract for arc and incandescent lighting and mains at the Albert Edward and Northumberland Docks to Messrs. Crompton & Co. at £6,185, in accordance with the specification prepared by their consulting engineers (Messrs. Handcock and Dykes), of Newcastle-on Tyne and London.

## BANKRUPTCIES.

The first meeting of creditors of Charles Bright, electrical engineer, 14, Copthall-avenue, London, E.C., took place on Tuesday. Debtor had not attended for examination, and no accounts were filed, but proofs for £10,509 were dealt with. Mr. Smurthwaite, who represented the debtor, said his client had been obliged to leave for South America, and he was appealing against the receiving order. Meeting adjourned for a week.

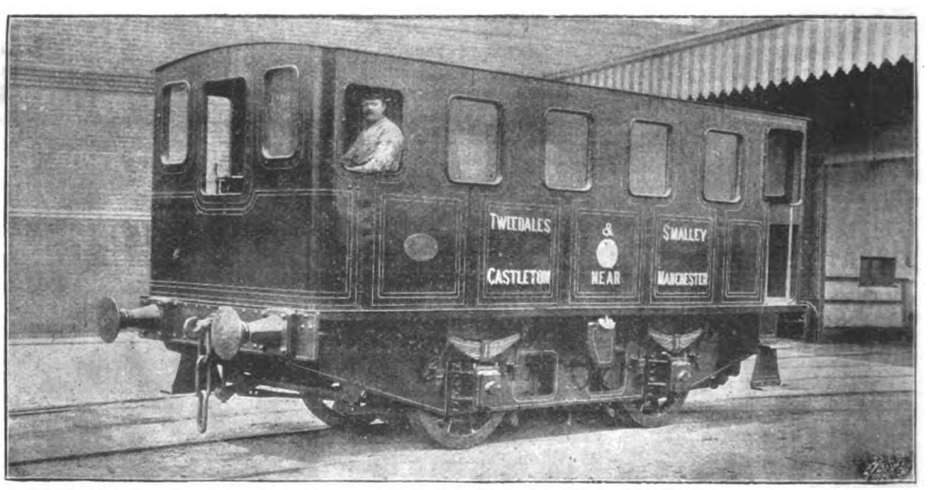
The examination of C. A. Church, electrical engineer, &c, trading under the style of Henry Conolly & Co., at 42-42B, Hampstead-road, London, N.W., was recently held at the London Bankruptcy Court. Gross liabilities £12,334. 6s. 5d., assets estimated at £7,386. 0s. 11d. It appeared that debtor purchased the business in 1889 for £8,500. Failure was attributed to pressure by moneylenders, bad debts and capital being locked up in business.

**Sale by Auction.**—Messrs. Fuller, Horsey, Sons & Cassell, 11, Billiter square, London, E.C., will offer for sale by auction, in one lot, at the Mart, Tokenhouse-yard, London, E.C., on Wednesday, Sept. 11, at 12 noon, the works, patents and assets of the Berrenberg Electric Lamp Syndicate (Ltd.). The sale will include the large factory premises at Wandsworth. Some further particulars are given in an advertisement.

**Plant for Sale.**—The County of London and Brush Provincial Electric lighting Co., Moorgate-place, Moorgate-street, London, E.C., have for sale three single-phase 150kw. alternators, direct-coupled to vertical compound condensing engines. Particulars may be obtained from the chief engineer. See advertisement.

**Circuit-Breakers.**—A new list of I.T.E. circuit-breakers up to 12,000 amperes capacity are issued by Messrs. R. W. Blackwell & Co. These instruments are of the laminated edgewise type, and are built to meet the severest conditions.

**Electric Shunting Locomotive** —An electric locomotive capable of drawing 120 tons has recently been built at the works of Messrs. Tweedales and Smalley, Castleton, near Manchester, for use on their siding connected with the L. and Y. Railway. Current is obtained from a battery of Monobloc cells discharging up to 390 amperes, and which furnishes current to two E.C.C. motors through a switchboard connected up for series and parallel control. The locomotive is mounted on two axles and four wheels, the latter of 43in. diameter on the tread. Each axle is geared to an E.C.C. enclosed traction motor by double-reduction machine-cut spur gear, having a total ratio of 20 to 1. Each motor gives a horizontal effort at the tread of the wheels of 2,500lb. The motors also give 1,000lb. horizontal effort at from 3 to 4 miles per hour with 68 amperes and 120 volts. They are specially designed to operate in conjunction with storage batteries. The controller is of the series parallel type, effecting these combinations on the motors, and not by manipulation of the battery. The locomotive is complete with instruments for registering charge and discharge of the battery, and to facilitate shunting operations the locomotive can be controlled from either end. The total weight in running order is 22 tons. At recent trials the result, we are informed, proved in every respect satisfactory, the locomotive starting with ease under the maximum load required, and being under perfect control. In shunting operations in connection with goods yards, where the ordinary locomotive has to be kept under steam for many hours in order to be available for comparatively short periods of use, there is doubtless a considerable field for the electric locomotive.




ELECTRIC SHUNTING LOCOMOTIVE, WITH MONOBLOC ACCUMULATORS.

**Turbines for Dynamo Driving.**—A useful and instructive descriptive catalogue of turbines manufactured by Messrs. W. Günther & Sons, of Oldham, is issued. This firm has been engaged in the construction of machinery for the utilisation of water power since 1869, and the business has progressed in a satisfactory manner, as is shown by the very considerable extensions to the works premises from time to time. Messrs. Günther & Sons are now able to boast that their machines are in use in all parts of the world. The catalogue under review gives particulars that will be found of much service to turbine users for general work, and in particular to those who are concerned in the installation of water-driven electric generating machinery. In the accompanying illustration we show a 26in. 25 H.P. Girard turbine which works at a 575ft. fall, coupled directly to a dynamo used in the lighting of a Scotch castle. The machine is shown complete with hydraulic governor, and the machines are made, where permissible, for hand regulation

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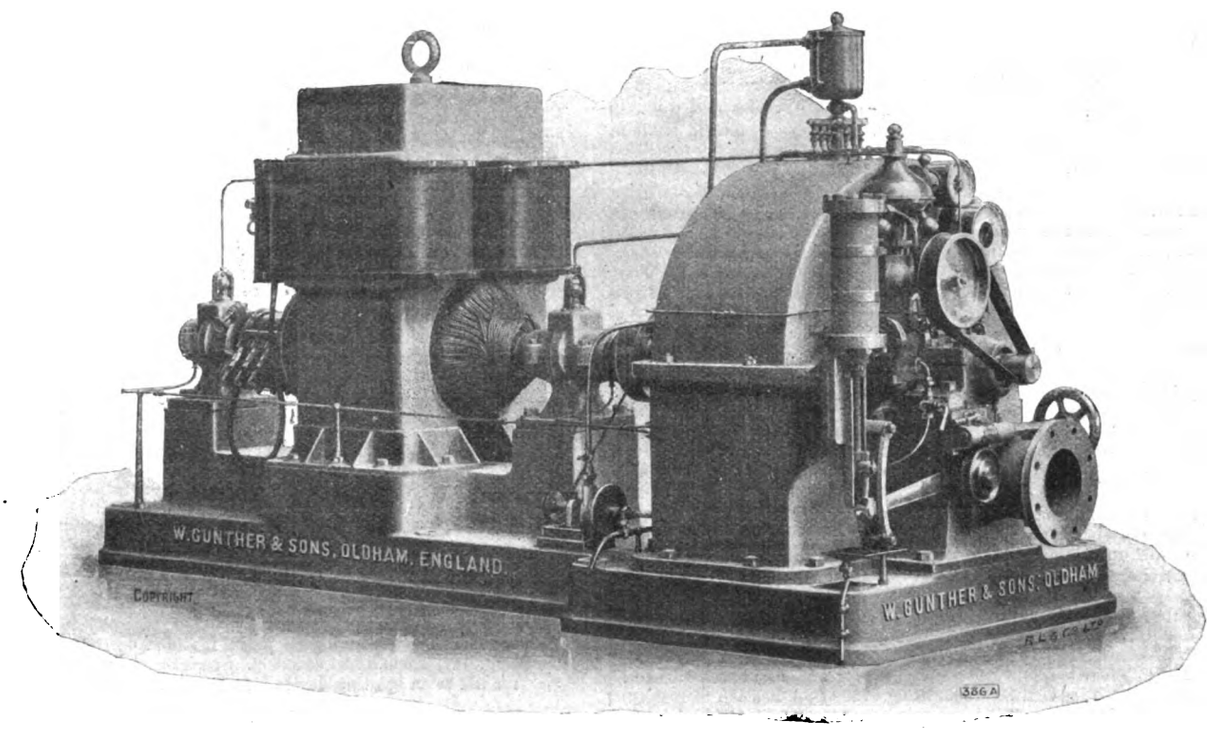
only. This question of governing has, of course, the most important bearing upon the design of turbines for electrical work, owing to the varying load, and, consequently, particular attention has been paid by Messrs. Günther & Sons to this important point in water-power generating machines. As an example of what has been achieved in this direction, it is pointed out that with high-fall turbines and hydraulic governors from 20 to 30 per cent. of the full load has been suddenly thrown off or on with a momentary variation of speed, as indicated by the tachometer fitted to the machine, of under 3 per cent. On very high falls a single guide port will often suffice to pass the water required, and when this is the case this firm make for electrical working a modified and quite special form of Girard turbine, with injection on the outside of the wheel, and a very short stroke of the adjustment slide. The firm has in course of construction a large installation of turbines for the Indian Government, for power transmission, comprising four special Impulse turbines of 230 H.P. each and two of 37 H.P. each for a fall of 600ft. These turbines are designed for use in the transmission of electric power from the Kateri Waterfalls to the Coonoor cordite factory, and will be coupled directly to their dynamo by means of flexible couplings. These turbines are provided with hydraulic governors, and are to be completed by the end of August for despatch to India early next month. The 230 H.P. machines run at 400 revs. per min. for driving the generating machines at 5,000 volts; the two smaller turbines are for




26-IN. 25 H.P. GIRARD TURBINE, DIRECT COUPLED TO DYNAMO.

driving the exciter dynamos and for lighting the power house. A special arrangement of air vessels and safety valves is provided in the pipe line close to the turbines, to minimise the risk of breakage by concussion if a large load is suddenly thrown off and the turbine gates quickly closed. A number of excellent illustrations (36 in all) are given in the list.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 14 to 20, with the ports of destination:—

*Africa*—Cape Town, £3,088; Durban, £194; Port Elizabeth, £100. *Australasia*—Adelaide, £38; Christchurch, £12; Fremantle, £224; Lyttleton, £75; Melbourne, £489; Perth, £626; Sydney, £764; Welington, £17. *Belgium*—Ostend, £50. *Ceylon*—Colombo, £20. *China*—Shanghai, £400. *Denmark*—Copenhagen, £319 (including £19 telegraph wire). *Ecuador*—Guayaquil, £35. *Gibraltar*—£25. *Holland*—Amsterdam, £20; Flushing, £30. *Hong Kong*—£35. *India*—Calcutta, £368 *Japan*—Nagasaki, £739 (telegraph cable). *Norway*—Bergen, £3,060 (submarine cable); Christiania, £24. *Philippine Islands*—Manila, £10. *Russia*—St. Petersburg, £415 (including £100 telegraph material). *Straits Settlements*—Singapore, £57 (telegraph material). Total £11,234, against £6,862 in the corresponding week last year (Aug. 15 to 21).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

April 20, 1901.

8,128. G. HILL. Manchester. An improved section or feeder pillar or box for electric cables.

8,162. V. J. FEENY. London. Improvements in and relating to electrical lamps. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

April 22, 1901.

8,227. J. P. BENNETT. Cork. An improved apparatus for localising, with the aid of the Röntgen rays and fluorescent screen, metallic objects in the human body or other bodies.

8,280. R. FORTUN and E. SEMBRUN. London. Improvements in or relating to accumulators or secondary batteries.*

April 23, 1901.

8,395. C. C. HUGHES. London. Improvements in telephone transmitters.

April 24, 1901.

8,402. C. C. METCALF. Cheshire. A new or improved combined system of electric lighting and fire alarms, and appliances connected therewith. (H. C. Blackwell, Russia.)

8,430. SAFETY THREE-WHEEL VEHICLE CO. and A. BATH. New York, U.S. Improvements in ignition spark plugs for explosive engines.

8,437. E. A. CLAREMONT. London. Improvements in the manufacture of vulcanised electric cables.

8,467. A. FORD-LLOYD. London. Improvements in electric battery jars.

April 25, 1901.

8,475. THE LANCASHIRE DYNAMO AND MOTOR CO. (LTD.) and A. P. WOOD. Liverpool. Improvements in brushholders for dynamo-electric machinery.

8,478. A. ECKSTEIN and A. E. ANGOLD. Manchester. An automatic shunt for protecting electric arc lamps.

8,480. C. W. KEMP. Birmingham. Improvements in or relating to means for attaching shades, globes and the like to gas and other lamps.

8,492. C. BRIDGMAN. Bristol. Improvements in means for preventing persons from being run over by mechanically-propelled tramcars, automobiles, and other locomotives.

8,455. A. B. SOAR. London. An improved form of field magnets for dynamos and electric magnets.

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8,508. J. G. L. Stephenson. London. Improvements in insulating watches, compasses, or other instruments.
8,518. V. Arcioni. London. Improvements in electric meters.*
8,535. J. E. Spagnoletti. London. Improvements in electrically lighting railway carriages and the like.
8,550. R. O'Brien. London. An improved electric arc lamp.

April 26, 1901.

8,563. B. Brander. Nottingham. Improvements in intercommunication telephone systems.
8,598. G. F. W. Kloth, O. H. G. Bunning, and J. G. L. D. Kunhardt. London. Improvements in or relating to accumulators or secondary batteries.*
8,615. F. M. Lewis. London. Improvements in electric arc lamps.
8,629. R. P. Wilson. London. Improved means applicable for use with overhead electric conductors for the prevention of danger in case of fracture.
8,648. W. L. Wise. London. Improved automatic electric exchange apparatus. (The American Machine Telephone Co., United States.)
8,677. R. M. Tyrer. Liverpool. Improvements in or connected with trolley heads or electric current collectors.
8,701. H. J. Cooke and M. Ehrenfeldt. London. Improvements in or connected with overhead railways or tramways and vehicles therefor.
8,716. O. A. Zander and B. Ingeström. London. An improvement in continuous-current dynamo-electric machines. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 12, 1900, being date of application in Sweden.)*
8,717. W. Fritsche. London. Improvements in or relating to secondary cells or batteries.
8,720. W. Mathieson. London. Impovements in differential alternating current arc lamps.*
8724. J. T. Armstrong and A. Orling. London. Improvements in and connected with controlling switches for use in electric light systems and for analogous purposes.
8,727. W. T. Henley's Telegraph Works Co. (Ltd.) and R. O. Wright. London. Improved gripper for electric or other cables or ropes.

April 29, 1901.

8,744. B. G. Hodges. Derby. Improvements in methods or means of insulating electric wires.
8,803. V. Alessandro. London. Improvements in safety devices for electrical measuring instruments.*
8,806. C. Dalmas. London. Improvements in switches for the trolley lines of electric tramways.

April 30, 1901.

8,831. W. Garner. Sheffield. Improvements in party line system telephony.
8,833. D. F. D. Turner. Edinburgh. Improvement in interrupters of induction coils.
8,837. A. Lomax. Blackpool. An apparatus for cleaning or taking records off phonographs and graphophone waxen cylinders.
8,883. J. Netter and H. Queyroul. London. Improvements in or relating to electric signals.
8,890. J. E. Heimerdinger. London. Improvements relating to printing electric telegraphs.*
8,892. R. M. Lowne. London. Improvements in electric clocks and timepieces.
8,906. L. Maiche. London. Improvements relating to the transmission of electric currents.
8,920. J. E. Spagnoletti. London. Improvements in electric switches.*
8,922. O. Angelini and A. Jengo. London. Improvements in or relating to telephone systems. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 20, 1900, being date of application in Italy.)*
8,932. F. M. Chaplet. London. Improvements in primary electric batteries.

May 1, 1901.

8,943. F. G. Baily. Edinburgh. Improvements in apparatus for measuring the magnetic properties of materials.
8,953. J. Hamer. Halifax. Improvements in main switches specially applicable for high-tension circuits.
8,956. E. S. G. Rees. Wolverhampton. Improvements in the construction of dynamo-electric machines and electro-motors.
8,957. J. A. Morton. Glasgow. An improved shade carrier for electric light fittings.
8,962. T. H. Parker. Wolverhampton. Improvements in switch apparatus for use in a surface contact system of electric traction, and in operating switches used in such system.*
8,964. T. H. Parker. Wolverhampton. Improved means for use in operating from a car or train switches employed with a surface contact system of electric traction.*
8,965. T. H. Parker. Wolverhampton. Improvements in or in and relating to skates or contact makers carried by cars for use in a surface contact system of electric traction.*
8,967. T. H. Parker. Wolverhampton. Improvements in the method of forming armature coils for dynamos and electric motors and in apparatus for use therein.*
8,985. L. Benier. London. An improved thermo-electric battery.*
8,997. A. W. Gattie. London. Improvements in apparatus for governing electric currents.
8,998. A. C. Cossor and W. H. Hilliar. London. Improvements relating to X-ray tubes.

May 2, 1901.

9,056. E. A. Claremont and C. J. Beaver. Manchester. Improvements in apparatus for treating telegraph or telephone cotton-covered cables or wires.*
9,076. H. W. C. Cox. London. Improvements in or relating to mercury or mechanical interrupter for induction coils in connection with X-ray work.
9,079. C. J. R. Le Mesurier. London. An improved method for the protection of overhead systems of transmission of electric currents.
9,080. J. A. Timmis. London. Improvement in the controlling of the working of railway signals and points by electricity.
9,123. J. Chandler. London. Improvements in or relating to means for utilising magnetic force for motive power, also applicable for insulating purposes generally.
9,127. The Electric Construction Co. (Ltd.). London. Improvements in switches for use with alternating current dynamos. (John Roberts, South Africa.)

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

4,719. Marr and Laidler. Electric motors.
5,387. Marconi. Apparatus for wireless telegraphy.
10,940. Swinburne. Incandescent electric lamps.
11,025. Binko. Electric apparatus for life buoys and lights to facilitate the rescue of persons from drowning and for other purposes.
11,206. Partridge and Elphinstone. Electric switches and like apparatus for making and breaking electric circuits.
11,208. Warden-Stevens. Electric signalling apparatus.
11,504. Kettler. Process for fitting submarine cables for quick signalling.
11,727. Kingsland. Electric switches having intermittent or step-by-step motions.
11,853. Grindrod. Flag or banner poles or for use in connection with arc lamps or for other like purposes.
12,303. Lawley-Pinching and Walton. Watertight switch cases.
12,531. Von Sedneff. Positive electrode for accumulators.
12,739. Ringsdorff. Dynamo brush.
12,855. Junge (Oberlausitzer Glashüttenwerke Otto Hirst). Manufacture of bulbs for electric incandescent lamps.
13,081. Purdy. Means for grinding and truing-up dynamo commutators and the like.
13,722. Staveley and Parsons. Contact devices chiefly designed for use in connection with electrical counting or recording devices.
14,422. Adams. Switches and apparatus for use in starting and controlling electric motors.
14,552. Lugby. Conduits for electric conductors, water or the like.
14,704. Brannerhjelm. Transmitters for electrical waves or like apparatus. (Date applied for under International Convention, January 26, 1900.)
15,019. Gould. Recovery of tin and the simultaneous generation of electric energy.
15,021. Alexandroff. Manufacture of carbon electrodes for arc lamps.
15,175. Bloxam (Schoeller). Apparatus for igniting by electricity combustible mixtures in internal combustion motors and the like.
17,379. Lake (Soc. pour L'Exploitation des Compteurs Electriques Rittner & Cie.). Electric meters.
17,765. Scharf. Connecting the glow bodies of incandescent electric lamps to the leading-in wires.
22,851. Gordon. Apparatus for automatically electrically collecting and conveying letters and other postal matters.
23,800. Moriarty, Tolger and Jackson. Sparking plugs, chiefly designed for use as an igniting device for explosion engines.

1901.

367. Lundberg and Lundberg. Multiple wall connections for electric lighting, heating, and the like.
1,994. Feeny (Allgemeine Elektricitäts Gesellschaft). Electrical meters.
2,099. Fairburn-Hart (General Electric Co.). Electric arc lamps.
3,002. Harloe. Electrical insulators.
3,206. Siemens Bros. & Co. (Ltd.) (Siemens and Halske Aktiengesellschaft). Equalising appliances for inter-connected polyphase currents.
4,494. Thompson (Akkumulatorem und Electricitätswerke Aktiengesellschaft vorm. W. A. Boese & Co.). Process for making electrodes for accumulators.
4,868. Scott. Electric switches. (Date applied for under International Convention, August 16, 1900.)
5,134. Hultman. Conduits for electric cables and the like.
5,596. Atkins. Electrolysis of chlorides of metals of the alkalies and alkaline earths for the purpose of obtaining chlorine and apparatus therefor.
6,288. Smith and Smith. Coin-freed meters for gas or electricity.
6,870. Lewis. Coin-controlled apparatus for telephones.
6,884. Hudson. Protecting covers for steam pipes, water pipes, rods, chains, wire ropes or electric wires for ship purposes.
6,919. Oxlade and Richardson. Audible electric telegraphy.
8,962. Parker. Switch apparatus for use in a surface-contact system of electric traction, and operating switches used in such systems.
9,265. Young. Electric arc lamps.
9,384. Johnson and Esson. Electric arc lamps.
9,502. Wise (Yocam). Telephone transmitters.
9,882. Lane. Electric arc lamps.
9,987. Gould. Electric cables.
10,623. Nicholson and New Phonopore Telephone Co. (Ltd.) Telephone apparatus.

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# COMPANIES' MEETINGS AND REPORTS.

## Schattner Electricity Meter Co. (Ltd.).

The first ordinary general meeting was held on Tuesday, Mr. R. STEWART BAIN, C.A., presiding.

The SECRETARY (Mr. W. K. Richmond) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: The report tells you that the Company was incorporated on June 29, 1900, although the business was taken over as a going concern as from April 1, 1900. Our total sales of meters, after deducting the returns during this period, amounted to £6,453. 13s. 5d., representing 1,613 meters, which, compared with the previous year, shows an increase of 304 meters, or about 22 per cent. This output would probably have been considerably increased, but during the period we found it necessary to remove the works from Norwich, where our manufacturing was carried on at considerable inconvenience owing to the smallness and scattered nature of the works, to London. These new works have been equipped with an additional number of new machines and tools, the introduction of which facilitates quicker production and has already effected a satisfactory saving in the cost of manufacture. Other savings which have been effected are in the carrriage of material, of meters and reduction in travelling expenses; we also get the advantage of a greater selection of labour, and as we are in the commercial centre of the kingdom we are able to get visits from electrical engineers who would not have visited us at Norwich. We were able to bring nearly our whole staff to London with us, a considerable further advantage. Our manufacturing charges of all descriptions amounted to £3,236. 10s. 11d., while our general charges amounted to £1,827. 3s. 4d. Although the Directors were entitled to the sum of £600 as their fees for the period, as they wished to study economy as far as possible during the first year of the Company's existence, they agreed to give up one-half of their fees, and you will see from the profit and loss account that only £300 has been accepted. We have written off £190. 5s. 6d. as depreciation of plant, machinery, furniture, &c., as well as providing for the only bad debt we know of. This leaves a credit balance of £1,149. 17s. 1d., but as £216. 1s. 10d. of this amount were profits made by the Company before incorporation, which, we are advised by our auditors, cannot be divided as profits, we have written off the whole of our preliminary expenses and part of the alteration to the new works with this amount, which leaves us with a sum of £933. 15s. 3d. now to be dealt with. This is equal to about 11 per cent. on the subscribed capital from the dates it was called up, and we recommend a dividend of 6 per cent., that a further £100 be written off alterations to works, and that we carry forward £347. 2s. 8d. Our total capital authorised is £50,000. Of this we have issued 15,000 ordinary and 12,500 deferred shares, making £27,500. As regards the ordinary shares, we have only so far called up 15s. It had been our intention to call up the balance of 5s. on July 1st, but as we found that we did not require the money, we deferred doing this until we were in actual need of it. As regards the position of the Company, I am pleased to be able to speak very hopefully. The actual orders in hand amount to about 400 meters, but in addition to this we have every reason to believe that we shall obtain orders amounting to over 2,000 meters from other lighting authorities with whom we have been carrying on negotiations. Further, we are manufacturing a demand indicator which will soon be ready for the market, and which we believe will be a source of considerable additional revenue to us and a factor in reducing our establishment charges. Although this instrument is not yet in the market, orders for over 300 have already been promised. The Board have been asked to take into consideration the manufacture of other instruments, and negotiations are pending. I now move the adoption of the report and accounts.

The resolution having been unanimously carried, after the re-election of Mr. F. W. Harmer, J.P., to his seat on the board and the re-appointment of the auditors, the proceedings terminated with a vote of thanks to the chairman.

## British Electric Transformer Manufacturing Co. (Ltd.).

The third ordinary general meeting was held on Wednesday, Mr. R. STEWART BAIN, C.A., presiding.

The SECRETARY (Mr. J. C. Wrist) read the notice calling the meeting and also the auditors' report.

The CHAIRMAN said: When I had the pleasure of addressing you last year, I pointed out that the various items contained in the accounts were of so satisfactory a nature that they did not require any explanation. I venture to submit that the payment of a regular dividend of 10 per cent., accompanied by an adequate but necessary amount to reserve, together with full provision for depreciation, and carrying forward a sum equal to a further dividend of 5 per cent. of undivided profits, is a position which we have all every reason to be satisfied with, and which, I am pleased to say, has been accomplished with careful and prudent management. During the year our output compared favourably with that of previous years. We have been very successful in securing contracts in competition, and repeat orders. Our net sales have been £25,067. 6s. 9d., as compared with £22,878. 8s. 5d. for the previous year. Our work in progress is £1,542. 0s. 2d., against £1.165. 0s. 5d., and our other receipts £1,175. 17s. 9d., as compared with £360. 16s., the total being £27,685. 4s. 8d., as compared with £24,404. 4s. 10d., an increase of £3,381. If we turn to the debit side of the account, it will be seen that our manufacturing charges have increased from £13,448. 11s. 4d. last year to £16,682. 12s. 11d. This increase has been entirely caused by the high price of materials, principally of copper; but we are now taking this increase into consideration in our prices for transformers. Our general charges are £2,666. 5s. 5d., as compared with £2,433. 9s. 9d. last year, an increase of about £200. This works out in the percentage of our sales at about the same percentage as last year, and about 1 per cent. more than in our first year. The percentages are respectively 9½, 10½, and 10⅜. As this point has been raised, I think this a very good opportunity to say that the small increase here is entirely accounted for by the commissions we are paying to our very excellent outdoor representative. The depreciation is £612. 16s. 5d., compared with £714. 3s. 8d., our total charges being £21,126. 15s. 2d., compared with £18,219. 16s. 1d. This leaves us with a profit on the year's working of £6,658. 9s. 6d., as compared with £6,184. 8s. 9d., being an increase of £474. 0s. 9d., which we believe would have been considerably more but for the high prices of material already mentioned. Our principal asset is the £25,404. 17s. 3d., balance-sheet value of our patents. We have apparently only added £68. 10s. 10d. to this item, but this only represents the balance between the amounts written off and the amount paid in respect of additional patents. During the year the Board have granted a licence to the Union Elektricitäts Gesellschaft, of Berlin, and a portion of the amount received equal to the value placed on the patent has been written off this item, the balance being placed to the credit of profit and loss. During the year additional patents were obtained for three-phase transformers in the United Kingdom, Germany and America, and since the date of the balance-sheet these patents have been covered in Austria, Belgium, France, Italy, Norway and Sweden, Russia and Switzerland. The next item, freehold land and buildings, on which we have expended £3,779. 3s. 3d. to June 30, is for new works, now rapidly nearing completion, which will put us in a greatly improved position for dealing with heavy work. We hope to complete and equip these new works without increasing the present capital. The stock, as per manager's valuation taken at cost price, £4,271. 5s. 5d., and the work in progress, £1,542. 0s. 2d., are both in excess of last year's figures. In addition, we have orders in hand which amount to £8,312. 5s., being £1,500 in excess of the orders in hand when we commenced the year. The amount due from customers, principally municipal corporations, £10,936. 1s. 10d., is all certified as good. The amount due to creditors is £4,183. 7s. 10d. Our reserve stands at £2,500, and the balance at credit of profit and loss account, after deducting interim dividend at the rate of 10 per cent. paid in February last, is £6,460. 14s. 11d. We recommend a dividend for the second six months at the same rate, and these dividends will be paid on the full capital of £40,000, the vendors' shares now ranking. We also recommend that a further £2,500 should be added to the reserve fund, making this up to £5,000, which is about 20 per cent. of the value we place on our patents, and to carry forward £1,960. 14s. 11d., a little in addition of last year. I now move the adoption of the report and the payment of the dividend therein recommended.

The motion was carried unanimously.

Mr. A. M. Billington was elected a director of the Company in the place of Mr. R. Wallis-Jones, who retired. A vote of thanks to Mr. Wallis-Jones for his past services was also carried unanimously.

The auditors having been re-appointed, a hearty vote of thanks to the chairman, directors and staff was agreed to, and the proceedings terminated.

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**DUBLIN AND LUCAN ELECTRIC RAILWAY CO.**—The report presented at the half-yearly meeting on Monday stated that, after including £49. 12s. 8d. from last half-year, and providing for debenture interest to June 30, there remained £497. 13s., which was more than sufficient to pay a dividend on the 5 per cent. preference shares. The traffic receipts showed an increase of £129 over the corresponding half of last year, whilst there was a reduced expenditure of £260. The chairman (Mr. W. Mooney, J.P.) said when it was borne in mind that the entire old steam line had to be removed and a perfectly new electric line made on a raised platform on the other side of the public road, and that all the capital required for the construction of the new line and its electrical equipment, including the power house, motor cars, &c., had been raised by debenture and preference stock exclusively, the result of the half-year's working must be considered satisfactory. The increased receipts for the seven weeks of the current half-year was £192 in excess of that for the corresponding period of 1900, a rise of 18 per cent.

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**METROPOLITAN DISTRICT RAILWAY CO.**—At the meeting on Friday last the chairman (Mr. J. Staats Forbes) said the report of the directors showed that the past half-year's results were very bad. The effect of the competition of the Central London Railway and of the electric tramways in West London was becoming more pronounced every day. The tramways had been further extended, and were more active, but they must expect that state of things to continue until the conversion of the Metropolitan District Railway to electric traction had been effected. They knew the nature of the agreement under which they had secured a contract for converting the railway, and also that the parties to that contract had backed their opinion by accepting it upon terms which they had reason to believe were extremely reasonable, upon an electric system which would be approved as being the best practicable one, although not, perhaps, the best scientific one. The contracting company had become possessed of considerably over £1,000,000 of their stock, and therefore had an additional incentive to use all their knowledge and efforts to improve their own property. There was no good in lamenting a state of things which they could not control—that no human foresight could have foreseen. The old pioneer underground railway had to stand aside for new things. Their bill confirming the agreement for the conversion of the line had been passed. They had a difficult question with the Metropolitan as to the system of traction upon which the railway should be worked. Everyone had got his own idea, and they (the directors), under the advice of eminent engineers (Sir William Preece and Mr. Thomas Parker), were captivated

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by the apparent merits of the Ganz system. The moment they selected the Ganz tender they were attacked on all sides by British companies, such as the British Westinghouse Company and others, who said what fools they were, that the system was a dead failure, and that it was impossible to adopt it. Then came the combination to convert their railway, who said, in the graphic language of the gentleman who was at the bottom of it (Mr. Yerkes), "I will not put a dollar into the Ganz system." The Metropolitan Company were blessed with a director (Col. Mellor) who had the misfortune of knowing a little about science, and nothing could persuade Col. Mellor to listen to any modification of his conviction, founded upon his own electrical knowledge, that it is a good system, and he would not have any other, and that had brought them to a deadlock. It was to be applied to the electrification of the Inner Circle railway. They had 4 miles of that line, and the Metropolitan had 9 miles, and throughout the whole negotiations he (the speaker) had limited their assent to any system whatever to those 4 miles as part of the Inner Circle, reserving to themselves the right to apply to the whole of the rest of their line any other system which proved to be better. A deadlock ensued, and the result was that the whole matter was to be settled by the Board of Trade. The Board of Trade showed no great disposition to take up the burden. They were approached to make a pronouncement, but, like wise people, they avoided cracking a nut of such a tremendous character. The Board of Trade were to appoint a special tribunal, consisting of an arbitrator and two engineers, one to be appointed by each company, to hear evidence and determine which system of working should be applied to the portions of each company's system. They had determined to go to the Board of Trade forthwith. Meanwhile Mr. Yerkes, who was deeply interested in the conversion as the founder and the chief shareholder in the Traction Company, had gone to Budapest with his engineers in order to satisfy himself by inquiry on the spot whether the Ganz system of electric working did or did not contain elements which overcame his objection to its adoption for the whole system, and he should not be at all surprised, from what he knew of Mr. Yerkes, if he brought back Ganz in his pocket. Mr. Forbes then announced his retirement from the position of chairman of the District Railway Co. He will, however retain his seat on the board as advisory director.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**CRYSTALATE MANUFACTURING CO. (LTD.)**—Reg. Aug. 2, capital £15,000 in £1 shares, to adopt agreements with G. H. Burt and the Endolithic Manufacturing Co. and to carry on the business of manufacturers of and dealers in mineral and vegetable substances and their products, engineers, indiarubber, vulcanite and ivory manufacturers, &c. The first directors are G. H. Burt, P. W. Davis and A. J. Keil.

**GEARINGS LIMITED.**—Reg. Aug. 13, capital £3,000 in 1s. shares, to carry on business as engineers, electricians and manufacturers of and dealers in mechanically propelled carriages, and all plant and appliances relating thereto, and to construct and maintain telegraph and telephone lines, electric and other lighting works, &c.

**UNION ELECTRIC CO. (LTD.)**—Reg. Aug. 13, capital £25,000 in £1 shares, to carry on the business of manufacturers, dealers and suppliers of electric lamps, electric light contractors, electricians, electrical, mechanical and general engineers, contractors for the supply of electricity, &c. The subscribers are M. Müller, engineer, H. Garbe, electrical apparatus manufacturer, M. Körting, manufacturer of electrical apparatus, H. J. Down, engineer, J. Eck, electrical engineer, O. Barwinkel and G. W. Newall. No initial public issue. The first directors are M. Müller, H. Garbe and M. Körting.

**SINGAPORE TRAMWAYS (LTD.)**—Reg. Aug. 15, capital £2,000 in £1 shares, to establish, maintain and work by electric or other power, rail and tramroads in the Straits Settlements, to carry on the business of generators, accumulators and distributors of electrical energy for the purposes of light, heat or power, and to construct machinery, lamps, accumulators, wires, cables, &c.

**PNEUMATIC, ELECTRIC AND GENERAL ENGINEERING CO. (LTD.)**—Reg. Aug. 16, capital £370,000 in £1 shares (220,000 preference), to carry on the business of engineers, mechanics, makers of pneumatic and electric tools and pneumatic, electric and hydraulic railway and marine signal appliances, and suppliers of electricity, &c.

**BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)**—The annual return to May 1 gives the capital as £300,000 in £1 shares (150,000 preference), of which 101,200 ordinary shares have been taken up. Mortgages and charges, £100,000.

**ELECTRICAL POWER DISTRIBUTION CO. (LTD)**—The annual return to June 18 gives the capital as £300,000 in 14,980 "A" and 15,000 "B" shares of £10 each, and 200 "C" shares of £1 each, of which 14,980 "A" and 200 "C" shares have been taken up. £8 per share has been called up on 12,980 "A," £10 per share on 2,000 "A" and £1 per share on 200 "C" shares. No mortgages or charges.

**ELECTRICAL POWER STORAGE CO. (LTD.)**—According to the annual return to July 25, the capital is £100,500 in 100 founders' and 20,000 ordinary shares of £5 each, of which 66 founders' and 18,592 ordinary have been taken up. £5 per share has been called up on 66 founders' and £4 per share on 3,132 ordinary shares. Mortgages and charges, £28,400.

**LISBON ELECTRIC TRAMWAYS (LTD.)**—In the annual return to July 23, the capital is given as £1,000,000 in 500,000 ordinary and 500,000 preference shares of £1 each, of which 500,000 ordinary and 165,007 preference have been taken up. All the shares are considered as fully paid. Mortgages and charges, £500,000. Since the date of the above return 165,000 preference shares have been allotted, considered as fully paid.

**MEXICO ELECTRIC TRAMWAYS (LTD.)**—The capital on June 19 was £1,000,000 in 500,000 ordinary and 500,000 preference shares of £1 each, of which 500,000 ordinary and 237,013 preference shares had been taken up. £1 per share has been called up on the preference shares, and £237,013 has been received. The ordinary shares are considered as fully paid. Mortgages and charges, £400,000.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27d. per oz. (Aug. 22). Consols (2¾ per cent.) 94⅜—94⅝ for money, 94⅜—94½ for account; 2½ per cent. 95—95¼ (Aug. 22). Consols Pay Day, Sept. 2; Stocks and Shares Continuation Days, Aug. 27 and Sept. 10; Ticket Days, Aug. 28 and Sept. 11; Pay Days, Aug. 29 and Sept. 12; Mining Share Carry-over Days, Aug. 26 and Sept. 9.

**AKTIEN GESELLSCHAFT BROWN, BOVERI & CO.**—For the past year a dividend of 16 per cent. has been declared, the gross profit amounting to 4,150,783fr. and the net profit to 2,271,003fr. The Mannheim affiliated company has paid a dividend of 10 per cent.

**W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.).**—An interim dividend has been declared for the half-year to June 30 on the 4½ per cent. preference shares, and at the rate of 10 per cent. per annum on the ordinary shares, payable Sept. 2.

**HOBART ELECTRIC TRAMWAY CO. (LTD.)**—The revenue for 1900 amounted to £14,769, against £13,624 last year, and the working expenses were £10,714 against £10,152 for the previous year.

**INVESTMENT OF JAPANESE CAPITAL IN ELECTRIC LIGHTING.**—Statistics recently compiled for 1899 show that the amount of capital invested in electric lighting undertakings in Japan at that date reached £800,000. This was an increase over 1895, the period to which previous statistics had been brought, of £140,000.

**MATHER AND PLATT (LTD.)**—The directors state that the net profit for the year to June 30, after allowing for depreciation and directors' remuneration, was £77,621, and after adding the balance from the previous year (£6,925) there was an available total of £84,547. The preference dividend for the half-year to Dec. 31 absorbed £8,126, leaving £76,421, and after payment of the balance preference dividend, taking £8,126, a dividend of 7 per cent. per annum on the ordinary shares for the year is recommended, absorbing £28,000; £30,000 is tranferred to reserve (making it £80,000), and £1,025 is carried forward.

**WEST AFRICAN TELEGRAPH CO. (LTD.)**—Notice is given that the half-yearly interest on this company's £300,000 5 per cent. mortgage debentures, due Sept. 2, will be paid by the National Bank of Scotland, 37, Nicholas-lane, London, E.C.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Aug. 17 | 936 | + 60 | 11 | 9,672 | + 1,057 |
| *Birmingham Tramways. | „ 17 | 4,490 | + 18 | 6 | 29,023 | + 1,554 |
| *Blackburn Corporation.. | ... | ... | ... | ... | ... | ... |
| Blackpool Corporation... | „ 15 | 2,254 | + 453 | †20 | 21,095 | + 5,207 |
| Blackpool and Fleetwood | „ 17 | 1,720 | + 253 | 7 | 9,403 | - 357 |
| Bolton Corporation .... | „ 18 | 1,593 | - 19 | 20 | 30,568 | + 2,978 |
| Bradford Corporation... | „ 18 | 1,243 | + 727 | 20 | 21,470 | +11,451 |
| Brisbane Trams ..... | July 3 | 1,952 | + 280 | ... | ... | ... |
| *Bristol Trams & Carriage | Aug. 16 | 3,646 | + 41 | 6 | 25,655 | + 3,784 |
| *Buenos Ayres & Belgrano | July 21 | 2,572 | + 526 | 3 | 7,900 | + 1,252 |
| Calcutta Trams. Co. ... | Aug. 17 | R21,208 | +R2,014 | 7 | R43,929 | + R8,401 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | „ 17 | 5,303 | + 724 | 7 | 41,205 | ... |
| City & South London Ry | „ 18 | 1,863 | + 329 | 7 | 12,911 | + 2,376 |
| Cork Elec. Trams ..... | „ 15 | 549 | - 27 | 32 | 15,129 | + 1,890 |
| Dover Corporation .... | „ 17 | 328 | - 25 | 20 | 4,937 | + 296 |
| Dublin & Lucan Rly. .. | „ 18 | 158 | + 7 | 7 | 1,050 | + 192 |
| Dublin United ..... | „ 16 | 4,030 | + 324 | ‡7 | 27,737 | + 1,402 |
| Dublin Southern Dist... | „ 16 | 1,068 | - 294 | ‡7 | 7,971 | |
| *Dundee Corporation ... | „ 14 | 664 | + 208 | 7 | 5,023 | + 1,692 |
| *Glasgow Corporation ... | „ 17 | 12,517 | +2,729 | 11 | 131,410 | +28,737 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 17 | 1,133 | + 306 | 20 | 19,071 | + 4,793 |
| Hull Corporation ..... | „ 17 | 1,706 | + 349 | 7 | 12,398 | + 2,964 |
| Liverpool Corporation... | „ 10 | 10,344 | +1,561 | 32 | 281,848 | +39,423 |
| *Liverpool Overhead Rly. | „ 18 | 1,734 | — 84 | 7 | 12,306 | + 113 |
| *Manchester Corporation | „ 17 | 2,200 | ... | §10 | 19,029 | - 177 |
| Perth (W.A.) Elec. Trams | „ 16 | 791 | + 427 | ‡7 | 6,558 | + 4,033 |
| Portsmouth Corporation | „ 17 | 1,140 | - 305 | ... | ... | ... |
| *Sheffield Corporation ... | „ 18 | 3,747 | +1,106 | 7 | 26,576 | + 8,365 |
| Southampton Corporat'n | „ 15 | 1,025 | + 197 | 7 | 6,813 | + 2,281 |
| Southend Corporation .. | „ 17 | 375 | ... | 4 | 1,343 | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 14. | | Price Wednesday, Aug. 21. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Aug. 21. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | El'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ¾ | ¾ | ¾ | ¾ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. ..... xd | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. ..... | 10 | 11 | 9½ | 10½ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ... | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 19,681 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord ..... xd | 7⅞ | 8¼ | 7⅞ | 8 | 3 15 0 | ... | 7⅛ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... xd | 8¼ | 8¾ | 8¼ | 8¾ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) ..... | 7⅞ | 8 | 7⅞ | 8 | 2 3 9 | ... | ... | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp xd | 9 | 10 | 9 | 10 | 4 5 0 | February and August | 9⅜ | 9¼ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... xd | 5¼ | 5⅝ | 5¼ | 5⅝ | 3 18 8 | ,, ,, | 5¼ | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs) ... | 103 | 105 | 103 | 105 | ... | ... | ... | ... |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary ..... | 5¼ | 6 | 5⅛ | 6 | 4 11 8 | March ..... | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) ..... | 107 | 110 | 107 | 110 | 4 2 0 | June and December... | ... | ... |
| 70,679 | 10 | 2/0 | City of London Electric Lighting Ord. ..... | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8⅜ | 8¼ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. ..... | 11½ | 12½ | 11½ | 12⅜ | 4 16 0 | January and July ..... | 12⅛ | 11⅞ |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ... | 120 | 125 | 120 | 125 | 4 0 0 | June and December ... | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) ... ... | 99 | 100 | 99 | 101 | 4 9 4 | ... | ... | ... |
| 40,000 | 10 | 6/0 | County of London and Brush Prov. Ordinary ... xd | 8⅛ | 9⅛ | 8 | 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference ... xd | 12 | 13 | 12 | 13 | 4 13 4 | March and September | 12 | ... |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ..... ... | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary ..... | 6½ | 6⅝ | 5½ | 5⅝ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary ..... | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary ..... | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. ..... | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July ..... | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)..... [Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knigtbg. Co. & Notting Hill Co. (J't. St'k.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary ..... | 1⅜ | 1⅝ | 1⅜ | 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference ..... | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ... | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) ... xd | 13 | 14 | 13 | 14 | 4 5 9 | April and October..... | 13½ | ... |
| 12,762 | 10 | 4/6 | Do. (85,001 to 98,769) ..... xd | 13 | 14 | 13 | 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage .. | 109 | 112 | 109 | 112 | 4 0 9 | June and December ... | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) ..... | 94 | 97 | 94 | 97 | 3 12 0 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary ..... | 15 | 16 | 15 | 16 | 4 7 6 | March ..... | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary ..... | 5⅝ | 6⅛ | 5⅝ | 6⅛ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock ..... ..... | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 500,000 | 1 | 1/8 | Rand Electric ..... | 9/16 | 9/16 | 9/16 | 9/16 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. ... | 60 | 70 | 60 | 70 | ... | January and July ..... | ... | ... |
| £107,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 101 | 103 | 4 9 1 | April and October..... | 10⅛ | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary ..... | 14⅛ | 15⅛ | 14⅛ | 15⅛ | 4 13 7 | February and August | 15⅛ | ... |
| 20,000 | 5 | 2/6 | Do. 7 per Cent. Preference ..... | 8⅜ | 9⅜ | 8⅜ | 9⅜ | 3 18 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3¼% | Do. 3½ per Cent. Debenture Stock (red.) ..... | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ..... | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2½ | 3½ | 2 | 3 | ... | ... | 2⅞ | 2½ |
| 109,518 | 5 | 5 0 | Westminster Electric Supply Ordinary ..... xd | 11⅝ | 12 | 12 | 13 | 4 0 9 | March and September | 12⅝ | 14/8 |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... | 3⅞ | 4¼ | 4 | 4¼ | 4 14 2 | April and October..... | 4 7/16 | 4¼ |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock ..... | 124 | 129 | 124 | 129 | 4 13 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary ..... | 8 | 9 | 8 | 10 | 2 4 5 | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference ..... | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures ..... | 95 | 100 | 95 | 100 | 5 0 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) ..... ..... | 92 | 97 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways..... | 14 | 15 | 14 | 15 | 4 6 6 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2 | 3 | 2 | 3 | ... | ... | 2⅜ | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. ..... | 4½ | 4⅝ | 4½ | 4⅝ | ... | ... | ... | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. ..... ..... | 102 | 104 | 102 | 104 | 4 7 0 | ... | 103½ | 103 |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary ..... | 21½ | 22½ | 22 | 23 | 3 15 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) ..... | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... ..... | 112 | 115 | 112 | 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary..... xd | 6¾ | 7 | 6 | 6¾ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference ..... | 9¼ | 9⅝ | 9¼ | 9⅝ | 5 2 7 | May and November ... | 9⅞ | 9⅛ |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs.... ..... ..... | 100⅝ | 102⅞ | 100⅞ | 102⅞ | 4 8 11 | ... | 101⅛ | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary..... | 13⅜ | 14⅛ | 13⅜ | 14⅛ | 7 0 4 | ... | 14⅛ | 13⅛ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref..... xd | 12 | 13⅛ | 11⅞ | 12⅛ | 4 18 0 | February and August | 12⅛ | 12⅛ |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... | 123 | 125 | 123 | 125 | 4 0 10 | ... | 124⅛ | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary ..... | 1⅛ | 1⅞ | 1⅛ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. ..... | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 5 4 4 | ... | 5⅜ | ... |
| 27,500 | 5 | 2/6 | Do. "B" ..... | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 2 3 6 | ... | 5⅛ | ... |
| £230,000 | Stock | 5% | Do. 5 per Cent. Debentures ..... | 102 | 105 | 103 | 105 | 4 15 3 | ... | 104⅛ | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 2 0 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) ..... | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 2 8 0 | ... | 12⅛ | 11⅛ |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) ..... | 104 | 106 | 104 | 106 | 4 5 6 | ... | 106 | 105⅛ |
| 400,000 | 1 | 1/2½ | Cape Electric Tramways Shares ..... | 1⅜ | 2 | 1⅜ | 2 | 3 0 0 | ... | ... | ... |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock ..... xd | 101 | 104 | 99 | 102 | 3 3 9 | June and December... | 102 | 100 |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock ..... xd | 103 | 103 | 103 | 106 | 3 15 6 | ... | 105 | 103 |
| £440,100 | Stock | ... | Do. Deferred Stock ..... | 96 | 100 | 93 | 101 | ... | ... | 99 | 98⅜ |
| £696,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs ..... ... | 113 | 118 | 113 | 118 | 3 7 10 | ... | 117⅛ | 117 |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 4 17 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. ..... | 101 | 105 | 102 | 105 | 3 17 1 | ... | 103 | ... |
| £956,000 | Stock | 1½% | City and South London Railway Con. Ordinary ..... | 52 | 54 | 54 | 54 | 2 15 7 | February and August | 54 | 52⅛ |
| 47,500 | 10 | 2/0 9/16 | Do. Ordinary (Nos. 22,501 to 70,000) ..... .. | 5⅛ | 5⅝ | 5⅛ | 5⅝ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) ... | 129 | 131 | 129 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) ..... | 123 | 127 | 123 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... ..... | 112 | 117 | 112 | 117 | 3 8 6 | May and November ... | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary ..... | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 4 0 0 | ... | 12⅛ | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference ..... ..... | 14⅛ | 15⅛ | 14⅛ | 15⅛ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) ..... ... | 98 | 102 | 98 | 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | | 5½ | | 5½ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary ..... | 22 | 22½ | 21½ | 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference ..... | 14½ | 15 | 14⅜ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... ..... | 111 | 113 | 111 | 113 | 3 19 8 | January and July ..... | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary ..... xd | 7⅜ | 7½ | 7 1/16 | 7 1/16 | 3 15 4 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ..... ..... xd | 13 | 13½ | 12½ | 13 | 3 16 11 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... ... | 103 | 104 | 103 | 104 | 3 16 11 | January and July ..... | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fully pd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | 106½ | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 7 9 | ... | ... | ... |
| £60,000 | 100 | 6% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) ... | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) ..... | 100 | 102 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary ..... | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference ..... | 4½ | 5 | 4½ | 5 | 6 0 0 | May ..... | ... | ... |
| 12,234 | 10 | 4/0 | Potteries Electric Traction Ordinary ..... | 12 | 13 | 12 | 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference .. xd | 9½ | 10⅛ | 9½ | 10⅛ | 4 15 3 | February and August | ... | ... |
| £126,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... ... | 105 | 108 | 106 | 109 | 4 3 1 | ... | 107½ | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | | ... | | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (6/0 paid) ..... ..... | | ... | | ... | ... | April and October..... | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) ..... | | ... | | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (30% paid) ..... | | ... | | ... | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary..... xd | 91 | 94 | 92 | 95 | 3 3 2 | June and December ... | 94 | 93½ |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 14. | | Price Wednesday, Aug. 21. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Aug. 21. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 98 | 101 | 99 | 102 | 3 18 9 | January and July | 101 | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ | 4½ | 3⅜ | 4½ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American | 52 | 55 | 52 | 55 | 5 14 0 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 97 | 99 | 97 | 99 | 6 1 3 | ,, ,, | 98½ | 97½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 9⅜ | 10 | 9¼ | 10⅛ | 2 8 9 | ,, ,, | 10 1/16 | 9 15/16 |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 17 9 | ,, ,, | 102½ | 101½ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 6 | 7 | 5 | 6 | 7 10 0 | February and August | 5 | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14½ | 15½ | 6 9 0 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 99% | 103% | 99% | 103% | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10½ | 11½ | 10½ | 11½ | 5 13 1 | Jan., Apr., July, Oct. | 11 | 10⅞ |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 100 | 103 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 142 | 147 | 143 | 148 | 4 14 7 | Jan., Apr., July, Oct. | 146 | 143 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 94 | 97 | 93 | 98 | 3 11 7 | ,, ,, | 94⅛ | 94⅛ |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 116 | 113 | 116 | 3 9 7 | May and November | 115 | 113⅝ |
| 300,000 | 10 | 2/6 | Eastern Extension | 13⅝ | 14⅛ | 13⅝ | 14⅛ | 4 15 0 | Jan., Apr., July, Oct. | 14⅛ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 113 | 118 | 3 7 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 | 102 | 99 | 102 | 3 18 5 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 100% | 103% | 101% | 104% | 3 17 7 | May and November | ... | ... |
| 150,000 | 10 | 5.0 | Great Northern of Copenhagen | 31 | 33 | 31 | 33 | 4 10 11 | January and July | ... | ... |
| £78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos | 99 | 102 | 100 | 103 | 4 7 10 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red. | 41 | 45 | 41 | 45 | 5 11 1 | May and November | 44 | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 104 | 107 | 5 15 5 | March and September | 104½ | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 100 | 103 | 3 18 1 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 101 | 104 | 101 | 104 | 4 18 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ | ⅜ | ¼ | ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 100 | 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅛ | ⅜ | ⅛ | ⅜ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 4½ | 5½ | 5 | 6 | ... | ,, ,, | 5 | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 | 104 | 101 | 104 | 4 16 2 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 13⅝ | 14½ | 13⅝ | 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | ... |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 100 | 103 | 101 | 104 | 3 17 4 | ... | 103 | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) xd | 3⅜ | 4½ | 3⅜ | 4½ | 5 17 8 | August | ... | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 3/0 | 3/6 | 2/0 | 3/0 | 10 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ | ⅜ | ⅛ | ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3¾ | 4 | 3¾ | 4⅛ | 6 1 3 | February and August | 4⅛ | 3⅞ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 13 | 11 | 13 | 4 12 1 | ,, ,, | 13 | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅛ | 4⅜ | 4⅛ | 5 | 5 0 0 | ,, ,, | 5 | 4 7/8 |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 89 | 92 | 92 | 95 | 3 14 1 | June and December | 92⅜ | 91 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 94 | 97 | 95 | 98 | 4 2 1 | ... | 97⅜ | 95½ |
| 171,504 | 1 | 0/8½ | Oriental | ⅞ | 1 | ⅞ | 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 | 5½ | 5 | 5½ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 101 | 104 | 102 | 105 | 4 15 11 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. xd | 7/8 | 1 | 7/8 | 1 | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 3/8 | 1/2 | 3/8 | 1/2 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ | ½ | ⅜ | ½ | 8 11 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 9½ | 10⅛ | 9½ | 10⅛ | 7 2 10 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6 | 6⅛ | 6 | 6⅛ | 4 12 4 | January and July | 5⅛ | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4⅝ | 5⅛ | 5 14 3 | ... | 4⅝ | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅝ | 1⅞ | 1⅝ | 1⅞ | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | ,, | 2⅝ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 4 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 | 102 | 99 | 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14½ | 15½ | 14½ | 15½ | 4 16 9 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¾ | 6¼ | 5¾ | 6¼ | 4 0 0 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 107 | 111 | 108 | 112 | 4 0 10 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 | 95 | 92 | 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 5 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/6 | Crompton and Co. (Nos. 1 to 54,000) | 3⅞ | 4 | 3¾ | 3⅞ | 6 0 0 | January and July | 3⅞ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red. xd | 100 | 105 | 100 | 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ½ | ... | ½ | ... | ... | February and August | ⅛ | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ | 2½ | 1½ | 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 | 85 | 80 | 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 85 | 90 | 85 | 90 | 5 11 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5⅜ | 6⅛ | 5⅜ | 6⅛ | 5 12 0 | Half-yearly | 5 15/16 | ... |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5½ | 6 | 5½ | 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 104 | 107 | 4 4 4 | ... | 105½ | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. | 1⅛ | 2 | 1⅛ | 2 | 6 0 0 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2¼ | 2⅜ | 2¼ | 2⅜ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 | 102 | 98 | 102 | 3 18 5 | January and July | 100 | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅜ | 10¼ | 9¼ | 10¼ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 16 | 17 | 16 | 17 | 5 7 8 | February and August | 17⅜ | 15⅝ |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5¼ | 6 | 3 16 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 | 113 | 110 | 114 | 4 0 6 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 13 0 | ,, ,, | 21⅛ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 37 | 41 | 38 | 42 | 5 0 0 | March and July | 41 | 39½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 102 | 105 | 104 | 106 | 3 15 10 | January and July | 105½ | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 10½ | 11½ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 16 | 5½ | 6½ | 4 0 0 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 | 11 | 10 | 11 | 5 9 0 | April and October | 11 | 10½ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ | 7 | 6½ | 7½ | 4 2 9 | ,, ,, | 7 | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | | | |
| 19,200 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 | 6 | 5 | 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 4 6 | Globe Telegraph and Trust | 10½ | 10⅝ | 10½ | 10⅝ | 4 17 8 | Jan., Apr., July, Oct. | 10 1/16 | 10⅛ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14⅝ | 15½ | 3 19 8 | ,, ,, | 15 | 14⅝ |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 126 | 131 | 4 12 8 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,215. [No. 19, Vol. XLVII.] FRIDAY, AUGUST 30, 1901. PRICE SIXPENCE (by post, 6d.). Abroad, 8d., or 15 cents, or 80c., or 70pf.


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## NOTES.

THE POSTMASTER-GENERAL'S annual report, just issued, for the financial year ended March 31, 1901, is unusually dreary reading, a change having come over its literary style concurrently with the retirement of Mr. CARDIN, the late comptroller and accountant-general. Its general dulness is rendered perfectly doleful when the telegraph accounts are dealt with, matters in that quarter being even less satisfactory than usual. For the first time in ten years the receipts in respect of the telegraph service have fallen below the year preceding; and for the first time since the service has been worked by the State the total number of telegrams has diminished. This looks as if the revenue from that source had reached high-water mark; and as the expenditure has continued at the usual rate of augmentation, the net result is that, at this critical turning point, there is a net deficit on the year's business of £358,216—a sum which is raised to £652,104 if the annual interest due (but never paid) on the original capital outlay be added. Taking into account the fact of a general election—a fact referred to as explaining a large increase of postal business—this falling off in the telegraph branch is somewhat startling. For the five or six previous years the growth of inland telegrams year by year has been at the rate of between three and four millions; in 1900-1 there was an actual decrease of 888,162, the bulk of this being under the heading of "London." Scotland and the provinces show also each a falling off, the only gratifying item being the one under "Ireland," which, happily, holds its own fairly well.

IF the telephone may be credited with appropriating the London business, the Post Office will have its opportunity of recapturing the lost traffic when the official system—whose mains are being rapidly laid down—gets into working order. The telephone trunk wires may account for the loss in provincial telegraph traffic, seeing that the revenue derived from the first-named source was £211,209. But this does not save the grand total from the deficiency commented upon above, and the outlook seems to us anything but cheering. Gracious reference is made to the generous action of the cable companies in affording facilities for the transmission of telegrams at half rates to the troops in South Africa and to the expeditionary forces of all nations in China. We should have been better pleased if less stress had been made in the report upon the inconvenience occasioned by the absence of skilled officers in South Africa—very many of whom are telegraph men—than upon the patriotism which induced them to go there. The death roll for the year just past alone numbers 69; how much more of sickness and permanent injury have been incurred the report does not mention. The service at home has not suffered perceptibly, whereas the task in South Africa would have been greatly aggravated but for their devotion and self-sacrifice.

STORAGE batteries are generally provided in continuous-current electricity supply stations for one of three reasons, or a combination of these reasons. They may be used (1) for regulating the pressure, (2) for supplying current during hours of light and maximum load, and (3) for use in cases of breakdown. We reprint in this issue an interesting record of the performance of the storage batteries in Chicago, when about 21,000 amperes was taken by two batteries for 40 minutes during the complete breakdown of the steam plant at one of the supply stations. It is a common practice on the Continent and in the United States to employ huge batteries that will take the whole or nearly the whole load; but there are few, if any, important stations in Great Britain where the batteries would save the situation in the case of a complete breakdown of the generating plant. There is something, of course, to be said for English practice on the score of the large capital outlay and decreased efficiency in using mammoth batteries; but there is no doubt that their installation must prevent many an uneasy moment to the station engineer.

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It is by no means a new thing that the political press "comes a cropper" when it attacks a scientific subject; but while this is pardonable in ordinary paragraphs and notes emanating from the reporters and special correspondents, who cannot be expected to possess any knowledge of scientific or technical matters, one expects something better in a leading article of a leading daily paper. The *Morning Post* has got hold of some account of the experiments of Prof. Nernst and Herr von Lieben with the electrolytic telegraphone recently described in our columns, and, associating with it recollections of Poulsen's telegraphone and the interesting discovery of magnetic pottery made a few years ago, it proceeds to investigate the potentialities of the two Austrian physicists' researches in a most sensational and amusing manner. The article first explains that they "arrived at the conclusion that the changes, produced by an electric current representing transformed sound waves, in what may be called the magnetic constitution of a body—of a ribbon of platinum, for example, or a disc of copper—form a record from which, by reversal, the sound waves themselves could be reproduced. They travelled independently to this particular Pisgah-height of scientific speculation. . . . "—and our contemporary makes almost a greater effort in unscientific speculation :—

So, in a somewhat similar way, our walls keep the records of all the speech they have ever heard. Stranger still, these records are not jumbled up nor confused; they are superimposed, as it were, in an ordinary manner. We might compare them with letters arranged in a pile according to date; or we might compare them with a palimpsest in which none of the older writing has been erased. Neither comparison is logically correct, but taking the two together, and extracting that which is common to either simile, we arrive at a tolerably clear understanding of the way in which the "magnetic photographs" of words uttered in the past are concealed in the walls and furniture about us. Some day, it may be, an instrument will be devised by means of which we can transmute them back to sound.

**Opening of the Farnworth Electricity Works.**—The formal opening of the combined electric lighting and traction station took place at Farnworth on Wednesday.

**Wireless Telegraphy Experiments.**—Mr. Marconi has, so far, erected 20 poles at the experimental station at Mullion, 300ft. above the sea level. They are 200ft. high, and arranged in a circle covering an area of about 1 acre.

**Glasgow Municpal Telephones.**—On Wednesday afternoon the Glasgow Corporation had a private trial of their municipal telephone service. The service will provide for 20,000 subscribers, the wires being underground and extending over 16,000 miles. The service was opened yesterday.

**Personal.**—Among the honours conferred on the occasion of the visit of T.R.H. the Duke and Duchess of Cornwall and York to the Cape of Good Hope was the promotion from C.M.G. to K.C.M.G. of Mr. S. R. French, the Postmaster-General and General Manager of the Cape Telegraphs.

**Cable Interruptions and Repairs :—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... | Mar. 2, 1900 ... | — |
| Cayenne—Pinheiros ..... | April 21, 1901 ... | Aug. 26, 1901 |
| Nase, Rinkin—Kelung, Formosa | Aug. 2, 1901 ... | Aug. 28, 1901 |
| Cadiz—Teneriffe..... ..... ... | Aug. 6, 1901 ... | — |
| Bolama—Bissao ..... | Aug. 16, 1901 ... | — |
| Trinidad—Demerara ..... | Aug. 27, 1901 ... | — |

**A Post Office Improvement.**—On Wednesday an electric travelling gangway was used for the first time between the cross Channel mail steamers at Dover and the shore. The apparatus consists of a platform on the endless chain system worked by electric motors, and the unloading was accomplished at double the speed to that it was done formerly, 15 seconds being about the average time for a package to travel from the boat to the shore at low tide, when the incline was at its steepest. Some of the packages weighed as much as 7cwt.

**Works Management.**—We have received six lectures on "The Management of Engineering Workshops" by Mr. A. H. Barker in book form. A summary of these lectures, which were delivered before the Institution of Junior Engineers, has already been given in these columns (see *The Electrician*, Vol. XLVI., pp. 571, 684, 768, 852, 924, and Vol. XLVII., p. 124). The lectures and discussions on each lecture are given in full, the whole being well printed. It is issued at the low price of 8s., and should be carefully read by everyone connected with the management of works. We are glad to learn from the secretary of the Institution that already steps are being taken at the Central Technical College to introduce engineering workshop book-keeping and accounts into the curriculum, as there is no doubt that this important subject should be mastered by all.

**Motor Car Trials at Glasgow.**—With reference to particulars of these forthcoming trials given in *The Electrician* of August 9th, page 585, we are informed that a special class was made for electrical autocars, with regulations as follows :—

Vehicles propelled by electricity to carry their full complement of passengers. To run daily on the route for one day to such a point as may be thought good by the driver and back to the exhibition on one charge. If the vehicle fails to run back to the exhibition no marks will be given in respect to the day's run. One mark will be deducted for every minute occupied in excess of the official maximum time—viz., 10 miles per hour on the open road and 8 miles per hour through controls. The same battery must be used throughout the five days. If desired, an electric car may complete the whole route for one day and the batteries may be re-charged during the run, but a note of the duration of the stops will be made on the records, and all arrangements for re-charging must be made by the owner.

The only electrical vehicle is entered by the British and Foreign Electrical Vehicle Co., which is using a 6 H.P. Krieger motor and Leitner battery. The car carries four passengers and weighs 1,968lb., or with battery 4,368lb.

**Electrical Treatment of Skin Diseases.**—With reference to our note in *The Electrician*, Vol. XLVI., page 851, we have received particulars of further experiments carried out by Dr. F. W. Smith. A piece of pig's skin was tied round the mouth of an open-mouthed vessel, the bottom of which had been previously knocked out. A piece of blotting-paper was placed outside the skin external to the vessel, and the positive end of an anode was placed on the blotting-paper. The vessel was then filled from the bottom with Harrogate sulphur water and the negative anode was put into it. Three milliamperes from a 13-celled battery were turned on for half an hour. The result was that nascent sulphur was deposited on the pig's skin, driven right through it and on to the blotting-paper at the positive pole. Dr. Smith considers that patients suffering from eczema do much better with electrical treatment than simply lying in the sulphur bath. With regard to the current density which is most suitable for the production of nascent sulphur on the patient's skin in the sulphur bath, he finds that the good effect is greatest with a small anode density—that is, with a weak current. While lying in the electric sulphur bath the patient has no unpleasant feelings but, on the contrary, is soothed.

**Obituary.**—We regret to record the death of Mr. Clement Sneyd Colvin, C.S.I., which occurred suddenly on 26th inst., from a stroke of apoplexy, at Cintra, Lisbon, where he was on a visit to the Marquis of Montserrat. Mr. Colvin was born in London on January 30, 1844, and in 1863 entered the India Office. After serving in several departments, he acted as secretary to the Secretary of State (the Duke of Argyll) 1873–74, and was private secretary to Sir Louis Mallet, then permanent Under-Secretary of State (1874 77), whom he accompanied to India in 1875-76. From 1880 he was Government Director of the Madras Irrigation and Canal Co., and afterwards became assistant-secretary in the Public Works, Railway and Telegraph department. In 1882 he became assistant Government Director of Indian Railway Companies. He was appointed secretary in the Public Works department in March, 1892; was created Companion of the Star of India June, 1897, and retired on account of health in August of that year. He was at the time of his death a director of the Eastern and of the Eastern Extension Telegraph Companies, and a trustee of the Submarine Cables Trust.

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**Municipal Electricity Works Abroad.**—Municipal control of electricity works has a family resemblance all the world over. An incident which has lately occurred in Hanover reminds us of a similar *contretemps* in connection with the equipment of a supply works in Great Britain. A new supply station has for some time been very urgently needed in Hanover, the old one being considerably overloaded. Mr. Prücker, the energetic and able manager of the Hanover electricity works, advised the town to award the contracts for steam engines either to Messrs. Sulzer or Messrs. Borsig. Contrary to his advice, however, the contracts were given to local firms of engine builders. It is now announced that considerable delay had been experienced in the completion of the new works, as some of the contractors, especially those supplying steam engines, are very much behind time. The first steam engine was ordered in March, 1900, and, according to the contract, should have been running by September 15th of this year. The completion of this machine, however, has been so delayed that current will not be delivered from the new works until December. The second steam engine is also about three months behind time, so that the new three-phase network which is being put down will only come into use in February instead of November. In the meantime there will be considerable risk of breakdown during the winter months, owing to the overload in the old Osterstrasse station.

**Short Circuit caused by Flies.**—The *Electrical World* of New York, in a recent number, gives a graphic description of a short circuit caused by "shad flies" on the 25,000 volt line at St. Paul, Wisconsin, where the line crosses the bridge. According to the above-named paper:

"The wires, six in number, are here supported on 8in. by 8in. oak beams, extending out 16ft. from the south side of the structure at the level of the track, each wire being 18in. from its neighbour and over 12in. above the supporting arm below. A large portion of the power transmitted is utilised as direct current, through the medium of six-phase rotary converters, and when one evening, about 8 o'clock, the converters went "out of step," thereby paralysing the whole system, the attention of the operators at the generating station was at once directed to the St. Croix bridge, some 5 miles away, by a series of brilliant electric discharges, which illuminated the whole heavens. The line was at once cut out, and an emergency crew dispatched to repair the supposed breakdown. They were much puzzled upon their arrival to find everything in perfect order, no evidence of any short circuit being visible on either wires, insulators or cross-arms. After some delay the current was again turned on, and the cause of the trouble then became apparent, for the flies soon gathered in such numbers on some of the arms that they formed a solid bridge from wire to wire, and the flash of each discharge, while it destroyed thousands, only added fuel to the flames by attracting additional thousands to the spot. The shut-down lasted about an hour, and it was found necessary to station an attendant upon the bridge, who was provided with a wooden hoe attached to a long pole, with which, from time to time, he dislodged the insects from the cross-arms, as soon as they collected in dangerous numbers. This incident is unique and probably unprecedented."

**The "Helios" Brake-Releasing Electromagnet.**—The electromagnets used for releasing the mechanical brake of electrically-driven cranes were originally wound for connecting in series with the motor; and this arrangement worked well, as the starting current of the motor was always sufficient to ensure the action of the magnet as long as the old pattern cranes, with worm-gearing and very slow hoisting speed, were in use. With the latest improvements in modern cranes, the gearing is so perfect that it is put in motion by the load alone; and there must therefore come a time when the motor current is zero. At this instant, a series-wound brake-releasing magnet would cause a sudden and inconvenient stopping of the gear, and the use of such winding has therefore become impracticable. A compound winding was tried, but with one of two results—either the pull of the magnet was insufficient, or the shunt winding was burnt out. We are informed the "Helios" shunt-wound electromagnet overcomes all these difficulties, and has the advantages of a very great pull and a long stroke. The chief feature in this new construction of break-releasing magnet is the employment of a small switch fixed to the magnet, which short-circuits a resistance, placed in series with the magnet windings, as long as the magnet is inactive. When the magnet is brought into use, the switch is opened in the last part of the stroke-movement and the resistance inserted in the circuit so that the current in the magnet winding is greatly reduced. The use of this switch is based on the well-known fact that the exciting current required by an electromagnet to retain its load is far smaller than that required to attract the same load from a distance. Besides the resistance mentioned above, there is another placed in parallel with the magnet winding to destroy the induction current at switching off. The consumption of energy by this type of break-releasing magnet is from 200 to 300 watts. The movement of the magnet core is damped by air-cushioning at either end.

**Electrical Transmission at Vickers' Gun Mounting Works.**—*Engineering* recently described the new gun mounting works of Messrs. Vickers, Sons and Maxim, which have been equipped throughout with electrically-driven tools. The department is supplied with power from the engine works electric power house, direct current being distributed at 200 volts on the ordinary two-wire system. As a general rule the machines in each bay are driven from a line shaft which is either belt or chain driven by one motor, the few exceptions being either large machines or those which, when placed conveniently for their work, are situated inconveniently for being driven from the nearest line shaft. The overhead travelling cranes are throughout of the three-motor pattern, and are for eight different sizes, ranging from 3 to 60 tons. In the steel foundry the converter blowers are direct geared to electric motors, and in the iron and brass and bronze foundries the saws, grinders, &c., are driven from line shaft belt by motors, the cupola blowers in the iron foundry being worked in the same way, as are also all the pan mills, crushing machinery, &c. In the power station there are five Lancashire boilers, 30ft. by 8ft. These were chosen in preference to water-tube boilers on account of the Barrow water being considered unsuitable for the latter type. The steam pressure is 180lb. The boilers are fitted with mechanical stokers, with automatic regulation dependent on the steam pressure; the flue gases are led through a fuel economiser, which raises the temperature of the boiler feed from about 130°F. to 240°F. The main engines are three in number, each capable of developing 700 B.H.P. at 300 revs. per min. From this to no load they are controlled within 3 per cent. by a governor mounted on the crankshaft, which actuates a throttle valve; above this load they can still be run by means of a by-pass valve admitting high-pressure steam to the intermediate-pressure receiver up to 875 B.H.P. The steam consumption in the latter case is 16·77lb. per brake horse-power-hour, and in the former 15·24lb., with 25½in. vacuum. These engines are direct-coupled to shunt-wound 200 volt direct-current 500kw. open multipolar-type generators, which supply current direct to the switchboard 'bus bars, and from these to the different circuits, each generator and each circuit having its own panel. The main exhaust can be discharged either to atmosphere through an automatic valve, or through a grease separator into a jet condenser, the injection water being drawn from this and delivered into a cooling tower, from which it falls into a concrete reservoir; the feed-pump suction can be taken direct from the injection water as it leaves the condenser, or from the reservoir itself.

**The Electrical Engineers in South Africa.**—It will interest our readers having friends in the Electrical Engineers in South Africa, to read the following report as to the stations and nature of the work being done by the various members of the corps sent us by the Acting Sergeant-Major:—

**Head Quarters.**—Major A. Bain (Commanding); Sergt.-Major J. Gunn, R.E. (Regt. Sergt.-Major), Sergt. W. McLeod (Pay Sergt.), Sapper Boult (storeman).

**Transvaal.**—Officers: Capt. O. Shaughnessy, Lieuts. Pearce and Rich *Johannesburg:* Fort and barrack installation—Sergt. Marshall and Sappers Solomon and Hawkins. No. 6 General Hospital—Sapper Bigge. Superintendent of electric lighting of buildings occupied by military—Corpl. Hamilton. *Belgravia and No. 13 general hospital:* Search light installation—2nd Corpl. Clarke, Sappers Hebden, Nebel, Collins and Squire. *Forest Hill:* Search light—Sappers Jones, Portway and Cameron. *Crown Reef:* Search light—Sappers Price, Linck, Coleman and Smith. *Springs:* Search light—2nd Corpl. Bell, Sappers Bayley, Cornelius, and Dellagana. *Klerksdorp:* Search light—Corpl. Shaw, Sappers Kelly, White and Crowder *Randfontein:* Search light—Sappers Lewis and Cockburn. *Krugersdorp:* (1) Search light—Corp. Rogers and Sapper Padmore. (2) Hospital installation—Sapper Amos. (3) Staff offices installation—Sapper Edmunds. *Heidelburg:* Search light—Sergt. Peart, Sappers Hedgecox and Peck. *Eden Kop:* Search light—Corp. Dobson, Sappers Rumble and Bartlett. *Standerton:* Installation (lighting hospital, railway station and bridge)—



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Sergt. Davis, Sappers Beatty, North and Gayford. *Pretoria:* (1) Barrack installation—Sergt. Holmes, Sappers Francis, Bryant, Dallison, Gentle and McGregor. (2) Traction engines—Lance-Corpl. Durling, Sappers Alcock, Middleton and Loe. (3) Fort installations—Corpl. Botting and four sappers when available.

**Orange River Colony.**—Officers: Capt. the Hon. R. C. Craven and Lieut. Leaf. *Bloemfontein:* Hospital installation—Corp. Thorpe and Sapper Stark. *Kroonstad:* Hospital installation—Being installed. *Norvals Pont:* (1) Hospital installation—Corpl. Liddle and Sapper White. (2) Bridge defence—Sappers Lynn, Jones and Gallimore. *Bethulie:* Bridge defence—Sappers Porte and Harrington. *Vereeninging:* Bridge defence—Corpl. Welling and Sapper Webb-Bowen.

**Cape Colony.**—N.C.O. in charge: Company Sergt.-Major J. H. Field. *Simons Bay:* Boer prisoners' camp installation—Lance Corpl. Haswell and four sappers. *Wynberg:* Hospital installation—Sapper Hickling. *Green Point:* Boer prisoners' camp installation—Sappers Harris and Hunt.

Sergts. J. Holmes and Brander, Corpls. Devonshire and Holliday, 2nd Corpls. Bertram and Coxon, and sappers not enumerated above are employed installing new lights or on necessary camp routine. All the foregoing installations, with few exceptions, have been put in by the Electrical Engineers Corps.

It is interesting to note that this detachment has been remarkably free from sickness and casualties; the health of the men has been capital, they have plenty of work to do of a varied nature, and also instructive; the letters that arrive are very cheerful, and altogether they seem to be having quite as good, if not a better, time than the first South African contingent had.

**Great Northern and City Railway.**—The contract recently secured by the British Thomson-Houston Co. for the electrical equipment of the Great Northern and City Railway is to provide sufficient apparatus for the operation of a three-minute service between Finsbury Park and Moorgate-street. Each train will consist of seven cars, the two end cars and the centre car being equipped with motors. The schedule time for the journey of 7 miles is 18½min., allowing for three intermediate stops of 20sec. each. The weight of the train will be approximately 200 tons, and it will be the first electric railway in Great Britain to be operated entirely on the multiple unit system.

*Boilers.*—The exact number and type of boilers has not yet been decided; they will be fed by three vertical duplex pumps, and the feed water heater will have a capacity of 7,500 gallons per hour; the economiser will consist of 480 tubes arranged in sections 10 tubes wide. All the steam pressure piping will be of heavy lap-welded pipe, tested to 500lb. per square inch. A Hunt coal-conveying plant of the noiseless automatic gravity bucket type will be employed sufficient to handle 30 tons of coal per hour. There will also be two vertical three-throw single-acting lifting pumps, a storage tank of 21,000 gallons capacity, and water-softening plant to treat 8,500 gallons per hour, and two receiving tanks, each of 4,700 gallons capacity. The economiser, mechanical stokers, coal conveyor, and lifting pumps are all to be operated by electric motors.

*Engines.*—Four vertical cross-compound condensing Musgrave engines, developing 1,250 I.H.P. as a normal load and 1,875 I.H.P as a maximum when running at 100 revs. per min. and working with a steam pressure of 150lb. per square inch, each engine being arranged to drive an 800kw. generator, which will be mounted on the main crank shaft between the engines. The specifications call for a speed variation of not more than 2½ per cent. either way between full load and no load. There will also be two vertical tandem compound non-condensing auxiliary engines, capable of developing 83 I.H.P. continuously. The condensing plant will consist of four surface condensers with combined air and circulating pumps. The engine room will be provided with a 30-ton overhead travelling crane, operated by three electric motors.

*Dynamos.*—Four main generators of the standard Thomson-Houston railway type, having 14 poles, voltage 525 no load, 575 full load. Two auxiliary generators of the same type, each 50kw. capacity, voltage 550 no load, 575 full load, running at 400 revs. per min.; these two generators are intended to supply current for the lighting and power required at night for the stations and repair shop tools, &c., when the main generators are shut down.

*Switchboard.*—The switchboard will consist of four main generator panels, four main feeder panels, two auxiliary generator panels, three auxiliary power panels, three auxiliary lighting panels, and voltmeter equipment. These panels will be equipped with magnetic blow-out circuit breakers, Thomson astatic instruments, wattmeters, switches, &c., all of B.T.H. standard pattern.

*Track.*—The third rail is to be of channel section, weighing 80lb. per yard. The resistance of the material, as specified, not to exceed 0·32 ohms per mile per square inch of cross-sectional area. The bonds will be of the copper plastic type, and the rails will be supported every 2 yds. on porcelain insulators of the double petticoat type. At intervals the collector rails of the up and down tracks will be inter-connected, an automatic circuit-breaker being placed in each inter-connecting circuit so as to enable either pair of rails to be isolated from the other when desired.

*Motor Cars.*—There will be 36 motor cars, each mounted on two four-wheel trucks, each truck carrying one Thomson-Houston GE 66 geared motor, and each car will have four collector shoes, and the usual controllers, circuit-breakers, &c., making complete motor car equipment. The brake equipment will be of the Christensen type.

*Repair Shop.*—The repair shop is to be equipped with lathes, wheel-press, drilling machines, shaping machines, &c., all driven by an electric motor.

**British Association.**—As already announced, the meeting of the British Association will take place this year in Glasgow, from September 11th to 19th. Prof. A. W. Rücker will be president this year, and will deliver his presidential address at 8.30 p.m. on Wednesday, September 11th, in St. Andrew's Hall, the sectional meetings beginning on the following morning. According to the semi-official forecast, published in *The Times*, Major P. A. Macmahon, F.R.S., president of Section A (Mathematical and Physical Science), will refer in his presidential address to the present state of mathematics and physics in Great Britain and the teaching of those subjects, and will conclude by considering what should be the work of a specialist in science, especially of a mathematical specialist, in relation to the general advance of scientific knowledge. Arrangements have been made for discussions on "The Magnetic Effect of Moving Electric Charges," which will be opened by Dr. Crémieu, of Paris, on "The New Unit of Pressure," and on "Optical Glass," the two latter being opened by Dr. Guillaume, of Paris, and Dr. Glazebrook. Other Papers are promised on "The Relations of Energetics to Molecular Theory," by Dr. J. Larmor; "The Amount of Matter in Interstellar Space," by Lord Kelvin; "The Results of Experiments on the Viscosity and Elastic Properties of Solids and Liquids, and the Effect on them of Magnetism and Changes of Temperature," by Prof. Gray and his assistants; and on "Low Temperature Thermometry," by Dr. Travers and Mr. Seute. Dr. Trantor has a simple method of testing hysteresis in iron to bring before the Section, and Capt. Creak hopes to exhibit one of the new instruments he has devised for magnetic work on board ship, which are to be used by members of the National Antartic Expedition in their magnetic survey south of the 40th parallel. Prof. Percy Frankland, F.R.S., is president of Section B (Chemistry), and his presidential address will be on "The Position of British Chemistry at the Dawn of the Twentieth Century." In the latter part of his address he intends to point out the disadvantages under which students of chemistry labour at the universities and to indicate some of the more important reforms which he considers desirable in the immediate future. Dr. Shields is down for a Paper on "The Present Position of Electrochemical Industries in this Country and Abroad." Mr. E. H. Vesey-Knox will read a Paper before Section F (Economic Science and Statistics) on "Economic Effects of the Tramways Act." Col. R. E. Crompton, who will preside over Section G (Engineering) will touch in his address on the probable future development of passenger and goods transport as affecting railways, tramways, and ordinary roads, besides referring to the standardisation of parts of machines to facilitate manufacture, and he will also refer to the National Physical Laboratory. Among other Section G Papers will be one by Sir W. C. Roberts-Austen on "Aluminium as a Fuel," Mr. Mark Barr on "Machinery for Engraving," Prof. E. Wilson on "The Commercial Importance of Aluminium," Mr. M. N. Macdonald on "Railway Rolling Stock, Present and Future," Mr. A. H. Gibbings on "The Carriage of Goods over Electric Trolley Systems," Mr. Killingworth Hedges on "The Protection of Public Buildings from Lightning," Mr. Diesel on "The Diesel Engine," Mr. D. H. Morton on "The Mechanical Exhibits in the Glasgow Exhibition," and Mr. C. R. Garrard on "The Recent Development of Chain Driving." A report will also be presented by a committee on "The Resistance of Road Vehicles to Traction." The new Section L (Educational Science) will be presided over by Sir John Gorst, K.C., M.P., and among those who have promised Papers are Prof. Armstrong, Prof. Miall, Prof. Withers and Prof. Perry, the last-named of whom will open a discussion on "The Teachings of Mathematics." A large number of visits to works and excursions have also been arranged. Those who intend to take part in the meeting should communicate with Mr. G. Griffith, the assistant general secretary (Burlington House, London, W.), as soon as possible.

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## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 667.*)

### THE MANUFACTURING WORKS OF THE A.E.G.

An illustrated description of these works having appeared in *The Electrician* two years ago, a few notes only need now be added. Readers should refer to the article in *The Electrician*, Vol. XLIII., p. 437. They will find there a plan and elevation of the fine new works in Brunnenstrasse, of which photographic views of the interior (Fig. 42) and the exterior (Fig. 43) are now added. The works chiefly consist of one enormous hall with a gallery, the hall being about 200 metres wide and its greatest length being 113 metres. It is divided into 14 parallel bays each 15 metres wide, and, as the machine tools are each driven by their own motors and there is no countershafting, the work can go straight through the shops and the heavy parts moved about as little as possible. Thus to a large extent each of these long bays can be devoted to one particular class of machine. In bay 14, transformers are built. Bays 13 to 8 are devoted to dynamo and motor building, the sizes gradually increasing, so that in bay 8 the largest machines up to over 4,000 H.P. are erected. Bays 7 and 6 are devoted to testing, 5 and 4 to fixing on the smaller fittings to the machines, and the last three bays to packing, &c.

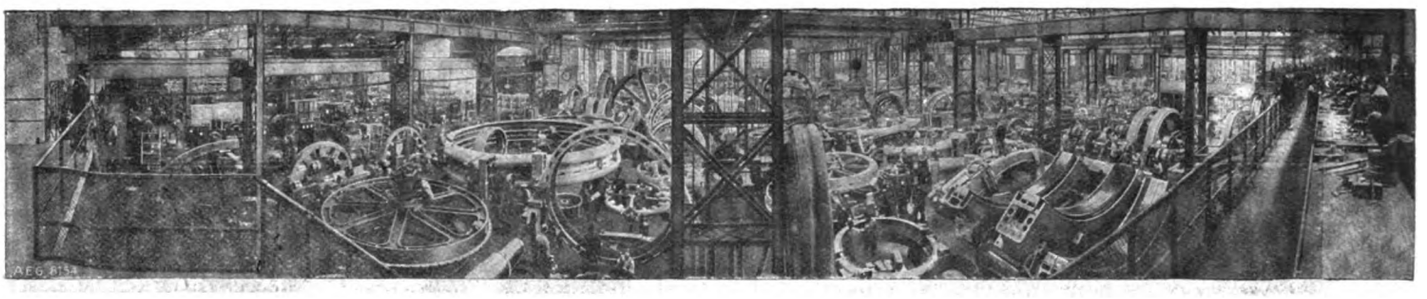

FIG. 42.—GENERAL VIEW OF THE INTERIOR OF THE BRUNNENSTRASSE MACHINE MANUFACTURING WORKS OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.

Three standard gauge lines of rails traverse the shops, one of these passing across the centre at right angles to the length of the bays, and thus dividing each of the latter into two parts. In one of these parts the machinery and fitting of the mechanical parts of the machines is carried on, in the other winding, commutator building, &c., so that the risk of damage to coils is reduced to a minimum. On the gallery the winding of coils for the smaller machines is chiefly done.

In all there are about 500 machine tools, and the enormous advantages of electric driving—in fact, one may say of three-phase motor driving—are more apparent than in any other works we visited. Among the larger machine tools are planing machines up to 6 metres stroke, and lathes for turning up stator castings of 7 to 11 metres diameter. About 50 portable electrically-driven machine tools are made use of, some capable of doing work of a large size. An example of this is shown in Fig. 44, which represents a large surface plate of 108 sq. metres surface on which two portable shaping machines are at work on a large casting, the same surface plate being employed for marking out large work and for fastening down the portable machine tools.

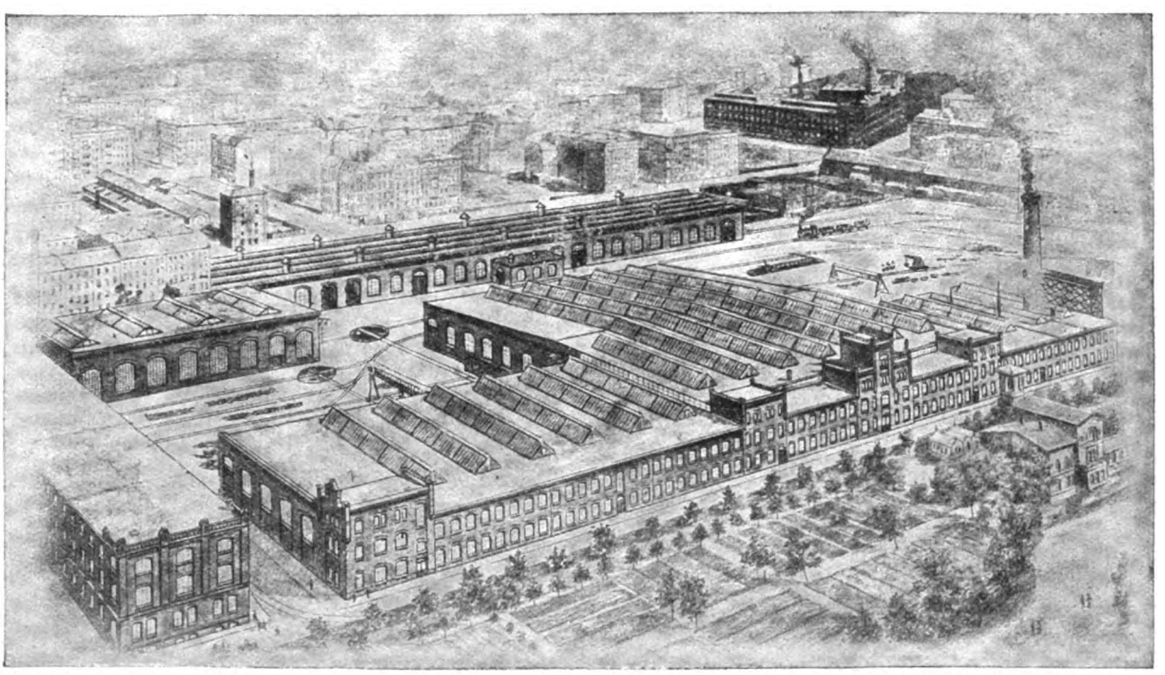

FIG. 43.—EXTERNAL VIEW OF THE BRUNNENSTRASSE MACHINE MANUFACTURING WORKS OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.

A new design of generator, especially suitable for three-phase machines, evoked considerable interest. Its object is to save cast iron for purely mechanical purposes in the large stators, and at the same time to increase the cooling surface of the armature coils wound on them. The general outlines of the machines are shown diagrammatically in Figs. 46 and 47, and a general view of an actual machine in Fig. 49. The

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laminated iron sheets and the copper are all that is necessary electrically in the stationary armature of an alternator, and the heavy casting is only to hold these in position. In this new design the A.E.G. provide a casting merely to clamp the lightened, and there is the great advantage that the castings only cover the side of the laminated iron, so that the outer circumference of this is fully exposed to the cooling action of the air. As is seen, this is paid for by using wrought iron

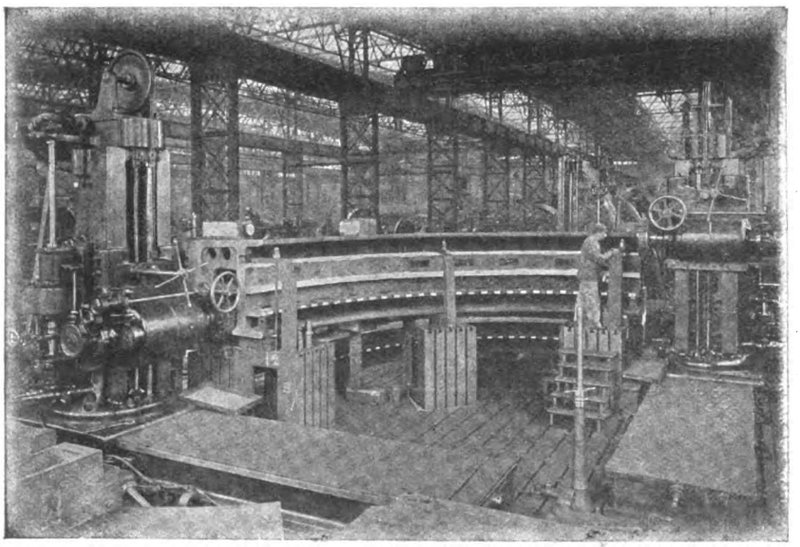

FIG. 44.—LARGE SURFACE PLATE WITH TWO SHAPING MACHINES.

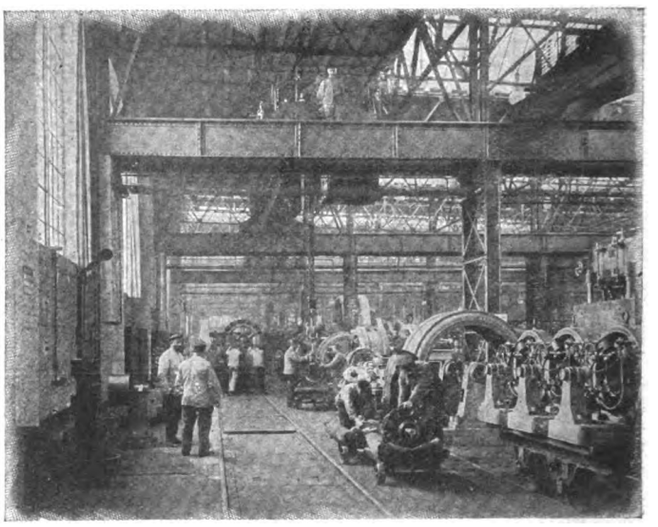

FIG. 45.—VIEW OF THE ERECTING END OF THE BAYS.

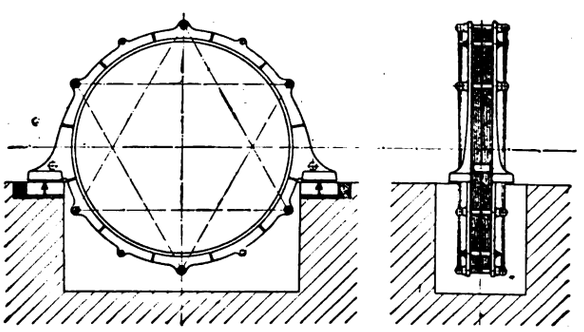

FIG. 46. - STIFFENED STATOR WITH CHORDAL STAYS.

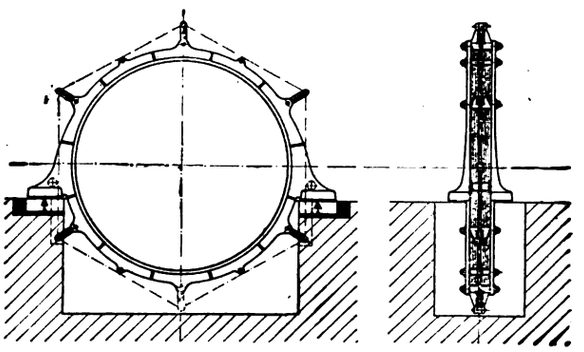

FIG. 47.—STIFFENED STATOR WITH TANGENTIAL STAYS.

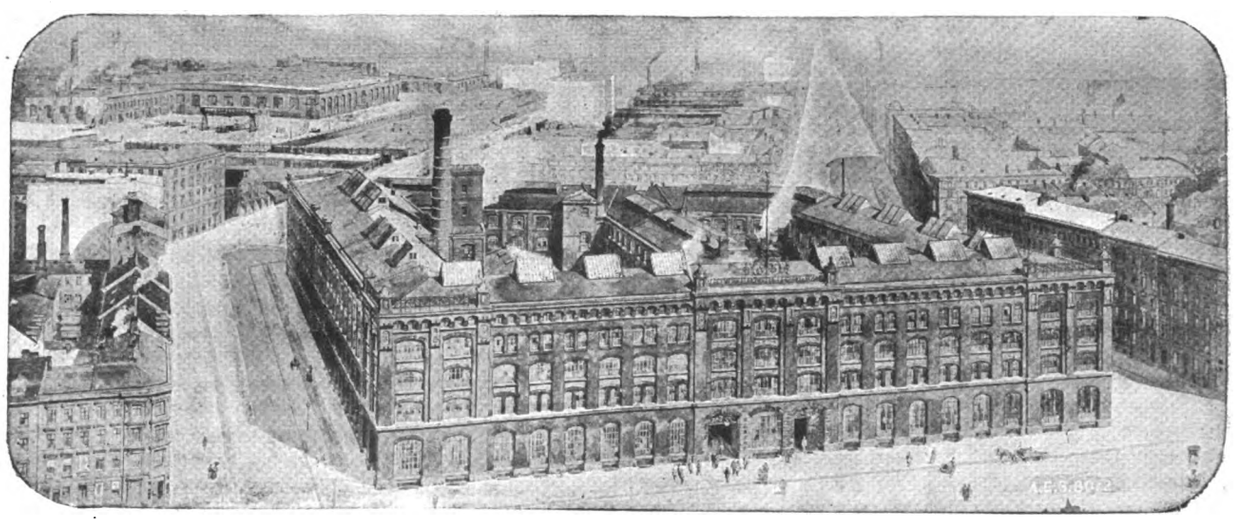

FIG. 48.—THE APPARATUS FACTORY IN ACKERSTRASSE.

laminations together and to hold the thing down; and the structure is stiffened by means of stays. Two constructions have been tried, one with these stays disposed as chords of the circle (Fig. 46), in the other with tangential stays (Fig. 47). By this means the whole structure is of course considerably and by increased cost of fitting and erecting. It will be interesting to see whether this new construction will prove economical. If so, it is to be welcomed, as the machine is rendered much lighter thereby, and should also be able to stand high overloads. Messrs. Schuckert & Co., and also a

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Belgian firm, it will be remembered, went a certain extent in the direction of a stiffened armature frame in machines exhibited at the Paris Exhibition. These had lighter stator castings than the average and of large diameter, and they were stiffened by radial arms projecting from a ring concentric with the shaft. The castings completely surrounded the laminated iron, however, and did not leave the large surface exposed to the air as in the A.E.G. construction. I believe, that Messrs. Schuckert have now abandoned this design in their later machines.

Fig. 48 is a general view of the Ackerstrasse works, where apparatus and instruments (including electric light fittings, switches, lamp-holders, &c., arc lamps and measuring instruments) are manufactured. They have been in operation for some time, and the dynamo shops were also there until the new works described above were built. A tunnel 300 metres long connects the two works, and an electric railway through it facilitates the transport of the material between them.

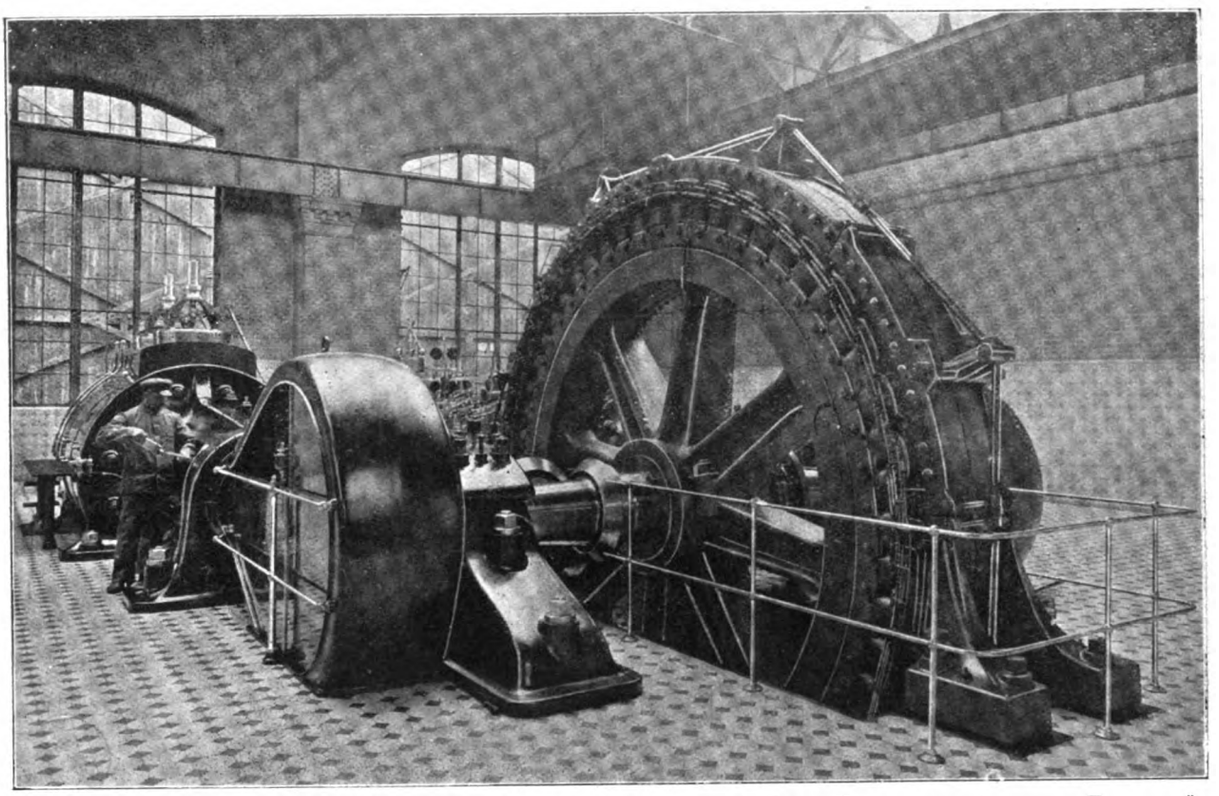

FIG. 49.—THREE-PHASE DYNAMO WITH TANGENTIALLY STIFFENED ARMATURE, IN THE POWER HOUSE OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT WORKS.

It may be of interest to add two figures which will convey a better idea of the magnitude of the works above described than will any illustration: 16,418 dynamos and motors were built by the works in the year 1899-1900, and their aggregate output was 153,241kw.

## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 629.*)

§21. **Belliss-Peebles Steam Generating Set.**—This set is shown in Fig. 17, and consists of a three-crank Belliss and Morcom engine of the usual type, direct-coupled to a D. Bruce Peebles & Co.'s continuous-current generators. The engine is double-acting, with triple expansion, having three cylinders—high, intermediate and low—working on cranks at angles of 120deg. It runs at a speed of 380 revs. per min., and is designed to exert 325 to 350 B.H.P. at a steam pressure of 170lb. non-condensing. The cylinders are fitted with piston slide valves, and are designed to be self-draining. Oil is supplied to all bearings by means of a simple form of pump, without valves or packing, discharging at a pressure of 10lb. to 20lb. per square inch through a specially arranged system of oil channels, the oil escaping from the bearings drains into a crank pit to be used over again. This system of forced lubrication was originated by the builders in 1890, and they have since that time worked it out in all its details with satisfactory results, both as regards steady and continuous working, reduction of wear, and the attainment of high mechanical efficiency. The engine they are exhibiting, though of somewhat small dimensions, is typical of their latest triple expansion design, of which they have a large number on hand or at work, including 17 sets of 1,000 to 1,200 B.H.P., and one set of 2,000 to 2,200 B.H.P. It may be worth mentioning that they have in the Glasgow Corporation Electricity Works two sets of 1,100 to 1,500 I.H.P. The dynamo is a 250kw. machine of Messrs. D. Bruce Peebles & Co.'s standard type, designed so that the position of the brushes need not be altered throughout the entire range of load.

§ 22. **Messrs. D. Bruce Peebles & Co.'s Exhibits.**—Fig. 18 is an illustration of the principal stand occupied by this firm. Reference has already been made to the fact that one of the two long line shafts in the Machinery Hall is driven by electric power. The motor for this purpose is situated at this stand, and is clearly shown in the illustration.

This firm has adopted the multipolar machine as its standard type, and makes these of the open, protected and completely enclosed type. One of the 150 B.H.P. standard motors, running at 400 revs. per min., supplied with current at a pressure of 500 volts from the exhibition generating plant under normal working conditions, is the machine used for driving the exhibits in the east bay of the Machinery Hall.

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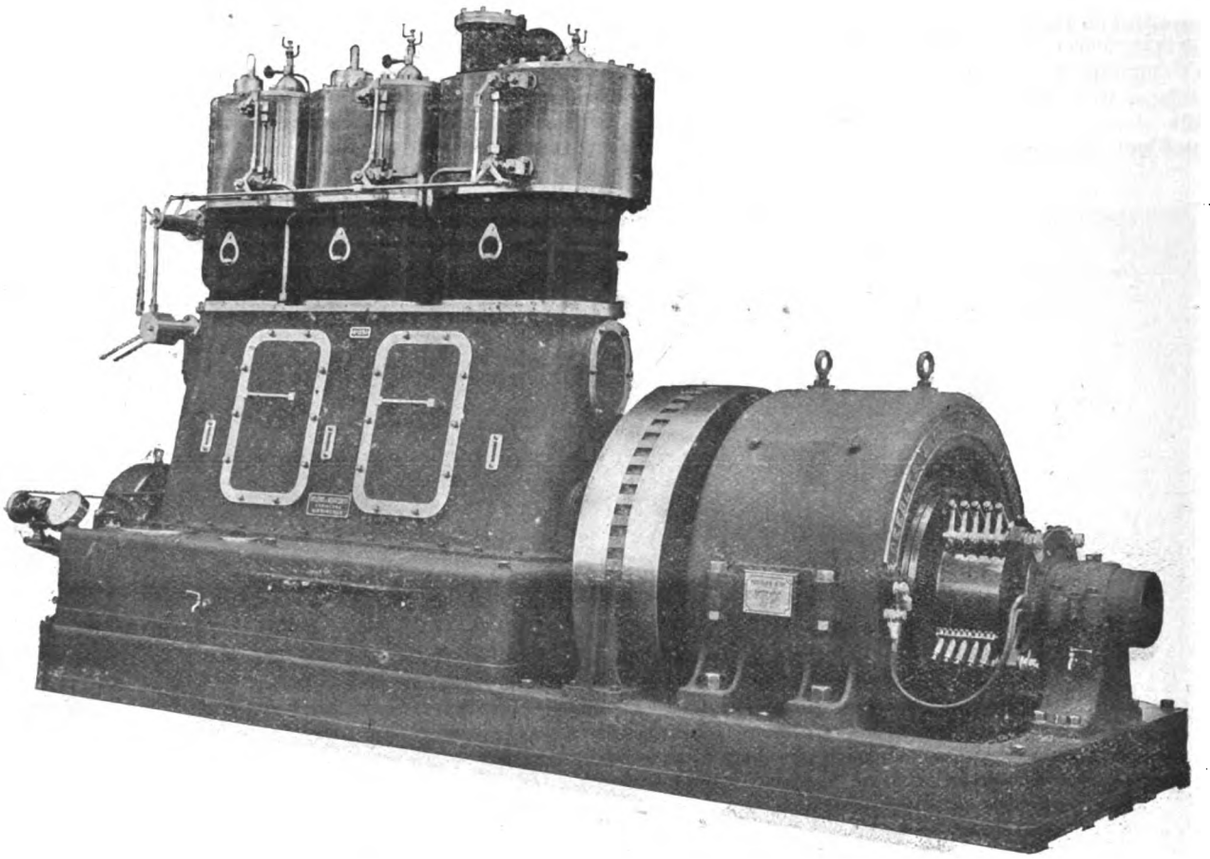

FIG. 17.—BELLISS-PEEBLES STEAM GENERATING SET.

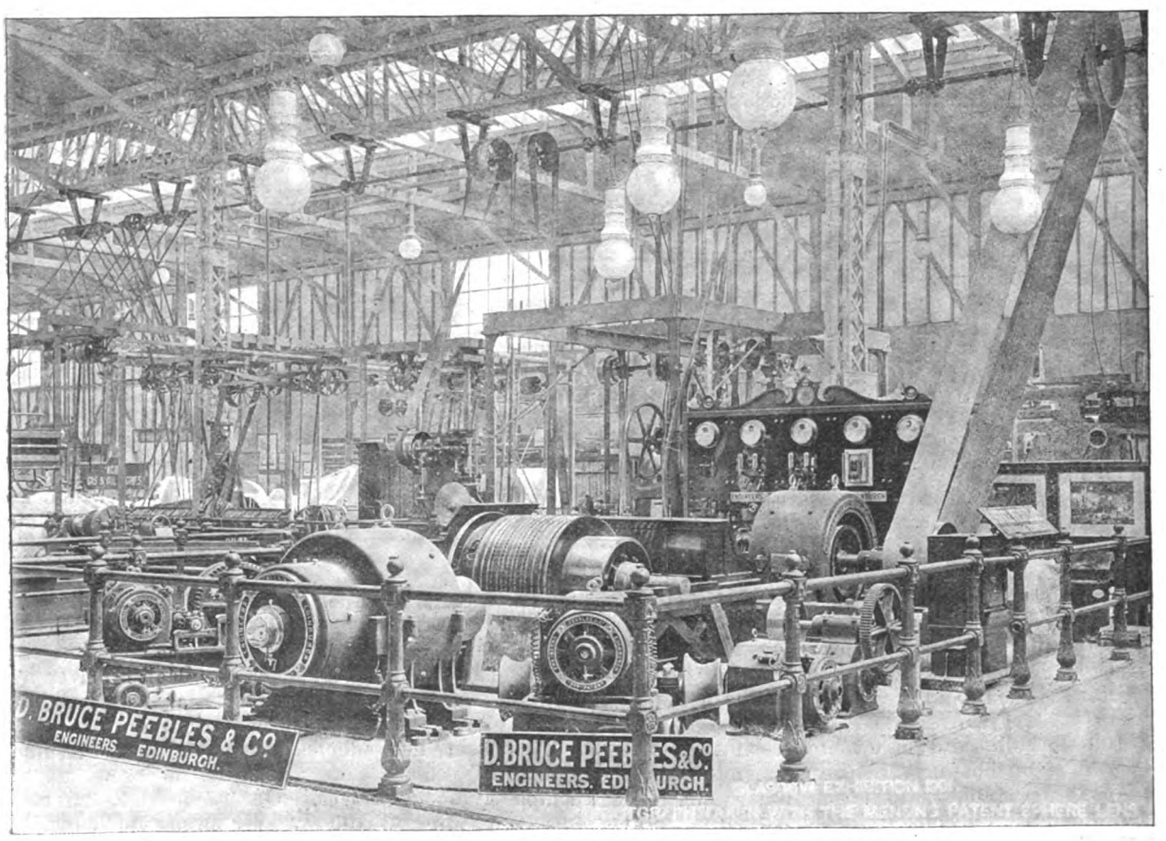


FIG. 18.—MESSRS. D. BRUCE PEEBLES AND CO.'S STAND.

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The machine is fitted with non-sparking pole-pieces, and is also provided with an improved form of brush adjusting gear, which consists of an accurately-cut screw fixed to the pedestal working a substantial sliding nut attached to the rocker, so that a very accurate setting of the brushes can be obtained.

In addition to this motor, there is a considerable amount of electrical machinery distributed about the building. We may mention the central station balancing set, capable of dealing with 100 amperes out of balance, which serves to equalise the electrical pressure throughout the system, as already described. On their stand Messrs. D. Bruce Peebles & Co. show a 40 B.H.P. completely enclosed mining motor which is guaranteed to be absolutely sparkless and entirely gas and watertight. The working parts are entirely enclosed, and these motors can be safely used, running at full load, in inflammable workshops. Also an electric hauling gear for underground work is shown mounted on a bogie. The maximum height from wheel base is 3ft. 6in., so that this motor can be used in shallow workings. Thirdly, a series centrifugal motor pump for mine workings is shown, the motor guaranteed to be absolutely gas and watertight. A considerable number of these electrical pumps and hauling gears are now at work in collieries all over the country. It may be interesting to owners of shipyards to note a simple but effective form of electricity-driven capstan for use either on board ship or dockyard work.

§ 23. E.C.C.–Evans Electrically-driven Ram Pump.—Fig. 19 represents one of Joseph Evans & Sons' standard horizontal treble ram pumps for high lifts in mines, &c., driven direct by an E.C.C. electric motor. The necessary gearing between the motor and crank-shaft is all machine cut, the first motion pinion on the motor shaft being of raw hide. The counter-shaft and crank-shaft are of mild steel, the latter having circular webs, being cut from the solid and carried in four pedestals fitted with gunmetal bearings. The connecting rods are also of steel, and are fitted at the large ends with gunmetal marine heads, the small ends being solid with adjustable gunmetal bearings. The lubrication of all the bearings, &c., is effected by means of tell-tale lubricators. The pump rams are of gunmetal, cottered to the cross heads; and the latter are provided with slipper blocks carried by adjustable slide bars. In the pump end the suction and delivery valve boxes and the pump barrels are interchangeable. The pump valves are also of gunmetal of the double beat type. The whole is mounted on cast-iron girders forming the bed-plate. This pump is capable of delivering 9,000 gallons of water per hour against 600ft. head.

The direct-coupled motor driving the pump is one of the E C.C. standard 50 H.P. four-pole type, wound in this case for an output of 40 B.H.P. at a speed of 465 revs., and for an E.M.F. of 500 volts. The armature is of the drum-wound multipolar slotted type, the conductors being machine formed and jointless. The field magnet system is identical in construction with that adopted by the E.C.C. in their larger multipolar machines, the yoke-ring being circular and of elliptical section, the material being cast-iron so as to obtain the utmost rigidity. The magnet poles are of high permeability rolled steel plates, cast in with the ring. The field magnet coils are wound on substantial detachable formers, heavily insulated, the winding being of the cumulative compound type. The maximum temperature rise on the armature and magnets after a run at full load of six hours are under 70°F. and 60°F. respectively, and the commercial efficiency of the machine under the normal full load conditions is over 92 per cent.

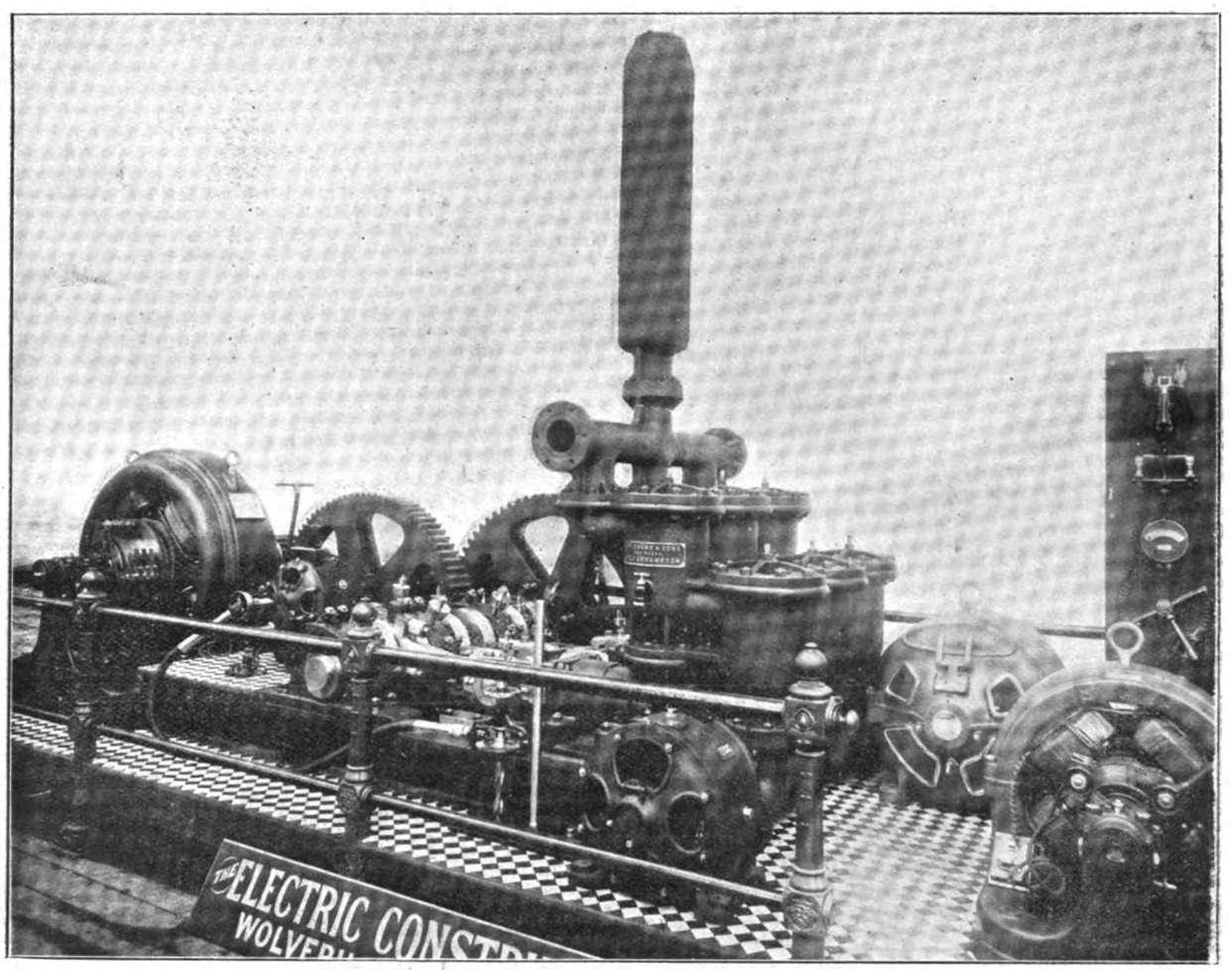


FIG. 19.—E.C.C.-EVANS ELECTRICALLY-DRIVEN RAM PUMP.

*(To be continued.)*

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## THE NEW TELEPHONE EXCHANGE AT MUNICH.*

The subscribers' lines in the Munich telephone system are led into two spacious and conveniently-situated exchanges known as "Exchange I." (Max Josephplatz) and "Exchange II." (Bahnhofplatz). Each office was originally fitted with indicator boards for 50 subscribers; but, in 1895, exchange I. was furnished by the Western Electric Co. with multiple switchboards capable of accommodating 6,000 subscribers. Although these boards have been barely four years in operation, and are not yet fully fitted up, they are no longer up to date. The indicator boards in exchange II. were replaced last year by a multiple-switch installation of the most modern construction, the system of communication between the local exchanges was greatly improved, and an entirely new office was fitted up for trunk line traffic.

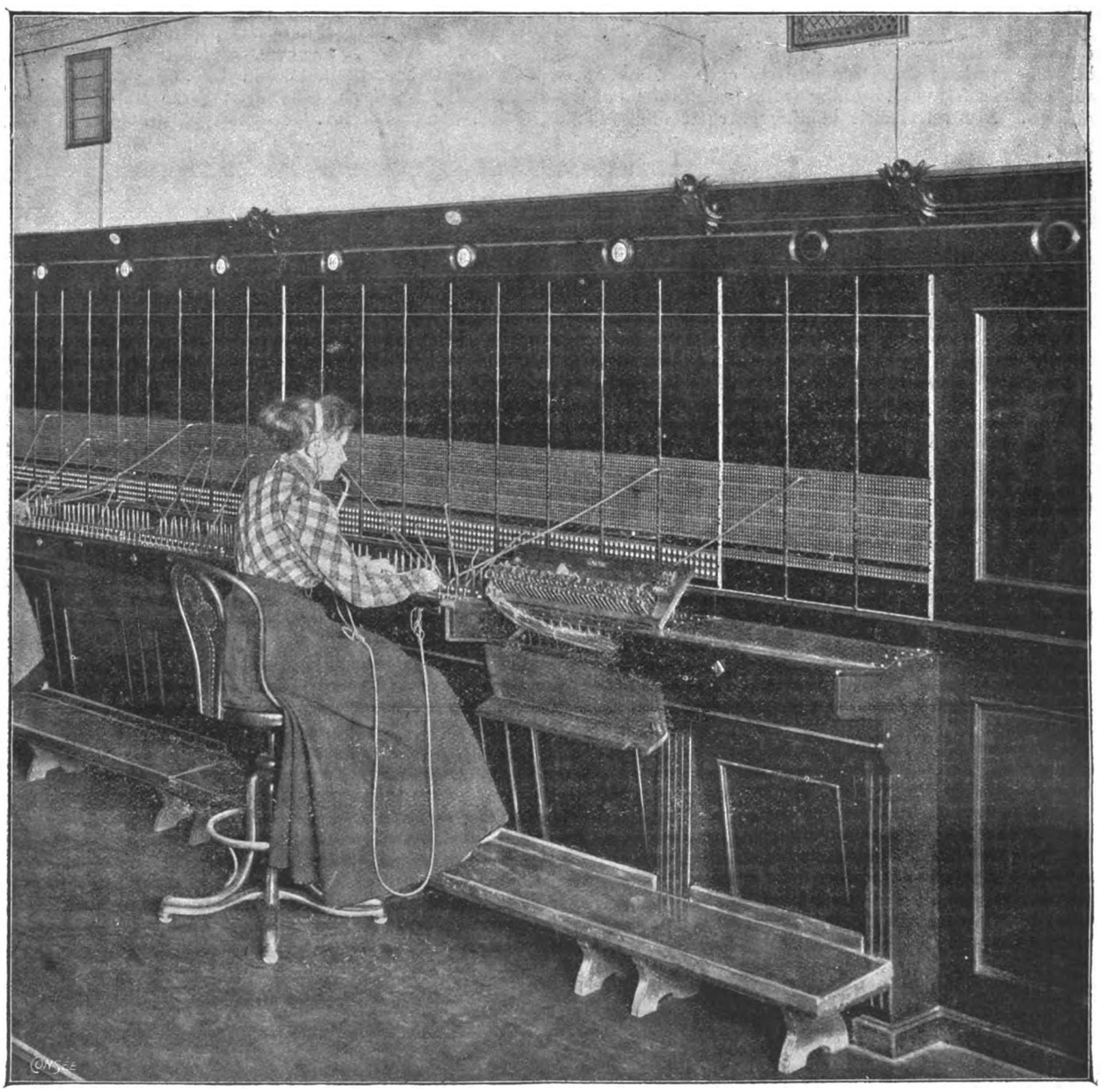

FIG. 1.—SUBSCRIBERS' BOARD.

### EXCHANGE II.

The characteristic feature of the new exchange (II.) is the use of glow lamps, by which the whole of the indicators have been replaced. The fact that the lamps are placed immediately over the corresponding local jacks saves an immense amount of time. Whereas the operator formerly had first to read the number of the fallen indicator, and then to look for the subscriber's jack bearing the same number in another part of the board, she now simply inserts the plug in the jack directly under the lighted lamp without troubling herself about the number of the calling subscriber. At the new Munich exchange it has been shown that a skilled operator can more easily and comfortably attend to 150 subscribers—assuming the number of conversations to be the same—than 120 in the old exchange. In a fully-equipped exchange of 10,800 lines the annual saving in the salaries of the switch staff alone as a result of this economy would amount to at least £2,700.

The switch-room has an area of 280 sq. metres and a height of 3·7 metres, and can be extended when necessary. The dynamo and accumulator room is separated from the switch-room only by a passage. 42-wire cables are led from the principal distributing frame into the switch-room through a fireproof chasing let into the wall. Near this chasing the series of multiple boards commences, the first being the trunk line communication board, in which the junction wires from the trunk line office terminate. Next in order come three junction-boards, to which the junction wires from exchange I. are brought, and then follow 12 subscribers' boards. The iron frames for supporting the various relays are fixed to the walls behind the respective switchboards; but a free passage 75cm. wide is left between them and the back of the switchboards. Close by is a board with meters for registering the connections made to the various operators positions of the subscribers' boards.

* Abstract from the *Elektrotechnische Zeitschrift*.

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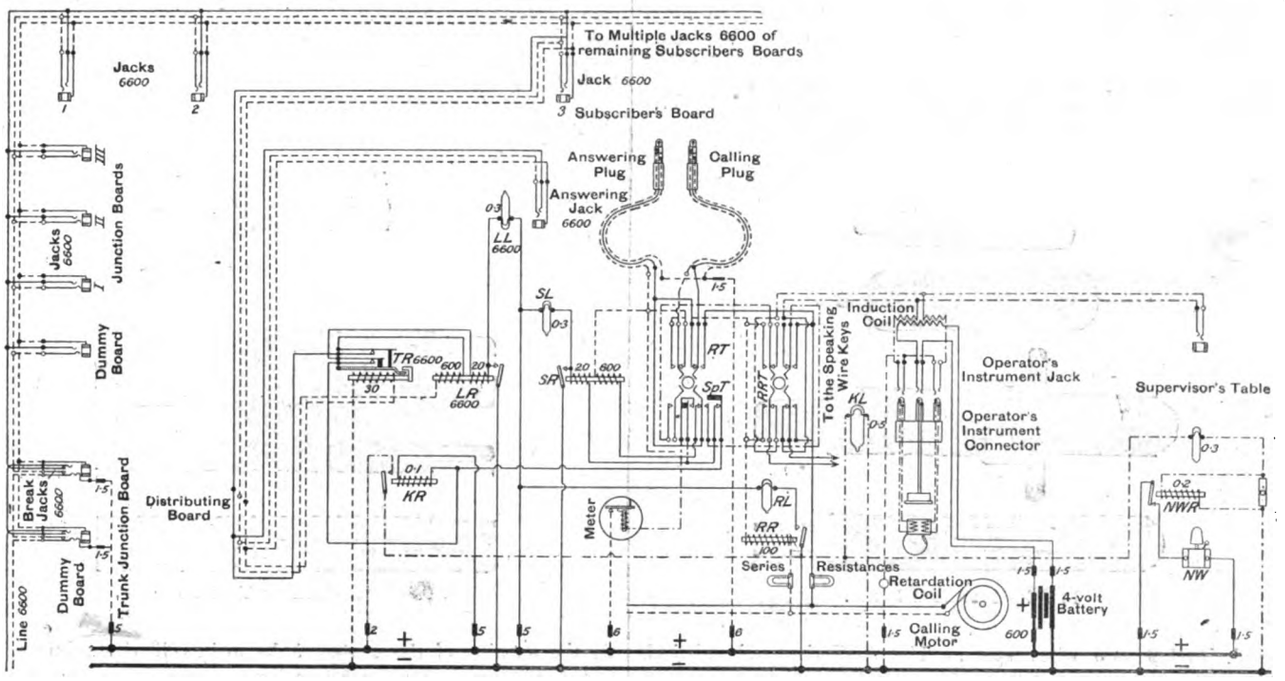
The switchboards are built with vertical jack tablets, and are, of course, arranged for metallic circuit working. With a view to ensure prompt communication between subscribers, the capacity of the exchange has been limited to 10,800 lines. The extent to which the size of the jacks has already been reduced may be gathered from the fact that, in the new exchange, 10,800 multiple jacks require less space than 6,000 jacks in exchange I., and that for the reception of these 10,800 jacks a space 60cm. high by 180cm. wide is sufficient. per operator, so that the 12 subscribers' boards, as at present arranged, suffice for 3,600 subscribers. Each board is, therefore, for the present fitted with only 3,600 multiple jacks distributed over nine vertical panels. Below these there is in each second operator's position a lamp and a single jack, from which a wire goes to record table II. at the trunk wire office; then follow 270 junction wire jacks for communication with exchange I. The lowest part of the jack space is occupied by the call lamps, arranged in rows of 10, and




LL, Line Lamp. SL, Signal Lamp. KL, Control Lamp. RL, Call Lamp. TR, Cut-off Relay. LR, Line Relay. KR, Control Relay. SR, Signal Relay. RR, Call Relay. RT, Calling Key. SpT, Speaking Key. RRT, Calling Back Key. NWR, Night Bell Relay. NW, Night Bell.

FIG. 2.—CONNECTIONS OF SUBSCRIBERS' BOARD.

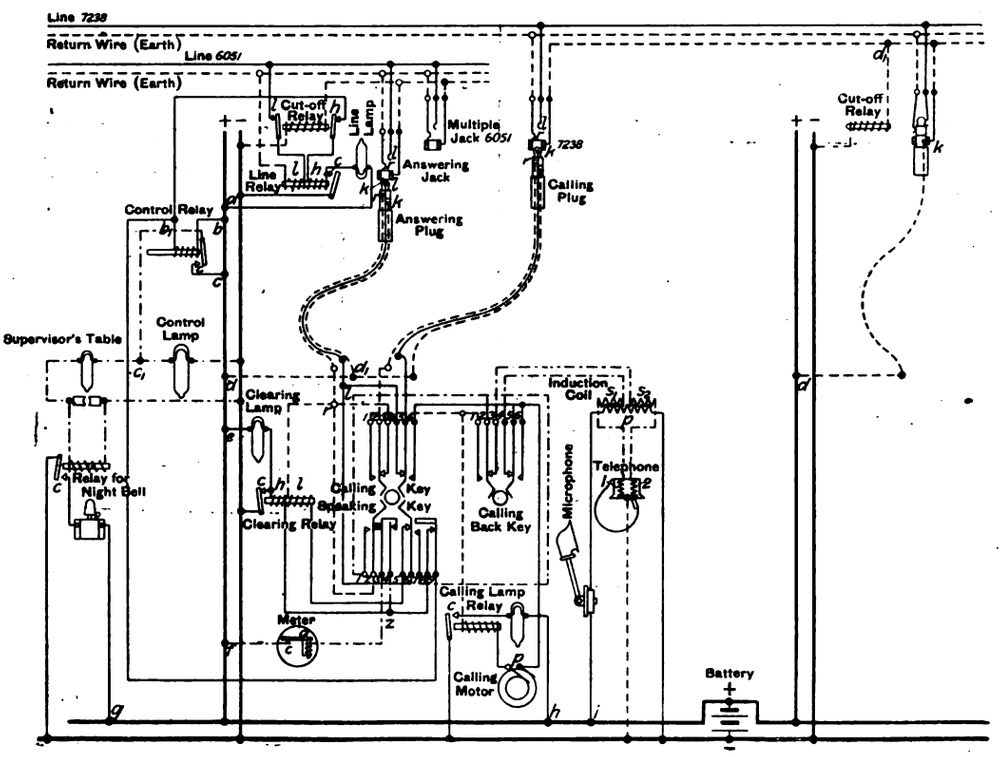



FIG. 3.—KEYBOARD CONNECTIONS.

The subscribers' boards (Fig. 1) are arranged on the double-cord system; the junction boards for local and trunk line communication are arranged on the single-cord system. Each subscribers' board is divided into three operators' positions, with 100 subscribers' lines the corresponding answering jacks. The keyboard of each operator's position is equipped with 15 pairs of plugs and cords, 15 clearing lamps, 15 combined speaking and calling keys, a calling-back key, a control lamp, a call signal lamp, and five speaking keys, with five



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lamps for the service wires to exchange I. The connector for the operator's telephone is placed just under the keyboard.

The panels of the local junction boards are furnished with 3,600 multiple jacks each. Each operator's position has 30 single cords and plugs, 30 clearing signal lamps, 30 combined speaking and calling keys, one control and one call lamp.

The trunk junction board is fitted with break-jacks grouped in seven vertical panels. Each of the three operator's positions is equipped with the same number of cords, keys and lamps as the local junction board, and with a plug of special construction.

The connections of the local exchange are shown in Fig. 2. The subscribers' double lines are brought from the principal distributing-board in 42-wire lead-covered cables; 20 pairs corresponding to the 20 jacks of a strip are led to the break-jacks of the trunk junction

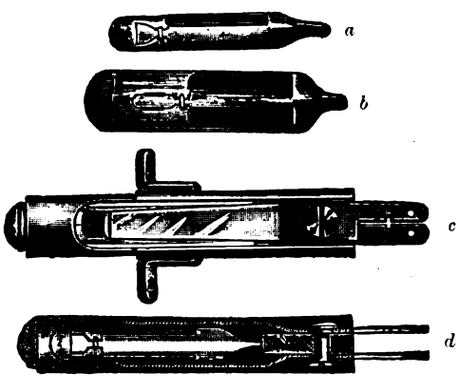


FIG. 4.—INDICATOR LAMPS.

board, leaving two wires spare. The similarly-numbered jack strips of all the boards are then connected by means of 63-wire cables, the two lines and the test wire being required for each subscriber. Much cable is saved by connecting the multiple cable with the call relays at the various boards. For example, at the first subscriber's board to which subscribers 6,000—6,300 are connected, cables branch off from multiple jacks 6,000—6,300 to the upper soldering tags of the intermediate distributing board, and then pass from the lower tags to the subscribers' jacks on the one hand, and to the respective cut-off or line relays on the other hand.

Fig. 3 shows the method of connecting two subscribers belonging to exchange II. It is assumed that subscriber No. 6,051 calls up the exchange; the incoming alternating current returns through the contact $l$ of the cut-off relay and the main coil $l$ of the line relay; the armature of the latter is attracted and closes the contact $c$. The

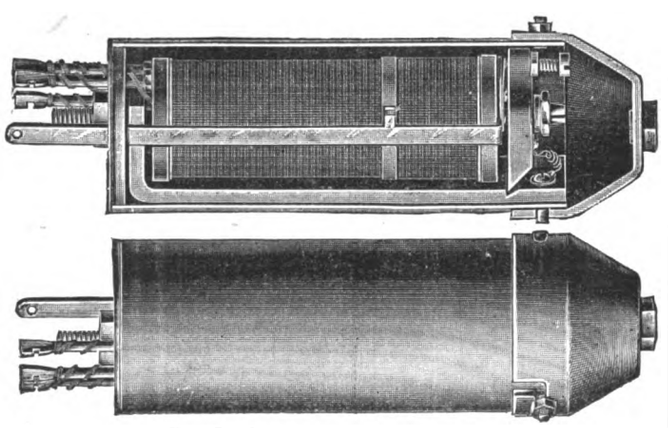

FIG. 5.—SUBSCRIBER'S CALLING RELAY.

call lamp lights up the circuit of the common battery, being completed through $a$, the lamp, and the contact $c$; but at the same time the retaining coil $h$ of the line relay is energised and the armature thereby prevented from falling back. The circuit is: Positive pole $b$, coil of control relay, contact $h$ of the cut-off relay, retaining coil $h$ of the line relay, contact $c$, negative pole. The common control relay for the whole of the calling and clearing lamps of an operator's position also now acts and lights up the control lamp and the lamp at the supervisor's table. Circuit: Positive pole $c$, contact $c$, $c^1$, control and supervisor's lamps in parallel, negative pole. Normally the control lamp always glows when a calling or clearing lamp lights up. If the former alone glowed this would be a proof that one of the calling or clearing lamps at the operator's position was defective. The faulty lamp could then be easily found by plugging the subscribers' jacks or by turning the speaking key. As soon as subscriber 6,051 turns his magneto, his call lamp, the control lamp and the supervisor's lamp glow. The operator then takes one of her answering plugs, inserts it in the jack directly underneath the call lamp, pulls over the lever of the speaking key and receives the demand of the subscriber. On inserting the plug its sleeve, $k$, comes into contact with the socket $k$ of the jack. A current now circulates from the positive pole $d$ through $d'$, third wire of the cord $k$, coil of the cut-off relay, to the negative pole. The cut-off relay attracts both armatures and breaks contact at $h$ and $l$. Breaking contact at $h$ releases the armatures of the line and control relays; the line lamp, the control lamp and supervisor's lamp consequently go out.

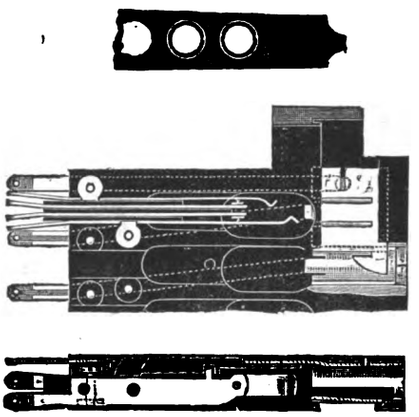

FIG. 6.—BREAK-JACK ON TRUNK BOARDS.

By the opening of the contact $l$ the main coil of the line relay, which is normally bridged across the subscriber's loop, is cut out. Suppose subscriber 6,051 wishes to speak to 7,238. The operator takes the second or calling plug of the cord she is using and tests multiple jack 7,238 in the usual way. If the line is free the operator makes the connection and calls up subscriber 7,238 by pulling forward—upward in Fig. 3—the lever of her combination key for a moment. The coil of the call relay inserted in the call circuit will be actuated by the alternating current from the motor, and will cause the call lamp, which is furnished with a red opal lens, to glow. As a rule, calling is effected through the connecting plug, and only in isolated cases is it necessary to call back through the subscriber's plug to the originating subscriber. If, for example, No. 6,051 has to be called up again the combination key is brought into the speaking position, and the calling-back key pressed forward for a moment.

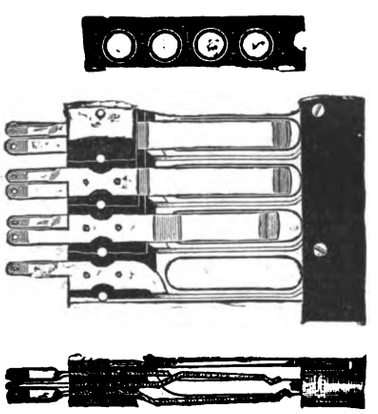

FIG. 7.—JACKS ON SUBSCRIBERS' BOARDS.

On inserting the connecting plug in multiple jack 7,238, the main coil of call-relay 7,238 will be cut out of the loop, so that during the conversation only the main coil of the clearing relay remains in bridge across the loop, whereas in the drop indicator system three electro-magnet coils remain in.

When the conversation is finished and the subscriber rings off, the main coil $l$ of the clearing relay is energised, the armature is attracted and closes the contact $c$. This, on the one hand, causes the clearing lamp to glow, and, on the other, brings in circuit the retaining coil $h$. The circuit is: Positive pole $b$, coil of control relay, $b^1$, springs 9 and 8 of the combination key, coil $h$, contact $c$, negative pole. The control lamp and the lamp at the supervisor's table light up again. On seeing the clearing signal, the operator reverses the combination key, then brings it to the normal position and with-

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draws the two plugs from the jacks. On reversing the combination key, contact between springs 3 and 4 is made before contact between 8 and 9 is broken. The magnet of the meter attracts its armature and registers the connection. The breaking of the contact between springs 8 and 9 causes the armature of the clearing relay to fall back and thereby extinguishes the clearing and control lamps and the lamp at the supervisor's table. The supervising officer can, therefore, see directly, by the lighting up and extinguishing of the lamp on his table, whether the calling and clearing signals are immediately attended to; he can, moreover, go into any operator's speaking circuit and listen to all the conversation which passes.

The lamps are represented in Fig. 4, *a* and *b*; they do not require more space than the subscribers' jacks, and can be mounted directly over the latter in so-called "lamp-jacks" (Fig. 4, *c* and *d*), which are furnished with thick opal lenses, in order to soften the light and protect the lamps. The colours of these lenses serve to distinguish different classes of subscribers. Ten lamp jacks together form a lamp strip.

In the Munich installation 4 volt lamps are used throughout with the sole exception of the lamps which indicate whether the service wires between the two exchanges are engaged or not; these require 24 volts. The normal 4 volt lamps (*a*, Fig. 4) take about 0·3 ampere, the somewhat larger control lamps (*b*, Fig. 4) 0·5, and the 24 volt lmaps 0·1 ampere. The renewals of lamps average 1·6 per day. The subscribers' calling relays (Fig. 5) have two coils; the main coil of about 500 ohms is connected with the subscribers' line; the local retaining coil of 20 ohms keeps the armature attracted until the coil is attended to. This relay is extremely sensitive, the magnetic resistance being made as good as possible. Each relay is enclosed in a brass case so as to be dust and fire proof. With each call relay is associated a cut-off relay, the function of which is to cut-out the main coil of the former when a plug is inserted in the line jacks, and to break the circuit of the retaining coil. Its resistance is about 20 ohms.

The clearing signal relays only differ from the call relays in being enclosed in copper cases. All the other relays, such as the control relay, the night alarm relay, &c., are constructed like the call relay, and only differ from it in the method of winding the coils.

The jacks of the trunk junction board (Fig. 6) are break jacks, with platinum contacts, and the "engaged" test is made in the usual way.

The jacks of the subscribers' board (Fig. 7) consist simply of two springs and a socket. The springs are not normally in a state of tension and are not connected with the battery until a plug is inserted.

The plugs are made up of three parts and are connected in the ordinary manner.

The multiple jack strips are connected with each other by means of 63-wire cables having conductors 0·6mm. in diameter, insulated with silk and wool. The insulation resistance and the capacity of these cables are from 150-250 megohms and 0·1-0·125 microfarads per mile respectively.

Each operator has her own speaking set consisting of a breast-plate transmitter and head-gear receiver.

*(To be continued.)*

## THE BREMER ARC LIGHT.*

Although the Bremer arc light has been the subject of many notices in European electrical journals for the past year or more, very little or no information has been obtainable by which to judge the remarkable claims that have been made as to its revolutionary character. Such information, however, is at length offered in two patents that were granted last week to Hugo Bremer, of Neheim, Germany, one on the material of arc light electrodes and the other on a form of arc lamp.

The electrode, it appears, is of the kind in which a metallic salt or salts is mixed with pure carbon, but with the addition of another substance which comprises the new feature. It is stated that disturbing influences have stood in the way of application of metallic salts, first through the scorified secretions of the salts, and, secondly, through the circumstance that if the percentage of metallic salts is increased and the amount of carbon reduced accordingly, the heating effect produced by the combustion of the carbon is greatly reduced, so that the metallic vapours are not completely brought to incandescence. The scorified secretions, on the other hand, will sooner or later form an incombustible coating which will eventually smother the arc.

The principle on which the Bremer invention is based consists in the introduction in the electrode of borine or fluorine, whereby the otherwise solid scoria will be softened or liquified, thus causing them to drip off periodically. In order that the fluxed scoria may drip off and not interfere with the light, the round form of carbon pencil is not used, the cross sections illustrated in the patent being of such a shape as to present sharp edges, such as a square or a section with four concave sides.

A specimen claim is for an electrode composed of pure coal and of from 10 to 70 per cent. of metallic salts or metalloids, such as calcium, magnesium, glass fluor-spar and the like, in combination with a high quantity of boron and fluorin, and a further quantity of 25 per cent. of fluorin, bromine or iodine—the electrode being provided with ribs or grooves to receive a sharply edged section.

For an electrode, the light of which shall give a yellowish tint, fluorine may be used mixed with the carbon in conjunction with more than twice its quantity of calcium or calcic salts; a more whitish tinge may be given to the light by adding some magnesium. It is stated that the easiest way to add the fluorine and borine is to bring it in connection with the other metal salts, such as cryolite or fluor calcium, or to mix the pure carbon with fluor carbonite.

The second Bremer patent describes an arc lamp in which two or more inclined carbons are used for both the positive and negative electrodes, both sets of carbons being inclined above the horizontal, the carbon points being surrounded by a metal chamber open below. With such an arrangement the Bremer type of electrode will deposit a snowy coating on the surface of the reflector during combustion, whereby the metallic parts will be better protected against the influence of the heat radiated, and a highly reflecting, dull-white coating provided. The coating obtained in this way will adhere to the metallic parts in a thickness of about an eighth of an inch, and it is only after they have exceeded a certain measure of thickness that the excess will fall down when fresh carbons are inserted. In the case of carbon pencils pointed upward at an acute angle, the influence of a magnet or solenoid is brought to bear on the arc so that it is projected downward, the magnet being energised by the same current which feeds the lamp. The coil itself is not in close proximity to the arc but is provided with an extension piece of more than twice the length of the magnet core, the end of which is immediately above the arc.

* From the *Electrical World* of New York.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Parts 5, 6, 7 and 8. Vol. XVII. (London and Newcastle: Andrew Reid & Co)

"Journal of the Institution of Electrical Engineers." No. 152. Vol. XXX. With Index. (London: E. and F. N. Spon; New York: Spon and Chamberlain.) 4s.

"Index to Journal of the Inst itution of Electrical Engineers.' Vols. XXI. to XXV. (London: E. and F. N. Spon; New York: Spon and Chamberlain.) 2s. 6d.

"Key to the Classification of the Patent Specifications of Germany, Austria, Denmark and Norway in the Library of the Patent Office." (London: Patent Office.) 6d.

"Essais et Vérification des Canalisations Électriques." By Paul Charpentier. (Paris: Ch. Béranger.) 15fr.

"La Télégraphie sans Fils. By Emile Pierard. (Paris: Dunod; and Brussels: Ramlot.) 1.50fr.

"Die Lage der Elektrischen Industrie in Deutschland." By Fritz Golwig. (Vienna: Neue Freie Presse.)

**A 22,000-ampere Alternator.**—We read in *L'Industrie Electrique* that the Mediterranean Thomson-Houston Co. has just completed three alternators of an unusual type for the Italian Calcium Carbide and Acetylene Co. Each of these alternators is capable of supplying 1,000kw. at 45 volts, the normal current on a non-inductive circuit being 22,000 amperes, and on an inductive circuit, with a power-factor 0·8, 28,000 amperes. The field magnets have 12 poles, and the armature, which is fixed, is made up of two windings brought out separately to two pairs of collecting rings, one on either side of the alternator. These windings can be connected either in series or in parallel, for 90 or 45 volts respectively. The machines are driven by turbines with horizontal shafts. All three are excited by a four-polar dynamo giving 50kw. at 125 volts, this machine also lighting the works. A second exciter the same size serves as reserve. In order to measure the large currents furnished from the alternators special transformers have been made with a reduction ratio of 700 to 1. Their primary circuit, traversed by the whole current furnished by the alternator, is formed of copper bars, and the secondary is wound on a laminated iron core, which surrounds the copper bars of the primary.



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Editorial, Publishing and Printing Offices,

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*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

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## THE FILINGS COHERER.

The filings coherer is one of those discoveries which have afforded interesting study both to the physicist and the engineer. From the point of view of the idealist in pure science, who investigates a matter entirely on account of its scientific aspect, and is rather perturbed if his researches may lead to issues of practical importance, what could be more fascinating than the problem of evolving a theory of the action of the very erratic phenomena which are observable in a small quantity of metallic filings placed between two electrodes? The mere practician, on the other hand, is satisfied with the fact that the filings do cohere under certain conditions, he has utilised this discovery in evolving a system of telegraphy by means of Hertzian waves, and his researches, so far as the coherer is concerned, are chiefly devoted to finding a sensitive form of this apparatus which will decohere automatically and be reliable in its action. It is remarkable that all the work on this subject that has been done hitherto has almost always followed these two lines. Those who have investigated the physical action of the coherer have so far done little to perfect this instrument in its application to the wireless transmission of telegraphic signals, and the few men who have devoted themselves to the technical rather than to the scientific question have been content with improving their coherers quite empirically. Yet it would seem that the two lines of research are so allied that they should be mutually helpful. If only an approximation to the true physical explanation of the phenomenon is attainable, it should help the wireless telegraph engineer in the design of his receiver, and possibly suggest a more serviceable substitute for the filings tube; and, on the other hand, the widely varying conditions and the large scale of the practical experiments should give the physicist facilities which he might otherwise not obtain of having his theories and hypotheses put to the test.

In an article which we conclude on another page of this issue Dr. Eccles has evidently started out in the true spirit

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of pure science. Excluding all practical questions which might tempt him away from the object in view, he has set himself the task of evolving a theory of the action of the filings coherer and of seeing how far it could be substantiated by experiment. In this he has been fairly successful, although he has, willy nilly, been obliged in the course of his experiments to evolve something of real practical and commercial importance—we refer to his method of comparing the relative efficacy of coherers which will enable them to be standardised and classified for sensitiveness just as any other electrical instruments.

The prime results of Dr. Eccles' experiments, however, was the establishment of the fact, in confirmation of other experimenters, that it is merely the difference of potential which causes the coherer to become conducting and not the actual oscillation of this potential difference. That is to say, that the property of the coherer which renders it useful as a receiver in wireless telegraphy is that it will respond to small differences of potential even if these be of a transient character, alternating with the period of a Hertzian wave.

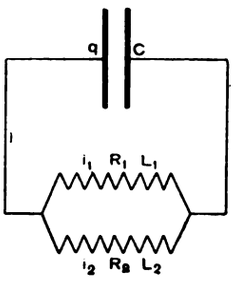
But Dr. Eccles goes further than this. He puts forward a complete theory of how this difference of potential produces the phenomenon which is still called coherence. He adopts Dr. Lodge's view that actual coherence takes place, but he deems it to be subsidiary to an actual motion of the particles. When a difference of potential is established between two surfaces, any intervening bodies will tend to place themselves with their longest axis parallel to the field. This, Dr. Eccles thinks, takes place in a coherer, and is followed by the welding action, the mechanical action or orientation being of first importance, however. The curves for the current flowing through a coherer for different E.M.F.s show a very slow rise in current up to a certain E.M.F., and then a sudden bend. This more or less pronounced "critical" E.M.F. (as it was called by Blondel) Dr. Eccles considers to be the E.M.F. which suffices to produce the orientation of the particles, the small increase of current beforehand being due to cohesion of some of the particles before this mechanical motion takes place. This hypothesis, for a more detailed explanation of which the reader must refer to the article itself, certainly explains a great deal that has been observed in connection with coherers, but it leaves a great deal unexplained. Can it be shown, for instance, that the substances which form an anti-coherer—an apparatus which increases its resistance when exposed to Hertzian waves—place themselves along the equipotential lines? Then again the anti-coherer consisting of cuts in a sheet of tinfoil or in silvering on glass, and also Branly's particles embedded in a solid substance, have to be considered, but all these may be phenomena entirely distinct from those observed in the ordinary coherer, and traceable to different causes. The test of Dr. Eccles' hypothesis is, of course, to make a coherer of nearly spherical particles, and see if it was irresponsive to E.M.F.s or Hertzian oscillations which would actuate an ordinary coherer of similar size. Unfortunately he was unable to perform this owing to the difficulty of obtaining filings of the requisite shape, although he tried various methods and devoted considerable time and patience to this end.

At all events, Dr. Eccles has entered upon a most interesting and useful research, which we trust will be continued both by himself and other workers. The study of the coherer, as we have said, should be fruitful both to the physicist and the engineer, and Dr. Eccles has certainly broken new ground.

## OSCILLATORY DISCHARGES THROUGH DIVIDED INDUCTIVE CIRCUITS.

BY T. MIZUNO.

Suppose a condenser to be discharged through two divided inductive circuits, as shown in the annexed figure. Let $i$ be the main current, and $i_1$ and $i_2$ be the currents in the divided circuits at any time $t$. Denote the resistances and the self-inductances of the divided circuits by $R_1$, $R_2$, and $L_1$, $L_2$ respectively.




Then, neglecting the resistance and the self-inductance of the main circuits, the equations of the discharge are

$$L_1\frac{di_1}{dt}+R_1i_1=\frac{q}{C}, \quad \ldots\ldots (1)$$

$$L_2\frac{di_2}{dt}+R_2i_2=\frac{q}{C}, \quad \ldots\ldots (2)$$

$$i=i_1+i_2, \quad \ldots\ldots (3)$$

and also

$$i=-\frac{dq}{dt}, \quad \ldots\ldots (4)$$

where $q$ and C are respectively the charge, at any time $t$, and the capacity of the condenser.

Differentiating (3), we get

$$\frac{di}{dt}=\frac{di_1}{dt}+\frac{di_2}{dt}. \quad \ldots\ldots (5)$$

Substituting the values of $i_2$ and $di_2/dt$ from the equations (3) and (5) in (2), we have

$$L_2\left(\frac{di}{dt}-\frac{di_1}{dt}\right)+R_2(i-i_1)=\frac{q}{C}. \quad \ldots (6)$$

Eliminating $i_1$ and $di_1/dt$, we find respectively

$$(R_1L_2-R_2L_1)\frac{di_1}{dt}=-(R_1+R_2)\frac{q}{C}+R_1R_2i+R_1L_2\frac{di}{dt}, \quad (7)$$

and

$$(R_1L_2-R_2L_1)i_1=(L_1+L_2)\frac{q}{C}-R_2L_1i-L_1L_2\frac{di}{dt}. \quad (8)$$

Differentiating the latter, we get

$$(R_1L_2-R_2L_1)\frac{di_1}{dt}=\frac{L_1+L_2}{C}\frac{dq}{dt}-L_1R_2\frac{di}{dt}-L_1L_2\frac{d^2i}{dt^2}.$$

Therefore, by (7) we have

$$L_1L_2\frac{d^2i}{dt^2}+(R_1L_2+R_2L_1)\frac{di}{dt}+R_1R_2i=\frac{R_1+R_2}{C}q+\frac{L_1+L_2}{C}\frac{dq}{dt}. \quad (9)$$

Differentiating once more, and observing the equation (4), we finally obtain

$$\frac{d^3i}{dt^3}+\frac{R_1L_2+R_2L_1}{L_1L_2}\frac{d^2i}{dt^2}+\frac{1}{L_1L_2}\left(R_1R_2+\frac{L_1+L_2}{C}\right)\frac{di}{dt}+\frac{R_1+R_2}{L_1L_2C}i=0. \quad (10)$$

This is the differential equation for the main current at any time $t$, and its solution depends upon the roots of the cubic.

$$\lambda^3+\frac{R_1L_2+R_2L_1}{L_1L_2}\lambda^2+\frac{1}{L_1L_2}\left(R_1R_2+\frac{L_1+L_2}{C}\right)\lambda+\frac{R_1+R_2}{L_1L_2C}=0. \quad (11)$$

If the two roots of the above cubic be imaginary, then the solution takes the following form of oscillatory discharges with the logarithmic term:

$$i=Ae^{-\alpha t}\sin\beta t+Be^{-\alpha t}\cos\beta t+Ce^{-\gamma t}, \quad \ldots (12)$$

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where $\alpha$, $\beta$ and $\gamma$, and A, B and C are the quantities all depending upon the values of the resistances and the self-inductances of the circuits, and also the capacity of the condenser.

This general case of the divided circuits, however, does not present to us any special interest. On the contrary, the following particular case will furnish us a great deal of interest and deserve a minute consideration.

Let us suppose that the time-constants of the divided circuits are equal to one another, namely,

$$\frac{L_1}{R_1}=\frac{L_2}{R_2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

Under this supposition, we have

$$\begin{cases}\dfrac{di_1}{dt}+\dfrac{R_1}{L_1}i_1=\dfrac{q}{L_1C}\\ \dfrac{di_2}{dt}+\dfrac{R_1}{L_1}i_2=\dfrac{q}{L_2C}.\end{cases}$$

Therefore, adding these equations, we get

$$\frac{di_1}{dt}+\frac{di_2}{dt}=\left(\frac{1}{L_1}+\frac{1}{L_2}\right)\frac{q}{C}-\frac{R_1}{L_1}(i_1+i_2).$$

From (3), (5), and this equation, we find

$$\frac{di}{dt}=\left(\frac{1}{L_1}+\frac{1}{L_2}\right)\frac{q}{C}-\frac{R_1}{L_1}i.$$

Differentiating this once more,

$$\frac{d^2i}{dt^2}+\frac{R_1}{L_1}\frac{di}{dt}+\frac{1}{C}\left(\frac{1}{L_1}+\frac{1}{L_2}\right)i=0;$$

*i.e.*,

$$\frac{d^2i}{dt^2}+\frac{\dfrac{R_1}{L_1}\left(\dfrac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}\right)}{\dfrac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}}\frac{di}{dt}+\frac{i}{C\dfrac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}}=0. \quad . \quad . \quad (14)$$

Putting

$$R_0=\frac{R_1}{L_1}\left(\frac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}\right), \quad . \quad . \quad . \quad . \quad (15)$$

and

$$L_0=\frac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}, \quad . \quad . \quad . \quad . \quad . \quad (16)$$

we obtain

$$\frac{d^2i}{dt^2}+\frac{R_0}{L_0}\frac{di}{dt}+\frac{i}{L_0}=0. \quad . \quad . \quad . \quad (17)$$

Again, by (13), we have

$$\frac{R_2}{R_1}=\frac{L_2}{L_1}.$$

$$\therefore \quad \frac{R_1}{R_1+R_2}=\frac{L_1}{L_1+L_2};$$

*i.e.*,

$$\frac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}=\frac{R_1}{R_1+R_2}\cdot L_2.$$

$$\therefore \quad R_0=\frac{R_1}{L_1}\cdot\frac{R_1}{R_1+R_2}\cdot L_2=\frac{1}{\dfrac{1}{R_1}+\dfrac{1}{R_2}}. \quad . \quad . \quad (18)$$

Hence, if the time-constants of the two divided inductive circuits be equal to one another, the latter may be replaced by an equivalent inductive circuit, whose equivalent self-inductance and resistance are given by the expressions (16) and (18) respectively.

It is, then, interesting to observe that under the above supposition a discharge current from a charged condenser behaves, with regard to resistance and self-inductance, just like an ohmic current flowing through divided circuits.

Now, in order that electric oscillations may take place in the main circuit, the following inequality must be satisfied:

$$R_0^2<\frac{4L_0}{C};$$

*i.e.*,

$$R_1^2<\frac{4}{C}\frac{L_1^2}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}. \quad . \quad . \quad . \quad . \quad (19)$$

or, what amounts to the same thing,

$$R_2^2<\frac{4}{C}\frac{L_2^2}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}. \quad . \quad . \quad . \quad . \quad (20)$$

If this inequality be fulfilled, then we have

$$i=\frac{Q}{L_0C\sqrt{\dfrac{1}{L_0C}-\dfrac{R_0^2}{4L_0^2}}}e^{-\frac{R_0}{2L_0}t}\sin\left[\sqrt{\frac{1}{L_0C}-\frac{R_0^2}{4L_0^2}}\cdot t\right], \quad (21)$$

where Q is the initial charge of the condenser, and the period of oscillations is

$$T=\frac{2\pi}{\sqrt{\dfrac{1}{L_0C}-\dfrac{R_0^2}{4L_0^2}}}. \quad . \quad . \quad . \quad . \quad (22)$$

Now, the two currents in the divided circuits must be in the following ratio:

$$\frac{i_1}{i_2}=\frac{R_2}{R_1}=\frac{L_2}{L_1}. \quad . \quad . \quad . \quad . \quad . \quad (23)$$

Therefore, differentiating (1) and substituting the value of $i_2$ from the above equation, we get

$$\frac{d^2i_1}{dt^2}+\frac{R_1}{L_1}\frac{di_1}{dt}+\frac{i_1}{L_1C\left(\dfrac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}\right)}=0. \quad . \quad (24)$$

Similarly, we obtain

$$\frac{d^2i_2}{dt^2}+\frac{R_2}{L_2}\frac{di_2}{dt}+\frac{i_2}{L_2C\left(\dfrac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}\right)}=0. \quad . \quad (25)$$

Hence, we see that the effective self-inductances and resistances of the divided circuits are not at all affected, their capacities being only reduced to the following values:

$$C_1=\frac{C}{L_1}\left(\frac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}\right), \quad . \quad . \quad . \quad . \quad (26)$$

and

$$C_2=\frac{C}{L_2}\left(\frac{1}{\dfrac{1}{L_1}+\dfrac{1}{L_2}}\right). \quad . \quad . \quad . \quad . \quad (27)$$

Provided the inequalities

$$R_1^2<\frac{4L_1}{C_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

and

$$R_2^2<\frac{4L_2}{C_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (29)$$

hold good, the values of the currents $i_1$ and $i_2$ will be respectively given by the following equations:

$$i_1=\frac{Q_1}{L_1C_1\sqrt{\dfrac{1}{L_1C_1}-\dfrac{R_1^2}{4L_1^2}}}e^{-\frac{R_1}{2L_1}t}\sin\left[\sqrt{\frac{1}{L_1C_1}-\frac{R_1^2}{4L_1^2}}\cdot t\right], \quad (30)$$

and

$$i_2=\frac{Q_2}{L_2C_2\sqrt{\dfrac{1}{L_2C_2}-\dfrac{R_2^2}{4L_2^2}}}e^{-\frac{R_2}{2L_2}t}\sin\left[\sqrt{\frac{1}{L_2C_2}-\frac{R_2^2}{4L_2^2}}\cdot t\right], \quad (31)$$

where

$$\begin{cases}Q_1=\dfrac{C_1}{C}Q, \quad . \quad . \quad . \quad . \quad (32)\\ Q_2=\dfrac{C_2}{C}Q, \quad . \quad . \quad . \quad . \quad (33)\end{cases}$$

and the periods of oscillations are

$$T_1=\frac{2\pi}{\sqrt{\dfrac{1}{L_1C_1}-\dfrac{R_1^2}{4L_1^2}}}, \quad . \quad . \quad . \quad . \quad (34)$$

and

$$T_2=\frac{2\pi}{\sqrt{\dfrac{1}{L_2C_2}-\dfrac{R_2^2}{4L_2^2}}}. \quad . \quad . \quad . \quad . \quad (35)$$

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Now, the period of oscillations of the main circuit is

$$T = \frac{2\pi}{\sqrt{\frac{1}{L_0C} - \frac{R_0^2}{4L_0^2}}} = \frac{2\pi}{\sqrt{\frac{1}{\left(\frac{1}{L_1}+\frac{1}{L_2}\right)}C - \frac{R_1^2}{4L_1^2}}} \quad . \quad (36)$$

Therefore, it is easy to see that $T = T_1 = T_2$. . . . (37)

Again, the sum of the two divided currents must be equal to the main current $i$, and this follows at once from the equations (21), (30) and (31). As a particular case, it is desirable to notice that when $R_1 = R_2$ and $L_1 = L_2$, the capacity of each of the divided circuits is, as might be *a priori* expected, reduced to one-half the original capacity, namely,

$$C_1 = C_2 = \frac{C}{2}, \quad . \quad . \quad . \quad . \quad . \quad (38)$$

and, consequently,

$$Q_1 = Q_2 = \frac{Q}{2}. \quad . \quad . \quad . \quad . \quad . \quad (39)$$

Thus, finally, we arrive at the following conclusions:—

(*a*) In general, when a charged condenser discharges through divided inductive circuits, the current does not take a simple form as in the case of oscillatory discharges in a single inductive circuit. But, if the time-constants of the divided circuits happen to be equal, then the circuits may be reduced to a single equivalent inductive circuit, giving rise, under a certain special condition, to simple harmonic discharge currents. Also, in this case, the conditions for oscillations in the main and the divided circuits are, as can be easily seen from the inequalities (19), (20), (28) and (29), all the same.

(*b*) Each inductive circuit has its own period of oscillations, whose value is definitely determined by the resistance, the self-inductance and the capacity at the ends of the circuit. However, by joining inductive circuits of equal time-constants in parallel to a charged condenser, we can reduce the effective capacities of the circuits, thereby causing the latter to have the same period of oscillation.

(*c*) The theory naturally holds true for any number of inductive circuits in parallel, provided their time-constants are equal to each other.

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**Treatment of Phthisis with High-Frequency Currents.**—In a Paper recently read by Mr. Chisholm Williams it was stated that very successful results had been obtained in the treatment of phthisis by means of electric currents of high frequency and pressure. A Tesla coil was used, which gave currents of a frequency estimated at 1,000,000 ~ per second, and with a pressure of some hundreds of thousand volts. In using this he found a general "electrification" of the patient better than a local one, and a combination of the two better still. Under this treatment the temperature first rose and then fell, and progress could be gauged by noting if the reactionary rise could be induced any longer. Mr. W lliams emphasised the fact that a large majority of patients are unable to afford any treatment away from their own homes, and that the treatment he had described could be carried out by their own medical man. Of 43 cases on which this system was tried 42 put on weight and lost practically all symptoms.

## ELECTRICITY WORKS ACCOUNTS.

### Bristol Municipal Electric Supply Works.

Good progress continues to be made by this undertaking in the sense of increased business. Last year we recorded an advance in the output of 33 per cent. and in the lamp connections of not quite 24 per cent. The figures for 1900–1 show that the units sold were higher than in the preceding year by nearly 21 per cent., with an increase in the lamp connections of 31·3 per cent. Unfortunately, the favourable load factor of 12·3 per cent. in 1899–1900 did not obtain last year but had fallen to 11·9 per cent.

In these circumstances it is not surprising that a bare reduction was effected in the aggregate costs, after making allowance for the increase in the coal bill. A reference to our subsidiary table below will show that the increase in the fuel item is practically entirely due to the increased price paid for coal. This increase, according to Mr. Proctor's report, amounted to 6s. 2d. per ton, as between the years ended in 1900 and 1901.

An unfortunate rise may be detected in all the other items of generating costs to an extent which brings up their respective values to rather higher than the average at the same output and load factor. On the other hand, the management and property charges have dropped considerably, and although still above the average, may be considered satisfactory in view of the salaries of certain members of the staff engaged on new works being charged on the revenue and not to capital.

Besides these salaries the new works at Avonbank were responsible for unremunerative capital (above £900) on which interest and sinking fund charges have had to be paid.

During the year one of the 52kw. arc lighting dynamos has been converted into an exciter. This accounts for the reduction shown in our table in the kilowatt capacity of the plant. A new exciting switchboard has been installed and a battery booster of 20kw. and a 1,500 ampere-hour battery are in course of instalment.

### Gloucester Municipal Electric Supply Works.

Our second analysis deals with the accounts for the first period of working of the Gloucester undertaking. It will be seen from the cost figures that the results are surprisingly good, attained, as they were, in the first few months of working, and with a low output. The aggregate costs at 2·26d. are well below the average 1899 figures for municipal stations of similar output, and this in spite of the high fuel cost which naturally obtained during the period. All the other costs, especially the management and property charges, present most satisfactory figures. With the revenue sharing the low character of the costs, it is not surprising that there was a slight deficit.

### Greenock Municipal Electric Supply Works.

This is another undertaking showing creditable results for its first year. The load factor here is considerably below the average, and to have kept the aggregate costs as low as 2·6d. per unit was good work. It will be noticed that, owing to the high fuel item alone, the aggregate generating and works costs are somewhat above the 1899 averages. The low management and property charges serve to bring back the total costs to quite reasonable limits.

| Year to | No. of public lampe. | | | Motors. | | Total 30 watt lamp connections (equiv.). | No. of consumers. | Plant capacity Kw. | Max. load. Kw. | Load factor per cent. | Units sold to private consumers. | Units sold for public lighting. | Total costs per total units sold. | Total rev. per unit sold. | Per cent. ratio total costs to rev. | Fuel cost per unit sold. | Fuel consumed per unit sold. Lbs. | Price of coal per ton. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Arc. | Glow. | Equiv. 30 watt. | Agg. H.P. | Equiv. 30 watt lamps. | | | | | | | | | | | | | |
| Dec., 1893 ... | 90 | ... | 1,500 | ... | ... | 9,403 | 120 | 700 | 225·5 | 8·48 | 53,829 | 10,019 | 9·97d. | 6·02d. | 166 | 1·82d. | ... | ... |
| „ 1894 ... | 97 | ... | 1,616 | ... | ... | 16,146 | 240 | 930 | 322 | 10·41 | 143,106 | 150,417 | 5·04d. | 5·41d. | 93·1 | 1·30d. | ... | ... |
| „ 1895 ... | 99 | ... | 1,650 | 3·33 | 83 | 25,696 | 439 | 1,014 | 514·5 | 9·06 | 251,708 | 156,593 | 3·51d. | 5·87d. | 59·8 | 0·97d. | 18·75 | ... |
| „ 1896 ... | 105 | ... | 1,750 | 3·33 | 83 | 38,049 | 593 | 1,216 | 766 | 9·7 | 483,527 | 167,231 | 2·75d. | 5·55d. | 49·5 | 0·76d. | 16·6 | ... |
| Mar. 25, 1897* | 105 | ... | 1,750 | 3·33 | 83 | 40,586 | 617 | ... | 656 | 17·8 | 188,357 | 47,607 | ... | ... | ... | 0·64d. | 4·55 | ... |
| „ 1898 | 105 | 3 | 1,778 | 19·53 | 486 | 51,495 | 749 | 1,972 | 1,010 | 10·3 | 743,163 | 167,725 | 2·50d. | 5·42d. | 46·1 | 0·88d. | 16·5 | ... |
| „ 1899 | 304 | 3 | 5,094 | 60·53 | 1,504 | 73,630 | 967 | 2,589 | 1,707 | 9·11 | 1,033,324 | 329,462 | 2·37d. | 4·60d. | 51·6 | 0·86d. | 14·25 | 8/6½ |
| „ 1900 | 308 | 3 | 5,161 | 111·53 | 2,770 | 91,117 | 1,215 | 3,154 | 1,676 | 12·35 | 1,330,670 | 481,841 | 2·38d. | 4·20d. | 56·6 | 0·83d. | 12·37 | 12/5 |
| „ 1901 | 310 | 9 | 5,241 | 377·5 | 9,389 | 119,615 | 1,507 | 3,102 | 2,009 | 11·92 | 1,716,212 | 475,347 | 2·80d. | 4·07d. | 68·7 | 1·25d. | 12·57 | 18/7 |

* Three months.

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| | BRISTOL. | | GLOUCESTER. | GREENOCK. |
|---|---|---|---|---|
| *Undertaking Worked by* | Bristol Corporation. | | Gloucester Corporat'n. | Greenock Corporation. |
| *Date of Commencement of Supply* | August, 1893. | [distribution. | July 19, 1900. | December, 1899. |
| *System of Supply* | Alt.-current trans. sub-stations with 3-wire | | 3-wire con.-current. | 3-wire con.-current. |
| *Chief Engineer* | H. Faraday Proctor. | | Walter J. Bache. | W. M. Nelson. |
| **YEAR ENDED** | MAR. 25, **1900.** | MAR. 25, **1901.** | MAR. 31, **1901.**[g] | DEC. 31, **1900.**[e] |
| **QUANTITIES—** | | | | |
| Units generated | 2,384,464 | 2,913,680 | 188,334 | 226,668 |
| „ **SOLD (TOTAL)** | 1,812,511 | 2,191,559 | 177,834 | 157,681 |
| „ sold to consumers | 1,330,670[a] | 1,716,212[a] | 123,792 | 90,245 |
| „ sold for public lighting, &c. | 481,841 | 475,347 | 54,042 | 67,436 |
| „ used on works | 571,953[b] | 722,121[h] | 10,500 | 54,125 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 18·4 | 22·6 | 7·6 | 12·6 |
| Maximum supply demanded | 1,676 kilowatts | 2,099 kilowatts | 223 kilowatts | 210 kilowatts |
| Number of public lamps | 308 arc, 3 incan. | 310 arc, 9 incan.[i] | 44 arc | 44 arc |
| Number of consumers | 1,215 | 1,507 | 190 | 165 |
| Connections to mains in 8-c.p. lamps | 91,117 | 119,615 | 14,008 | 13,180 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 98,600 | 97,000 | 23,400 | 12,500 |
| **CAPACITY OF PLANT IN KILOWATTS** | 3,154 | 3,102 | 750 | 400 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £254,950 / £80·8 | £408,165 / £132 | £52,875 / £70·5 | £100,000 / £250 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 254,950 / 80·8 | 408,165 / 132 | 52,875 / 70·5 | 100,000 / 250 |
| **RECEIVED (TOTAL)** | 228,730 / 72·5 | 283,015 / 91·2 | 10,286 / 13·7 | 50,000 / 125 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 228,730 / 72·5 | 283,015 / 91·2 | 10,000 / 13·3 | 50,000 / 125 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 26,220 / 8·31 | 125,150 / 40·3 | 42,875 / 57·2 | 50,000 / 125 |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | 26,220 / 8·31 | 125,150 / 40·3 | 42,875 / 57·2 | 50,000 / 125 |
| **REPAID (TOTAL)** | 30,110 / 9·55 | 36,922 / 11·9 | 283 / 0·378 | 833 / 2·08 |
| **RESERVE OR SINKING FUND** | 6,474[c] / 2·05 | 5,200[j] / 1·68 | −627[d] / 0·836 | — / — |
| **DEPRECIATION FUND** | 2,025 / 0·642 | 1,390 / 0·448 | nil / — | — / — |
| **EXPENDED (TOTAL)** | 252,588 / 80·1 | 299,260 / 96·4 | 54,383 / 72·5 | 40,425 / 101 |
| Lands and buildings | 65,435 / 20·7 | 78,122 / 25·2 | 9,371 / 12·5 | 9,042 / 22·6 |
| Plant | 93,825[d] / 29·75 | 105,415[k] / 34·0 | 22,202[e] / 29·6 | 16,676[a] / 41·7 |
| Mains | 87,283 / 27·7 | 105,663 / 34·0 | 19,442 / 25·9 | 13,289 / 33·2 |
| Miscellaneous | 6,046 / 1·92 | 10,060 / 3·24 | 3,367 / 4·49 | 1,418 / 3·54 |
| **BALANCE OF CAPITAL ACCOUNT** | −23,858[e] / −7·57 | −16,245[e] / −5·23 | −44,098[f] / −58·8 | 9,575 / 23·9 |
| **REVENUE—** | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold | Total. / Per unit sold |
| **TOTAL** | £31,718 / 4·200d. | £37,217 / 4·075d. | £3,035 / 4·095d. | £2,531 / 3·852d. |
| Revenue from supply | 23,169 / 3·069d. | 28,522 / 3·123d. | 2,218 / 2·994d. | 1,570 / 2·390d. |
| „ meters, &c. | 1,118 / 0·148d. | 1,383 / 0·151d. | 60 / 0·081d. | — / — |
| „ public lighting | 7,073[f] / 0·937d. | 7,144[l] / 0·783d. | 681 / 0·919d. | 953 / 1·450d. |
| „ sale of lamps, &c. | 149 / 0·020d. | 29 / 0·003d. | — / — | — / — |
| „ miscellaneous sources | 210 / 0·028d. | 139 / 0·015d. | 75 / 0·101d. | 8 / 0·012d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £17,962 / 2·378d. | £25,535 / 2·796d. | £1,675 / 2·260d. | £1,711 / 2·604d. |
| **WORKS COSTS** | 12,807 / 1·696d. | 19,929 / 2·183d. | 1,282 / 1·730d. | 1,323 / 2·013d. |
| *Generation of electricity* | *10,022 / 1·327d.* | *16,887 / 1·850d.* | *1,072 / 1·447d.* | *1,122 / 1·708d.* |
| Fuel (including cartage, &c.) | 6,231 / 0·825d. | 11,437 / 1·253d. | 642 / 0·866d. | 654 / 0·995d. |
| Oil, waste, water, stores | 511 / 0·068d. | 726 / 0·079d. | 57 / 0·077d. | 75 / 0·114d. |
| Wages at station | 2,190 / 0·290d. | 2,793 / 0·306d. | 310 / 0·418d. | 371 / 0·565d. |
| Repairs and maintenance at station | 1,090 / 0·144d. | 1,931 / 0·211d. | 63 / 0·085d. | 21 / 0·032d. |
| *Distribution of electricity* | *1,342 / 0·178d.* | *1,290 / 0·141d.* | *71 / 0·096d.* | *39 / 0·046d.* |
| Wages, &c. | 548 / 0·073d. | 664 / 0·073d. | 71 / 0·096d. | 20 / 0·030d. |
| Repairs, renewals of mains, &c. | 794 / 0·105d. | 626 / 0·069d. | | 10 / 0·015d. |
| *Public lighting* | *1,442 / 0·191d.* | *1,752 / 0·192d.* | *139 / 0·188d.* | *171 / 0·260d.* |
| Attendance | 1,086 / 0·144d. | 1,108[m] / 0·121d. | 77 / 0·104d. | 126 / 0·192d. |
| Renewals | 356 / 0·047d. | 645 / 0·071d. | 62 / 0·084d. | 45[b] / 0·069d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 5,156 / 0·683d. | 5,606 / 0·614d. | 393 / 0·531d. | 388 / 0·591d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *1,767 / 0·234d.* | *2,033 / 0·223d.* | *125 / 0·169d.* | *158 / 0·240d.* |
| *Management* | *3,389 / 0·449d.* | *3,573 / 0·391d.* | *268 / 0·362d.* | *230 / 0·350d.* |
| Salaries | 1,996 / 0·264d. | 2,542 / 0·278d. | 139 / 0·188d. | 121 / 0·184d. |
| Stationery, &c. | 179 / 0·024d. | 242 / 0·027d. | 66 / 0·089d. | 66 / 0·100d. |
| Establishment charges | 465 / 0·062d. | 421 / 0·046d. | 29 / 0·039d. | 23 / 0·035d. |
| Law charges, &c. | 749[g] / 0·099d. | 368[n] / 0·040d. | 34[g] / 0·046d. | 20[c] / 0·030d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £13,756 / 6·18% | £11,682 / 4·24% | £1,360 / 3·19% | £820 / 2·03%[d] |
| Sum carried to Depreciation Fund | — / — | — / — | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 7,590 / 3·41% | 6,812 / 2·47% | 283 / 0·665% | 2,284[f] / 5·65%[d] |
| Net interest on loans (incl. Debenture charges) | 6,020 / 2·70% | 7,337 / 2·66% | 1,139 / 2·67% | — / — |
| **BALANCE FROM LAST ACCOUNT** | 2,916 / 1·31% | 3,062 / 1·11% | — / — | — / — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 3,062 / 1·37% | 505 / 0·183% | — / — | — / — |
| *Deficit* | — / — | — / — | *63 / 0·148%* | *1,464 / 3·62%[d]* |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 56·6% | 68·7% | 55·2% | 67·6% |
| Expenditure per kilowatt capacity | £5. 13s. 11d. | £8. 4s. 10d. | £2. 4s. 8d. | £4. 5s. 7d. |
| **REVENUE PER KILOWATT CAPACITY** | £10. 1s. 0d. | £12. 0s. 0d. | £4. 0s. 11d. | £6. 6s. 7d. |
| Expenditure per 8-c.p. lamp capacity | 3s. 7¾d. | 5s. 3½d. | 1s. 5½d. | 2s. 9d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 6s. 5½d. | 7s. 8d. | 2s. 7d. | 4s. 0½d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 6s. 11½d. | 6s. 2½d. | 4s. 4d. | 3s. 10d. |
| Price charged for lighting, per unit | 5d. (max.), 2½d. (min.) | 5d. (max.), 2·33d. (min.) | 7d. to 2d.[a] | 7d. (1 hr.) to 1½d. or 5½d. |
| Price charged for power, per unit | 1½d. (max.), 1¼d. (min.) | 1·5d. (max.), 1·2d. (min.) | 4½d. to 1½d.[b] | 4d. (1 hr.) to 1½d. or 2d. |
| Price charged for public lighting | £23 per lamp per ann. | £23 arc, £1. 6s. 5d. 8 c.p. glow | £24 to £20 per arc[c] | £20 per lamp per ann. |

**BRISTOL.**—REMARKS—*a* Of which 102,546 units (estimated) in 1899-1900 and 140,882 units (estimated) were used by day-load customers through controlling clocks and unregistered. *b* 216,219 units at generating station, 355,734 units (estimated) by external system. *c* Includes £5,000 balance of reserve fund, £1,190 balance of redemption account and £281 at credit of suspense account. *d* Including £8,300 on public lamps, and carbons. *e* Over-expended. *f* Includes £5,631 electricity supplied and £1,442 attendance, repairs *g* £179 insurance and £108 to electrical inspector. *h* 225,362 at generating station and 496,758 external system. *i* The glow lamps are five 16 c.p., one 25 c.p., and three 75 c.p. each. *j* £5,000 in reserve fund and £200 at credit of suspense account. *k* Includes £8,363 on public lamps. *l* £5,392 for electricity and £1,752 for attendance, repairs and carbons. *m* Attendance and repairs. *n* Stock management £111, insurance £141.

**GLOUCESTER.**—REMARKS—*a* 7d. for first 100 hours per quarter of maximum demand 2d. after. *b* 4½d for first 160 hours per quarter of maximum demand, 1½d. after. *c* £24 per arc per ann. for all night lamps and £20 for half night lamps. *d* Suspense account. *e* Includes public lamps £1,530 and accumulators £1,365. *f* Over-expended. *g* Period from opening to March 31st.

**GREENOCK.**—REMARKS—*a* Includes £1,391 on arc lamps and posts and £2,150 on accumulators. *b* Being £32 on carbons and £13 on repairs. *c* Insurance. *d* Per cent. to capital at end of period. *e* Period from opening to December 31, 1900. *f* Includes £833 to sinking fund in repayment of loans and £560 proportion of principal and interest due on loan from Public Works Loan Commissioners from date of last payment to date of balance.

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## SOME EXPERIMENTS ON FILINGS COHERERS.*

BY W. H. ECCLES, D.SC.

(*Concluded from page 685.*)

In the late summer opportunity arose of applying this method of examination to a very large number of coherers. But before beginning the work an attempt was made to overcome certain irregularities. For instance, it had been noticed that the same tube tested again and again gave curves which were not quite coincident, and sometimes the motion of the galvanometer mirror was erratic. These and other small vagaries were traced to variations in the speed of the vibrator, to variations in the vigour of the blow, and, not least, to the occasional occurrence of minute sparks at the contacts of the vibrator. In the absence of a convenient mechanical tapper the bell-trembler used was supplied with a small-resistance shunt across the spark-gap, and means were taken to steady the current energising the magnets. Several sizes of hammer were tried, and the weight of the blow and the speed of tapping altered through a considerable range. No such alteration changed the character of the curves, so convenient conditions were adopted and adhered to. The speed of tapping chosen had, judging by ear, a frequency of about 50 vibrations per second. It was arranged that the inductance of the coherer circuit was as low as possible.

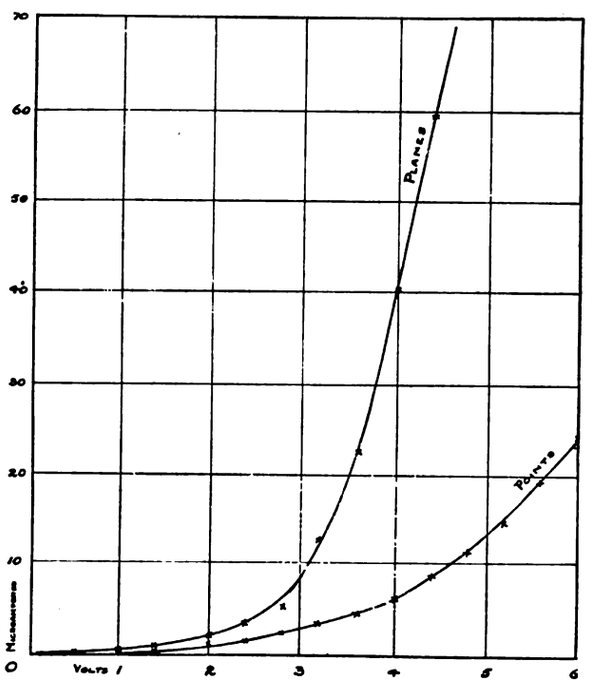


FIG. 6.

With these precautions several hundreds of coherers were examined. The curves obtained were more regular than those obtained hitherto but presented no new features. The occasional throws so noticeable while the spark-gap of the trembler was only slightly shunted were comporatively infrequent. The final conclusion which these trials led to need here be merely stated. The complete correspondence between the sensitiveness of a coherer to electromagnetic radiation and the position on the chart of the characteristic curve obtained by this method was fully demonstrated.

It may here be mentioned that the majority of the coherers examined were of one type, consisting, as before stated, of filings, usually nickel, between plane silver electrodes. The author purposely kept to this one type for a reason which will be seen later. Other types of coherers were, however, occasionally examined. As a matter of interest there is given in Fig. 6 an example of the curves obtained from a coherer which consisted of two steel needles projecting co-linearly from opposite directions into iron filings, the needle points being about 1mm. apart. In the same figure is also a curve given by a coherer of the ordinary type, but containing iron filings. The general results of the mass of observations briefly described in the preceding pages and a study of the characteristic curves led the author to a kinetic theory of the filings coherer, which makes the typical coherer consist of filings free to move throughout

* Many of the tables accompanying this article were obtained from coherers forming part of the stock of the Marconi Company. It is only by the company's kind permission that the writer is now enabled to publish them.

**Table VI.** (Fig. 6).—*Coherers with Iron Filings.*

| Volts. | Microamperes. | | Volts. | Microamperes. | |
|---|---|---|---|---|---|
| | Planes. | Points. | | Planes. | Points. |
| 0 | 0 | 0 | 3·6 | 22·8 | 4·8 |
| 0·5 | 0·3 | 0 | 4·0 | 40·5 | 6·3 |
| 1·0 | 0·6 | 0·3 | 4·4 | 59·4 | 9·7 |
| 1·4 | 1·2 | 0·6 | 4·8 | ... | 11·1 |
| 2·0 | 2·1 | 1·5 | 5·2 | ... | 14·4 |
| 2·4 | 3·6 | 1·8 | 5·6 | ... | 19·2 |
| 2·8 | 6·6 | 2·7 | 6·0 | ... | 24·3 |
| 3·2 | 12·6 | 3·3 | | | |

the space of a narrow crevasse bounded at its ends by plane conducting faces. It is necessary to state this hypothesis tersely, so that the aim of the experiments to be described may be understood.

When a difference of potential, steady or oscillatory, is established between two opposed plane conductors separated by a distance which is small compared with their own magnitude a fairly uniform electric field is created between them. Any conducting piece of matter, not spherical in shape, moving freely in this field will experience a couple tending to place it, in general, with its longest axis parallel to the field.* Other particles present will be similarly acted upon, and if they come to rest while the electric field is maintained they may be expected to exhibit distinct orientation. The degree of orientation among the mass of filings will evidently bear some relation to the strength of the electric field—that is, to the applied E.M.F. In this state the process of "coherence" will be easier than when the arrangement of the particles is fortuitous. If we take Dr. Lodge's view, that an actual welding occurs between contiguous particles till complete chains are formed across the gap, it must be noticed that the perfection of the weldings will also in all probability depend on the E.M.F. producing them. Thus, in filings coherers, the writer thinks, two distinct actions—one, the mechanical, resulting in orientation of the particles, the other, the true "coherence" phenomenon, resulting in weldings—occur, and these are both dependent on the applied E.M.F. It is the author's contention that the share of the mechanical action is great. The series of experiments whose description follows were designed to prove the existence and the importance of this mechanical action.

In seeking for modes of attack, the idea of sorting filings according to their size and shape presented itself prominently. A coherer containing only spherical particles and others each containing uniform ellipsoidal particles of selected degrees of elongation ought in the ideal case to be constructed and compared. In an endeavour to realise these conditions the author spent much time in sifting silver, aluminium, iron, nickel and copper filings. But even after many siftings all these filings, on examination under a microscope, were of astonishing irregularity as regards both size and shape. A process of sorting by allowing sifted filings to fall through liquids was then tried, but proved equally unsatisfactory. Finally, after many other attempts—which included such methods as rolling the filings down a vibrated inclined glass plate, and the use of air blasts—it was decided to abandon this phase of the work inasmuch as the use of filings not perfectly regular could not but yield inconclusive results. It is known that if the gap between the electrodes of a coherer be increased the sensitiveness of the coherer is diminished. It is mentioned later that a certain constant in the theoretical equation of the curves is directly proportional to the length of the gap. This constant is, roughly, for each position of the electrodes, that value of the abscissa at which rapid curvature commences. A number of experiments were therefore performed on several coherers of the ordinary type. First, the characteristic curve of a coherer was obtained by the general method described, and the distance between the plugs measured. Then the tube was heated towards the part where the platinum wire emerges, and, by a strong pull, the electrodes separated slightly. When the tube had cooled another characteristic curve was drawn and the gap again measured. This operation, it was found, could only be repeated once, or at most twice, on home-made coherers. The results of a series of measurements conducted in this manner on one tube are given diagrammatically in Fig. 7, the measurements from which the curves are plotted being set out in Table VII. A glance at the last lines of the table will show the reader that the accordance between the crude theory and the experimental data obtained is fair but not remarkable enough to call for emphasis.

Only a day or two before going to press it occurred to the writer that Tissot's discovery, that the sensitiveness of a coherer made with magnetic filings is greatly increased by the presence of a magnetic field whose direction is parallel to the axis of the tube, might be utilised to indicate the share the mechanical actions have in the alterations of conductivity in a filings coherer. Magnetic particles in such a field will experience a couple similar in kind to that

* This much, the author believes, has been suggested before, but he has not been able to find any distinct statement.



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**Table VII.** (Fig. 7).—*Effect of Increasing the Gap.*

| Volts. | Microamperes. | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 0 | 0 | 0 | 0 | 0 |
| 0·1 | 0·3 | 0 | 0 | ... |
| 1·6 | 0·9 | 0·3 | 0·3 | 0 |
| 2·0 | 1·8 | 0·6 | 0·3 | 0·3 |
| 2·4 | 6·0 | 0·9 | 0·9 | 0·6 |
| 2·6 | 14·2 | 1·5 | 1·5 | 0·6 |
| 3·0 | 42·0 | 3·0 | 2·1 | 0·9 |
| 3·4 | ... | 7·5 | 4·5 | 1·5 |
| 3·8 | ... | 22·2 | 10·2 | 3·0 |
| 4·2 | ... | 37·8 | 21·3 | 7·5 |
| 4·6 | ... | ... | 34·5 | 16·5 |
| 5·0 | ... | ... | 58·0 | 34·2 |
| 5·4 | ... | ... | ... | 61·0 |
| Curvature commences at | E=2·1 | E=3·0 | E=3·3 | E=3·5 volts |
| Size of gap ..... | $l$=0·22 | $l$=0·34 | $l$=0·38 | $l$=0·45mm. |
| | E/$l$=9·5 | E/$l$=8·8 | E/$l$=8·9 | E/$l$=7·8 |

which they experience in an electric field. A short calculation shows, besides, that the couples exerted on the same (paramagnetic) particles by an electric field due to 1 volt across a small gap and by a magnetic field of one C.G.S. unit are of the same order of magnitude. A

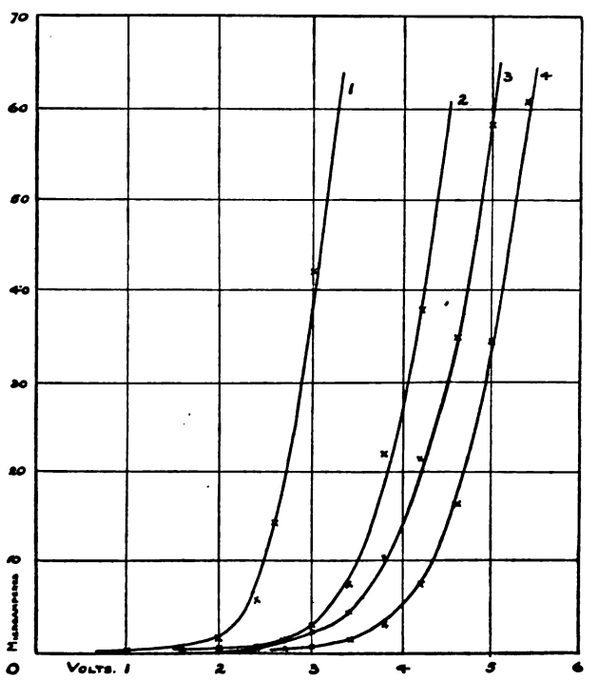


Fig. 7.

knowledge of the permeability of the material of the filings is, however, necessary to make any experimental results valuable. The writer has not yet had opportunity to perform by the characteristic curve method any quantitative experiments with iron filings coherers, but he has found that the effect of the magnetic field due to a small solenoid is quite appreciable on a nickel-alloy coherer which happened to be at hand. Tissot states that the effect of a magnetic field on the sensitiveness of a coherer containing iron filings is very great.

*Elementary Theory of the Motion of the Particles.*

If a difference of potential of $e$ volts be established between the parallel faces of the electrodes of a filings coherer, and if the distance between the faces be $l$cm., the approximately uniform electric field in the narrow gap will be of intensity $F=e/l$. This field intensity is independent of the specific inductive capacity of the medium occupying the gap, and, therefore, if we assume that the presence of the flying metallic particles is merely equivalent to an increase of the specific inductive capacity, the above expression for the field intensity will be unaltered by the presence of the filings. An application of the well-known formula for the couple on a solid prolate spheroid in a uniform magnetic field shows that in an electric field of strength F, the couple tending to bring the long axis of the ellipsoid towards coincidence with the direction of the field is given by the expression

$$4\pi F^2 \sin\theta \cos\theta \frac{M-L}{LM},$$

where $\theta$ is the angle between the major axis and the direction of the field, and L and M are constants which are somewhat complicated functions of the axes of the ellipsoid. The particle will therefore acquire in its flight an oscillatory motion the same in nature as that of a quadrantal pendulum (Thomson and Tait, Part 1, p. 392). The period of small oscillations can in any particular case easily be computed. For example, if we take a particle whose length is 0·02mm. and two or three times its minor axis, of mass $\frac{1}{2}\times10^{-4}$ gramme, moving in a field due to a P.D. of 1 volt across a gap of 0·2mm., we find that its time of swing, when the oscillations are small, is of the order $\frac{1}{5000}$th of a second. Thus the time required to pull a particle into line with the field is very small indeed if its angular displacement from that line is small. In the actual case of coherers subjected to the experimental processes described in the preceding part of this Paper, the filings in the gap were, by blows repeated at intervals of $\frac{1}{50}$th of a second, scattered throughout the space between the electrodes. Observation shows that they have time in each cycle to settle at the bottom of the space free to them. They settle while under the influence of an electric field. Very many more of the particles, therefore, will fall with their long axes parallel to the axis of the tube than would so fall had no field influenced them. Moreover, the more will so fall the greater the couple acting on each particle—that is, the greater the field, or the greater the applied E.M.F.

If we agree with those who affirm that chains are formed (see Lodge's letter to *The Electrician*, Vol. XLV., p. 938) among the mass of filings during coherence and assume that the number of complete

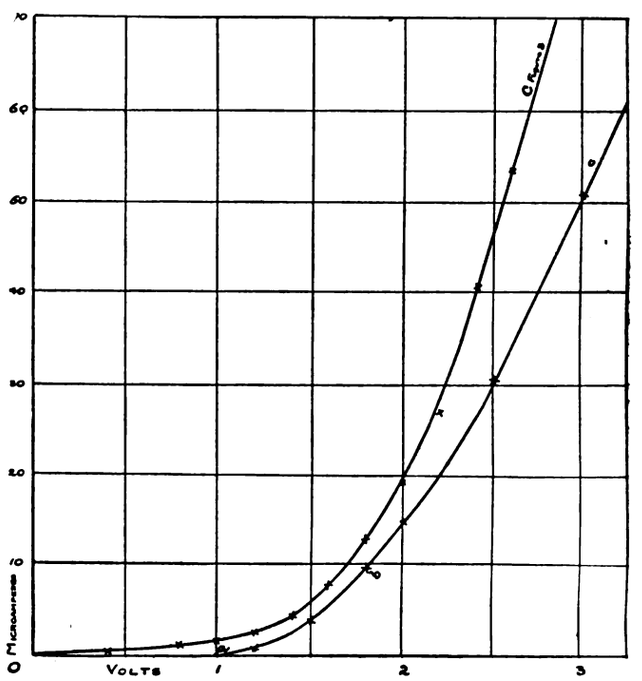


Fig. 8.

chains so formed is related linearly to the number of particles brought to rest all parallel, we may, for our rough purposes deduce an expression for the conductivity of the coherer by calculating the proportion of the flying particles which will be pulled into parallelism with the axis by a given electric field. It is to be remembered, however, that in all probability the cohesion or welding between particle and particle is itself dependent on the strength of the field, that is, on the electromotive force applied at the electrodes; but this question it is not intended to discuss. Besides which, there are also other and less abstruse considerations which bear on the chance of a complete chain being formed. This chance is the greater, for instance, the greater the length of a particle and the smaller the distance across the gap.*

To avoid going into details it may be stated that by making suitable approximations a simple form of the equation of the characteristic curve is easily arrived at. The equation reduces, in fact, to the hyperbola

$$y=\frac{x-C}{R+\frac{B}{x-E}},$$

where $y$ is the current through the coherer when $x$ is the applied E.M.F., R is the external resistance, B and C are constants, and E is a constant which is proportional to the length of the gap and

* Previously noticed by Malagoli.

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which it is well to keep prominently in view. Only a portion of one branch of this hyperbola is applicable to the present case, and that, moreover, only while the amount of coherence is not great. This portion represents, besides, but a part, though the most important part, of the whole characteristic curve of a coherer, but it enables us to compare the whole action of the filings coherer with that part of the whole action which can possibly be due to the motion of the particles.

**Table VIII.** (Fig. 8).—*Example of Calculated Curve.*

| $x$ (volts). | $y$ (microamperes). | $x$ (volts). | $y$ (microamperes). |
|---|---|---|---|
| 1·0 | 0 | 2·0 | 14·7 |
| 1·2 | 0·7 | 2·5 | 30·6 |
| 1·5 | 4·1 | 3·0 | 50·7 |
| 1·8 | 9·7 | | |

E=1·0. C=0·17. B=60.

It will be noticed that this approximate equation makes the current zero when the applied E.M.F. is E. Thus this constant E is that E.M.F. which just suffices to turn particles only very slightly displaced into complete coincidence with the axis, and of these there is theoretically only an infinitely small proportion of the whole number of filings. In other words, it is that voltage at which the characteristic curve of a coherer begins to bend sharply. The bending which occurs before that E.M.F. is reached is due to the coherence which may be expected to take place in the actual case at some of the many contacts which are afforded even when the filings fall perfectly fortuitously. These views are excellently expressed by the curve in Fig. 8, which has been selected for this purpose. The line *abc* represents the calculated curve, E being taken as 1 volt, B as 60 kilohms, and C as 0·17 volt. It indicates how much of the whole action might be effected by the mechanical agencies alone. But there is reason to believe, from considerations not to be entered upon here, that the constant C has in this case been taken unduly large, and that as it stands the curve somewhat exaggerates the share of the mechanical action. The amount by which the calculated curve falls short of the experimental curve affords, however, an idea of the proportion of induced conductivity for which coherence proper is responsible. The writer has found, by using different resistances in series with the coherer, that this degree of coherence proper is the greater the smaller the external resistance, that is, the larger the current, and thus that the coherence proper depends on the amount of current allowed to pass through the coherer. Since only small currents were permitted in obtaining the curves given in this article, the true coherence effect was of less weight than the mechanical effect.

*Conclusion.*

So much has been said on the main points at issue as they arose during the progress of the descriptive parts of this article, that a lengthy discussion of any of these points seems now quite unnecessary. But it would be well to state as concisely as possible the general tendency of the writer's work on the whole subject of coherers made with filings. The first series of experiments with the liquid and wire potentiometers demonstrated satisfactorily that electrical surgings, such as are no doubt produced in any circuit to which an E.M.F. is abruptly applied, had no effect—as surgings—in producing coherence. From this result alone it may be concluded fairly that, as Branly and others have always insisted, the phenomenon of coherence is an effect of E.M.F. merely. But, besides, these first experiments brought prominently before us the many vagaries which have caused the filings coherer to be universally regarded as an instrument of erratic and unaccountable behaviour.

The next portion of the work led to the invention of a very general and powerful method of examining filings coherers. By the use of this method all the anomalies which have hitherto accompanied the manipulation of a coherer seem to disappear and a curve is obtained which expresses most definitely all the characters of the coherer from which it is drawn. It may be termed a true quantitative method of investigating the qualities of a coherer. As one example of its utility in such investigations the curves in Fig. 7, tracing the effect of separating the electrodes, may be cited. The curves indicate plainly that very definite and invariable laws govern the action of a coherer. They prove, besides, that coherence is a continuous phenomenon, and that there can be no true "critical voltage." Moreover, the complete agreement which the author found, during his work with hundreds of coherers, between the sensitiveness to electromagnetic radiation and the position on the chart of the curves of the respective coherers, prove most emphatically that the ultimate causes of the whole phenomenon of coherence are the same with oscillatory and with non-oscillatory E.M.F.s. Thus those common expressions "the impinging of waves" and "the incidence of radiation on a coherer" might, with advantage, the writer thinks, be deleted from our phraseology. For the production of coherence by radiation is in all probability entirely due to oscillations of potential set up in the coherer connections.

The theory which the writer has put forward to explain the merely mechanical portions of the complex phenomenon of coherence in filings coherers is, the writer recognises, not yet backed by any irrefutable evidence. Against it can be brought many objections. One which will occur to every reader will take the form of the question: Are there sufficient complete oscillations in the radiation which falls, ordinarily, on a coherer circuit to produce an appreciable motion in one of the particles? As has been mentioned above, an average filing of the dimensions which the writer found by rough measurement under a microscope required not more than $\frac{1}{20000}$th of a second to turn from rest to parallelism with the electric field acting upon it. For the couple to be maintained so long a time about 100 oscillations of the period commonly employed in wireless telegraphy would be necessary; and this is not impossible in reconant circuits. On the other hand, the proposed theory throws light on many points hitherto unexplained. For instance, the ability of tremors, and even of sounds to assist coherence and the increase of sensitiveness which follows a proper application of a magnetic field to coherers containing magnetic filings become more easily understood. And, again, the "critical voltage" of Blondel and Dobkevitch is shown to have a cause though its existence as an experimental actuality is made impossible by the simultaneous occurrence of coherence proper. The theory shows very clearly, too, how liable to yield conflicting conclusions must be all comparisons made by different observers on coherers supposed exactly similar, and how doubtful in value are comparisons made, even by the one experimenter, on coherers containing filings of different metals. For, the behaviour of different instruments must depend very largely on the size and shape of the filings. That highly contradictory results have been obtained by different workers was pointed out in the preliminary part of the article. Finally, if the theory be accepted, the direction of improvement in the manufacture of coherers is, by its aid, most clearly indicated. On the whole the writer thinks the aim of this article may well be described as an attempt to reduce the complicated case of the filings coherer to the elementary case of the single microphonic contact.

## "COLUMN" MEASURING INSTRUMENTS.

Messrs. Robert W. Blackwell & Co. have lately introduced from the United States a type of continuous-current voltmeter and ammeter which we do not think has been described in this country. It appears to be chiefly applicable for the switchboards of large electricity supply works and tramway power houses. The principle on which the operation of the instruments is based consists in causing the current to be measured to control the variation in pressure of a body of air in a closed vessel, this variation being in turn indicated by the rise and fall of a column of oil. A small pump delivers air at a fairly constant pressure of about 1¾lb. per square inch through the pipe A (Fig. 1). This enters the chamber B, and then flows through a series of porous diaphragms made of filter paper, the function of which is to act as a resistance, and, incidentally, remove any dust particles. The air then enters the passage D, into which is drilled the opening E, which is capped by the valve F. The valve itself consists simply of a small flat disc of non-oxidisable metal, resting on a circular seat, with escape ports G below it and a pin, H, fixed to the top. On the pin rests a spool, J, carried by the lever I, on the other end of which is a counter-weight, K, by means of which the effective weight on the pin H can be adjusted.

The spool is wound with fine wire, which is a shunt to the main current in the case of an ammeter, and the connection to it is made by two copper ligaments, L, which form the fulcrum of the lever.

The reaction between the magnet M and the current in the coil forces the spool down with a force increasing as the current increases. The valve F thus acts as a variably loaded safety valve whose blowing-off point is constantly and proportionately varied by the current variation. The counter-weight K is so adjusted that when no current is passing through the spool the weight on the valve pin is such that the blowing-off pressure in D is sufficient to force the liquid in the closed chamber N up through the tube O to a height which is the zero of the scale. When there is no current any tendency for the pressure to increase simply results in lifting the valve slightly higher, whereupon more air escapes and the pressure decreases; any tendency to diminish would partially close the valve because of the spool weight, and the less rapid escape of air through it would cause the pressure to build up again on account of the constant flow of air from the high-pressure supply.

Exactly the same thing holds good when the weight on the valve is that due to the non-counterbalanced portion of the spool weight plus the downward thrust caused by a given current through it. This gives what is practically a heavier loaded safety valve, so that the blowing-off pressure is higher, and this higher pressure forces the liquid up further in the glass tube. The heights to which the

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liquid rises are directly measures of the current, as the extra downward thrust on the spool is, from the magnetic field and spool design, proportionate to the current.

The air resistance C not only prevents the action from being so sudden that the indications are not dead-beat, but in the case of a decrease in current allows the air in the closed chamber N to flow back promptly and so register the decrease, instead of having the greater part of the escaping air furnished from the higher pressure source A. The glass tube being but 24in. long, the pressure at A (equivalent to about a 49in. column of the liquid) is always sufficiently in excess of that in the passage D and the chamber N to cause the changes to be promptly registered. From the foregoing it is seen that the zero adjustment is made by screwing in or out the counter-weight K, thus shifting all scale values an equal distance up or down the tube. For actual calibration before shipment an iron screw, S, of heavy cross section is provided, which, on being brought closer to or taken further from the opposite leg of the magnet, weakens or strengthens the field in which the active spool works by shunting a portion of the lines of force. The total motion of the spool is exceedingly small, less than $\frac{1}{100}$th of an inch, and, therefore, there is not only no spring action of the suspending ligaments, the action in this particular being like that of the Kelvin balance, but as the spool acts always in the same field, the pressure it exerts on the valve, and hence the air pressure in N and the

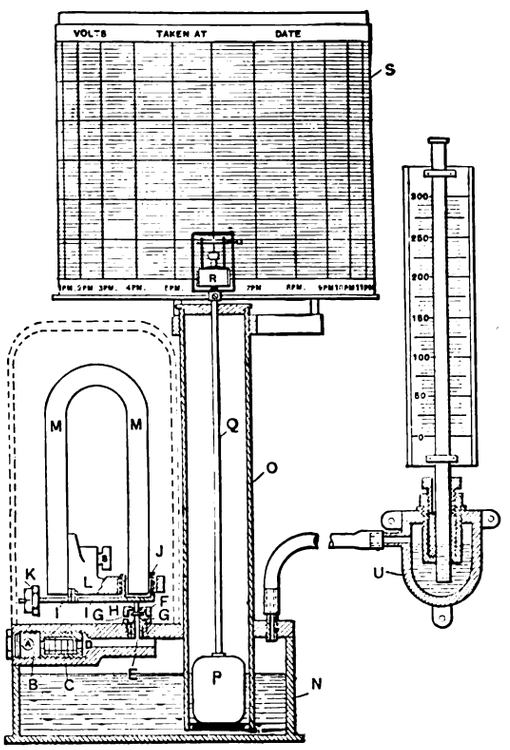


FIG. 1.

resulting liquid column height, are exactly proportional to the current strength. In other words, the scale divisions are absolutely evenly spaced.

It should also be noted that the only work that the varying current has to perform is to control the air pressure, the actual energy required to move the liquid being supplied by an independent source. The length of the instrument scale that has been adopted as standard is 18in. from the 0 to the maximum reading, and this, combined with the conspicuous colour of the liquid employed (a mineral oil coloured a deep clear red or a dark yellow, as may be desired), results in making the indications exceptionally legible.

We are informed by Messrs. Blackwell & Co. that within extremely wide limits variations in the pressure of the air supplied to the instrument have no influence whatsoever on the accuracy of the meter readings, as it is the weight on the safety valve, and not the quantity of air flowing through the valve, that determines the blowing-off pressure. As long as the supply pressure is sufficiently in excess of the blowing-off pressure in the closed chamber to cause a continuous flow of air to take place through the air resistance the meter will indicate correctly, although the rate of speed of the column movement when the current strength measured changes will be slightly less or greater as the supply pressure is lowered or raised. Experience has shown that dial illumination is entirely superfluous with this instrument, as the liquid is an excellent reflector of itself, and the ordinary station illumination renders it visible at great distances. A 20 to 25 milivolt drop for full scale indication in an ammeter is said to be perfectly feasible, so there is ample margin for adjustment, and all the instruments can be made that the same drop is required for each, thus making all shunts strictly interchangeable.

The above description is applicable for both the recording and indicating patterns of this meter. Fig. 1 illustrates the recording meter with an indicating meter attachment. The indicating meter is similar in every respect, except that the reservoir N, the float P, the pen R, together with the tube O and the drum S are absent, and the passage D is led straight to the reservoir U of the indicator, which is placed at the front of the board, the whole mechanism being fixed by three screws.

The over-all width of the indicating meters is $2\frac{3}{4}$in., and they can be mounted on centres 3in. apart without mutual interference. The space occupied behind the board is $2\frac{3}{4}$in. wide by $10\frac{3}{4}$in. high, and on the face of the board $2\frac{3}{4}$in. by 27in.

In the case of the recording meter a pen stroke of 6in. has been adopted for the recorder scale, and a drum circumference of 24in., and it is claimed that by making the column diameter of a proper size a float of such power can be used that the pen friction becomes negligible, and the pen can be made to carry a large supply of ink, sufficient for long records.

To furnish the air required one of two types of compressors can be used. The first is a simple, single cylinder, single-acting air pump, mounted on a square iron box which serves as an air reservoir, and driven by a $\frac{1}{20}$th H.P. motor suspended underneath

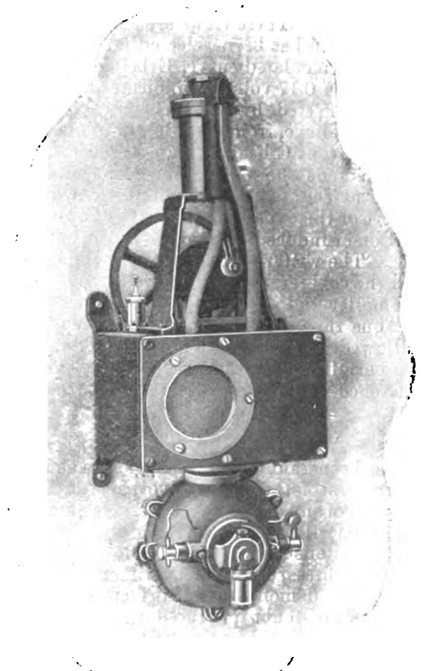

FIG. 2.

and connected to the pump by a belt (see Fig. 2). This type is of sufficient capacity to run 50 indicators or 12 recorders. The second type is a water-operated compressor, which operates like an injector, the water carrying the air with it and compressing it to the desired point. These require about 10 gallons of water per hour per instrument, with 3ft. head, and are built in sizes to suit the particular installation.

The voltmeters are made with a range from 0 to 3 volts with 0·02 volt divisions, up to instruments reading from 0 to 750 volts with 5 volt divisions, whilst the smallest ammeter has a range from 0 to 10 amperes in 0·05 ampere divisions, and the largest reads from 0 to 10,000 amperes in 50 ampere divisions.

**A New System of Wireless Telegraphy.**—According to the *Western Electrician* of Chicago a new system of wireless telegraphy has lately been developed in that city, the receiver being the joint invention of a Mr. L. de Forest and a Mr. E. H. Smythe, whilst the sending apparatus has been developed by Prof. C. E. Freeman. Details are not given, owing to the patents not having being granted yet, but it is said that neither coherer nor induction coil are used, and that the "responder" which replaces the coherer is self-restoring.

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## REGULATIONS FOR HIGH-PRESSURE MAINS.

The Electrical Trades Section of the London Chamber of Commerce has sent us a report by the "Electrical Power Mains Regulations Committee" which it appointed in February, 1901, with a view to considering what modifications (if any) it considered desirable in the existing Board of Trade rules and regulations affecting electric power supply and transmission, having regard to the situation created by the passage of the Electric Power Acts in the session of 1900. The committee consisted of the following members:—

R. Percy Sellon (Chairman of the section), A. Siemens (Deputy-Chairman of the section), Wm. L. Madgen (Deputy-Chairman of the section), S. Z. de Ferranti, F. E. Gripper, A. J. Lawson, E. Manville, C. H. Merz, A. M. Sillar, C. P. Sparks, J. J. Steinitz, A. Campbell Swinton, and E. G. Cruise (Technical Secretary).

The general course adopted by the committee was to obtain the opinions of its members and others interested as to the adequacy of the existing Board of Trade regulations, and also as to the special regulations imposed in the Manchester, Midland Corporation and Walker Wallsend Power Supply undertakings, these being the only important electric power transmission schemes which had been attempted so far in this country. The committee further decided that it would be of importance to compare regulations existing in foreign countries as to electric power transmission and supply, notably Switzerland, Germany, France and the United States of America.

The leading points which came under discussion and investigation were as follows:—

1. The maximum pressure in volts to be used for a transmission of electrical energy at extra high pressure.
2. The maximum power in kilowatts allowed to be transmitted through any one cable and whether trunk mains must be always laid in duplicate. Also the manner of laying the trunk mains.
3. The supply of a metal sheath of electrical continuity round the extra high tension cables, and this sheath to be other than the lead covering.
4. The thickness of dielectric in underground extra high tension cables.
5. The employment of bare wire overhead transmissions in suitable rural districts.
6. The nature and construction of sub-stations and the maximum power to be dealt with in any one sub-station; also the amount of obligatory attendance in a sub-station.
7. The maximum pressure allowed on to consumers' premises.
8. The inspection of the lines and earthing devices, &c.

These questions were carefully considered at numerous meetings of the committee, in the light of foreign practice, in regard to which the regulations referred to were obtained. It was found that, in the Continental countries referred to, regulations exist in regard to public safety, and the safety of telegraphic and telephonic lines and of the lines of other electric power transmissions in the same districts, which, taken as a whole are, in the opinion of the committee, more favourable to the free development of undertakings of this nature than the existing regulations in Great Britain.

The committee arrived at the conclusion that an effort should be made to procure some modification of the existing Board of Trade regulations, and their views were embodied in the following suggestions, which the London Chamber of Commerce has placed before Mr. A. P. Trotter, the electrical adviser to the Board of Trade:—

1. *Voltage of Supply.*—Speaking generally, the committee submit that the Board of Trade should be prepared to sanction distributing systems at voltages at least up to 20,000 volts between any two conductors, on the undertakers describing and adopting an approved method of working, and on the understanding that precautions are adopted similar to those which have been found successful in other countries. The committee do not think that an arbitrary limit should be fixed even at 20,000 volts, as cases may arise where higher voltages are desirable; but, in such cases, admit that undertakers might reasonably be asked to specify in detail, for the approval of the Board, the character of the extra precautions they propose to adopt.

2. *Power Conveyed by Mains.*—The committee consider that limitation of the size of mains, or the output which they may carry, is unnecessary and incompatible with natural development, though they think that the Board might reasonably require that undertakers should as far as possible arrange their system of mains to include an alternative route in case of accident. Where, however, more than 2,000kw. is habitually to be transmitted by one main the undertakers might be required to notify the same to the Board of Trade for the purpose of record; and the committee would regard as reasonable a regulation to the effect that, after exceeding a capacity of 8,000kw., a central station should not transmit more than one-fourth of its total energy by one set of mains without notification to the Board of Trade; but that not more than two sets of mains should be required up to 4,000kw.

3. *Laying and Protecting of Cables.*—The committee strongly urge on the Board of Trade that the regulations under this head should be open and elastic. Most of the power transmission work which has been done abroad has been carried out by means of overhead wires, and there do not exist at present such large and complicated networks of underground mains for power distributions as are contemplated in the power distributions in this country. There can be no doubt that the use of underground mains on a large scale will ultimately lead to great improvements diminishing their cost and increasing their efficiency, and it would be highly undesirable that rigid regulations should be laid down before experience has been acquired and thus stand in the way of legitimate experiment, development or invention, and place undertakers in this country at a disadvantage compared with undertakers abroad. Where the conductors are interwoven into a single cable, and where the neutral point of the system is earthed the committee submit that the use of a metal sheath in addition to the lead covering should be optional, provided suitable mechanical protection is afforded.

4. *Thickness of Dielectric in Cables.*—The committee would point out that they can find no rule in any country abroad or in America making a particular thickness of dielectric compulsory. They submit that the present Board of Trade rule is not founded on any scientific basis, and since it was made further advances have shown that great thickness of dielectric is sometimes actually a disadvantage. Abroad, makers after careful experiment have successfully adopted much thinner layers with advantage, while there is a great saving in cost. The committee suggest that undertakers and cable makers should be left to settle this matter between themselves.

5. *Permission to use Bare Overhead Conductors.*—The committee would particularly point out the fact that the Board of Trade regulations have hitherto practically entirely prohibited overhead work in the United Kingdom, except under such onerous regulations as to make it impracticable. There are large areas in this country and in the districts over which power supply bills have been granted, the character of which is similar to districts where bare overhead wires have been successfully and safely used on the Continent and in America at very high voltages for the past 10 years. The great development of power transmission on the Continent and in America has been largely by bare overhead wires in a form which has been entirely prohibited in this country, and great industries have arisen based on their use which have no counterpart here at all. The committee are strongly of opinion that permission to use overhead wires outside crowded city areas is vital to the commercial success of power schemes over large districts, and suggest that on this point the regulations should be brought into line with those current in other countries.

6. *Sub-stations and Transformers on Consumers' Premises.*—The committee consider that undertakers should be permitted to place transformers up to the voltages contemplated above on consumers' premises in sub-stations above or below ground provided they are properly designed, drained, and ventilated; and that the amount of power to be installed in sub-stations should be left to the undertaker's discretion.

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The Extra High-Pressure Regulations issued for the Manchester extensions were published in *The Electrician*, Vol. XLVI., p. 165. We now append those issued to the Midland Electric Corporation for Power Distribution and the Metropolitan Electric Supply Co.

### MIDLAND ELECTRIC CORPORATION FOR POWER DISTRIBUTION.

#### Description of System.

An extra high-pressure two-phase alternating current supply at a pressure not exceeding 7,000 volts by more than 10 per cent. at a frequency of 50 complete periods per second to sub-stations.

From these sub-stations, or directly from the generating station, a high-pressure two-phase alternating current supply will be given at a pressure not exceeding 2,700 volts by more than 10 per cent., and at a frequency of 50 complete periods per second to transformers, situated in some cases on the consumers' premises, or in street boxes, or in sub-stations either above or below ground. The sub-stations below ground will be constructed in accordance with plans submitted to the Board of Trade, and the maximum power to be submitted to any such underground sub-station will not exceed 75kw. without the written consent of the Board of Trade. The maximum power supplied to any transformer placed singly in a street box will not exceed 30kw. without the written consent of the Board of Trade, and the vacant space within the box will be so restricted as to prevent danger from explosion.

From the transformers a two-phase or a single-phase alternating current supply will be given to consumers at a constant pressure of 800 volts, and at a frequency of 50 complete periods per second. From rotary converters, rectifiers or batteries a continuous-current supply at a constant pressure not exceeding 550 volts will be given for tramways and distribution of power. Rotary converters and rectifiers will only be used where an attendant is on duty.



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The trunk mains for the extra high-pressure supply to the sub-stations and the high-pressure mains will consist of two highly-insulated conductors twisted together, enclosed within a lightly-insulated conductor. The external conductor will, with the approval of the Board of Trade, be connected with earth at the generating station, but insulated at all other parts. The cables will be insulated with paper impregnated with insulating compound, the whole being enclosed in a lead sheath and drawn into earthenware conduits or laid in earthenware troughs filled in solid with composition and protected by hard bricks or tiles. The low-pressure mains will be similar to the foregoing, or, alternatively, will consist of two simple concentric cables, where two-phase supply is given, or simple concentric where the supply is single-phase.

CONDITIONS UNDER WHICH THE CONSENT OF THE BOARD OF TRADE IS GIVEN.

1. The extra high pressure shall not exceed a pressure of more than 7,000 volts by more than 10 per cent. under any conditions of working, and the supply at that pressure shall not be given except through the trunk mains to transforming stations, which are to be in the sole occupation of the undertakers.

2. At least two separate and distinct trunk mains shall be laid to each distributing station, supply being given for the most part on the ring main system.

3. Each trunk main may be used for the transmission of electrical energy not exceeding 1,000kw., provided that efficient means are adopted to prevent this limit being at any time exceeded, and that at all times when the load is sufficiently reduced the main is protected by means of oil fuses, set to blow at a current corresponding to 500kw.

4. The trunk mains throughout such portion of their length as are laid outside the generating or distributing stations of the undertakers shall be formed of two twisted conductors enclosed within a concentric outer conductor, this outer conductor being rendered continuous throughout without appreciable openings (except such as may be necessary at test boxes) so as to completely enclose the two inner conductors.

5. All high-pressure mains and surface lines supplied by transformation from extra high-pressure mains shall be formed of similar conductors to the extra high-pressure trunk mains, or, alternatively, of two simple concentric cables, the outer conductor in both cases being rendered continuous, so as to completely enclose the inner conductors.

6. The outer conductor of every extra high-pressure trunk main shall be connected with earth at the generating station, and the outer conductor of every concentric high-pressure main, and the middle point of the secondary winding of every transformer supplying separately insulated high-pressure mains, shall be connected with earth at each distributing station; such earth connection being made by means of a conductor possessing a mechanical strength and offering a passage to electrical discharges equal to a strand of 19 No. 12 copper wires.

7. The efficiency of all earth connections made as described in the preceding regulation shall be tested at least once in every week by means of tests made at every distributing station, and a record shall be kept of such tests.

8. The transforming apparatus at the distributing stations shall be so arranged that there shall be no danger of the high-pressure distributing mains being charged to any pressure beyond the limits of ordinary high-pressure as defined in the general regulations.

9. The metallic portions, other than the conductors of every transformer, used in connection with the extra high-pressure supply and the casing thereof shall be efficiently connected to earth.

10. All test boxes used in connection with the extra high-pressure trunk mains shall be formed of strong metal, which shall be in good electrical connection with earth, and every such test box shall be placed in such a position that persons cannot be brought into accidental contact with it.

11. Every transforming station shall be under the sole charge of the undertakers, and in such of these where rotatory transformers or rectifiers are in use, a properly qualified electrician employed by the undertakers shall be in constant attendance.

12. Each distributing station shall be in direct telegraphic or telephonic communication with the generating station from which it is supplied.

13. The officers of the Board of Trade shall at all times have the right of entry into any of the generating or distributing stations of the undertakers, and they shall be permitted to make any examination or tests of the mains, dynamos, transformers and other apparatus in use in such stations as may appear to them necessary, and the undertakers shall afford all due facilities for any such examination and tests.

14. The undertakers shall bring to the notice of the Board of Trade any failure or abnormal action in any part of their supply system, or any accidental injury to persons or property caused thereby.

15. Nothing herein shall exempt the undertakers from the provisions of the general regulations, save in so far as the same are modified by these regulations.

## METROPOLITAN ELECTRIC SUPPLY CO.

DESCRIPTION OF SYSTEM.

An extra high-pressure two-phase alternating-current transmission at a frequency of 60, 75 or 100 complete periods per second and at a pressure not exceeding 10,000 volts by more than 10 per cent. to distributing stations from which—

1. A high-pressure alternating-current supply at a frequency of not less than 60 complete periods per second, and at a pressure not exceeding 1,200 volts, will be given to transformers situated in some cases on consumers' premises, but mainly in sub-stations constructed, as a rule, above ground. Sub-stations, where necessarily underground, will be constructed in accordance with plans submitted to the Board of Trade, and the maximum power transmitted to any such sub-station will not exceed 75kw. without the written consent of the Board of Trade. From these transformers an alternating current supply at a frequency of not less than 60 periods per second and at a constant pressure not exceeding 450 volts across the outer conductors of a three-wire system will be given to consumers, the intermediate conductor being, with the approval of the Board of Trade, connected to earth at the sub-stations but insulated at all other parts.

2. A continuous-current supply at constant pressure not exceeding 450 volts across the outer conductors of a three-wire system, from rotary transformers, motor generators, rectifiers or batteries, the intermediate conductor being, with the approval of the Board of Trade, connected to earth at the sub-stations, but insulated at all other parts. This transmission will be assisted by the direct supply from the low-pressure generating works of the company.

CONDITIONS UNDER WHICH THE CONSENT OF THE BOARD OF TRADE IS GIVEN.

1. The extra high pressure shall not exceed a pressure of 10,000 volts by more than 10 per cent. under any conditions of working, and the supply at that pressure shall not be given except through the trunk mains, that is to say, the mains laid between a generating station and a distributing station.

2. At least two separate and distinct trunk mains shall be laid to each distributing station, and these mains shall, where practicable, be laid by different routes.

3. Each trunk main may be used for the transmission of electrical power not exceeding 1,000kw., provided that efficient means are adopted to prevent this limit being at any time exceeded, and that at all times when the load is sufficiently reduced the main is protected by means of a magnetic cutout set to act at a current corresponding to an output of 500kw.

4. The trunk mains throughout such portions of their length as are laid outside the generating and distributing stations of the undertakers shall be formed of concentric conductors, of which the outer conductor shall be continuous throughout, without appreciable openings (except such as may be necessary at test boxes) so as to completely enclose the inner conductor, and the outer conductor shall be itself throughout completely enclosed in strong metal casing.

5. All high-pressure mains and service lines supplied by transformation from extra high-pressure mains shall be formed of concentric conductors of similar construction to the extra high-pressure trunk mains, and the outer conductor shall, in like manner, be throughout completely enclosed in strong metal casing.

Provided that the undertakers may continue the use of their existing separately-insulated high-pressure mains enclosed in strong metal casing, and may supply them by transformation from the extra high-pressure supply in accordance with these regulations and conditions.

6. The metal casing specified in the preceding regulations shall be either continuously in electrical connection with the soil, or shall be efficiently connected with earth at intervals not exceeding 200yds. throughout its length, and these earth connections shall be so arranged and constructed that they can be easily examined.

7. The outer conductor of every extra high-pressure trunk main shall be connected with earth at the generating station, and the outer conductor of every concenrric high-pressure main (and the middle point of the secondary winding of every transformer supplying separately insulated high-pressure mains) shall be connected with earth at each distributing station, such earth connections being made by a connection to the outer metallic casing of every extra high-pressure trunk main entering the generating or distributing station by means of a conductor possessing a mechanical strength and offering a passage to electrical discharges equal to that of a strand of 19 No. 12 copper wires.

8. The efficiency of all earth connections, made as described in the preceding regulation, shall be tested at least once in every week by means of tests made at every distributing station between the ends of the outer conductors of each trunk main and the metal casing thereof, and the resistance found by such tests shall not exceed the resistance of the outer conductor of the trunk main forming part of the circuit tested by more than 1 ohm, and a record shall be kept of the results of such tests.

9. The transforming apparatus at the distributing stations shall be so arranged that there shall be no danger of the high-pressure distributing mains being charged to any pressure beyond the limits of ordinary high pressure as defined in the general regulations.

10. The metallic portions, other than the conductors of every transformer, used in connection with the extra high-pressure supply, and the casing thereof, shall be efficiently connected with earth.

11. All test boxes used in connection with the extra high-pressure trunk mains shall be formed of strong metal, which shall be in good electrical connection with the metallic casing of the mains on each side, and every such test box shall be placed in such a position that persons cannot be brought into accidental contact with it.

12. Each distributing station shall be under the sole charge of the undertakers, and a properly qualified electrician employed by them shall be in constant attendance at each such station to regulate and control the supply of energy.

13. Each distributing station shall be in direct telegraphic or telephonic connection with every generating station from which it is supplied.

14. The officers of the Board of Trade shall at all times have the right of entry into any of the generating or distributing stations of the undertakers, and they shall be permitted to make any examination or tests of the mains, dynamos, transformers and other apparatus in use in such stations as may appear to them necessary, and the undertakers shall afford all due facilities for any such examination and tests.

15. The undertakers shall bring to the notice of the Board of Trade the failure or abnormal action in any part of their supply system, or any accidental injury to persons or property caused thereby.

16. Nothing herein shall exempt the undertakers from the provisions of the general regulations, save in so far as the same are modified by these regulations.

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The Board of Trade, with the concurrence of the Postmaster-General, have provisionally approved of the Metropolitan Company connecting the following parts of their circuits with earth, viz. :—

1. The outer conductors of the extra high-pressure trunk mains at the generating station.

2. The outer conductors of all concentric high-pressure mains supplied by transformation from the generating station at each distributing station.

Provided that the electrical circuits on which these earth connections are used are made to comply with the following conditions :—

(*a*) That the extra high-pressure and high-pressure mains, and any service lines or branches in connection therewith, be concentric throughout.

(*b*) That the outer conductor in all cases forms a complete metal sheathing round the inner conductor.

(*c*) That the connection with earth of each electrical circuit be made at one place only, and that its insulation be efficiently maintained at all other points.

(*d*) That the connection be such that the outer conductor of every extra high-pressure and high-pressure main shall be connected with earth.

(*e*) That the inner conductor of every extra high-pressure and high-pressure main, and all conductors in connection therewith, be properly protected and guarded at the generating station, and at every distributing station and transformer.

3. The intermediate conductor of the three-wire system of mains at the generating station, this conductor being thoroughly insulated at all other points, subject to the following conditions :—

(*a*) No fuses will be used on the branch connections from the intermediate conductor.

(*b*) All branch connections from the outer conductors will be protected by suitable fuses, which will be so arranged as to be easily inspected, and so as to be completely free from all risk of causing fire by defective action, arcing, &c.

(*c*) The current from the intermediate conductor to earth will be continuously recorded at the generating station, and if it at any time exceeds one-thousandth part of the maximum supply current, steps will be immediately taken to improve the insulation of the system.

This approval is given subject to the observance by the undertakers of the regulations for securing the safety of the public made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, and of the above-named act and orders, and of the further regulations for extra high-pressure supply made by the Board of Trade under regulation 3 of the said regulations, and may be revoked or varied at any time by the Board of Trade.

The concurrence of the Postmaster-General in this approval may be withdrawn at any time as to either the whole or any one or more of the earth connections to which this approval relates.

## STORAGE BATTERIES IN CENTRAL STATIONS.*

BY R. F. SCHUCHARDT.

An excellent illustration of the value of a storage battery in connection with an electric lighting system was shown in Chicago on Monday, June 24th, when an accident in the Harrison-street station of the Chicago Edison Co. caused the complete shut down of that station for about 40 minutes. The accident in question occurred in the boiler room, and because of its peculiar nature most of the steam had to escape before the seat of the trouble could be gotten at. The steam gauge in the office of the chief engineer gave the warning and the chief operating engineer's office on Adams-street was immediately notified of the trouble by telephone. Orders were telephoned to Washington-street station to put on all low-tension generators, and the battery operator at the Adams-street sub-station was asked to prepare for full load. The accident occurred at 12:25 p.m., and 15 minutes later not a wheel was turning at Harrison-street station, the generators having been taken off as the steam pressure dropped. The load carried by the stations at the time of the accident was as follows :—

Harrison-street station (station No. 1).—Low-tension to district No. 1, 18,000 amperes; low-tension to district No. 3, 2,000 amperes; three-phase to sub-stations, about 100kw. Washington-street station (station No. 5).—Low-tension to district No. 1, 11,000 amperes; low-tension to district No. 3, 400 amperes; high-tension (various), about 300kw. The Adams-street sub-station batteries were "floating" on the system.

In a remarkably short time after the orders were received station No. 5 was carrying its full capacity, delivering 23,000 amperes to district No. 1 and some 400 amperes to district No. 3 (west side), in addition to the high-tension load. Sub-station No. 2, on the south side, shut down its rotary converters, and carried the district No. 2 load of about 1,000 amperes on the battery of that sub-station. Of the north side three-phase transmission lines, that to station No. 4 was shut down, while the North Avenue sub-station rotary converters were kept running on the converse rotary converters at station No. 1, which latter received current from the Adams-street sub-station batteries fed *back* over the trunk lines. The steam engines of station No. 4 were pressed into service, and by raising the voltage of the long north-running feeders much of the load was taken off from the North Avenue rotary converters, thus relieving

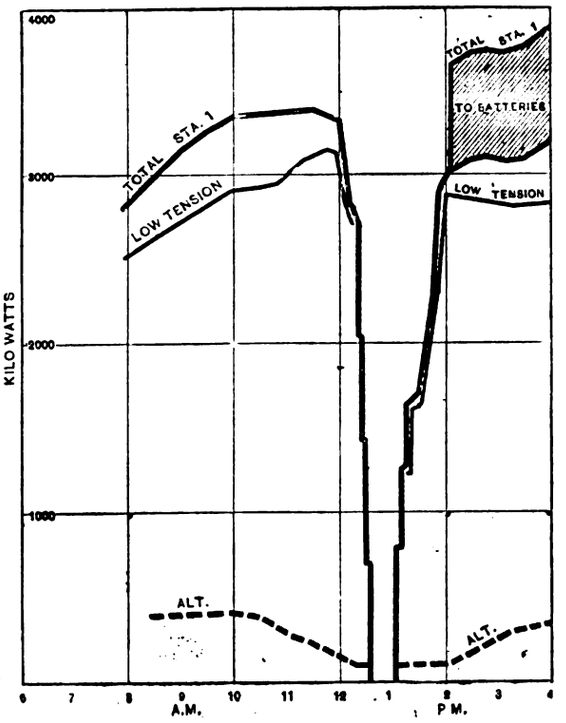


FIG. 1.—Load Curve. Station No. 1.

the battery feeding into station No. 1. Station No. 1 load to district No. 3 was carried on bus No. 2 of the station by the Adams-street batteries through the charging switchboard over trunk line tubes switched to this board. All of district No. 1 load not taken

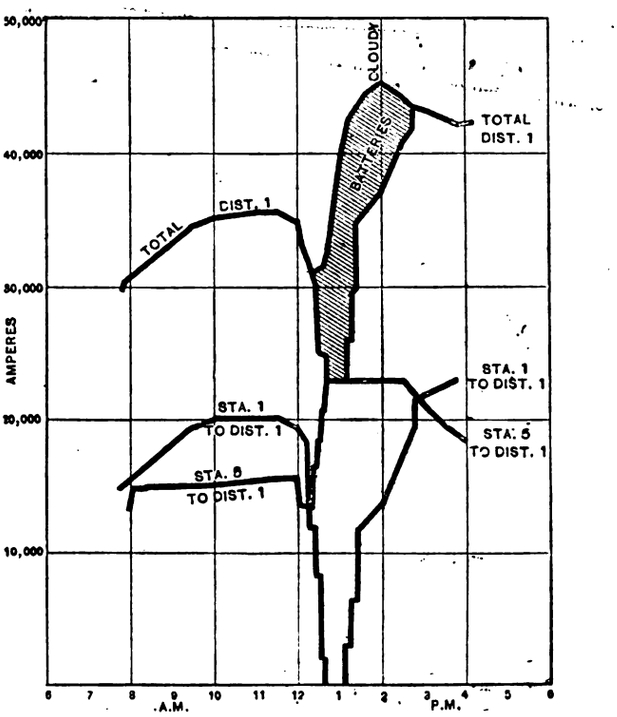


FIG. 2.—Load Curve. Station No. 5.

care of by station No. 5 was carried by the batteries, amounting to about 21,000 amperes average, with 23,000 amperes maximum. This load continued for about 40 minutes. The batteries had been "floating" on the system since the charge of the night before, and thus both of them—each with a capacity at a one-hour rate of dis-

* From the *Electrical World* of New York.



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charge of 11,200 amperes—were "full." On the first signal from station No. 1 each battery picked up 3,000 amperes, and then increased this as the station No. 1 dynamos were taken off, until each carried about 11,000 amperes.

At five minutes past 1 o'clock sufficient steam had been generated at station No. 1 to begin to take back the load, and after normal conditions again obtained the batteries were charged so as to be prepared for a possible peak later in the afternoon, as the day was cloudy. There was, however, still about 20 per cent. of the battery capacity left at the end of the heavy discharge. The load curves, Figs. 1 and 2, give a good idea of how the load was dropped by station No. 1, and picked up by station No. 5 and the batteries. The voltage of the system never fell below 3 volts under standard pressure and, outside of the company's engineers, no one even suspected the occurence of an accident.

## ELECTRIC RAILWAYS.*

BY MAJOR P. CARDEW.

### Lecture I.

When I undertook, with considerable hesitation and diffidence, to give a short course of lectures to this Society, it appeared to me that the subject of electric railways was one that was at the present time interesting to many, and also one with which I ought to be capable of dealing in a manner that might be considered instructive by a non-technical audience; but I am now very doubtful whether any instruction can be gleaned from the imperfect sketch of the subject which is all I can present to you. I can only plead in extenuation of my short-comings that I am not a lecturer by profession, and that my time has been very fully occupied with professional work, and I beg you to accord me your most charitable forbearance, and that you will not take it ill that I have assumed a condition of complete ignorance in electrical matters on the part of my audience. This seems to me a postulate of the position—*parmi les aveugles le borgne est roi.*

The art of locomotion has been advanced very considerably in the past century, and its progress has probably affected the conditions of human existence to a greater extent than any other advance in engineering. Looking back into its past history, it is astonishing to observe what little progress was effected between the time of the Romans—who at least thoroughly understood the art of road-making—and the advent of the steam locomotive; indeed, the accounts that we have of the amenities of travelling even so recently as the 18th century, convey the impression of extreme discomfort and tediousness, while the "Lightning Express" mail coach of the commencement of the 19th century was not at all times and seasons the acme of speed and comfort. We have advanced far under the reign of steam, but how much further shall we not advance under that of electricity.

In the case of tramways and street railways, the electric motor has been universally accepted as the best mechanical means of propulsion, and its superiority to the steam, gas, or compressed air motor is generally conceded. The cable system certainly possesses a distinct advantage for very steep gradients, but this system can be worked electrically, and grafted on to an electric system wherever necessary. For the working of underground railways again electricity is without a rival, and for the numerous deep level underground lines constructed or in progress to London no other system of propulsion has been so much as suggested.

So far, however, electric propulsion has not been established on any of our ordinary railways, and the question naturally arises, What is the real limit to the advantageous use of electric locomotion? Under what conditions, and for what reasons does it cease to be preferable to the existing system of steam locomotion? The two systems differ so radically, inasmuch as in steam locomotion the power is entirely self-contained, whereas the electric train derives its propelling power from an outside source, that we instinctively feel that there must be a field for each method, especially since the self-contained system has beaten all systems analogous to the electric under all conditions of traffic, and it is only in consequence of its great superiority to any other known system of transmission of power that electricity can claim to compete with steam in the field of railway working.

### Historical Summary.

The idea of electric traction is not by any means a new conception, model electric railways have been devised and shown in action many years ago—in fact, very shortly after Faraday's discovery in 1831 of the correlation of electricity and magnetism. So long, however, as the voltaic cell was the only available source of electrical energy, nothing practical could possibly result. The dynamo-electric machine was perfected about 30 years ago, and this placed in the hands of inventors a simple and efficient means for the conversion of mechanical into electrical energy, and for the converse operation at any distance through the medium of the electric circuit.

In the early days of dynamo machines, two erroneous ideas led many electricians astray. One was that although it was known that the dynamo was reversible, and could be used either as generator or motor, a really efficient motor ought to be designed on different principles from a generator. This led to the waste of much ingenuity in the designing of curious motors which did not realise the expectations of their inventors, and by their failure to some extent impeded the progress of the use of electric power. The second prevalent error was that it was a physical impossibility to obtain in electric transmission an efficiency exceeding 50 per cent. This arose from the old-text-book statement that the maximum power is obtained from a battery when the external equals the internal resistance. Similarly, the maximum power is given out by a motor when its speed is such that its counter E.M.F. is one-half of the applied E.M.F., and the efficiency is then, of course, 50 per cent. But maximum power is not the same thing as maximum efficiency.

The first practical electrical railway was that laid by Siemens in the grounds of the Berlin Exhibition of 1879, and this was exhibited in 1881 in Paris. The power was transmitted by means of an insulated rail, the ordinary rails being used as a return; in fact, by exactly the same means as is now used on railways where the lines are not accessible to the public. This successful demonstration was followed by the construction of the Portrush and Giant's Causeway electric tram road, which is still working. Unfortunately, in this case also the third-rail system was adopted, and as the charged rail was easily accessible to persons and animals passing along the road by the side of which it was laid, it was soon found to be dangerous to the latter, although the electrical pressure was only 300 volts, and eventually a fatal accident to an unfortunate excursionist, who was thrown off his bicycle by collision with the railway in the dark and fell across the charged rail, made it necessary for the Board of Trade to insist upon the charged conductor being placed out of reach, as in the overhead trolley system.

In 1884 the Blackpool tramway was opened for traffic. In this case the charged conductor was placed in a conduit between the rails, and contact was made by means of a "plough" passing through a slot in the top of the conduit, the "return" being provided by the running rails. This system had the advantage of preventing access to the conductor and of avoiding the æsthetic objection to overhead wires and their supports; but the selection of Blackpool as a field for the exhibition of the virtues of the conduit system was very unfortunate. It does not of course follow from the failure of the conduit system at Blackpool that it cannot give excellent results under other conditions; and its adoption in Washington, New York, and other towns, and Prof. Kennedy's recommendation of it for the London tramways prove that it has advantages in its own field which outweigh its admitted difficulties.

In 1889 a very interesting system was tried upon the Northfleet tramways. This was a conduit system, but differed from all others in that the various motor cars took their supply of energy in "series" in place of the usual parallel connection. The arrangements were very ingenious, and are fully described in *Nature*, May 9, 1889, but the "series" system contains in its essence so many disadvantages as compared with the "parallel," that it is not surprising to find that it has made no progress, and it is no longer seriously considered.

The Liverpool Overhead Railway, which was opened in 1893, is very interesting as an early experiment in two directions of development—viz., the construction of a railway on an elevated structure, leaving a clear roadway underneath, and the use of electricity for traction, under conditions where steam traction would have been quite practicable.

The electrical equipment of this line was mainly, I believe, the work of Mr. Thomas Parker. The conception was at the time a bold one, and thoroughly deserved the success which, under careful management, it has attained. The overhead trolley system had in the meantime been developed by the Americans with their usual thoroughness and fertility of resource, and in the year 1891 was introduced into this country by the equipment of a short line at Leeds. This occasioned a conflict with the telephone company, whose circuits were found to be seriously disturbed.

The necessity for obtaining a settlement of the question, whether electric tramways and railways were to be allowed the use of the uninsulated running rails as a return conductor for their currents, having regard to the fact that this user introduced serious danger of electrolytic injury to gas and water pipes and other metallic structures in the adjacent soil, and also certainly disturbed telephonic and, to some extent, telegraphic circuits, led to the appointment of a Joint Committee of both Houses of Parliament, by which such user was sanctioned, subject to suitable regulations to be made by the Board of Trade.

These regulations were submitted in draft to a conference of representatives of all interests affected, in accordance with the custom of the Board of Trade, and approved with some modification, and it may, I think, be said for them that while not hampering the develop-

* Cantor Lectures, delivered at the Society of Arts.

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ment of the electric traction industry, but on the contrary guiding it in the right way, they have so far proved sufficient to prevent any ascertainable injury to pipes, even where electric tramways have been working for several years. It is true that various disturbances and some injury have resulted from the working of the South London Railway, which offences are continually being put forward as proof of the inherent viciousness of the rail return system, but this exception is easily explained by the fact that when this railway was constructed the Board of Trade was not empowered to make any regulations for the prevention of disturbances or electrolytic injury. This railway is also noteworthy as being the first of the deep level tube lines which are now being pushed in so many directions under the congested arteries of this great city, and while others have to a large extent reaped the reward, we must not forget that it is in great measure to the genius and untiring energy of the late Mr. J. H. Greathead that London owes a system of railways peculiarly suited to its topographical divisions and the geological formation of its subsoil. These railways are the latest development of electric traction in operation in this country, though their novelty consists more in the construction of the line than in any advance made in the methods of transmission and utilisation of the electric power.

On the Continent some very interesting railways are now working on the "three-phase system," especially in Switzerland, the Burgdorf-Thun line, so well described by Prof. Carus Wilson, being a notable instance. Urban railways and tramways on the usual system are, of course, very generally in use, while everyone must be fully cognisant of the magnificent work accomplished in America.

### Advantages of Electrical Traction.

Coming to the subject I have undertaken, the first point to which I would direct your attention is, What are the advantages that may be expected to result from the change from steam to electricity as the propelling power for trains on ordinary railways, because unless these advantages can be shown to be real and substantial, it is, of course, hopeless to expect the railway companies to dismiss their old and faithful servant, the steam locomotive.

Considering the matter first from the point of view of the travelling public, we must admit, I think, that for long journeys of several hundred miles, such as those performed by the Scotch expresses, no very great advantage to passengers could be hoped for at present. A few tunnels would be less asphyxiating, and a comparatively short time would be saved in stops and starts; but these are minor matters. No considerable saving of time could be made in the case of a Scotch express without correspondingly increasing the maximum speed of the train. It is true that this maximum speed can be more easily and safely increased with electric than with steam traction, and we already hear of serious proposals to establish a service of electrically-propelled trains between important centres of population and commerce at a speed exceeding 100 miles per hour.

I have no doubt that such speeds are possible. The shape, construction and equipment of the rolling stock will require special modifications, and the adaptation of means to the required end will, as in all similar advances, be a gradual process. What appears doubtful is not whether a speed of 120 miles can be accomplished, but whether it will pay to provide such a service within the limits of the British Isles. It does not need to be demonstrated that the special service would not be done for the same money. Special fares must be charged, and how many passengers would care to avail themselves of the privilege?

Our long distances are easily accomplished in the time usually devoted to sleep, and the sleeping car trains are all that the man of business requires to enable him to put in a full working day in London and be perfectly fit for work in Glasgow next morning. The habits and necessities of existence prescribe the times of departure and arrival of the Scotch expresses, and it is not to provide for such traffic that electric traction is about to displace steam.

When we regard the traffic arrangements on the lines communicating between important towns not exceeding 100 miles apart and their branches, however, the possibilities of improvement from the introduction of electric traction and of the new methods of working traffic which must accompany the change become far more considerable. The most important advantages to the passenger may be summed up as--

1. Greatly increased frequency of service.
2. Regular time schedule.
3. Time occupied on journey considerably reduced without increase of maximum speed, especially in the case of trains stopping at intermediate stations or branching off from the main line.

Given the problem of conveying a fixed number of passengers per diem between two places, the economical means with steam traction is a few heavy trains at considerable intervals; whereas, with electric traction, or any other method whereby power is transmitted from a central station, economy is best secured by running light trains at frequent intervals. Now in the case of long journeys occupying practically the whole working day, or the portion of the night devoted to sleep, the times of departure are practically fixed, and the advantage to be gained by electric working is small, but for journeys of two hours or less duration the advantages of a frequent service at fixed intervals are very considerable. It will only pay under the conditions of frequent, regular, and punctual service, and the electrifying of a line must involve what we may call the electrifying of the traffic arrangements. The question which many directorates will have to determine, and which some are already considering is, whether to take the plunge; whether the response of the public to the offer of these greatly enhanced travelling facilities will be such as to justify the necessary expenditure. Steam traffic has been evolved from the stage coach, and bears the unmistakable impress of its descent. Electric traction tends towards the ideal of the continuous moving platform.

I will next attempt to show in what particulars the railway companies may expect to derive advantage from the change of system. The chief and dominating one is no doubt very greatly increased receipts, arising from the improved service and increased earning capacity of the line; but how about expenditure? The capital expense involved is certainly considerable, and can be easily calculated, but the effect of the change upon working cost is perhaps more doubtful. The following are the main points in favour of electricity where the conditions are such that a frequent service of comparatively light trains will qe decidedly preferable to the provision of heavy trains running at longer intervals:—

1. Power costs far less when generated in bulk in a properly-equipped station than in detail in a number of separate locomotives.

Mr. W. Langdon, electrical engineer of the Midland Railway, has estimated the cost of running the existing traffic over a section of the Midland Railway, 50 miles in length, by electricity, and gives it as 7d. per train mile for working cost, and 1d. to provide interest on the necessary capital expenditure, or a total cost of 8d. as against 9d. for steam, but we can do better than this where the conditions admit of full advantage being taken of the possibilities of electric traction.

2. The daily run of electric motors is far in excess of what can be practically obtained with steam locomotives.

From the Board of Trade returns for 1899 it appears that the average run of steam locomotives is under 54 miles per diem, while on electric lines a daily run of 300 miles is quite usual. Much time is required by a steam locomotive for repairs, cleaning, raising and lowering steam, taking in supplies of coal and water, &c. During all this time it is earning nothing, and is costing heavily in wages and maintenance charges.

3. The motive power is not restricted to a limited number of locomotives, but may be distributed over a large proportion of the passenger carriages. Hence it can always be exactly proportioned to the length and weight of the train, which, again, can be varied to suit the traffic requirements.

4. The wear of permanent way is greatly reduced on account of the distribution of driving power over the length of the train, especially when, as should be the case, the whole of the weight of the motors is spring-borne.

5. Loss of adhesion or slip of driving-wheels on the rails is entirely avoided owing, in the first place, to the distribution of driving power, and to the utilisation of so large a proportion of the whole weight moved for adhesion, and, in the second place, to the fact that the turning effort of an electric motor is perfectly uniform, and not a succession of jerks.

6. Much greater power can be provided for accelerating the train and for mounting steep grades.

7. Many economies can be effected in heavy items of running expense.

The item of repairs is a case in point. Mr. Langdon puts the cost of repairs and renewals at 2·641d. per train mile for steam and 2d. for electricity, but I think he has much understated the advantage to be derived from the substitution of so simple a machine as the electric motor for the complicated steam machine. Mr. E. C. Boynton, in a Paper read before the American Institution of Electrical Engineers, on February 28, 1900, states:—

> I have under my personal observation a considerable number of such motors, some of which have been in service over two years, making a daily mileage of over 300 miles, and have never had one armature burn out. In one case a pair of motors were in service eight months, including a winter. No repairs whatever were made during that time beyond the ordinary daily inspection, cleaning, and renewals of carbon brushes.
>
> In another case a pair of motors made upwards of 100,000 miles after being put into service, the only repairs being renewal of armature and axle brasses, gears and pinions.

Taking other points, Mr. Langdon, in the Paper I have already referred to, states:—

> We may now perhaps glance at possible economies on that which is indispensable for the steam locomotive, but which is unnecessary, or not so largely necessary with electricity. Water pillars, turn-tables, engine sheds, coal stages—all these are expensive items, which with electricity, are either not required, or capable of modification.
>
> Water pillars, supplemented in many instances by fixed engine-power for pumping the water into reserve tanks, involving power houses, sheds, and other structures, form part of all large stations, and many other points at which the locomotive requires to take water. With electricity, water to any extent would be required only at that point at which the

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central generating station is placed. If this station served 50 miles of railway, then it would take the place of all the pumping plants, water pillars, &c., otherwise required throughout that section for the steam locomotive. Every pumping station involves the provision of labour, fuel, &c. All water pillars require special attention during hard weather. Economies in first outlay, and annual charges on this account should accompany the use of electricity. Turn-tables would be unnecessary. The annual outlay for repairs in this respect is not great, but the cost of laying down the large turn-tables now required, is very heavy.

As the number of locomotives increase, so increases the demand for engine shed. Electric locomotives would, of course, need housing as well as the steam locomotive, but the space which they would occupy would probably be about half that now required. Wherever we find an engine-shed, there we see an area of land covered with coal; lines of rails applicable thereto; coal stages to which the coal has to be carried, and from which it has to be distributed to the locomotives. First the coal has to be stacked, then loaded into trucks and carried to the coal-stage and thence weighed and placed on the engine's tender. This is the course of procedure at each engine depôt. If we compare it with the work of a large central station, such as that sketched out in this Paper, I think it will come home to us that although the work would be large, it could not be nearly so large as at present. If stacking were at all necessary there would be the less quantity to stack, and it would all be dealt with in a more concrete form and at comparatively few centres. Again, in this respect there is reason to look for economies in land, in buildings and labour.

8. All danger from a following train can be prevented automatically by providing that each train cuts off the supply of electric power to the block section in rear. On the other hand, we have the cost of equipment, the losses in transmission and conversion of power, and the fact that the power is not self-contained, but has to be picked up from one or more charged conductors.

In this country we have looked upon electric traction as a condition of refined excellence which can only be contemplated for dealing with the congested traffic of great cities, or at the utmost that it may extend to the suburbs and residential districts. That this is by no means necessarily the case will be clearly shown by a few lantern slides illustrating what has been already accomplished in this direction in Switzerland. You will, of course, appreciate that the conditions are different from what obtains here. Water-power is abundant, tourist traffic is lucrative where facilities can be afforded for visiting places of interest otherwise inaccessible to most, and steam-power is relatively costly.

### Details of Electric Traction.

We will next examine the details of electric traction as applied to railways, in order to understand the essential differences in method and appliances as compared with steam traction. The first and most obvious requirement is the motor. The principles and construction of the electric motor have been recently most ably and fully expounded by Prof. Carus Wilson to this Society, and I need not, therefore, do more than mention a few elementary points.

### Motors.

The electric motor is, as is well known, exactly similar in principle and construction to a dynamo machine or generator. Such a machine, if mechanical power be applied to it, will give out electric current, and is then called a generator. If, on the other hand, electric current be supplied to it, it gives mechanical power, and is then a motor. As a matter of fact, the first machine constructed on the principles of the modern dynamo was intended to be a motor.

The essential principle of action of all electric machinery is found in the natural law, first thoroughly expounded by Faraday, which connects the mysterious natural agencies known as electricity and magnetism—viz., that when electricity passes in a conductor it creates magnetic force in the space surrounding that conductor, and conversely, when a magnetic field of force passing through a conducting body is altered electricity moves in that conducting body. This interaction is made effective by forming the conductor into a coil of many turns, which multiplies the effect, and by the use of soft iron, which directs and intensifies the magnetic field.

All dynamos and motors, therefore, broadly consist of coils of wire and magnetic fields moved relatively in each other. The currents produced in the coils of dynamos are what are known as alternating currents, that is, they reverse in direction once or several times in each revolution, and form a succession of waves. In continuous-current machines, however, these waves of current are altered by commutation, as it is called, into a practically uniform flow in one direction outside the armature, or moving portion of the machine, when used as a generator. In the case of a motor, a continuous current is given to the machine, and altered by commutation to an alternating current in the armature.

In alternating machines no such commutation is necessary, hence they are less complicated machines; but while any properly designed continuous-current machine will act efficiently as a motor, this is by no means the case with alternating machines, and until very lately continuous-current motors alone were used for traction, and we will, therefore, first deal with them. They consist essentially of a fixed and a moving member. The fixed portion provides the magnetic field, and, for simplicity, we will at first consider this invariable.

The function of a motor is to supply force wherewith to move or alter the motion of bodies in accordance with Newton's first law of motion. It also has, in order to maintain uniform motion, always to neutralise the opposing force of friction, and generally, other opposing forces. The torque or turning moment of a motor depends upon the strength of the magnetic field and the amount of the current passing in the armature. When the armature is revolving in a magnetic field, however, it opposes the passage of current with a counter E.M.F., as it is called, proportional to the strength of the magnetic field and the speed of rotation. Perhaps the simplest way to get a clear idea of this action is to consider the armature connected by means of its brushes to an external circuit. If, then, the armature is turned by mechanical power, it will produce an electric current in one direction or the other according to the direction of the motion. If, on the other hand, an electric current is caused to pass in the circuit by means of another source of E.M.F., the armature will turn in the contrary direction to that in which it must be turned to generate a similarly directed current. By turning it tends to produce current just as if it were turned by mechanical power, *i.e.*, it opposes the applied E.M.F. to this extent.

The applied E.M.F. must always be greater than the counter E.M.F. generated in the motor which results from it because of frictional resistance, even when the motor is running light, for if the two E.M.F.s were equal no current would pass, and no electrical energy would be consumed in maintaining the motion. The limit of speed to which an electric motor tends under the conditions of constant applied E.M.F. and constant magnetic field is, therefore, such a speed as to produce a counter E.M.F. equal to the applied E.M.F. When the motor does work in overcoming resistance, the speed falls perceptibly and the counter E.M.F. with it; current accordingly passes proportional in amount to the difference in the two E.M.F.s, and electrical power is absorbed by the motor, some of which power is wasted, as in all mechanical operations, while the rest is efficient in doing work. Shortly, if E be the applied E.M.F., and $e$ be the counter E.M.F., a proportion $e/E$ of the absorbed electrical power is utilised as mechanical power. $E-e/E$ is wasted, or the efficiency of conversion of electrical into mechanical power is $e/E$. Of the mechanical power obtained, however, some is expended in overcoming friction, so that the real efficiency of the motor is rather less.

The higher the speed of the electrical motor, therefore, the greater is its efficiency of conversion of electrical into mechanical energy, but since the power absorbed is proportional to the current as well as to the E.M.F., we have the result that with a very high efficiency of conversion very little power is obtained. In fact, the mechanical output of the motor is proportional to $e(E-e)$ which is easily shown to be a maximum when $e=E/2$ or when the efficiency of conversion is $\frac{1}{2}$. No motor, however, as at present made, could run for long at so low an efficiency, simply because it would be burnt up by its own waste energy. The rated full load of a motor is such as to give an efficiency of well over 80, and sometimes over 90 per cent.

So far we have considered the applied E.M.F. and the magnetic field to remain constant. If the E.M.F. be varied, the speed to which the motor tends is correspondingly varied. If the magnetic field be varied, the speed is inversely varied. It can still exert the same power, but at a greater speed in a weaker field, because the torque due to a given current has been reduced in proportion to the weakening of the field.

### Field Magnets.

Now, in electric motors the magnetic field is produced by the electrical energy supplied, and the field magnets may be either "series" or "shunt" wound—that is to say, the whole current supplied may pass through the field magnets and armature in series, or it may be divided between the field magnets and armature in parallel. Or again, the field may be excited by a separate current from another source. In electric traction "series" wound field magnets are generally employed, although with "shunt" wound or separately excited fields greatly increased efficiency can be obtained under some conditions, but they have some disadvantages which have been held to outweigh this.

In my opinion, the advantages which may be obtained from the use of separate excitation for railway motors have not as yet been thoroughly appreciated. Control may in this case be largely affected by variation of the strength of field instead of by wasteful resistances inserted in the supply circuit, and return of energy to the supply circuit is possible when retarding the train. For stopping trains on suburban lines there is a great possibility of economy in a well-devised system based upon separate excitation.

It has been already pointed out that the current in a motor is proportional to the difference between the applied and the counter E.M.F.s. At the moment of starting there is no counter E.M.F., and if the full E.M.F. were applied the motor would be damaged by the excessive current. In order to prevent this, external resistances are introduced to limit the current. This is one of the weak points in electrical traction. The greatest torque or turning effort is required from the motor at starting, but torque is proportional to the current, therefore the current has to be greater at starting than at

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other times, and as this current has generally to be provided by the full E.M.F. of the supply, the power absorbed is then a maximum, and of this maximum power the greater portion is wasted in resistances. The real power required at starting is not great, as although the force is large it moves slowly; as the train accelerates the power utilised increases proportionally to the speed, and the counter E.M.F. of the motors also increasing with the speed, the added resistances can be gradually cut out, and the efficiency of conversion increased. When full speed is nearly attained the counter E.M.F. automatically reduces the current and torque until at full speed the latter exactly balances the resistance to motion encountered by the train, the efficiency of the motors, if they are properly adjusted, being then about 90 per cent. It will be understood that I am now describing what takes place on a level or nearly level line. On grades the effect of the force of gravity is added to or subtracted from the motor effect, the acceleration on an up-grade is lessened because the motor force cannot be safely increased, and the ultimate speed is also slightly reduced because more force is required to maintain speed, and force means current, and increased current is only possible with diminished counter E.M.F. On a down-grade acceleration is increased, and speed can also be increased with series wound motors up to the limits of safety. Thus, on electric railways stations are arranged as far as possible on the tops of slight eminences in order to lessen waste in accelerating and stopping the train. This cannot always be arranged, however, and we have to admit that there is at present great waste in starting an electric train. This waste, moreover, is not confined to the train itself, but implies waste and extra cost throughout the equipment. Thus, at the generating station extra power has to be provided for the large starting currents, and, although when one station provides power for many trains the proportionate increase may be somewhat lessened, it is impossible to ensure that several trains will not start at practically the same time. In some cases a large proportion of the trains habitually do so. For the same reason the size of mains and distributing plant has to be increased, and we have the inefficiency and waste unavoidable in a very fluctuating and suddenly varying load.

### Ward Leonard System.

A very ingenious method of diminishing the waste of energy and the current required at starting has been proposed by Mr. Ward Leonard. In his system each train carries a large motor, which is always running at full speed, the fields being shunt or separately excited. This motor does not itself propel the train, but is connected to drive a generator, and this generator is connected electrically to the motors which drive the train. The regulation of speed is effected by varying the strength of the magnetic field of the generator. While the train is at rest no exciting current is allowed to pass; and thus, although the generator is running at full speed, it provides no current for the motors. At first starting a small exciting current is used, and the E.M.F. of the generator is correspondingly small. Full current is, however, generated, since the counter E.M.F. of the motor is nil. The motors, therefore, start with full torque, while the power taken, although passed through so many conversions, is decidedly less than in the case of the ordinary method of inserting resistances in the motor circuit.

The expense of the motor generator, added to the equipment of the train and the additional and very considerable weight which has to be carried, are decided objections to this system. Other objections are the extra complication of electrical circuits, the losses of energy in the motor generator arrangement, especially if it is to be kept in operation throughout an extended run, and probably some trouble from sparking, caused by a very weak magnetic field.

For lines where stops are frequent and rapid acceleration necessary to meet the traffic requirements there certainly seems to be an opening for a system dispensing with the wasteful rheostat and its crude method of reducing the electrical pressure on the motors, and thus increasing the efficiency of power conversion during the period of acceleration, in which, under such conditions, most of the energy is expended.

*(To be continued.)*

## OPERATING COSTS OF A SHUNT MOTOR.*

The first part of a Paper with the title "The Efficiency Curve of a Shunt Motor and its Relation to Operating Characteristics and the Cost of Operation," read by Prof. Budd Frankenfeld, at the Sheboygan Convention of the North-Western Electrical Association, was devoted to an investigation of the factors entering into efficiency, and the conclusion is established that the maximum efficiency is reached when the loss varying as the square of the armature current equals the fixed losses. After a study of the nature of the various losses, the method of testing for efficiency was outlined. By far the most convenient and accurate method of testing efficiency is the stray power method. In this method the losses are measured after the machine has reached normal full-load temperature, and the efficiency curve is computed from the measured losses.

In making an acceptance test on any machine, it should first be submitted to a temperature run. This matter is so thoroughly covered by the rules of the American Institute of Electrical Engineers that nothing need be added as to requirements or methods. Before starting the temperature run, the motor should be adjusted for the best possible working conditions. The brushes should be properly set and fitted to the commutator and their tension adjusted for the least possible friction consistent with good commutation. Any necessary alignment of the bearings should also be attended to. This is but fair to the manufacturer. Unless some means, such as a Prony brake, for measuring the power delivered by the motor is provided, the question as to just what the full-load current is will rise. This may be had from the manufacturer; absolute check on him will be obtained after the efficiency is calculated, and if there is any discrepancy a second temperature run may be made, using the corrected full-load current. Another method is to calculate the current from an assumed efficiency, and then make a second run at the corrected current. The motor may be loaded up either on an actual load or by some one of the three machine methods. In giving the method of test it will perhaps make it clearer to follow out the steps in the test of a specific motor.

The motor is a four-pole, 110 volt, 5 H.P. machine, running at 1,000 revs. per min. The full-load current is 41·5 amperes, of which 1·5 amperes is field current. It has been running for four hours at full load, and has been found to have reached a constant temperature, the thermometer on the field coils and the field current both having been steady for the last half-hour. The voltmeter across the terminals of the machine reads exactly 110 after correcting from the calibration curve of the instrument, and the corrected reading for the ammeter is exactly 1·5. The field loss is, therefore, $110 \times 1{\cdot}5 = 165$ watts. Only the corrected readings are used in this test. With a low-reading voltmeter tests are now made for loss in the lead wires of the machine and their contacts. The drop is found to be almost nothing, which speaks well for the design and workmanship. In this case the loss is so small that it may be neglected. The motor is now shut down and a large water rheostat is placed in series with the armature. A low-reading voltmeter, having a resistance of about 100 ohms per volt, is connected across segments that are under brushes of opposite polarity, the contact being made on the segments, not on the brushes. A current is now sent through the armature and readings of both voltmeter and ammeter obtained. This being a four-brush machine, voltmeter readings are taken under each pair of brushes. Four such readings are possible. This operation is repeated with five or six different currents, and the resistances found by dividing volts by amperes are computed and averaged. This average is 0·25 ohms. This same set of readings is necessary to compute the rise in temperature in the heating test. The machine is now started up as a motor without belt or load. The voltage is adjusted to exactly 110, and it is found that the armature current is 2·42 amperes. The watts consumed by the armature are hence $100 \times 2{\cdot}42 = 266{\cdot}2$. Of this $2{\cdot}42^2 \times 0{\cdot}25 = 1{\cdot}45$ watts are used up as $I^2R$ loss. This leaves nearly 265 watts as the stray power. The various components of the stray power can be separated out by a somewhat involved method, but this a problem of more interest to the manufacturer than to the purchaser.

The low-reading voltmeter is again called into requisition. It is provided with a pair of flexible cords terminating in stiff, pointed copper rods about 6in. long. Arrangements having been previously made, the machine is shut down and started up as a separately excited dynamo without load. One of the copper points is held on a brush close to the commutator, the other on the commutator opposite the centre of this brush. The central position is determined by shifting the latter point until the voltmeter reads zero. Full load current is now thrown on, care being taken not to change the position of the point. The voltmeter reading is found to be very unsteady, and a condenser of about 1 microfarad capacity is then shunted across its terminals, the trial being made again. This time a fairly steady reading of 1·25 volts is obtained, and it is found to be about the same for all the brushes, and also for various loads, excepting at currents below 4 amperes, where it appears to be negligible. Thus no correction need be made for brush drop in the stray power measurements. The total brush drop is then $1{\cdot}25 \times 2 = 2{\cdot}5$ volts.

The efficiency curve of the machine may now be calculated. Assuming an armature current of 10 amperes, the total intake in current will be $10 + 1{\cdot}5 = 11{\cdot}5$ amperes, and the efficiency will be

$$\frac{110 \times 11{\cdot}5 - 265 - 165 - 10 \times 2{\cdot}5 - 10^2 \times 0{\cdot}25}{110 \times 11{\cdot}5} = \frac{285}{1{,}265} = 62{\cdot}1 \text{ per cent.}$$

The rated output of the machine being 5 H.P., or 3,730 watts, the load at this assumed current will be 285/3,730 = 21 per cent. of full load. The efficiency at any other current may be found in a similar manner, but the computation may be simplified by a graphical construction. In Fig. 1 the armature current is plotted along the horizontal line and the losses in watts vertically. The first line from the bottom represents the 265 watts stray power; the next line above it is drawn at a distance representing 165 watts, the field loss. Both

* From the *Electrical World* of New York.

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these losses are shown to remain the same regardless of the armature current. The other losses vary; the brush $I^2R$ directly with the current, as shown by the slanting straight line, and the armature $I^2R$ as the square, as represented by the distances between the slanting and curved lines. The distances between the slanting line and the upper curved line are calculated for several currents, their values being plotted and a curve thus drawn. The sum of all the losses at any assumed armature current can now be obtained by reading the

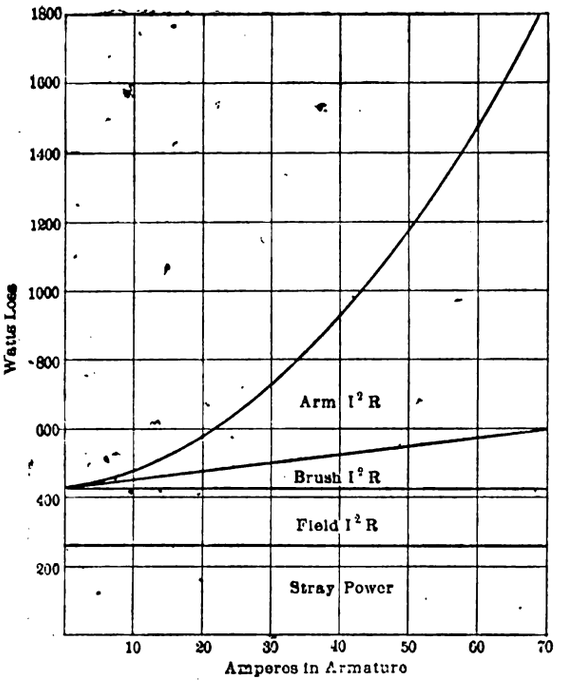


FIG. 1.– Efficiency Curves.

vertical distance at that current from the base line to the upper curve. An efficiency curve is thus calculated, and it is shown as efficiency curve, I, in Fig. 2.

In order to bring out points in the selection of an electric motor, four machines of 5 H.P. each were designed and some of their characteristic curves plotted in Fig. 2. Only those features influenced by the form of the efficiency curve will be considered. Temperature and sparking limits are fully covered by the rules of the American Institute. Motor 1 represents the average slow-speed machine of a reputable manufacturer. Its maximum efficiency is

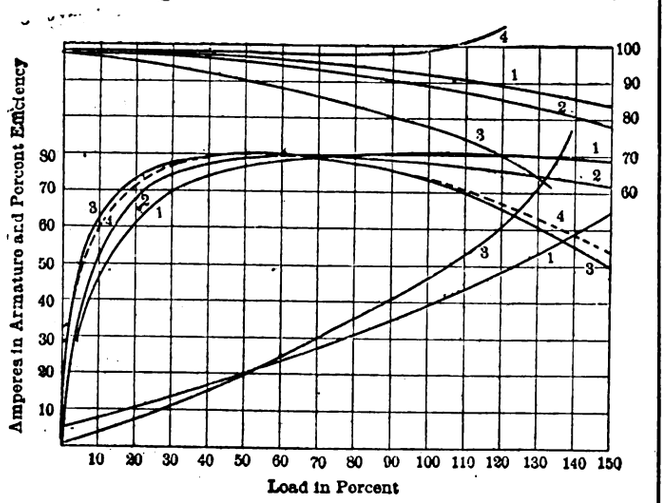


FIG. 2.—Efficiency Curves.

reached at full load and is 80 per cent. The other motors have the same maximum efficiency. In 2 it occurs at three-quarter load and in 3 and 4 at half load. The speed regulation of machine 1 is shown by the curve marked 1 at the top of the cut. Machine 2 has a smaller stray power and a higher armature resistance. The greater drop in volts for a given current, due to armature resistance, of necessity causes this motor to slow down more. Its regulation, as shown by the curve, is about 3·7 per cent. lower at full load than that of 1, but this is not objectionable for most general purposes. It will be noticed that the efficiency curve is considerably higher at light load than that of 1, and that it is less than 1 per cent. lower at full load. Motor 3 has a still higher light-load efficiency and has the advantage of 1 in this respect up to 60 per cent. load. At full load it is below 1 by 7·5 per cent. The speed regulation is something abominable. Motor 4 has its maximum efficiency at the same load as 3, but it is differentially compounded for the same speed at full load as at no load. Its speed regulation is better than any of the others. A similar, though less marked, effect may be obtained by giving the brushes a large motor lead. It has a slightly lower light-load efficiency and a somewhat higher efficiency beyond 50 per cent. load than 3. This is because of the change in magnetic flux with the load. This machine, if built in the ordinary way, is liable to spark under load, but there are designs that overcome this difficulty admirably. These designs involve some method of eliminating armature reactions. While more expensive to build, a lighter machine is the result and a higher efficiency is possible. Such machines are characterised by a relatively small amount of iron, a relatively large amount of copper on the armature and a small amount on the field. The curves 4 really do not represent the commercial possibilities of this type.

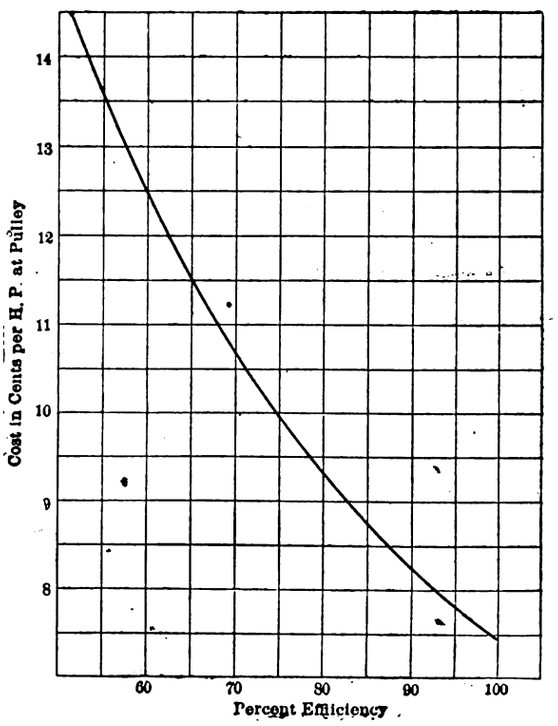


FIG. 3.—Cost of Power at the Pulley.

One serious objection to a heavy differential compounding is the weak starting torque. A motor of this kind should not be used where a large starting torque is required. Another objection is the liability to reverse on a heavy overload. This may be obviated by the use of a circuit breaker or a starting box having an over-load device. All motors should be so provided in any case. The curves at the bottom of Fig. 2 show the armature current for different loads. Curve 1 applies to motor 1, and closely approximates motor 2. Curve 3 is plotted for motor 3 and closely approximates the performance of 4. At 50 per cent. overload machine No. 1 has the same current as 3 at 25 per cent. overload. This means that it will stand a heavier overload than 3 for the same rise in temperature. No. 3 also requires 15 per cent. more current at full load, but the current at light load is less. The curve in Fig. 3 gives the cost of 1 H.P. at the pulley of a motor, for various efficiencies, the basis being 10 cents per kilowatt-hour. This price is taken merely for convenience. The correction for 12 cents would be obtained by multiplying by 1·2, for 8 cents by 9·8, and so on. It should be noticed how rapidly the cost increases as the efficiency drops off.

A comparison of the cost of operating motors 1, 2 and 3 will now be made on the basis of steady loads of several different values. The cost of operation is based on 10 cents per kilowatt-hour, and is figured for a working year of 300 days at 10 hours per day. The accompanying table shows the cost at 25, 50, 75 and 100 per cent. load for each machine. It shows the advantage of working the motor at its point of maximum efficiency. A larger machine than the immediate needs demand is often installed in a small establishment on the faith of a growth in business. There is some reason in

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this. Motor 1, for instance, has an efficiency at half load of 76·7 per cent. It is doubtful if this could be beaten in a 2½ H.P. motor operating at full load.

Cost of operation of 5 H.P. motors, 10 hours per day, 300 days per year, at $0.10 per kilowatt-hour :—

| | 25% Load. | 50% Load. | 75% Load. | 100% Load. |
|---|---|---|---|---|
| No. 1 | $426.50 | $729.60 | $1,054.80 | $1,398.60 |
| Less than No. 2 | — | — | — | 15.60 |
| Less than No. 3 | — | — | 24.30 | 146.40 |
| No. 2 | 394.20 | 710.10 | 1,048.20 | 1,414.50 |
| Less than No. 1 | 32.10 | 19.50 | 6.60 | — |
| Less than No. 3 | — | — | 30.90 | 130.50 |
| No. 3 | 367.80 | 699.30 | 1,079.10 | 1,545.00 |
| Less than No. 1 | 58.50 | 30.30 | — | — |
| Less than No. 2 | 26.40 | 10.80 | — | — |

Motor 2 operating at half-load will save $19.50 per year over 1 ; $6.60 per year at three-quarters load, and will lose $15.90 per year at full load. In a term of eight years, three at half load, one at three-fourths load, and four at full load, the total cost of operation for machines 1 and 2 would be about the same ; after that, if full load continued, 1 would be the cheaper machine. Where the future is in doubt, machine 2 is the better. It also saves $19.50 per year over a 2½ H.P. machine with a full-load efficiency of 76 7 per cent. A number of interesting comparisons of like nature can be made by a study of the table.

Let us now pass to the question of variable load. The following schedule is assumed :—

| | |
|---|---|
| 4 hours at ¼ load. | 1 hour at full load. |
| 2 „ ½ load. | 1 „ 1¼ load. |
| 2 „ ¾ load. | |

The average load is

$$\frac{4\times1\cdot25+2\times2\cdot5+2\times3\cdot75+5+6\cdot25}{10}=2\cdot475 \text{ H.P.}$$

This schedule may be taken as representing, roughly, the load in a small wood-working shop, with a light running line shaft and several tools operating intermittently. The cost of operation for 300 days of 10 hours is as follows :—

$$1\cdot25\times4\times0\cdot1137^{*}=\$0.5675$$
$$2\cdot50\times2\times0\cdot0973=0.4865$$
$$3\cdot75\times2\times0\cdot0937=0.7025$$
$$5\cdot00\times1\times0\cdot0933=0.4665$$
$$6\cdot25\times1\times0\cdot0941=0.5880$$
$$2.8110$$
$$300$$

| | |
|---|---|
| No. 1 = | $843.3000 |
| No. 2 = | 833.73 |
| No. 3 = | 875.55 |

Machine No. 1 is $32.25 per year cheaper than No. 3, and 2 is cheaper than 1 and 3 by $9.57 and $41.82 respectively.

It is thus seen that the motor having its maximum efficiency at three-fourths load is the best all-round machine. This refutes the statement sometimes made that the maximum efficiency should occur at the average load ; for 3 has its maximum at nearly average load, and is the most expensive to operate. Just where the maximum should occur depends upon the load schedule, and as this is seldom known and almost impossible to predetermine, it is at least safe to select a machine giving its maximum at about three-fourths load. Motor 2 meets these requirements. Its speed regulation is good enough for most purposes, and all other requirements can be easily met by the designer. Where absolute constancy of speed is demanded a differential compounding with some means for eliminating armature reactions should be employed. Of course, there are all kinds of variable loads, and it is possible that under certain circumstances machine No. 3 may be the most economical. If direct connected to a tool where the load is light most of the time and full load is attained for an instant only, this motor would have a decided advantage. A heavy punch runs light excepting when the tool is being forced through the metal, and a planer requires a heavy current only during the moment of reversal. For such tools machine No. 3 is a suitable one. In some instances of this class it might even prove of advantage to compound it cumulatively, as close speed regulation is of no particular consequence. The moral of this whole matter is to ascertain beforehand the nature of the load and to specify the *value* and *position* of the point of maximum efficiency before purchasing a motor. *It is useless to specify any more points in the case of a shunt motor.* A large amount of data for getting the probable load is in the hands of manufacturers and consulting engineers. After purchase, the motor should be submitted to an acceptance test. Such tests are very commonly made where a large number of motors are installed under the direction of an engineer ; but the average purchaser of a single motor usually buys a motor without knowing anything about it. It is entirely possible that central station men would find it to their advantage to test motors free of charge for their small consumers just as they have found it to their interest to test incandescent lamps and meters on request.

* From efficiency curve and Fig. 3.

SUMMARY.

It should be borne in mind that most of the following conclusions apply particularly to small machines of not more than 15 H.P. capacity. Statements 11 and 12 are especially limited in this direction.

1. The point of maximum efficiency of a shunt motor occurs where the $I^2R$ loss in the armature circuit (exclusive of brush $I^2R$ loss) equals the sum of the fixed losses.
2. The earlier the maximum efficiency the poorer the speed regulation.
3. An early maximum with excellent speed regulation may be obtained by a differential compounding.
4. Differential compounding, unless some device for eliminating armature reactions is employed, is likely to produce sparking.
5. If such device be used, a lighter machine of higher efficiency is possible. Its first cost will be higher.
6. A differential compounding should not be used where a great starting torque is desired, or where overloads are likely to be heavy.
7. All motors should be protected with overload devices for opening the circuit at a predetermined current.
8. In a shunt motor the later the maximum efficiency the greater the ability to withstand overloads.
9. The cost of operation per horse-power hour, at the pulley, increases rapidly as the efficiency drops off.
10. Where the load is steady and always of the same value, a motor of a rating equal to the load should be used, the point of maximum efficiency being at full load.
11. If the load is steady but small, but is expected to increase due to growth of business, it might pay to instal a machine of as high as double the immediate capacity. This does not hold for large units.
12. If the increased load is to come in a short time, say a year or two, the maximum efficiency should occur at full load ; but if the time is distant and indefinite, but sure to come, the efficiency should reach a maximum at about three-fourths load.
13. For all-round service, where the load is subject to wide variations, the motor having its efficiency a maximum at about three-fourths load will give better economy than most of the present standard designs. Its speed regulation will not be so close, but still good enough for average shop purposes. The assertion sometimes made, that the maximum efficiency should occur at the average load, is not, as a general statement, correct.
14. In special work, such as the driving of metal planers and heavy punches, the maximum efficiency may be specified at as low as half-load.
15. Ascertain the nature of the load before ordering the motor, then specify accordingly.
16. Test the machine before accepting it.

## CORRESPONDENCE.

### EDISON'S ALKALINE STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : In common, no doubt, with the majority of your readers, I have perused with considerable interest the suggestive article on Edison's alkaline storage batteries by Mr. E. J. Wade in the current number of *The Electrician*. There is one passage in the article, however, which I feel ought not to be allowed currency without comment. It is as follows :—

Edison has been subjected to some criticism for saying there can be no local action because iron cannot decompose water, but the remark appears to be substantially correct. According to the thermo-chemical figures, the E.M.F. due to the oxidisation of iron,

$$Fe+O=FeO,$$

is 1·47 volts, while the *mimimum* E.M.F. required to electrolyse water is 1·48 volts, so it is hardly likely that iron will effect the transfer of the oxygen except in the presence of something which acts as a depolariser and combines with the liberated hydrogen.

I do not know whether it was Mr. Wade's intention to include myself among the number of the critics he refers to, but I may, I think, be excused for assuming that it is, as in an article by me dealing critically with Edison's patent in the July number of the *Automotor Journal* occurs the following :—

There is one curious passage in the body of the specification which gives food for thought—"since iron does not decompose water, there is no local action between it and the graphite." What is puzzling in regard to this statement, is that the decomposition of water has nothing whatever to do with the question. It is a solution of caustic alkali that is present, and which alone is liable to decomposition. But the finely divided iron must be capable of decomposing a solution of caustic alkali, or else the battery would be absolutely inert. However, an inventor is not bound to be correct in his theory, provided he tells the persons to whom his specification is addressed how efficiently to "perform" his invention, but it does bring into prominence the fact that at any rate across the Atlantic a man

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may be a great and successful inventor, even in such an essentially specialised line as electro-chemistry, while being distinctly shaky in regard to the elementary facts of that science.

It is clear that Mr. Wade is making the same mistake as that made by Edison—that is to say, he assumes that the voltage required to electrolyse a solution of caustic alkali is the same as that required to electrolyse water. This is quite incorrect, as Mr. Wade will find if he takes the trouble to make the very simple experiment required. A moderately strong solution of caustic soda will be electrolysed freely by 1·2 volts. The assumption, therefore, on which local action is supposed by Edison to be impossible is thus without foundation, and the criticisms which have been passed upon him for making the statement would appear to be justified.—Yours, &c.

Byfleet, Aug. 26. R. N. Lucas.

## LEGAL INTELLIGENCE.

### Higton v. Aldersley.

At Skipton County Court last week, Judge Bompas delivered judgment in an action possessing interest for manufacturers of patented articles. The plaintiff, trading as the Skipton Bon Marché, sought to recover damages for an alleged breach of warranty on the sale of incandescent gas mantles. It appeared that these were sold to plaintiff for use in his shop, and while being so used the Welsbach Company entered action for an injunction against him. Defendant was notified of the action, but made no reply; and the action was settled by payment into court of £5. 5s. This and other expenses brought the plaintiff's costs up to £13, and the present action was to recover this amount. The defendant pleaded that the County Court had no jurisdiction, but Judge Bompas held the contrary, as defendant did not expressly refuse to warrant that the mantles were not an infringement of a patent, though he probably avoided giving a personal warranty. The judge considered the mantles infringed the Welsbach patent, and the further objections raised by defendant that the Welsbach patent was not valid, and that, therefore, there could be no infringement, and that as the validity of a patent came into question, the County Court jurisdiction was ousted, Judge Bompas held to be unfounded, deciding that the Court had jurisdiction. The Welsbach patent, he said, was valid, and the mantles sold to plaintiff by defendant were an infringement. Plaintiff, therefore, was entitled to recover, and judgment would be in his favour for £13, with costs on the High Court scale.

### Filing of Liquidators' Accounts.

At Bow-street (London) Police Court, on Friday last, Mr. De Rutzen disposed of a case of considerable interest to creditors and others affected by the liquidation of joint-stock and similar undertakings. A Mr. Arthur Mackenzie appeared to a summons charging him, as liquidator of the Tamar Potteries Co., with failing to send to the Registrar of Joint-Stock Companies a statement showing the position of the company at the time of the liquidation. The case was treated as a test one, and Mr. De Rutzen, in giving his decision, said he had no doubt that a court of summary jurisdiction was entitled under the new Companies Act to dispose of the case, and he imposed a penalty of £10 and 2s. costs, or, in default, one month's imprisonment. This will be good news for creditors, whose position on the appointment of a liquidator is frequently rendered less satisfactory than when dealing direct with the original debtor. A liquidator is usually the master, not the servant, of the creditors who appoint him.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The D.P. Battery Co., Lumford Mill, Bakewell, Derbyshire, require an electrician (preferably with chemical knowledge) accustomed to the testing of accumulators. See advertisement.

An advertisement on another page announces that the Admiralty require able-bodied young men, with experience as fitters in electrical shops, as electricians in the Royal Navy. Applications to the Admiralty Recruiting Department, 22, Spring-gardens, London, S.W., or to any Royal Navy or Royal Marine recruiting officer in the United Kingdom.

An assistant is required in the electrical engineering department of the City and Guilds Central Technical College, Exhibition-road, S.W. Applications to Prof. Ayrton.

An electrical engineer is required by the municipality of East London, Cape Colony. Applications to town clerk by noon of Oct. 10.

The committee of University College, Nottingham, require a demonstrator in electrical engineering. Applications before Sept. 7.

An assistant lecturer and demonstrator in physics is required for University College of North Wales, Bangor. Applications by Oct. 12.

Mr. L. Collins, assistant superintending engineer, has been appointed superintending engineer of the Southern District of Ireland Postal Telegraphs in place of Mr. H. Pomeroy, promoted to the Midland District of Ireland.

Mr. E. W. Dunton has been appointed chief electrical engineer at Earl's Court (London) exhibitions.

Mr. F. R. Tillotson has been appointed clerk of works at the Shipley electricity works.

**Aberdeen.**—The accounts of the Electricity department for the year ended July 31, show the amount authorised to be borrowed is £185,000, and £112,000 has been borrowed. The revenue for the year was £19,176, expenditure £9,815, leaving a gross profit of £9,360. During the year 1,389,385 units of current were generated, against 1,005,505 in the previous year, and the units sold reached 1,199,913, compared with 846,012; 61,054 units were used on the works, and 156,248 for public lighting, which is effected by 145 arc and 156 incandescent lamps, compared with 76 and 80 respectively in the previous year.

**Amble.**—The Council have approved the proposals of the Northern Counties Electricity Supply Co. for supply of electric current in this district.

**Ayr.**—There was a deficiency of £1,127. 2s. 6d. on the past year's working of the electricity department.

**Bideford.**—The offer of Messrs. Southam & Co. to erect electricity works has been rejected by the Council.

**Bradford.**—The manager of the tramways (Mr. C. J. Spencer) has submitted a proposal to the Tramways committee for watering the main streets of the city by means of a tank car carrying 500 gallons of water propelled along the tramlines by electricity. Behind the tank car would be coupled up an ordinary watering cart. A scheme by which street refuse could be conveyed along the lines by electric power is also under consideration.

**Bristol.**—The Corporation is borrowing £950 for the purchase of land for the electric lighting department and an enquiry into the application was held last week.

**Bristol Electric Tramway Strike.**—When the history of notable contests between employers and their workmen comes to be written a prominent place will be given to the strike which has prevailed for some time past on the Bristol electric tramways. The company owning these lines has, in the regular course of business, considered it necessary to adopt a certain course of action which has not found favour with a section of the company's employés. This is an everyday experience, and will happen until the arrival of the Millennium; but the serious aspect of the Bristol strike is the grossly malicious efforts that have been made by the strikers to interfere with the public convenience, and with the due observation by the company of its obligations to the public. The strike has, throughout, been marked by bad temper on the part of the men, by criminal attempts to upset the working of the tramway system, and by cruel and illegal interference with the due performance of their duty by those engaged to take the place of the strikers. These actions on the part of the discontented workmen have culminated in a reward of £100 being offered by the company for the discovery of the scoundrels who, between Aug. 13 and 16, placed a number of mechanical impediments in the way of the running of the trams, to the imminent danger of the passengers. It is to be hoped, in the public interest, that the scoundrels guilty of these malicious acts will be brought to justice and severely punished.

**Buxton.**—Sanction to a further loan of £16,520 for electric lighting has been obtained by the Council.

**Cathedral Lighting.**—The choir and organ of the Hereford Cathedral are now lighted electrically, and further extensions are projected.

**Electric Lighting Licence.**—The Board of Trade have renewed the Ingleton electric lighting licence (1899) for two years.

**Electricity Meters in Spain.**—A decree has been issued by the Spanish Government approving the use of the Aron, Thomson, Schuckert and Lasesche types of electricity meters in Spain.

**International Exhibition at Wolverhampton.**—An exhibition is to be held at Wolverhampton next year. The guarantee fund already amounts to over £30,000. The Earl of Dartmouth is president, and the vice-presidents include a number of prominent persons associated with the district. Lord Barnard has granted part of the site, and an area of over 30 acres is made up of a portion of the park, including a lake belonging to the town. Mr. H. A. Hedley, who has scored so signal a success at Glasgow, and Messrs. Walker and Ramsey, the architects of part of the Glasgow buildings, are engaged in maturing the plans at Wolverhampton. Provision will be made for the display of examples of modern machinery, many assurances of exhibits from leading engineering firms having already, we are informed, been obtained, as well as from manufacturers in other branches of industry. Negotiations are in progress with several Colonial Governments with a view of exhibiting their resources. Railway facilities with all parts of the kingdom are

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exceptional. Applications for space must be received by Oct. 1, 1901, at Gresham-chambers, Wolverhampton.

**Kilmarnock**.—On Wednesday the Council had under consideration a report from the Electric Lighting committee recommending the acceptance of tenders, amounting in the aggregate to £29,000, for erecting and equipping electricity works, but it was decided to defer the matter until a further report had been submitted by the engineer.

**Leicester**.—The Leicester Tramways Co. last week accepted the offer of the Town Council to purchase the tramway undertaking at £134,000. The purchase is to date from July 1, and the Council are maturing a scheme for extending and converting the system to electric traction.

**Light Railways**.—The Bolton, Turton and Darwen and the Barton-upon-Irwell light railway orders have been submitted to the Board of Trade for confirmation. Objections by Sept. 9 and 20 respectively.

**Limerick**.—Though there have been many discussions in committee and in full Council on electric lighting, little progress has been made with the proposal to establish electricity supply. The Limerick provisional order was obtained as far back as 1892, and the Council have induced the Board of Trade to postpone the moment of revocation. Prof. Kennedy was originally called in to advise, and after his report had been shelved an inconvenient notice from a company of intention to apply for a provisional order caused the Council to consult Mr. J. S. Enright, and tenders were in due course invited. Financial considerations have, however, played an important part in retarding progress. At Friday's meeting of the Electric Lighting committee the tenders recently submitted were considered, and a resolution requesting Prof. Kennedy to attend to confer as to the best means to be adopted in carrying out the order was carried by the mayor's casting vote. It was afterwards decided that new tenders be invited in consequence of the reduction in the price of coal and iron since the old tenders were received.

**Motor Car Speed in Scotland**.—The Secretary for Scotland has issued an order which raises the maximum rate of speed for motor cars from 10 to 12 miles an hour—the speed allowed in England.

**Municipal Telephony**.—Barnsley Town Council have instructed their electrical engineer (Mr. S. E. Bastow) to prepare a report on the question of establishing a municipal telephone service.

Halifax Chamber of Commerce recently sent out circulars to 954 subscribers to the National Telephone Co.'s system in the Halifax area in order to test local feeling as to establishing of a municipal exchange. 324 replies were received, 160 being in favour of a municipal exchange with 98 conditional approvals. At the meeting of the Chamber on Wednesday, a proposal urging the Corporation to obtain a telephone licence was rejected by 11 votes to 3.

**Nottingham**.—The Council will consider on Monday a report of the Tramways committee recommending the promotion of a bill for power to construct seven additional lengths of electric lines. The annual report of the committee states that the work of converting the old horse lines to overhead electric traction is progressing. The Sherwood section (over 2 miles in length) was opened on Jan. 1. A car shed, capable of holding 40 cars, has been built near the Sherwood terminus. The tramway centre in Market-place, to which the lines will converge, has been completed, together with the line along Wheeler-gate extending from the Market-place to St. Peter's-square. The work of constructing the Basford and Bulwell section (4¼ miles) was commenced in September last, and was completed after the close of the financial year. A car shed for 40 cars has been provided near the Highbury-road at Bulwell, and a site in Basford has been purchased for a battery station. The reconstruction of the Trent Brid[illegible] and Station-street lines was not commenced till after the close of the financial year, but the committee hope to have these lines open for traffic at an early date. The receipts from the electric cars on the Sherwood section during three months from Jan. 1 were £4,810. 12s. 4d. The total revenue of the lines was £48,074. 10s. 1d., or 13·23d. per mile, against total working expenses (including lighting and maintenance of arc lamps on Mansfield-road, training of drivers, conductors, &c., for electric traction) £33,136. 9s. 10d. (9·12d. per mile).

**Penzance**.—The Council have invited Mr. W. H. Trentham to submit a report on the best means of carrying out the provisions of the electric lighting order.

**Presentations**.—Mr. G. E. V. Thomas was recently presented by a committee of the Jensonia Club, Singapore, with a silver table service, in appreciation of the manner in which the club's electric lighting had been carried out by Mr. Thomas.

Mr. A. B. Gridley, who has been four years in the office of the secretary of the Bristol electricity department, was presented on Monday with a travelling bag on the occasion of his leaving to take up the position of local secretary of the Kidderminster and District Electric Light and Traction Co.

**Provisional Order Revocation**.—The Board of Trade have revoked the Cowes electric lighting order (1896).

**Reigate**.—An unopposed application to borrow £6,500 for electric lighting was heard last week. £1,500 was to meet excess of expenditure on the original scheme and £5,000 for extensions.

**St. Petersburg (Russia)**.—The directors of the St. Petersburg Shore Railway Co. are considering the question of introducing electric traction on their lines. The Lahmeyer Co., of Frankfort, have submitted plans for the conversion.

The negotiations between the three electricity supply companies in St. Petersburg have, it is announced, been brought to a successful issue, and a uniform system of charging for current is to come into force at once. In this way competition will be obviated.

**Singapore**.—The Municipal Commissioners have voted £15,000 to be expended upon electricity supply works, and are taking counsel with Messrs. Burstall and Monkhouse as to the most suitable system for Singapore to be obtained for this sum.

**Stockport**.—The electric tramway route to Bredbury and Woodley was opened for traffic on Monday. At the subsequent luncheon the chairman of the Tramways committee (Ald. Giles Atherton) said the average cost of the double track was £12,944 per mile, and of single track about half that amount. The cars had cost about £700 each. The cost of overhead equipment, &c., had been £1,389 per mile.

**Yucatan (Mexico)**.—A project to convert the tramways now constructed at Progreso, in this district (the property of the Progreso R. R., Wharf and Warehouse Co.), is under consideration, and specifications are being prepared. The existing lines are about 8 miles in length, and are horse-driven. These are to be converted to electric traction and an extension of 5 miles of track is to be added. Electric power is to be utilised also in the operation of machinery, &c., at the large docks now in course of construction for the company, and Progreso itself, with a population of between 8,000 and 10,000, is to be lighted electrically.

**Annual Excursion**.—The second annual excursion of the Glasgow electricity department employés took place on Saturday. About 800 members and friends journeyed to Stirling.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Poplar* (London) Electricity committee require multiple core lead-covered feeder and network cables and accessories for mains extensions. Specifications, &c., from the borough electrical engineer (Mr. Alfred Blackman), Electricity Works, Glaucus-street, Bromley-by-Bow, E., and tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, E., by 10 a.m., Sept. 18. An advertisement contains further particulars.

*Oldham* Corporation Electricity committee invite tenders for two electric overhead travelling cranes. Specifications, &c., can be had from Mr. Arthur Andrew, Gas and Water Offices, and specifications, &c., can be seen at, but not obtained from, the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W. Tenders to Mr. Andrew by Sept. 10. An advertisement contains further particulars.

*Hull* Electric Lighting committee require two high-speed three-crank compound steam engines of 800 I.H.P. each, and four steel Lancashire boilers. An advertisement contains additional particulars. Forms of tender, &c., from the city treasurer, Mr. T. G. Milner. Tenders to chairman, Town Hall, Hull, by noon Sept. 26. Further information can be obtained from the city electrical engineer (Mr. A. S. Barnard), Sculcoates-lane, Hull.

*Kirkcaldy* Corporation invite tenders for the supply of overhead construction for electric tramways. Specifications from the town clerk (Mr. Wm. Macindoe), and specifications and drawings can be seen at, but not obtained from, the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. An advertisement contains further particulars. Tenders to Mr. Macindoe by 10 a.m. Sept. 13.

*Kirkcaldy* Corporation also invite tenders for the supply and erection of arc lamp posts, wall brackets and switchboxes. An advertisement contains further particulars. Specifications and drawings from town clerk (Mr. Wm. L. Macindoe), and can also be seen at, but not obtained from, the office of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to Mr. Macindoe by Sept. 16.

*Glasgow* Corporation invite tenders for the supply and laying of cables. Specifications may be obtained from the general manager of the tramways department (Mr. John Young), 88, Renfield-street. Tenders to the town clerk (Sir J. D. Marwick), City Chambers,

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Glasgow, by 5 p.m. Sept. 25. An advertisement contains further particulars.

*Dundee* Town Council invite tenders for the overhead equipment of the Constitution-road and Victoria-road and Ferrymuir tramway routes. Specifications, &c., from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, and tenders to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Sept. 14. See advertisement.

*Whitehaven* Water and Lighting committee invite tenders for six months' supply of incandescent lamps. Further particulars from the borough electrical engineer (Mr. P. J. Watts), Electricity Works, Whitehaven. Tenders by Sept. 16. See advertisement.

*Salford* Health committee invite tenders for a 55kw. steam dynamo at the Ladywell Sanatorium. An advertisement contains further particulars. Specifications from the borough electrical engineer (Mr. C. D. Taite), Strawberry-road electricity works. Tenders to town clerk (Mr. L. C. Evans) by Sept. 14.

*Manchester* Tramways Committee invite tenders for trolley wire, &c, line materials, span wire, brackets, &c. Specifications and tender forms from the general manager (Mr. J. M. McElroy), 55, Piccadilly, Manchester, and tenders to chairman by 1 p.m., Sept. 14. See advertisement.

*Bournemouth* Town Council invite tenders for steel-grooved girder rails, &c., conduit, permanent way construction and rail bonding, ploughs and carrying attachments to cars, and wood-block, tar, macadam and granite sett paving. Further particulars are given in an advertisement. Forms of tender and specification of the borough and tramway engineer (Mr. F. W. Lacey, M.I.C.E.), and tenders to the town clerk (Mr. J. Druitt, jun.) by noon Sept. 17.

*Willesden* Guardians invite tenders for economisers, dry-back marine boilers, piping, pumps, heaters, &c.; steam dynamos, boosters, accumulators, switchboards, &c.; wiring for about 1,000 lights on the conduit system; cranes, motors, electric fans, &c. The work is to be carried out to the specification of Mr. Morgan Williams, M.I.E.E., and applications must be made to the clerk (Mr. J. Hutton Haylor), 329, High-road, Kilburn, N.W. See advertisement.

*Aston Manor* District Council invite tenders for pipework, fitters shop and cables; also water-tube boilers, stokers and economiser, two 500kw. and one 200kw. steam dynamos and motor balancer, switchboard, crane and arc lamps. Tenders by noon Sept. 4.

*British Electric Traction Co.*, Donington House, Norfolk-street, W.C., invite tenders for about 5,000 tons of steel-grooved girder tramway rails, fish-plates, &c. Tenders to secretary by Sept. 20.

*Edinburgh* Corporation invite tenders for electric lighting of second portion of Colinton Mains Fever Hospital. Tenders to town clerk by Sept. 9.

*Southend-on-Sea* Corporation invite tenders for supplying and laying electric lighting cables (solid system). Tenders to town clerk by Sept. 7.

*Lowestoft* Corporation invite tenders for a 500kw. steam dynamo and switchboard panels. Tenders to town clerk by noon Sept. 9.

*Batley* Corporation require tramway rails, points, crossings, bonds, &c. Tenders by Sept. 14.

*London County Council* require tenders for electric lifts, pumps, fans, &c., for the electrical equipment of the Greenwich footway tunnel and its approaches. Tenders by Oct. 8.

*London County Council* invite tenders for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

*Manchester* Electricity committee invite tenders for erecting two chimneys at their Stuart-street station. Tenders by Sept. 10.

*Middlesbrough* Electric Lighting committee invite tenders for mechanical coal handling plant. Tenders to town clerk by Sept. 3.

*Mansfield* Electric Lighting committee require tenders for refuse destructors. Tenders to town clerk by Sept. 5.

*Newport (Mon.)* Guardians require tenders for installing telephones, electric bells, &c., at the workhouse. Tenders by Sept. 4.

*Doncaster* Corporation require a tramway switchboard. Tenders by noon 31st inst.

*Halifax* Tramways and Electricity committee invite tenders for erecting a chimney shaft at the electricity works. Tenders by Sept. 4.

*Barking* District Council require tenders for erecting a corrugated iron building at the electricity station. Tenders by Sept. 6.

The Egyptian Ministry of Public Works, *Cairo*, invite tenders until Sept. 15 for the erection and equipment of electricity works in Fayoum for public and private lighting. Overhead mains will be permitted. Particulars from and tenders to Le Ministère des Travaux Publics, Cairo, Egypt.

Tenders are invited, until 22nd prox., for a concession to work an electric tramway from *Barcelona* to Molins de Rez, with a branch to Santa Cruz de Calafel. Tenders to Minister of Works.

## TENDERS RECEIVED AND ACCEPTED.

Manchester Electricity committee considered on Wednesday tenders for two high-tension switchboards, two low-tension exciter switchboards, one low-tension auxiliary switchboard, 20 high-tension and 19 low-tension switchboards, with all connections, for the new Stuart-street station and for 15 sub-stations, and yesterday decided to accept the tender of the Electrical Company, London. A large number of tenders were received, and we learn that the successful tenderers submitted their tenders in three forms: (1) All English instruments, (2) mixed English and German instruments, and (3) all German instruments.

Brighton Guardians received the following tenders for wiring and fitting up the workhouse for the electric light:—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| H.J. Galliers *(accepted)* | £688 | 16 | 0 | G. Weston & Co. ..... | £887 | 0 | 0 |
| Electric & Gas Co. ... | 2,327 | 10 | 0 | R. Alger & Son ..... | 854 | 0 | 0 |
| Warner & Co..... | 2,125 | 14 | 3 | G. Hignett & Co. ..... | 835 | 15 | 6 |
| F. A. Glover & Co. ... | 991 | 13 | 0 | E. G. Reed (Ltd.) ..... | 827 | 10 | 0 |
| Page & Miles ..... | 899 | 10 | 0 | M. A. Fileman ..... | 786 | 0 | 0 |
| Lighting Corporation.. | 895 | 0 | 0 | G. W. Clarke ..... | 678 | 5 | 0 |

In our last issue we gave the list of tenders received by the Mansfield Corporation for the supply of plant and apparatus for the electricity works. The accepted tender for accumulators should read as follows:—Tudor Accumulator Co. (accumulators, with 100 per cent. maintenance capacity guarantee), £2,987.

Farnworth (Lancs.) Council have accepted the tender of the British Isulated Wire Co. for the overhead equipment of about 5 miles of tramways.

The Hart Accumulator Co. have secured the contract for the supply of the storage battery required for the Royal Masonic Institution for Boys at Bushey.

Bristol Electrical committee have accepted the tender of Messrs. Crompton & Co. for arc lamp carbons.

Dundee Tramways committee have accepted the tender of Messrs. J. M'Adam & Co., Aberdeen, for the construction of the Meadowside to Dens-road tramway route at £12,104.

Keynsham Parish Council have accepted the tender of the Keynsham Electric Light Syndicate for supplying electric current to 96 16 c.p. incandescent lamps for public lighting at £188. 10s.

## BUSINESS NOTICES.

Mr. W. J. Murphy, M.I.E.E., and Mr. G. Rosenbusch, A.M.I.C.E. (late resident engineer in England of the Sprague Electric Co.), have started as consulting engineers at 25, Victoria-street, Westminster, London, S.W. Mr. Murphy will make a speciality of telegraphic work in general and the submarine branch in particular, while Mr. Rosenbusch will deal with power and traction work. Our readers will remember Mr. Murphy as a frequent contributor to *The Electrician* from 1897 to date, and his experience from 1876 in connection with submarine telegraphic work, and a good knowledge of modern languages, should bring Mr. Murphy's services into request.

We are informed that Messrs. Brown & Co., of Pelham-street, Nottingham, have ceased to act as agents for Messrs. Johnson and Phillips.

Messrs. W. E. Burnand & Co. have removed from Ocean Works, St. Mary's-road, to larger premises at Lowfield Works, 428–434, London-road, Sheffield.

## BANKRUPTCIES, LIQUIDATIONS, &c.

An adjourned meeting of the creditors of Charles Bright, electrical engineer, 14, Copthall-avenue, London, E.C., was held on Wednesday. Debtor, who is largely interested in Buenos Ayres electric tramway projects, was still abroad. No accounts had been lodged, but proofs for £110,739 had been put in. Mr. G. C. Harrower, C.A., was appointed trustee in bankruptcy, with a committee of inspection.

Thos. Morley, electrical engineer, 16, Whalley-road, and Borough Engineering Works, Argyle-street, Accrington, has been adjudicated bankrupt. The first meeting of creditors to-day at 14, Chapel-street, Preston, and the public examination on Oct. 9 at the County Court, Blackburn.

A first and final dividend of 2s. 3½d. is payable at 25, John-street, Sunderland, in the failure of J. Brown, electrical engineer, &c., lately trading at 28, Silksworth-row, Sunderland.

Claims against the Bute Electrical Manufacturing Co. (in liquidation) are to be sent by Sept. 30 to Mr. R. Leyshon, 12, Mount Stuart-square, Cardiff.

**Sale by Auction.**—Messrs. Fuller, Horsey, Sons & Cassell, 11, Billiter square, London, E.C., will offer for sale by auction, in one lot, at the Mart, Tokenhouse-yard, London, E.C., on Wednesday, Sept. 11, at 12 noon, the works, patents and assets of the Berrenberg Electric Lamp Syndicate (Ltd.). The sale will include the large factory premises at Wandsworth. Some further particulars are given in an advertisement.

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**Plant, &c., for Sale.**—The joint committee of management of the Mullingar (Ireland) District Asylum have a Manchester dynamo, nine Brockie-Pell arc lamps, &c., for sale. See advertisement.

Hadfield's Steel Foundry Co. (Ltd.), Sheffield, have for sale (owing to installation of larger plant) two Thomson-Houston series arc lighting dynamos. See advertisement.

Two electrical vans and an electrical victoria are advertised for sale on another page. Applications to Mr. H. H. Simmons, 6, Old Jewry, E.C.

**A Gutta-Percha Substitute.**—The Board of Trade has received, through the Foreign Office, a copy of a memorandum drawn up by Mr. A. Percy Bennett, the commercial attaché to H.M. Embassy at Vienna, on the subject of a gutta-percha substitute. He reports that the Imperial German Postal authorities have decided to give a trial to this material, which is the invention of a naturalised Austrian, Adolf Gentzsch, and is covered by the British patent No. 15,255 of 1899. A further process by the same inventor for raising the point of fusion of resins, wax and wax-like substances, pitch and tar, is the subject of British patent No. 4,902 of 1899. It is stated that the patents for Germany, the United States, Russia and Switzerland have already been sold, but not the British ones. The inventor claims that this substitute can be manufactured at one quarter the price of real gutta-percha. Specimens of the new insulating material in blocks and in the form of cable and copies of the specifications, &c., may be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

**The Journal.**—Nos. 151 and 152 of the *Journal* of the Institution of Electrical Engineers are now ready. The contents are set out in an advertisement.

**B.T.H. Plant.**—Pamphlets Nos. 106 and 107, published by the British Thomson-Houston Co., deal with rotary converters for railway and tramway systems and slow and moderate speed motors for various industrial uses respectively.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 21 to 27, with the ports of destination:—

*Africa*—Alexandria, £75 (telegraph material); Beira £142 (telegraph material); Cape Town, £262; Chinde, £12. *Argentina*—Buenos Ayres, £439 (including £385 telegraph material). *Australasia*—Adelaide, £183; Melbourne, £118; Perth, £5,370 (telegraph cable); Sydney, £647; Wellington, £830. *Belgium*—Ghent, £3. *Brazil*—Rio Janeiro, £188 (including £166 telegraph material). *Ceylon*—Colombo, £46. *Chili*—Valparaiso, £93. *China*—Shanghai, £21. *Colombia*—Santos £604. *Denmark*—Copenhagen, £4,090 (including £150 telegraph wire). *Germany*—Hamburg, £114. *Holland*—Amsterdam, £60. *India*—Bombay, £70; Calcutta, £618. *Japan*—Nagasaki, £4,962; Tokyo, £49; Yokohama, £4,862. *Norway*—Christiania, £72 (telegraph wire). *Portugal*—Lisbon, £46 (telegraph material). *Rodriguez*—£580,694 (telegraph material). *Russia*—St. Petersburg, £100. *Spain*—Barcelona, £40. *Straits Settlements*—Singapore, £25. *Sweden*—Stockholm, £643 (including £186 telegraph wire). *United States*—New York, £156. Total £605,636, against £199,150 in the corresponding week last year (Aug. 22 to 28).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

May 3, 1901.

9,147. G. KIRBY. Liverpool. A life-guard for electric cars, railway locomotive engines, motor cars and all steam machines on the public road.*

9,154. G. E. HEYL-DIA. Manchester. Improvements in or relating to telegraph, telephone, overhead tramway and like wires.

9,187. C. P. ELIESON and V. DE ROBINSKY. London. Improvements in electrical accumulators.

9,188. Sir C. S. FORBES, Bart. London. Improvements in induction coils.

9,193. Sir W. G. ARMSTRONG, WHITWORTH & Co. (Ltd.) and J. HONNER. London. Improvements in gear for actuating the electric switches of cranes, capstans and the like.

9,203. W. BEHRENS and J. P. TIHON. Liverpool. Improvements in and connected with current collecting devices for electric railways, tramways and the like.

9,211. H. H. LAKE. London. Improvements relating to the insulation of electrical conductors and the like, and to compounds thereof. (Oliver T. Hungerford, United States.)*

9,212. F. IRVINE. London. Improvements in the method for protecting underground electric mains and for like purposes.

9,213. G. B. RUCHMULLER. London. A new or improved galvanic cell.

9,217. J. Y. JOHNSON. London. Improvements in electric fuses or cut-outs. (The D. and W. Fuse Co., United States.)

May 4, 1901.

9,227. W. C. WESTWOOD and A. HITCHEN. Halifax. Improvements in contacts and spring actions for electric switches.

9,265. T. W. YOUNG. London. Electric arc lamp.*

9,275. J. T. ARMSTRONG and A. ORLING. London. Improvements in and connected with means of supplying current to electrically propelled vehicles from an overhead conductor.

9,276. J. TIMAR. London. An improved electric heating body.*

9,279. P. MCCULLOUGH, T. BLANEY and R. BARON. Liverpool. Improvements in and connected with the trolley poles of electric cars and the like.

9,284. E. TYER, F. T. HOLLINS and F. W. LEAKE. London. Improvements in electrical instruments for signalling on railways.

9,295. R. HADDAN. London. Improvements in means for preventing the oscillation of alternators connected in parallel. (O. T. Blathy, Hungary.)*

9,302. A. F. BERRY and THE BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.). London. Improvements in electrical transformers.

9,303. G. BERRY. London. Improvements in electrical transformers.

9,307. A. C. BROWN and J. H. HAWKSWORTH. London. Improvements in circuit arrangements for inter-communication telephone or telegraph systems and other electric signals and switches for same.

May 6, 1901.

9,311. F. RENDER. Manchester. Improved fuse head for electric blasting.

9,326. G. H. SMITH. Cardiff. Improvements in X-ray tubes.

9,330. E. J. SIMMONDS. Plymouth. A device for quickly connecting the trolley wheel of electrically-driven tramcars or other vehicles with the overhead wire supplying the power, and which is usable in any position of the trolley arm.

9,350. A. GROBET. London. Improvements in and relating to electric furnaces for heating or reheating objects to a predeterminined degree.

9,384. W. C. JOHNSON and W. B. ESSON. London. Improvements in electric arc lamps.*

9,388. HELIOS-UPTON CO. and T. SPENCER. London. Improvements in electric arc lamps.*

May 7, 1901.

9,405. H. E. WIMPERIS. Cambridge. The training of guns by electric motors without the use of resistances.

9,445. R. S. WRIGHT. London. Improvements in the rectification of high tension alternating electric currents.

9,502. W. L. WISE. London. Improvements in telephone transmitters. (Charlton E. Yocom, United States.)*

9,512. J. A. HEANY. London. Improvements in solenoid and other electric coils.*

9,527. J. Y. JOHNSON. London. Improvements in connection with electrical fuses. (The D. and W. Fuse Co., United States.)*

May 8, 1901.

9,532. F. J. A. MATTHEWS. Cheshire. Improvements in motor starting switches.

9,547. T. CHADWICK. Halifax. Improvements in electric stop motions of drawing frames.

9,574. C. V. DRYSDALE. London. An instrument for the testing of the magnetic qualities of materials in bulk.

9,586. F. LACON and A. FOSTER. London. An invention for extending the present range of wireless telegraphy.

9,590. B. G. ROYAL. London. Improvements in coin-operated talking machines.*

9,593. SIEMENS BROS. & CO. (LTD.) and M. HIRD. London. An improved electric switch for starting motors or like purposes.*

9,595. Q. AUSTEN. Sussex. Instantaneous device for securing telegraph, telephone or other wires.

9,610. H. H. LAKE. London. Improvements in electrical exercising machines. (Albert Williamson Courtney, United States.)*

9,611. A. METCALFE. London. Improvements in trolley heads for use in connection with the overhead system of electric traction.

9,615. F. C. BLAKE. London. Improvements in and relating to ignition plugs for explosion engines.

9,616. W. RAUSCH. London. Improvements in and relating to electrical time switches.*

May 9, 1901.

9,619. J. IRON. Dover. A new or improved method of conveying electric current, a new or improved apparatus in connection therewith.

9,651. C. J. R. LE MESURIER. London. An improved method for the protection of overhead systems of transmission of electric currents.

9,674. THE JANDUS ARC LAMP AND ELECTRIC CO. (LTD.), A. D. JONES, and B. M. DRAKE. London. Improvements in electric arc lamps.

9,675. THE JANDUS ARC-LAMP AND ELECTRIC CO. (LTD.) and A. D. JONES. London. Improvements in the regulating mechanism for electric arc lamps.

9,676. THE BRITISH ALUMINIUM CO. (LTD.). London. An improved electric smelting process and apparatus to be used therein. (A. H. Cowles, United States.)*

9,692. C. HAGGEMILLER. Liverpool. Improvements in underground systems for electric traction railways and the like.

9,697. J. C. BOSE and S. C. BALL. London. Improvements in or connected with wireless and other telegraphic signalling.

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May 10, 1901.

9,718. A. Eckstein and C. H. Archer. Manchester. Improvements in electrical heating apparatus.
9,727. W. C. Runge. London. Improvements in or relating to graphophones, phonographs and the like.
9,730. W. Patterson. Manchester. Improvements in the method of lighting oil and other lamps by electricity.
9,745. E. F. Moy and P. H. Bastie. London. An improvement in or relating to current circuit-breakers.
9,769. H. H. Lake. London. Improvements in current collectors or contact-shoes for electric railways. (McElroy-Grunow Electric Railway System, United States.)*
9,770. A. C. Brown. London. Improvements in electrical sparking devices for firing the charges in internal combustion engines and for similar purposes.

May 11, 1901.

9,781. R. C. Quin and J. B. Smith. Fleetwood. An improved insulator for use with bracket suspensions of overhead trolley systems and the like.
9,785. R. J. Hughes and A. B. Shaw. Kingston-on-Thames. Improvements in reversing apparatus for electrical devices. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 13, 1900, being date of application in United States.)
9,801. S. G. Brown. London. Improvements in electric telegraphy.
9,812. J. Bush and M. T. Medway. London. An improvement in controllers for electric motors for lifts and other purposes.
9,829. The British Thomson-Houston Co. (Ltd.) and E. B. Wedmore. London. Improvements in automatic electric circuit-breakers.

May 13, 1901.

9,840. H. C. Newton. Improvements in motor interrupters for use with induction coils.
9,844. C. V. Drysdale. New Barnet. An electrical transmission dynamometer and tachometer.
9,865. J. D. F. Andrews. London. Improvements in apparatus for opening and closing electrical circuits.
9,882. G. M. Lane. London. Improvements in and relating to electric arc lamps.*
9,833. A. O. Fox. London. Improvements in controllers for motors.*
9,915. W. H. Flood and A. E. Honey. London. Improvements in or connected with electric motors.
9,916. W. H. Flood and A. E. Honey. London. Improvements in collecting brushes and holders for dynamo-electric machines.
9,925. H. C. Newton and R. S. Wright. London. Improvements in the working of induction coils and other apparatus with alternating and pulsating currents.
9,926. E. G. Coker. Montreal, Canada. Improvements in and relating to transmission dynamometers.

May 14, 1901.

9,929. A. E. Thomas and J. Buckley. Birmingham. The electric revolving brush.
9,933. C. H. Wilkinson. Huddersfield. Improvements in or connected with trolley arms and in attaching same to the outside covers of electric tramcars.
9,959. E. Böhm. London. Improvements in incandescent electric lamp globes.
9,962. A. Stockton and S. H. Heywood. Manchester. Improvements in or relating to the pole pieces of dynamos and other magneto-electric machines.
9,987. J. D. Gould. London. Improvements in electric cables.*
9,993. W. O. Jennings. London. An improvement in electrical lighting as applied to advertisements and the like.
10,010. H. von Kramer and F. G. Sharp. Glasgow. A new form of standard electric resistances for small and large current strengths.

May 15, 1901.

10,053. E. M. Munro, H. Brecknell, and H. J. Rogers. Bristol. An improved trolley wheel for overhead wire systems of electric traction.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**LANCASHIRE AND YORKSHIRE ELECTRIC TRAMWAYS.**—Reg. Aug. 20, capital £100 in £1 shares, to construct, maintain and work tramways, light railways, electrical and other railways and motors therefor, and to carry on the business of builders of vehicles of all kinds, producers and suppliers of light, heat or power, &c.

**LANCASHIRE UNITED ELECTRIC TRAMWAYS (LTD.)**—Reg. Aug. 20, capital £100 in £1 shares, to carry on same business as above company.

**MICA INSULATOR CO. (LTD.)**—Reg. Aug. 20, capital £20,000 in £10 shares, to carry on business as manufacturers, importers and exporters of and dealers in electric, magnetic, galvanic and other apparatus, machinery and appliances, electrical and general engineers, makers of mica and other insulating materials, &c. The first directors are E. Munsell, mica merchant, L. W. Kingsley, F. Brooks, A. H. S. Dyer, A. Bergtheil, H. W. Young, E. Bergtheil, and R. O. Ritchie.

**PERSONAL.**—We are asked to state that Mr. J. B. Atherton and Mr. Jacob Atherton have resigned their seats at the boards of the South Lancashire Electric Traction and Power Co., the South Lancashire Tramways Co. and the Lancashire Light Railways Co.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27d. per oz. (Aug. 29). Consols (2¾ per cent.) 94½—94½ for money, 94¼—94½ for account; 2½ per cent. 95½—95⅝ (Aug. 29). Consols Pay Day, Sept. 2; Stocks and Shares Continuation Days, Sept. 10 and 25; Ticket Days, Sept. 11 and 26; Pay Day, Sept. 12; Mining Share Carry-over Days, Sept. 9 and 24.

**BLACKPOOL AND FLEETWOOD TRAMROAD CO.**—At the half-yearly meeting on Friday the chairman (Mr. Geo. Richardson) said the number of passengers carried had been 648,569 and the receipts £10,183. The profit, after providing for interest, was £3,556, and the directors recommended a dividend of 4 per cent., absorbing £3,000; £500 was written off for depreciation, leaving £56 to carry forward. Considering they had not taken anything from reserve, and were yet able to pay the same dividend as last year, he thought the report was satisfactory. The gross receipts, in spite of bad weather in the early part of the year, were £126 in excess of those of the previous period.

**CIE INTERNATIONALE D'ELECTRICITE (LIEGE).**—The directors' report for the past year states that the company during that period turned out 1,268 dynamos of an aggregate capacity of 30,126kw., against 769 dynamos of 22,128kw. capacity in the previous year.

**ELECTRICAL FINANCE IN RUSSIA.**—The Russian Schuckert Electrical Co., following the example of the German parent company (the Elektricitäts-Aktiengesellschaft vormals Schuckert & Co.), has decided to pass this year's dividend. The German company originally proposed a dividend at the rate of 10 per cent. on its capital of £2,100,000, but this recommendation was withdrawn owing to the failure of the Leipziger Bank. The Russian Schuckert Company had a capital of £317,000, and the surplus profits for the past year (£22,780) is to be carried forward. It had been anticipated by the parent company, which is interested to the extent of £144,000, that the subsidiary company, with its branches in Moscow, Kieff and Odessa, would yield 5 per cent. on the subscribed capital, but these expectations have not been fulfilled.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed Sept. 11 a special settling day in £200,000 5 per cent. first mortgage sterling debentures of £100 (Nos. 1 to 2,000) of the *Castner Electrolytic Alkali Co. (U.S.A.)*, and has ordered the same to be quoted in the official list. The committee has also been asked to allow the further issue of £100,000 4½ per cent. first debenture stock of the *Calcutta Tramways Co. (Ltd.)*, and the further issue of 12,500 7 per cent. cumulative preference £2 fully paid shares of the *Electric Construction Co. (Ltd.)* to be quoted in the official list.

**WIRRAL RAILWAY CO.**—Mr. T. H. Jackson, at the half-yearly meeting on Monday, announced that the company would follow the example of the Mersey Railway Co. and convert their line into an electrical one when the money market became easier.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Aug. 24 | 1,015 | + 221 | 12 | 10,687 | + 1,278 |
| *Birmingham Tramways | „ 24 | 4,872 | + 423 | 7 | 33,895 | + 1,977 |
| *Blackburn Corporation.. | ... | ... | ... | ... | ... | ... |
| Blackpool Corporation... | „ 22 | 2,725 | + 932 | †21 | 23,821 | + 6,140 |
| Blackpool and Fleetwood | „ 24 | 2,421 | + 576 | 8 | 11,824 | + 218 |
| Bolton Corporation ..... | „ 25 | 2,032 | + 428 | 21 | 32,600 | + 3,406 |
| Bradford Corporation... | „ 25 | 1,361 | + 907 | 21 | 22,831 | +12,358 |
| Brisbane Trams ..... | July 10 | 1,756 | + 87 | ... | ... | ... |
| *Bristol Trams & Carriage | Aug. 23 | 4,123 | + 669 | 7 | 29,778 | + 4,453 |
| *Buenos Ayres & Belgrano | July 28 | 2,552 | + 703 | 4 | 10,452 | + 1,955 |
| Calcutta Trams. Co. ... | Aug. 24 | R20,352 | +R 558 | 8 | R64,281 | + R8,989 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | „ 24 | 5,409 | +1,024 | 8 | 45,615 | ... |
| City & South London Ry. | „ 25 | 1,697 | + 224 | 8 | 14,608 | + 2,600 |
| Cork Elec. Trams ..... | „ 22 | 577 | + 114 | 33 | 15,706 | + 2,001 |
| Dover Corporation ..... | „ 24 | 335 | + 10 | 21 | 5,272 | + 306 |
| Dublin & Lucan Rly. ... | „ 25 | 138 | + 24 | 8 | 1,188 | + 216 |
| Dublin United ..... | „ 23 | 4,149 | + 390 | ‡8 | 31,886 | + 1,748 |
| Dublin Southern Dist.... | „ 23 | 1,187 | + 138 | ‡8 | 9,158 | |
| *Dundee Corporation ... | „ 21 | 696 | + 257 | 8 | 5,719 | + 1,949 |
| *Glasgow Corporation ... | „ 24 | 13,424 | +4,557 | 12 | 144,834 | +33,294 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation..... | „ 24 | 1,726 | + 429 | 8 | 14,124 | + 3,394 |
| Liverpool Corporation... | „ 17 | 9,357 | − 99 | 33 | 291,205 | +39,324 |
| *Liverpool Overhead Rly. | „ 25 | 1,778 | + 11 | 8 | 14,084 | + 124 |
| *Manchester Corporation | „ 24 | 2,349 | ... | §11 | 21,378 | + 149 |
| Perth (W.A.) Elec. Trams | „ 23 | 772 | + 376 | ‡8 | 7,330 | + 4,403 |
| Portsmouth Corporation | „ 24 | 1,378 | + 90 | ... | ... | ... |
| *Sheffield Corporation ... | „ 25 | 3,981 | +1,474 | 8 | 30,557 | + 9,839 |
| Southampton Corporat'n | „ 22 | 1,153 | + 333 | 8 | 7,966 | + 2,614 |
| Southend Corporation... | ... | ... | ... | .. | ... | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 21. | Price Wednesday, Aug. 28. | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending Aug. 28. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ¾ ¾ | ¾ ¾ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 100 | 95 100 | ... | ... | ... | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 13 | 12 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ 10½ | 9½ 10 | 4 10 0 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 6 9 | ... | ... | ... |
| 19,651 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ 8 | 7⅞ 8⅛ | 3 12 9 | ... | 8⅛ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅛ 8⅜ | 8⅛ 8⅜ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅞ 8 | 7⅞ 8 | 2 3 9 | ... | ... | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 5 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 5⅛ | 5⅛ 5⅛ | 3 18 3 | " " | 5⅛ | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 103 105 | 103 105 | ... | ... | 104 | ... |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5⅛ 6 | 5⅛ 6 | 4 11 8 | March | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 107 110 | 107 110 | 4 2 0 | June and December | ... | ... |
| 70,579 | 10 | 3/0 | City of London Electric Lighting Ord. | 8 9 | 8 9 | 4 8 11 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11½ 12⅝ | 11⅝ 12⅝ | 4 16 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 120 125 | 120 125 | 4 0 0 | June and December | ... | ... |
| £300,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 99 101 | 100 102 | 4 8 10 | ... | 102 | 101 |
| 40,000 | 10 | 9/0 | County of London and Brush Prov. Ordinary | 8 9 | 8 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 13 | 12 13 | 4 13 4 | March and September | 12⅝ | ... |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 103 106 | 103 106 | 4 5 1 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5⅛ 5⅜ | 5⅛ 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ 8⅛ | 7⅛ 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 12 | 11 12 | 4 3 4 | ... | 11⅛ | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅝ 7 | 6⅝ 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 104 | 101 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 105 | 103 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Company | 1½ 1⅝ | 1½ 1⅝ | ... | ... | ... | ... |
| 42,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 100 | 96 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 14 | 13 14 | 4 5 9 | April and October | 13⅜ | 13½ |
| 13,769 | 10 | 4/6 | Do. (85,001 to 98,769) | 13 14 | 13 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 109 112 | 110 113 | 4 0 2 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 94 97 | 97 100 | 3 10 3 | ... | 97 | 96½ |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 16 | 15 16 | 4 7 6 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ 6⅛ | 5⅝ 6⅛ | 3 16 11 | " | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 102 | 99 102 | 3 18 5 | ... | ... | ... |
| 400,000 | 1 | 1/0 | Rand Electric | 1/16 1/8 | 60/64 70/64 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | £0 70 | 60/64 70/64 | ... | January and July | ... | ... |
| £107,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 101 103 | 102 104 | 4 9 1 | April and October | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary | 14½ 15½ | 14½ 15½ | 4 13 7 | February and August | 15⅝ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9⅛ | 8⅝ 9⅛ | 3 18 8 | " " | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 100 | 97 100 | 3 10 0 | ... | 98 | ... |
| 13,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2 3 | 2 3 | ... | ... | 2⅛ | ... |
| 109,518 | 5 | 5 0 | Westminster Electric Supply Ordinary | 12 13 | 12 13 | 4 0 9 | March and September | 12⅝ | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 4½ | 4 4½ | 4 14 2 | April and October | ... | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 129 | 124 129 | 4 13 6 | ... | ... | ... |
| 20,000 | 10 | ... | Barcelona Tramways Ordinary | 8 10 | 8 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 95 100 | 95 100 | 5 0 0 | ... | ... | ... |
| £118,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 3/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2 3 | 2 3 | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ 4⅝ | 4½ 4⅝ | ... | ... | ... | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 102 104 | 102 104 | 4 7 0 | ... | ... | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 22 23 | 21½ 22½ | 3 15 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ 10⅝ | 10⅜ 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 115 | 113 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 6¼ | 6 6⅛ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9¼ 9⅝ | 9¼ 9⅝ | 5 2 7 | May and November | 9⅜ | 9⅛ |
| £250,000 | 40 | 4½ | Do. 4½% 1st Mort. Debs. | 100⅞ 102⅞ | 100⅞ 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 13⅜ 14⅜ | 13⅜ 14⅜ | 7 0 4 | ... | 14⅛ | 14 |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11⅞ 12⅛ | 11⅞ 12⅛ | 4 18 0 | February and August | 12⅛ | 11⅞ |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 123 125 | 123 125 | 4 0 10 | ... | 124⅝ | 124⅛ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ 1⅞ | 1⅝ 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5⅛ 5⅜ | 5⅛ 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5⅛ 5⅜ | 5⅛ 5⅜ | 2 3 6 | ... | ... | ... |
| £330,000 | Stock | 5% | Do. 5 per Cent. Debentures | 102 105 | 1 3 103 | 4 14 10 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 99 | 97 100 | 5 0 9 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11½ 12½ | 11½ 12½ | 2 8 0 | ... | ... | ... |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 104 106 | 105 107 | 4 4 8 | ... | ... | ... |
| 400,000 | 1 | 1/24 | Cape Electric Tramways Shares | 1⅝ 2 | 1⅞ 2⅛ | 2 16 6 | ... | 2 1/16 | 2 |
| £1,962,800 | Stock | 4% | Central London Ordinary Stock | 99 102 | 103 106 | 3 15 6 | June and December | 105 | 101 |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 103 106 | 105 108 | 3 14 1 | ... | 107½ | 106½ |
| £440,100 | Stock | 4% | Do. Deferred Stock | 98 101 | 98 101 | 3 19 8 | ... | 101 | 100 |
| £898,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 118 | 113 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5⅛ 5⅜ | 5⅛ 5⅜ | 4 10 11 | ... | 5⅜ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 102 105 | 104 105 | 3 17 1 | ... | 104 | ... |
| £355,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 52 54 | 52 54 | 2 15 7 | February and August | ... | ... |
| 47,500 | 10 | 2/0 1/6 | Do. Ordinary (Nos. 22,501 to 70,000) | 5⅛ 5⅜ | 5⅛ 5⅜ | 2 3 6 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 134 | 129 134 | 3 14 8 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 123 127 | 123 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 117 | 113 118 | 3 8 0 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 11⅛ 14⅛ | 12 13 | 3 16 11 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 14⅛ 15⅛ | 14⅛ 15⅛ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 2½% | Do. 3½ per Cent. Mort. Debs. (red.) | 98 102 | 98 102 | 3 8 8 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5⅛ | 5⅛ | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4⅛ 5 | 4⅛ 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21⅛ 22⅛ | 22 23⅛ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14⅛ 15 | 14⅛ 15 | 4 0 0 | " " | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 113 | 111 113 | 3 19 8 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 7 7/16 | 7 7/16 | 3 16 0 | February and August | ... | ... |
| 10,000 | 10 | 6% | Do. 5 per Cent. Preference xd | 12⅝ 13 | 13 13⅜ | 3 16 11 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 104 | 103 104 | 3 16 11 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 107 | 105 107 | 3 14 9 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 114 | 113 114 | 4 7 9 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y 5% Mort. Debs. (1908) | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) | 100 102 | 100 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 3½ | 3 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ 5 | 4½ 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 12 13 | 12 13 | 1 10 9 | ... | ... | ... |
| 20,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9½ 10⅛ | 9½ 10⅛ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 106 109 | 106 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | " " | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 92 95 | 92 95 | 3 3 2 | June and December | 94 | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 21. | Price Wednesday, Aug. 28. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Aug. 23. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 9 | January and July | 101 | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3½ 4½ | 3½ 4½ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 52 55 | 51 54 | 5 15 9 | Feb., May, Aug., Nov. | 54 | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 97 99 | 97 99 | 6 1 3 | ,, ,, | 98½ | 97½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 9½ 10½ | 10 10½ | 2 7 6 | ,, ,, | 10 | ... |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | 185 | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 103 | 101 103 | 3 17 9 | ,, ,, | 103 | 101½ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 6 | 5 6 | 7 10 0 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ 15½ | 14 15 | 6 13 4 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 99⅞ 103⅞ | 100⅞ 104⅞ | 4 7 0 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10½ 11½ | 10½ 11½ | 5 13 1 | Jan., Apr., July, Oct. | ... | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 143 148 | 143 148 | 4 14 7 | Jan., Apr., July, Oct. | 145½ | 143½ |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 98 | 95 99 | 3 10 6 | ,, ,, | 98 | ... |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 116 | 114 117 | 3 9 1 | May and November | 115 | 114½ |
| 300,000 | 10 | 2/6 | Eastern Extension | 13¾ 14½ | 13¾ 14½ | 4 15 0 | Jan., Apr., July, Oct. | 14 7/16 | 14 |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 118 | 113 119 | 3 7 4 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 102 | 100 103 | 3 17 8 | February and August | 1 1½ | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101⅞ 104⅞ | 101⅞ 104⅞ | 3 17 7 | May and November | ... | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 33 | 31 33 | 4 10 11 | January and July | ... | ... |
| £78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos | 100 103 | 100 103 | 4 7 10 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red.) | 41 45 | 41 45 | 5 11 1 | May and November | 44 | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 107 | 105 103 | 5 14 9 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 1 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 101 104 | 101 104 | 4 18 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¾ ¾ | ¾ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 101 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | ... | West India and Panama | ½ ¾ | ½ ¾ | ... | May and November | ... | ... |
| 31,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 6 | 5 6 | ... | ,, ,, | 5⅜ | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 16 2 | January and July | 101½ | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 13¾ 14½ | 14 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14⅜ | ... |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 103 105 | 4 15 10 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 101 104 | 102 105 | 3 16 7 | ... | 103½ | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) | 3½ 4½ | 3½ 4½ | 5 17 8 | August | ... | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 2/0 3/0 | 2/6 2/9 | 10 13 2 | April and October | ... | ... |
| 72,680 | 1 | [2]1% | Monte Video Telephone Ordinary | ¼ ½ | ¼ ½ | 5 0 0 | November | ... | ... |
| 88,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3½ 4½ | 3½ 4½ | 6 1 3 | February and August | 4 1/16 | 3½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 13 | 12 14 | 4 5 9 | ,, ,, | 14 | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 13 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4¾ 5 | 4½ 5 | 5 0 0 | ,, ,, | 4⅞ | ... |
| £7,700,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 92 95 | 92 95 | 3 14 1 | June and December | ... | ... |
| £500,000 | Stock | 4% | * Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 1 | ... | 97½ | 95 |
| 171,504 | 1 | 0/8[2] | Oriental | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5½ | 5 5½ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ 5¼ | 4¾ 5¼ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 15 11 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅜ ½ | ⅜ ½ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ ½ | ⅜ ½ | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 9½ 10½ | 8 9 | 8 6 8 | July and February | 9½ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6 6½ | 5½ 5¾ | 5 4 4 | January and July | 6 | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ 5¼ | 4¾ 5¼ | 5 14 3 | ... | 5 1/8 | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1½ 1¾ | 1½ 1¾ | 5 14 3 | September | 1 1/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2¼ | 2 2¼ | 5 6 8 | ,, | 2 1/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 108 | 103 108 | 4 4 11 | March and September | 104½ | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 8 3 | January and July | 100 | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 14½ 15½ | 15 15 | 4 13 9 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¾ 6¼ | 5¾ 6¼ | 4 0 0 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 108 112 | 108 112 | 4 0 10 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 95 | 92 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 5 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3¼ 3½ | 3¼ 3½ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 105 | 100 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7⅛ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ¼ ½ | ¼ ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ 2½ | 1½ 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 85 90 | 85 90 | 5 15 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5¾ 6¼ | 5¾ 6¼ | 5 12 0 | Half-yearly | 6 7/16 | ... |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5½ 6 | 5½ 6 | 5 0 0 | ... | 5⅞ | 5 1/16 |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 107 | 104 107 | 4 4 4 | ... | 105½ | ... |
| 112,100 | 2 | 1/2[2] | Electric Construction Co. | 1½ 2 | 1½ 2 | 6 0 0 | January and July | ... | ... |
| 25,000 | 2 | 2/9[2] | Do. 7 per Cent. Cumulative Preference | 2¼ 2¾ | 2¼ 2¾ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 102 | 98 102 | 3 18 5 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9½ 10½ | 9¾ 10¼ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 102 | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 16 17 | 16½ 17½ | 5 14 3 | February and August | 1 3/4 | 1½ |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6 | 5½ 6 | 3 16 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 110 114 | 110 114 | 4 0 6 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 13 0 | ,, ,, | 21 | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 38 42 | 38 42 | 5 0 0 | March and July | 41 | 39 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 106 | 104 106 | 3 15 10 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11¼ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6½ | 5½ 6½ | 4 0 0 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | 11½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6¾ 7¼ | 6¾ 7¼ | 4 2 9 | ,, ,, | ... | ... |
| £ 00,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 10½ 10¾ | 10½ 11 | 4 15 [7]5 | Jan., Apr., July, Oct. | 10¼ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ 15½ | 14¾ 15½ | 3 18 8 | ,, ,, | 14¼ | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 126 131 | 126 131 | 4 12 0 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,216. [No. 20. Vol. XLVII.] FRIDAY, SEPTEMBER 6, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 15 cents, or 30c., or 70f.


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## NOTES.

THE first International Engineering Congress in Great Britain was inaugurated on Tuesday in Glasgow under the most auspicious patronage of civic and academic authorities, the meeting-place being the ancient university buildings at Gilmorehill. Considering the immensity of the programme drawn up for the members, who numbered over 2,500, and the variety of interests to be provided for, the authorities responsible for the arrangements of the Congress are to be congratulated upon the marked success of their united efforts. Smoothly, and with evident comfort to all concerned, the provisions for the welfare of the members have been secured—an achievement all the more remarkable seeing that Glasgow was already overcrowded with tourists and exhibition excursionists. The marked success of this the first congress of the kind in Great Britain, should lead the engineering profession to endeavour to hold similar conventions at regular intervals of a few years in the future.

THE proceedings commenced with a reception of the foreign delegates by the Lord Provost, Mr. SAMUEL CHISHOLM, the president, Mr. JAMES MANSERGH, president I.C.E., and other officials, in the Bute Hall, where an immense audience were gathered together. Nearly every British engineer of eminence in all the branches of the profession was present, and the delegates included eminent engineers from every Continental nation, the United States and Japan. After the reception the PRESIDENT delivered his address, his main theme being an intelligent eulogy of the profession of the engineer. As we reprint the address this week it is unnecessary to recapitulate its substance; we may, however, observe that the various original suggestions which it advanced were warmly appreciated by the audience. Engineering is by no means merely a matter of "engines," and there is force in Mr. MANSERGH'S contention for an initial "I" instead of the British "E"; indeed, we of the electrical profession may claim to have removed from the mechanical section of engineering the pre-eminence of engines and established the pre-eminence of electric motors, notwithstanding that in the last resort our dynamos are largely dependent upon engines.

IT will be noted with some surprise that Mr. MANSERGH attributes the origin of modern engineering to MACADAM'S discovery "that good roads could be made with stones broken small." The discovery of the steam engine, however, soon took mechanical engineers away from common roads, and concentrated their attention upon railroads, though, curiously enough, in recent years, common roads have again come to play an important part in mechanical engineering through the renaissance of the motor car. The civil and the mechanical engineer, in fact, will find a common problem in the motor car on common roads—a problem that is of the greatest interest to the future of rural life and agricultural prosperity in the United Kingdom. Apropos of the motor car, we may remark that, concurrently with the Engineering Conference, Glasgow has been visited with a—shall we say—plague of motor cars, in connection with the 500-mile endurance trials announced in our last issue.

OUR issue next week will contain a detailed account of the electrical proceedings of the various sections of the Engineering Conference, the deliberations of which will conclude this afternoon.

A REMARKABLE instance of the keenness of foreign competition was given on Wednesday, at Manchester, when the City Council discussed the recent tenders for new

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switchboards. From the report of the proceedings in another column it will be seen that out of 20 tenders two only were from firms prepared to manufacture the switchboards entirely in Great Britain. The lowest tender was by the Electrical Company, the English representatives of the Allgemeine Elektricitäts Gesellschaft, and its amount (as announced in our last issue, page 730) was £39,306. The next tender (£42,551) was by a firm which would have manufactured the switchboards in America; and the acceptance of the third lowest (£50,004), although it was from an old-established English firm, Messrs. Siemens Bros. & Co., would equally have implied that the work would have been done abroad. The lowest all-British tender was over £58,000. It seems incredible that the makers of switchboards in this country should have been left behind in this way. Whether the difficulty lay in the magnitude of the work or in the specified time of delivery—or possibly in a combination of the two—it was to have been expected that several British firms would have been equal to the occasion.

On another page we give an account of the Thomson-Houston system of train control which is being tried on two extensions of the main railways running into Paris. We think it will be of special interest to our readers in view of the fact that the same system is used on the experimental train of the Central London Railway. This train was started on ordinary schedule time last Tuesday at 8 p.m., when it made two journeys to the Bank and back in the 2½ hours that it was in service. The difference between the apparatus used in London and Paris is so small that the description virtually is a description of the plant installed on the train of the Central London Railway. The principal difference is in the disposition of the resistances, electromagnetic switches, &c.; and this is solely due to the system in the case of the London railway being adapted to existing carriages. Owing to insufficiency of space under the cars, it was found necessary to partition off a small portion of the interior of each motor car to hold the apparatus. The trial train on the Central London Railway was also run 10 times on Saturday past a fixed position to enable experiments to be made by Lord Rayleigh's Committee relative to the important question of vibration, and we shall look with great interest for a report on the relative vibration caused by the new geared locomotive, mentioned in a previous issue, and the many-motored train. It is to be noted that the Great Northern and City Railway has decided to use the Thomson-Houston train-control system from the commencement, and this points to the probable conclusion that it contemplates in the future extending its lines in more than one direction.

An unfortunate stoppage occurred on the Central London Railway on Monday afternoon for about three quarters of an hour, not due precisely to an accident but to a technical reason which, although it will be well understood by engineers, will not, we fear, have the sympathy of the general public. The Central London Railway Co. has been subjected to almost a persecution from the local authority for allowing black smoke to issue from the chimney of their generating station, and was forced to do all in its power to mitigate this "nuisance." The boilers are fitted with Vicars' stokers, in which hitherto a Nottinghamshire coal has been burnt. A few weeks ago a trial was made with a small quantity of Monmouthshire coal, and it was found that it was necessary to remove the clinker from the back of the grate at a much faster rate than with the Nottinghamshire coal, but that this could be done and steam could be kept up quite well. It was, therefore, determined to use this coal regularly, and the bunkers were filled up with it, a quantity of the Nottinghamshire coal being left at the bottom. The difficulty on Monday was due to the boilers being stoked with a mixture of the old coal and the new—a mixture of bituminous and anthracite coal, in the use of which the boiler room hands had not had a previous rehearsal. The faster clinkering above referred to took place and was not removed quickly enough, and matters were further complicated by the different rate of feed required, the result being that the steam pressure gradually dropped, and the train service had to be stopped for a short time to get things in order again. Arrangements are now complete for dealing with the new fuel, and the men have already become quite accustomed to it, so that a recurrence of Monday's accident will not happen.

University College, Bristol.—The Session 1901-2 begins on Oct. 8. An announcement elsewhere gives some further particulars.

Battersea Polytechnic.—The session opens on September 17th, the evening classes commencing on September 23rd. Prospectuses are ready.

Crystal Palace Co.'s School of Practical Engineering.—The winter term commences on Sept. 9th. An entrance examination for students will be held on the same day at 10:30 a.m.

Northampton Institute, Clerkenwell, London, E.C.—Some particulars of the evening courses in mechanical and electrical engineering, which commence on Monday, September 23rd, are given on another page.

Opening of the Sleaford Municipal Electricity Works.—The opening of this undertaking took place this week, and the streets, which have been in darkness for some time owing to a dispute with the gas company, now have the electric light.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus ... | June 21, 1899 |
| Pará—Maranham ... | Mar. 2, 1900 |
| Cadiz—Teneriffe | Aug. 6, 1901 |
| Bolama—Bissao | Aug. 16, 1901 |
| Trinidad—Demerara | Aug. 27, 1901 |

A New Tramway Line in Paris.—A new electric tramway between St. Cloud, Suresnes, Puteaux, Courbevoie, Asnières, St. Denis and Pierrefitte has just been completed and opened for traffic. The line, which is 20km. long, is on the overhead conductor system, and is worked by La Compagnie des Tramways Mecaniques des Environs de Paris.

Invention of the Compass.—The *Italia Militaire e Marina* states that a committee is being formed at Amalfi to arrange for the celebration of the fourth centenary of the invention of the compass. The Duke of the Abruzzi has agreed to be president of the committee, and Signor Morin, the Italian Minister of Marine, the vice-president. The celebration will take place next year.

The New Lupus Cure.—The report presented to the governors of the London Hospital on Wednesday last told of the continued success of the Finsen light treatment for lupus. In 15 months no less than 218 patients had been

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treated. Although the lamps originally installed have been of the utmost service, equally effective work is now accomplished by the aid of smaller and cheaper ones.

**Tramways and Light Railways Association.**—On Wednesday the Lord Provost of Glasgow, and the convener and members of the Tramways committee of the Corporation of Glasgow, entertained the Tramways and Light Railways Association at luncheon in the banqueting hall of the City Chambers. A large number of members and others interested in tramway and light railway traction were present. Among the speakers were the Lord Provost, Councillor Paton, Sir Rivers Wilson and Mr. J. S. Raworth. In the evening the Association held its annual dinner.

**James Watt Engineering Laboratories at Glasgow.**—In connection with the International Engineering Congress at Glasgow this week, Lord Kelvin formally opened the new James Watt engineering laboratories at Glasgow University, on Tuesday afternoon. The function was attended by a large number of eminent engineers. We may observe that although this was the formal opening of these laboratories, the actual opening of them for work will not take place for some time, as the buildings are not yet completed. It is expected that the equipment of the laboratories, which are under the direction of Prof. Barr, will cost about £14,000.

**Trials of the Ganz High-Pressure Traction System.**—The preliminary trials upon the lines of the Valtellina–Colico–Sondrio electric railway were made last month. We learn that the dynamos have supplied their 21,000 volts without trouble, and that the rolling stock has given satisfaction. Report states that the system has shown itself capable of transporting five cars and preserving a speed of 72km. per hour, even on the up gradients, which are considerable. During the descent of inclines of 14 per cent. the starting of the train is very gradual, and the decrease in load is very marked at the central station, where the gates which admit water to the turbines are partly closed until the motors again take their normal current.

**Errata.**— Mr. Mizuno corrects the following clerical errors in his article on "Oscillatory Discharges Through Divided Inductive Circuits" in our last issue. Equation (14) on page 712 should read

$$\frac{d^2i}{dt^2} + \frac{\frac{R_1}{L_1}\left(\frac{1}{1}\right)\frac{di}{dt}}{\frac{1}{\frac{1}{L_1}+\frac{1}{L_2}}} + \frac{i}{C\left(\frac{1}{L_1}+\frac{1}{L_2}\right)} = 0;$$

and equation 17 on the same page should read

$$\frac{d^2i}{dt^2} + \frac{R_0}{L_0}\frac{di}{dt} + \frac{i}{L_0 C} = 0.$$

On page 700, in our last issue, the length of the journey from end to end on the Great Northern and City Railway was given as 7 miles. This is the length of the double journey, the single trip being 3½ miles.

**Personal.**—We announced in our last issue that Mr. C. H. Reynolds, C.I.E., had been appointed manager by the Pacific Cable Board. The following biographical notice will be read with interest:—Mr. Reynolds was born in India in 1844. He is the son of the late Major W. Reynolds, of the Bombay Army, and comes of an old Hampshire family. Before choosing telegraphy as his profession, Mr. Reynolds was employed for three years with the London Chartered Bank of Australia, and in the London and Westminster Bank. In 1866 he was nominated for an appointment in the Indian Telegraph Department, which was then being re-organised under the direction of the late Major-General D. G. Robinson, R.E. After undergoing the prescribed courses of study in physics, science, electricity, and practical telegraphy at University College, London, and under Mr. (now Sir William) Preece, Mr. Reynolds passed first in the final examination for the Indian Telegraph Department, and was sent to Glasgow University for a laboratory course under Sir W. Thomson (Lord Kelvin). He joined his appointment in India in May, 1868, and rose through all the upper grades of the department till he received the appointment of Director-General of Telegraphs in India in April, 1895. In 1885, conjointly with the late Sir John Champain, R.E., he represented India at the International Telegraph Conference of Berlin, and since then his official duties have constantly kept him in touch with all questions connected with international telegraphy. In the course of his Indian career Mr. Reynolds received on several occasions the thanks of the Government of India for services rendered in connection with the developments of telegraphy in that country during the past 30 years; and in the Chitral and Tirah campaigns on the North-West frontier in 1895 and 1897, the telegraph department afforded important and valuable services to the Government and to the army which were duly acknowledged in official despatches. Mr. Reynolds retired from the Indian service in 1899. He is a member of the Institute of Electrical Engineers, and was created a C.I.E. in 1897.

**The Electrical Plant of a Philadelphia Newspaper.**—Under the above title, the *Electrical World* of New York describes the electrical transmission for the *North American*, the oldest newspaper in America. Five 60-ton presses are in use, and the work has reached such perfection that the material is not touched from the moment the logs are felled to make the pulp until the printed sheet is delivered to the carrier. At the side of each press below the floor is an enclosed chamber of steel plate, in which is set the motor-driving equipment. The motors are cooled by a blast of cold air from a motor-driven blower. Each press is driven by a 50 H.P. Bullock motor, with teaser and booster. The starting current is momentarily about 40 per cent. above the current at full load. Remarkable steadiness of operation is attained under slow speed, and there is no uneven or jerking movement of the press, which in some instances is found liable to break the web of the paper. The speed is under absolute control of the operator, who can, by the movement of a hand-wheel, start the press in exceedingly slow motion, moving it along inch by inch, and bring it up to a regular slow motion and then to any speed required in the operation of the press. Push-buttons are placed at convenient points about the press by the use of any one of which the press may be immediately stopped. In the composing room, 30 Mergenthaler linotype machines are operated by individual motors, mounted on a frame and connected by a worm-gear reduction. The formes are raised from the composing room on the nineteenth floor by elevator to the electrotype room on the twentieth floor, slid swiftly on trucks to the steam bed, where the soft matrix is applied and the usual process of casting is completed. In less than a minute the heavy plate is taken from the mould and passed to the cutting, trimming and planing machines, all driven by individual electric motors, and with a few finishing touches it is sent to another elevator and descends 21 storeys to the pressroom at a speed of 600ft. per minute. The following is a complete list of the motors employed:—

Five Hoe sextuple presses, each driven by a 50 H.P. Bullock motor and teaser; forme hoist, 2 H.P.; refrigerating apparatus, 7 H.P.; ash hoist, 3 H.P.; coal conveyor, 5 H.P.; ventilating fans, one motor of 4 H.P., four of 5 H.P., one of 12 H.P., two of 2 H.P., and one of 1½ H.P.; two curved shaving machines, each with a 4 H.P. motor, direct connected; three cutting off cylinders, 4 H.P., each geared; one matrix-rolling machine, 4 H.P. each, direct connected: one saw trimmer, ½ H.P., belted; one screw driven shaving machine, 3 H.P., belted; one electrotype-curving machine, 2 H.P., belted; one saw table, 1 H.P., belted; two curved routing machines, 2 H.P. each, direct connected; 30 linotype machines, ¼ H.P. each, worm-gear reduction; two boiler-feed pumps, 7½ H.P. each, geared.

The electrical conductors leading to the motors on the numerous machines are fully protected by flexible armoured conduit, its flexibility permitting of close fitting to the frames of the machines. In most instances the starting and regulating devices to control the individual motors are attached to the machines at a convenient point. The total number of incandescent lights in the building aggregates 3,100, and of enclosed arc lamps 30

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# THE KENSINGTON AND NOTTING HILL COMPANIES' JOINT ELECTRICITY SUPPLY WORKS.

The history of the electricity supply works within the area of the County of London will in future years be of great interest to the student as examples of almost every system of supply now in operation. The system which we now propose to describe is especially interesting for two reasons: It is the first time that two of the companies within the metropolitan area have combined to build a joint station, and it is for the first time in this country that a system of any magnitude has been adopted which has employed asynchronous motor-generators in its sub-station equipment.

In 1898 both the Kensington and Knightsbridge Electric Light Co. and the Notting Hill Electric Lighting Co. found themselves in the position of urgently requiring new generating stations, and at the same time both companies were unable to secure suitable sites within their respective areas of supply. Negotiations between the two companies ended in the decision to erect a joint station at Wood-lane, Shepherd's Bush, on land adjoining the generating station of the Central London Railway. The land is portion of a plot bought by the Kensington Vestry for use as a depôt; it is in Hammersmith, and is situated about 2½ miles from the district of the Kensington Company, and 1 mile from the works of the Notting Hill Company. A bill authorising the purchase of land, building, the station, and laying the mains was passed through Parliament and received the Royal assent in July, 1899, immediately after which the committee of management commenced work on the new undertakings. This committee consisted of two of the directors of each company, Sir F. Bramwell and Mr. R. W. Wallace representing Kensington, and Mr. A. E. Franklin and Mr. J. T. Jervis, Notting Hill. Mr. R. S. Erskine and Mr. R. G. Rawkins were appointed joint secretaries, Mr. John Slater consulting architect, and Mr. A. Langton clerk of works.

The committee of management were advised by the chief engineer of each company, Mr. H. W. Miller, of Kensington, and Mr. G. Schultz, of Notting Hill, the specification and construction of the joint station being undertaken by these gentlemen, who were assisted by Mr. C. M. Bennett and Mr. S. F. Weston; and when the work was completed Mr. Bennett was appointed resident engineer, with Mr. Weston as his chief assistant. The following is a list of the principal contractors:

| | |
|---|---|
| J. Smith & Sons ..... | Builders. |
| Babcock and Wilcox ..... | Boilers. |
| Willans and Robinson..... | Engines. |
| General Electric Co. ..... | Alternators, motor-generators and switchboards at Notting Hill sub-stations. |
| Thomas Parker (Ltd.)..... | Exciters. |
| Stewart and Menzies ..... | Steam Pipes. |
| Pulsometer Engineering Co. | Pumps. |
| Marshall, Fleming and Jack | Cranes. |
| O. Berend & Co. ..... | Switchboards at generating station and Kensington sub-stations. |
| Graham, Morton & Co. ... | Coal and ashes plant. |
| Stanton Ironworks ..... | Water tanks. |
| Körting Bros. ..... | Condensers and pipes. |
| Dorman, Long & Co. .. ... | Steel work. |
| St. Pancras Iron Co. ..... | Roofs. |
| Myles and Warner ..... | Chimney. |
| Kerr, Stuart & Co. ..... | Railway plant. |
| Doulton & Co. ..... | Water softener. |
| E. Green & Son ..... | Economisers. |
| W. Renshaw & Co. ..... | Tipping platform. |
| W. and T. Avery ..... | Weighbridge. |
| Hart Accumulator Co. ... | Accumulators. |
| J. Aird ..... | Feed pipes, small steam pipes, &c. |
| Templer and Rance..... | Valves. |
| Bruce Peebles & Co. ..... J. H. Holmes & Co. ..... | Electric motors. |

**System of Supply.**—Considering the distance from the areas of supply, the alternating-current system was decided upon as being the most suitable, and the pressure of 5,250 volts at the generating station, with three-phase generators was chosen. Both companies are supplying current under somewhat similar conditions, the three-wire system being used with 220 volts pressure between the outers, whilst in each case special facilities are being given to consumers to change over to the higher pressure, and no houses are being connected at 110 volts, so that the companies hope in the future to change to a three-wire system at 440 volts. At present, however, all the switchboards and generators are made for 220 volts, the balancing being done by existing accumulators at the Kensington Court and Bayswater-road sub-stations; whilst at the new sub-stations of both companies only 220 volt motor-generators are being installed, no arrangements being made for balancing, as supply in their neighbourhood is almost alto gether at the single voltage. The question of using rotatory transformers, synchronous motor-generators or asynchronous motor-generators was very carefully considered, and it was decided in the first instance to use nothing but the last-named type of machine in the sub-stations. The principal advantage of using the asynchronous motor-generator is on account of the exceedingly rapid increase of load that always occurs in London, and, in fact, in most large towns, due to either a thick fog or a heavy thunderstorm. Speed in starting fresh motor-generators is consequently a great desideratum, and the asynchronous motor-generator can be switched on to the mains within two minutes of starting up. It also takes the whole of the starting current from the supply station, whilst in the case of the synchronous motor-generator the starting current is taken from the side already fully loaded. The mains have been laid with a very wide margin for increased output, so the question of power factor was not considered of prime importance; and, if found necessary, synchronous machines can be fixed when extensions are necessary.

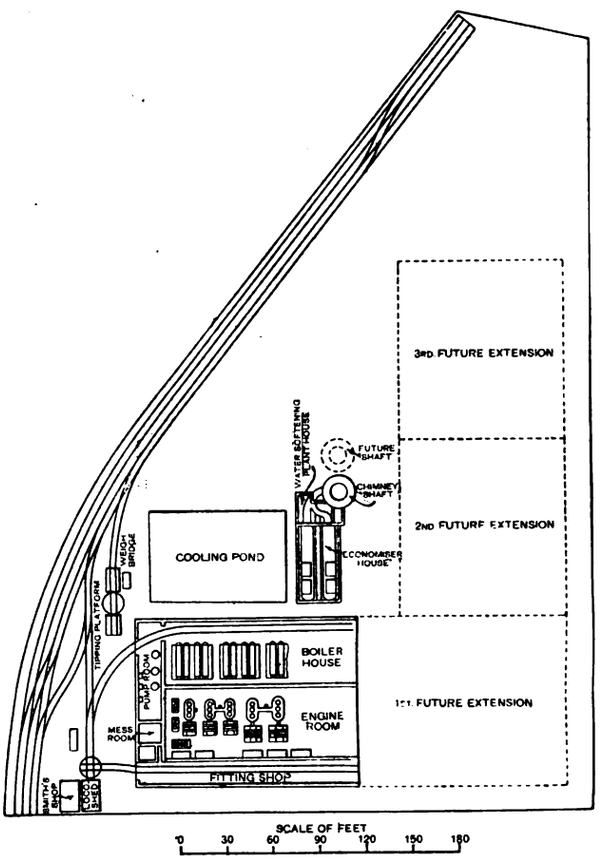


FIG. 1.—PLAN OF GENERATING STATION.

**Site of Works.**—An area of 3¼ acres was acquired from the Kensington Borough Council on the south of the plot used for

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the Council's depôt, the site being bounded on the south by the Great Western and London and North Western Railways, on the east by the West London Railway, and on the west by the Central London Railway generating station. Work was commenced by the middle of December on the building foundations pending the placing of the building contract, this work being carried out by men in the employ of the joint company under the supervision of Mr. Bennett. Every part of the work was carried out as speedily as possible, so that the first engine and alternator was in use supplying current to Kensington by October 23, 1900. A single line from the railway enters the land of the Kensington Borough Council, where it connects with two lines provided for the joint use of the council and the companies. On the companies' land the two main sidings have a length of 650ft. each, with accommodation for 80 waggons. Secondary sidings of about 750ft. run allow of shunting operations for delivering machinery into the engine house, boiler house, coal handling plant and workshop. The sidings are substantially built with standard railway plant and rails, and a small locomotive for shunting has been provided. The position of these sidings is clearly shown on the plan of the generating station (Fig. 1), and it is evident, from inspecting this, that the design of the whole station has been carefully thought out for utilising the area to its fullest extent.

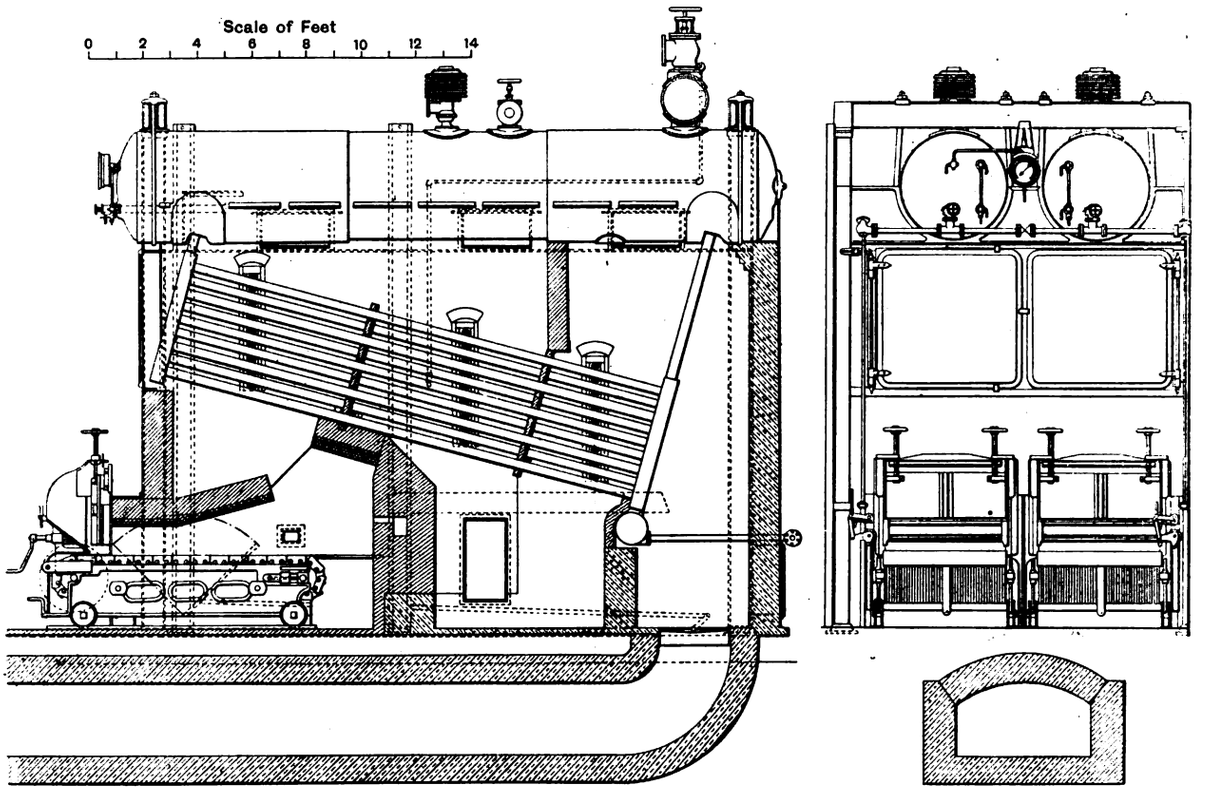


FIG. 2.—SECTION AND FRONT ELEVATION OF ONE OF THE BOILERS.

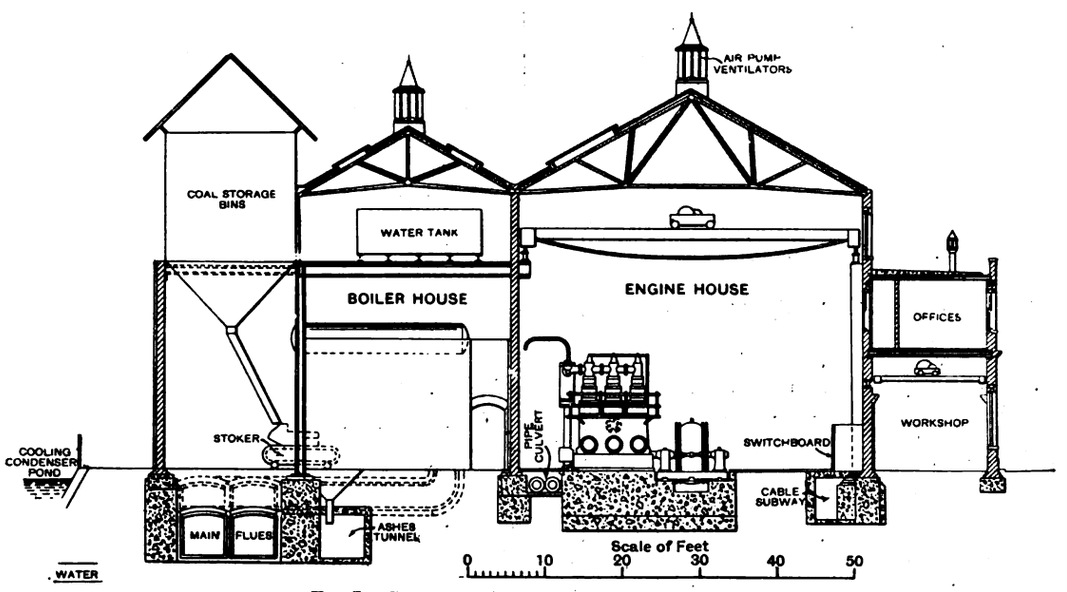


FIG. 3.—SECTION THROUGH GENERATING STATION.

Buildings.—Both the boiler house and engine room are 126ft. long by 45ft. wide, the travelling crane gantry being 28½ft. above the floor level in the engine room. The walls are faced with special leadless white glazed bricks, with a brown dado and black line formed to a height of 6ft. above the floor, which is of concrete covered with a maple block

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flooring. The boiler house roof is constructed with non-inflammable wood and steel, and slated outside. Boyle's air-pump ventilators are fixed on the ridge of the roofs of both engine and boiler house.

The chimney has been designed to deal with the flue gases from boilers of 10,000 H.P. It is 230ft. high and 210ft. above the estate level. The section is circular, with an 11ft. bore throughout. The excavation was taken down 26ft. until the hard blue clay was reached, this depth being 13ft. below the standing water level. A cement concrete block was then put in measuring 36ft. square by 10ft. thick. On this foundation the footings were built, consisting of 28 rings of London stock bricks in blue lias lime mortar. The shaft then commences at a depth of about 9ft. below estate level, and is provided with two arched openings, one for the present boiler flues and one for the future extensions. The stock brickwork is carried

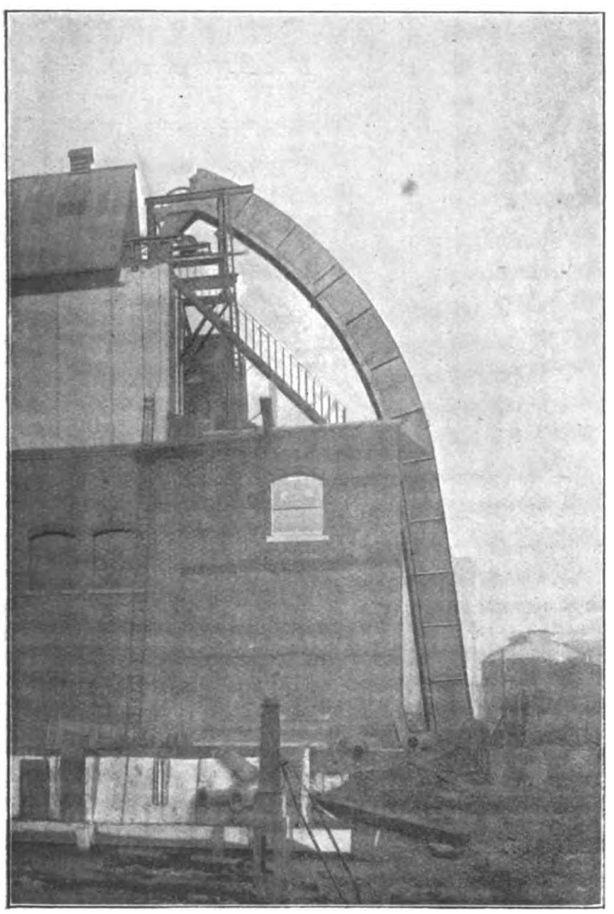

FIG. 4.—COAL ELEVATOR.

up to the estate level, after this the outside courses are constructed with red radiating bricks from the Highbroome Brick Works near Tunbridge Wells. Up to the height of 170ft. above ground, the chimney bond is used, above this the old English bond is used, and the top 20ft. of 14in. work is built in cement mortar. The outside diameter varies from 22ft. at the bottom to 13ft. 4in. at the top. The firebrick lining and air space extends to a height of 40ft. from the bottom.

The cap is of terra-cotta and is of a special shape to deflect the wind striking the cap upwards, and thus prevent the wind beating down the gases coming out of the chimney. The lightning conductor consists of two copper bands 1½in. by ⅛in., four copper earth plates, and six gold-plated copper points with a copper ring round the tip of the cap.

Boilers.—Space is provided in the present boiler house for eight boilers, of which five have been fixed, with 4ft. passages between each battery of two boilers. Each has 3,654 sq. ft. of heating surface, works at a pressure of 200lb., and is capable of evaporating 14,000lb. of water per hour. Each boiler is constructed of 18 sections of nine 4in. weldless steel tubes, 18ft. long, superposed and expanded at each end into wrought-steel staggered headers, suspended in the usual way from the drum and free of the brickwork. The tube doors, which close in the ends of the tubes, are lined 3in. thick with "magnesia," and covered with an inner sheet-iron lining. The plates of the drums are ⅝in. thick, having a tensile strength of 26 to 30 tons. The two 48in. drums are connected by a 20in. cross-drum. The boilers are fitted with the usual fittings. Each boiler is provided with a flexible hose, lance, and cock for removing soot or dust from the exterior of the tubes. The general design of the Babcock and Wilcox self-clinkering chain grate stoker which is used can be seen from Fig. 2. These stokers have a grate area of 63 sq. ft. The coal hoppers and other details of the fronts of the boilers are the result of experiments made on a similar boiler at one of the Kensington Company's works during the past 12 months; Mr. J. F. Jones, engineer of the Chapel-place station, having suggested and designed the improvements. A 5 H.P. motor drives the shafting for the stoker gear.

It will also be seen that the boiler tubes have been lifted 2ft. higher than usual, to form a firebrick-lined combustion chamber directly over the fire, and two firebrick arches are used instead of one, and the flame-plate division wall between

FIG. 5.—WAGON TIPPING PLATFORM.

the furnace and the middle chamber has been moved nearer the front of boiler, so as to raise the temperature and get more work done in the middle chamber, and thus obtain smokeless combustion.

The general arrangement of the flues can be traced from Figs. 1 and 3, the branch flue from each boiler being taken into one or other of the two main flues. Each pair of boilers is connected to alternate flues, so that one of the flues can be cleaned whilst the other one is in use. Each main flue is provided with a 320-tube economiser with bye-pass flue between them, space being allowed for doubling the number of pipes. The scrapers are driven by electric motors.

Coal and Ash Handling Plant.—Twenty 10 tons capacity coal wagons have been purchased, each provided with one end door; these are passed over a 20-ton weighbridge on to a turn-table, then on to a special tipping platform, shown in Fig. 5, where the contents are shot into a steel receiver, from which the coal is taken through a Graham's revolving automatic feeder at the bottom of the hopper into a bucket elevator and lifted up to the top of the boiler house. The feeder is designed so that it allows the coal to be discharged from the hopper into the elevator at a specified amount per revolution. In this way it is impossible to choke the elevator boot with a large weight of coal, and reduces to a minimum the excessive strain on the elevator chains. Inside the hopper at the bottom is placed a small grid so as to prevent foreign material from passing through into the elevator

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and consequently into the mechanical stokers, and is arranged with a suitable hand hole so that this material may be removed from time to time. The feeder is driven from the trailing shaft of the elevator so that the speed of the feeder is in constant ratio with the speed of the elevator.

After the coal is received into the elevator boot, it is raised by means of a 24in. elevator 75ft., and discharged into the coal storage conveyor over the tanks. The elevator is built with a curved framing, and is of the cased-in type, consisting of a framework of four angle iron runners the entire length of the elevator; and to these runners is riveted the steel casing covering the sides, back and front, and forming a box girder, the front plates being removable at any time. The four angle irons which form the longitudinal stiffeners for the girder are arranged in such a manner that they support the elevator buckets and chain both on their upward and downward course, and are lined with renewable greenheart wood liners for the whole of their length so as to reduce the noise and friction whilst at work. The elevator is supported off the coal stores hopper at the head by a suitable arrangement of steel joist structure. The elevator is fitted with two endless strands

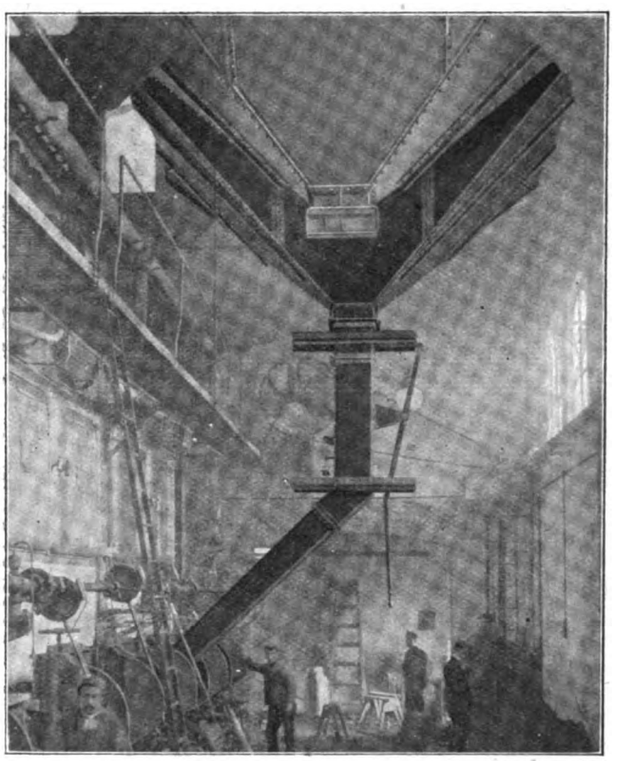

FIG. 6.—VIEW OF BOILER HOUSE SHOWING COAL SHUTS.

of steel roller chain, each strand being tightly stretched over its respective top and bottom sprockets, and to the chain is attached riveted steel buckets, about 2ft. pitch, and also the skidder bars which rest on the greenheart liners, the whole forming a continuous and endless strand of moving steel buckets. These buckets are also arranged with longer backs so as to prevent the coal spilling when the bucket reaches the curved portion of the elevator. Fig. 4 shows the elevator, nearly completed. As each bucket delivers its contents it is carried by means of shutes on to the push-plate conveyor, which automatically distributes the coal throughout the series of seven bunkers. This conveyor is 20in. wide and 160ft. long, and is fitted with the latest improvements in the type of push-plates and skidder bars. In the trough of the conveyor is arranged a series of 20 outlets, each outlet being fitted with slide doors and so arranged that the coal may be delivered into any portion of the storage as required, or by opening the whole of the doors the coal may be automatically distributed, it being discharged through the first outlet until the coal reaches the level of the conveyor, whence it is scraped forward to the second outlet, and so on for the entire length. A gantry is arranged along the whole length of the conveyor and up to the elevator head, so that the attendant may have access to any portion of the working parts for oiling and cleaning. The large storage bunkers are 108ft. long, 17ft. wide and 17ft. deep, capable of storing 800 tons of coal directly above the boilers, and the hoppers are arranged with seven self-emptying bottoms to which is attached a Miller and Graham's patent swinging shute, by means of which the coal is discharged in specified quantities into the mechanical stoking hoppers. The steel bunkers are built of $\frac{3}{8}$in. steel plates, with $\frac{1}{4}$in. bottom plates, and well stiffened by means of angles, tees and flats, and supported by means of rolled steel joist columns in a suitable manner; the columns which constitute the front of the boiler house are walled in, but the skeleton structure of the building is composed of steel.

The engineers decided to adopt the measuring chambers similar to those which have been used with such great success in gas works, and the design of this measuring chamber is shown in Fig. 6, but owing to the tubes in the boilers having to be taken out, it is arranged that the shute may be swung

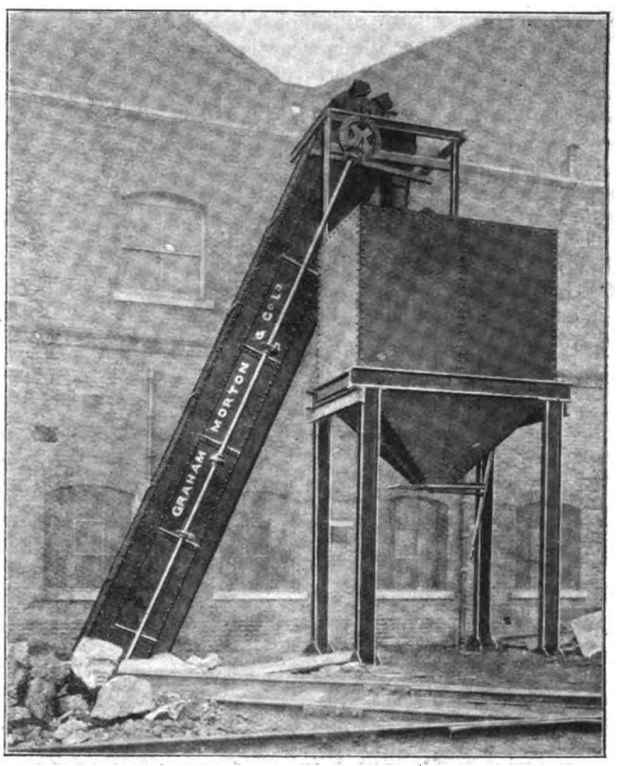


FIG. 7.—ASH ELEVATOR.

out of place so as to allow of the tubes being withdrawn without disturbing the coal in the bunkers. Each of the shutes hold 10 cwt. of coal, and are provided with flap doors so that the capacity may be adjusted from time to time according to the quality of the coal which is being used, and to the lever is connected a counter so that the number of discharges are registered. In addition to this, the shutes are provided with a Graham patent sure-feed, which is a simple and efficient device for preventing the chambers being half-emptied or being tampered with, and the slide having been once withdrawn must remain open until the whole of the coal is discharged. The whole plant is designed to deal with 30 tons of coal per hour, and is driven by two 10 H.P. electric motors.

In addition to the coal handling plant the engineers have adopted an efficient form for carrying away the ash from the boilers. In front of the boilers is arranged an underground trench in which is placed an 18in. tray conveyor, and the ash is received from the boiler and discharged on to the conveyor through a Bennett and Miller's patent flap shute, which is so arranged as to deliver the ash on to the conveyor in specified amounts, and prevents any cold air passing through the

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underside of the furnace of the Babcock and Wilcox boilers. the length of the conveyor is 124ft., consisting of an endless strand of overlapping steel trays, which carry the ash and discharge it into the ash elevator, which discharges it into a hopper supported at a sufficient height for discharging the ash into carts. The elevator is of the cased-in continuous-bucket type, the buckets being arranged so that the front of one overlaps the tail of its predecessor, thus preventing any small gritty material from falling through into the working portions, and the buckets are fed by means of a suitable flap-door feed arrangement so as to prevent overflow. After the ash is discharged at the top of the elevator it is conveyed by means of a revolving spout and distributed over the area of the hopper, which will hold 10 tons of ash. The ash plant is also driven by means of electric motors suitably reduced in speed by means of raw hide pinions and machine cut spur wheels. The ashes are carried by the conveyor to an elevator (Fig. 7) and discharged into a storage tank, from which they are emptied into a railway waggon or cart as required.

Feed and Condensing Plant.—Water is obtained either from the Grand Junction Water Co. or by means of a three-throw electrically-driven pump from a well on the grounds. A water-softening plant has been fixed near the economisers capable of dealing with 1,500 gallons of water per hour.

Over the boilers two cast-iron tanks are fixed. These measure 112ft. long by 16ft. wide by 6ft. deep, and will hold about 55,000 gallons of water, so that at full load the tanks contain half-an-hour's supply. These tanks give the necessary head of water required by the ejector condensers fixed on each engine, and are filled by one of the circulating pumps, the steam valve on the pump being controlled by a float in the tank.

Three direct-acting steam-driven feed pumps of the "Karoome" type have been fixed, each having a capacity of 4,000 gallons per hour against the 200lb. boiler pressure, and exhausting into two feed water heaters. The same room contains three low-pressure pumps, each capable of dealing

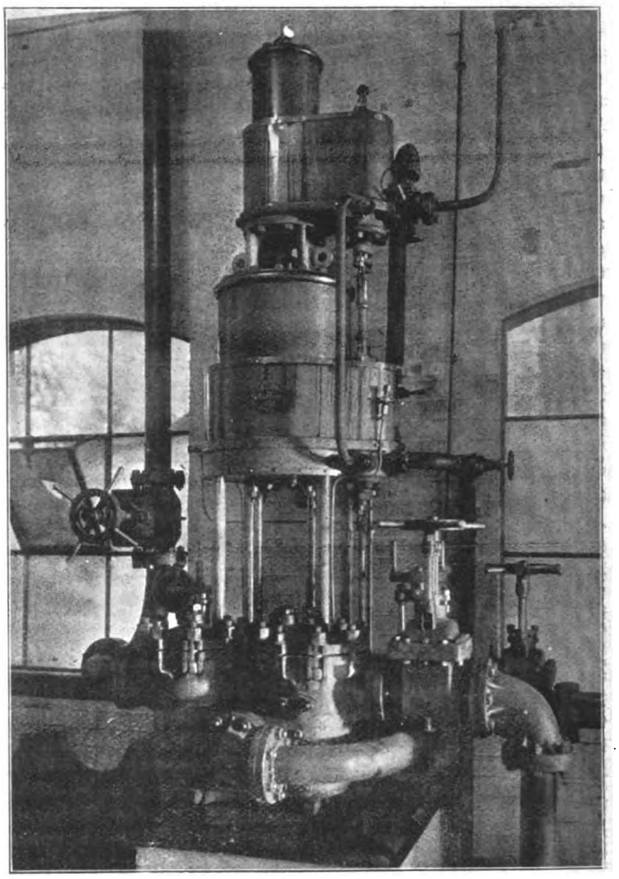

Fig. 8.—One of the "Karoome" Feed Pumps.

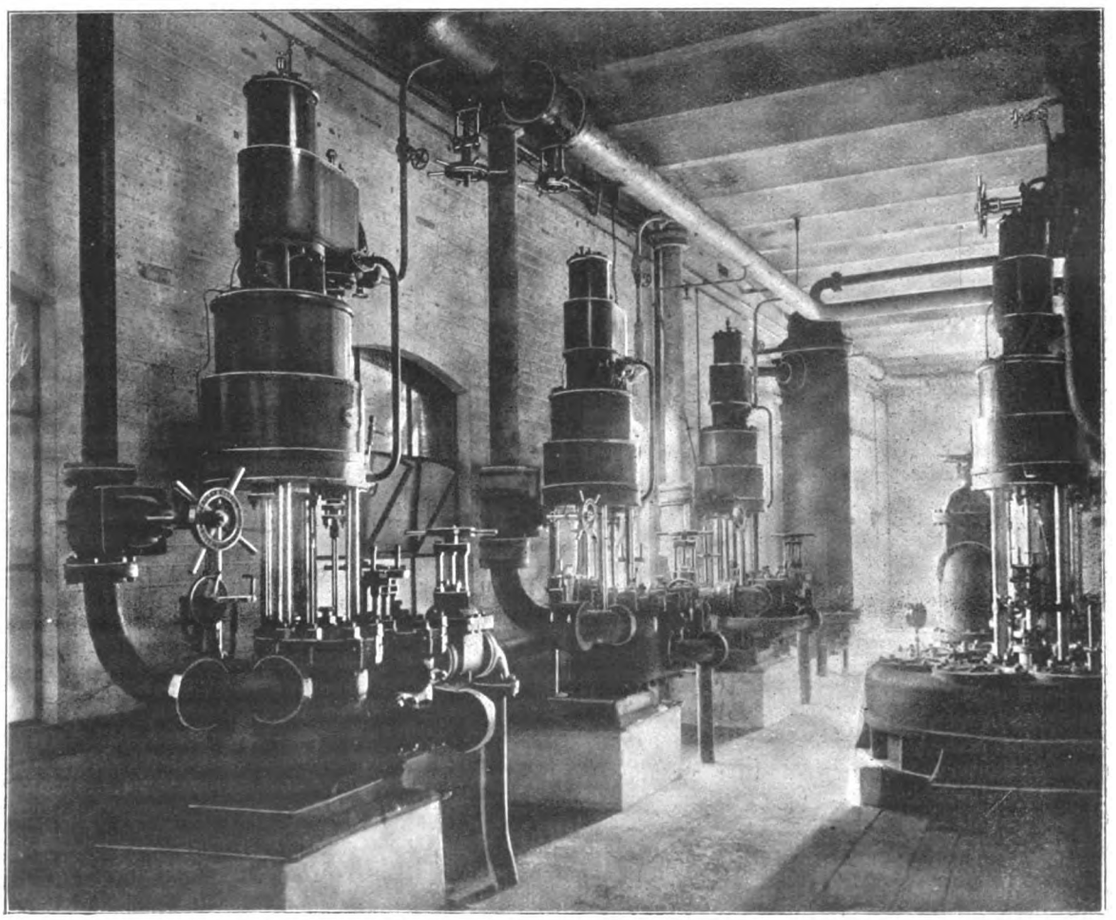

Fig. 9.—General View of Pump Room.

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with 100,000 gallons per hour against a 35ft. head. One of these deals with the circulating water, one with the cooling water, whilst the third is spare and can be connected to either service. Steam is supplied through a ring main connected direct with the boilers and also with the engine-room main steam pipe.

The steam ends of all six pumps are precisely similar in every respect, and thus, having all parts interchangeable, only one set of spare gear is required for the whole plant. The steam cylinders are 5in. high and 15in. low by 18in. stroke, the pumps being 27in. in diameter in the case of the circulating pumps, and 7½in. in that of the feed pumps, the steam pipe supplying the engines being 1in. in each case.

The feed pumps draw their water through heaters at about 210°F., and deliver it at about 210lb. per square inch pressure through the economisers into the boilers. The steam consumption of the feed pumps is 48lb. per water horse-power-hour, whilst the steam consumption of each circulating pump is 45lb. per water-horse-power.

The feed pipes are of lap-welded steel and iron with flanges forged on solid, but some have screwed-on flanges. A 5in. bore pipe is taken from the pumps to the economisers, and the return is by two 4in. pipes running the length of the boilers

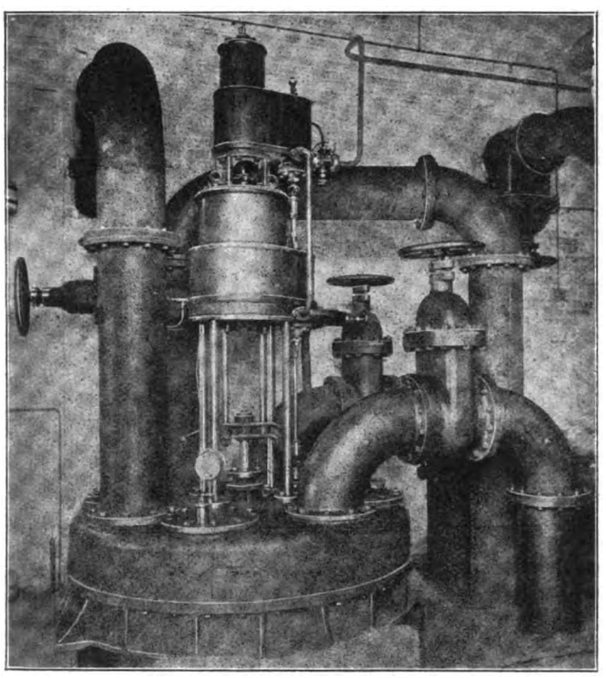

Fig. 10.—One of the "Karoome" Low-Pressure Pumps.

with branches off each pipe to each boiler. There is also a bye-pass pipe direct from the pumps to the boilers. The suctions and deliveries are in duplicate. All T-pieces were specially designed by Mr. Miller to reduce obstruction to the flow of water and to prevent shock, the area being considerably increased and the corners rounded off.

A cooling pond, measuring 100ft. by 60ft. by 7ft. deep, has been excavated; the bottom is in a thick bed of clay; it has been lined with cement concrete and Callender's bitumen sheeting; 84 jet fountains have been fixed. The pond was designed to deal continuously with the condensing water from about 2,500 H.P., and the water pipes will still be large enough when the pond is increased to twice its present size. The water is pumped to the fountains under a head of 15ft., and the whole of the rain water collected on the roofs is delivered into the pond.

Steam Pipes.—The steam pipes are of lap-welded steel with iron flanges welded on solid with the pipe; the T pieces are of wrought steel riveted to the pipes. The main pipe is 7in. bore, and is situated in the engine house, with 5in. branches from the boilers and 4in. branches to the engines. Sectional valves of Messrs. Templer and Ranoe's "Sterling" double-acting straightway type, fitted with steel bodies, are provided for dividing up the boilers and engines. "Tempo" combined stop and non-return valves are fitted to the boilers and "T.R." stop valves control the engines. The steam pipes are all covered with Snowdon's special asbestos pipe covering 2in. thick. Thermoscopic loop steam traps with delta metal valves and seats are used.

*(To be continued.)*

## THE THOMSON-HOUSTON SYSTEM OF TRAIN CONTROL.

As has been announced in our issue of August 23rd, the Central London Railway Co. is making experiments with a train equipped with the new system of train control which is being introduced by the British Thomson-Houston Co. A train on the extension of the French Western Railway into Paris has recently been equipped on the Thomson-Houston multiple control system, and is now running with success; and by the courtesy of the French Thomson-Houston Co. we are enabled to give a complete description of the system employed there, which is, in all essential particulars, similar to the one that is being fitted by the British Thomson-Houston Co. The advantages of a multiple unit control system for certain services have been so frequently discussed that it is unnecessary to enlarge on them here. Briefly they are the obtaining of better adhesion by distributing the motors on several axles all along the train instead of merely placing them on the locomotive; secondly, a diminution of vibration; and thirdly—the most important advantage—the ease with which the trains may be sub-divided or increased in length. Against these advantages must, of course, be set the extra capital expenditure and the additional complication involved by the system.

Two types of car are used, motor-cars and trailers. The motor-cars are fitted with two electric circuits—a main circuit, which brings the current to the motors, resistances, &c., and a controlling circuit with a special form of master controller working electromagnetic switches which perform the same functions as are usually performed by a tramway controller. The second class of car consists of ordinary trailers, with the addition of a nine-conductor cable running from one end of the car to the other. The following is a list of the apparatus required for equipping one motor car on this system:—

Two master controllers.
Electromagnetic switches (the number depending on the type of equipment).
One electromagnetic reversing switch.
One motor-controller cut-out switch.
Two control circuit-breakers.
Rheostats (the number depending on the type of equipment).
One lightning arrester.
Two control-coupler sockets and plugs.
Necessary cables, &c.

Fig. 1 shows that in its general lines the main circuit is more or less analogous to that of an ordinary motor-car circuit. The diagram represents a two-motor equipment. The contacts of the main controller, which are replaced by blow-out electromagnetic switches (Fig. 4), both for the series paralleling and the combination of resistances, are shown on the right, and numbered 1 to 13. The connection at T at the extreme right bottom corner goes to the shoe through a motor circuit switch, which enables the motors in any car to be cut out without in any way affecting the control circuit, which is led to the shoe from T, shown at the right-hand top corner. This is done through a control-circuit switch, and the current is cut off and handle removed when the master controller at that end of the car is not in use. Neither of these switches are shown in the diagram.

It will be seen that, working from right to left at one position of the master controller, the first three solenoids (shown directly under the through wires from coupling to coupling) work electromagnetic switches 1 to 3. Nos. 1 and 2 are duplicate, and make the top circuit alive; No. 3 connects

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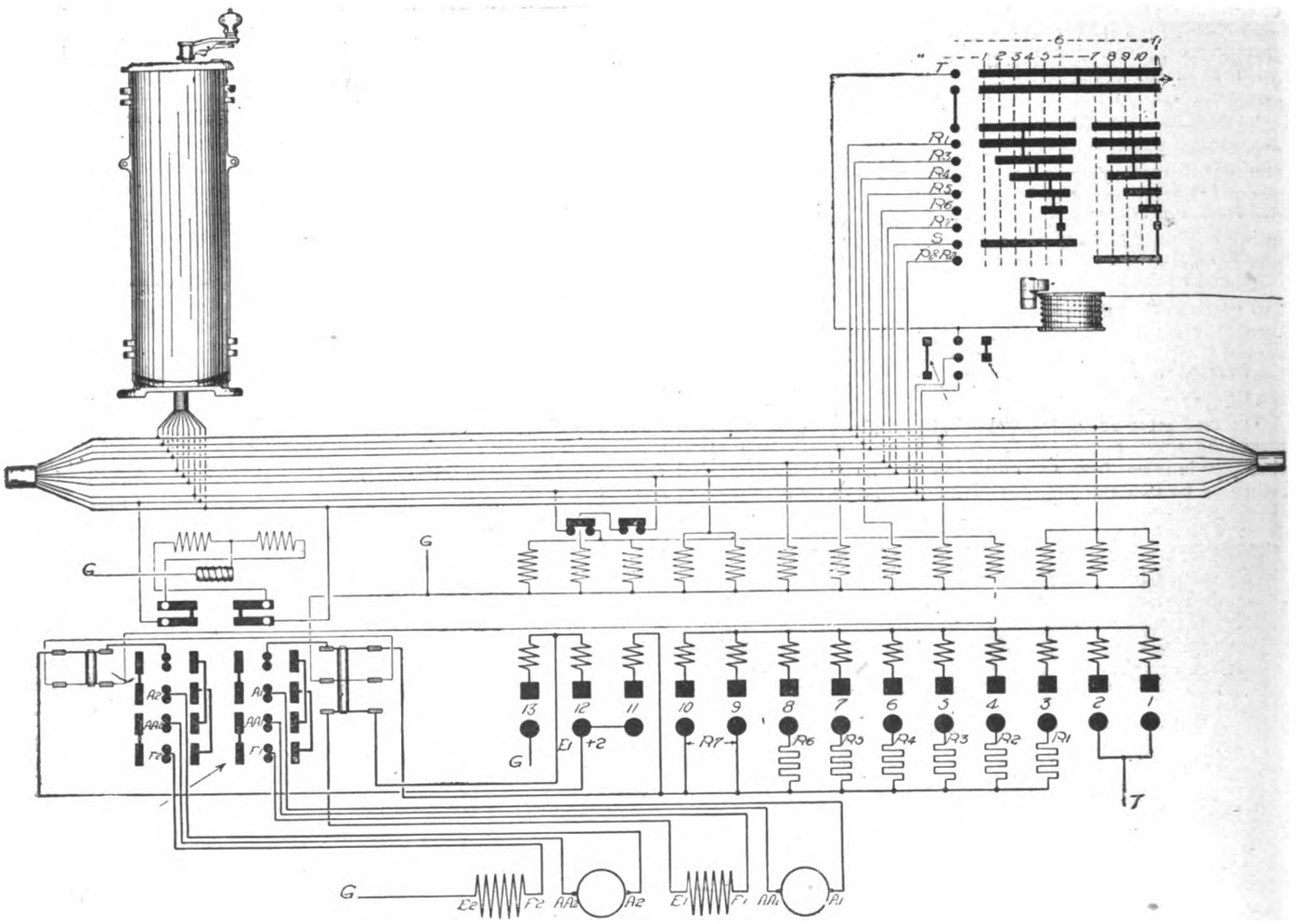


FIG. 1.—DIAGRAM OF EQUIPMENT.

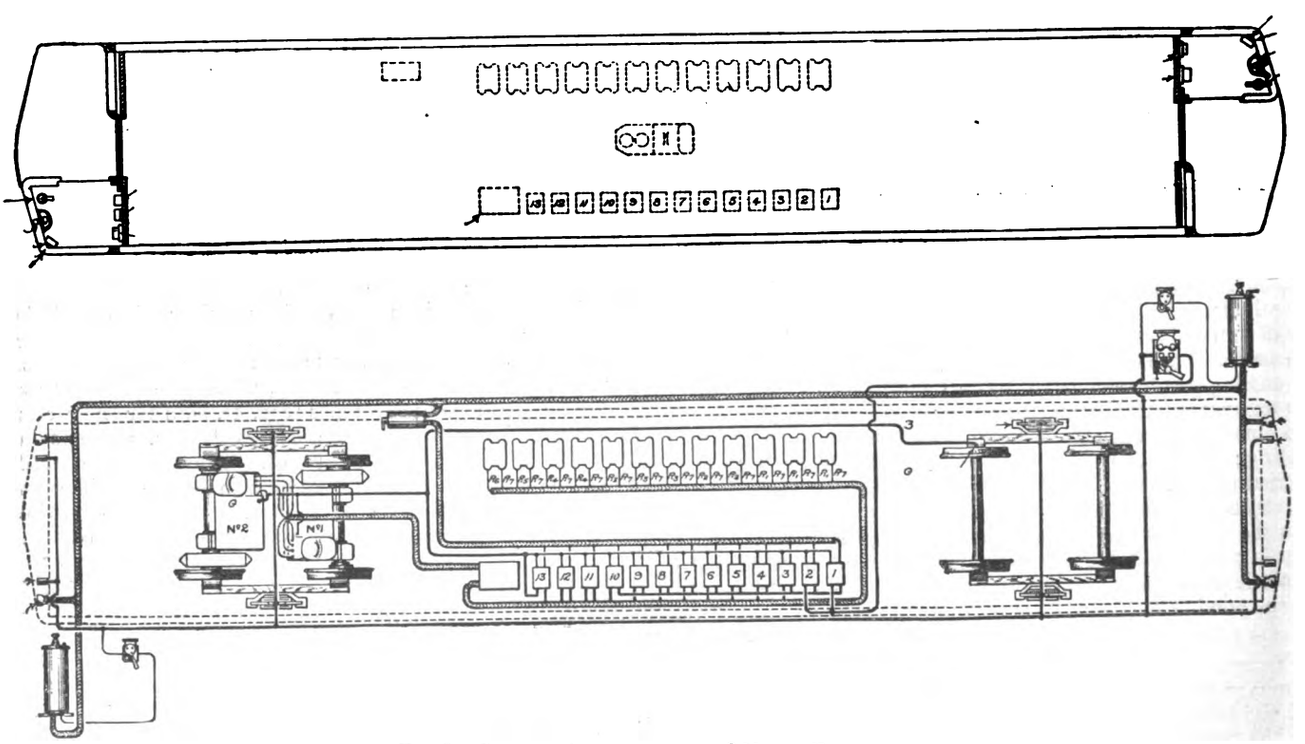


FIG. 2.—GENERAL ARRANGEMENT OF 2-MOTOR EQUIPMENT.

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up the motors through resistance $R_1$. The electromagnetic switches 8 to 8 are for cutting in or out resistance from the motor circuits, the motors being either in series or parallel, whilst the switches 9 to 13 are for arranging the motors in series or parallel. In the diagram the blow-out coils C are shown above the switches. The reversing switch is shown on the left, and includes two ordinary hand cut-out switches, on either side of the reversing switch in the diagram, which serve to isolate one of the motors in case of damage, and to allow the remaining motor to be in circuit only in such positions of the controller that it cannot be short-circuited. The operating coils of the reversing switch are shown above the main reverse switch, and two master controllers are also shown at the top. That on the right also

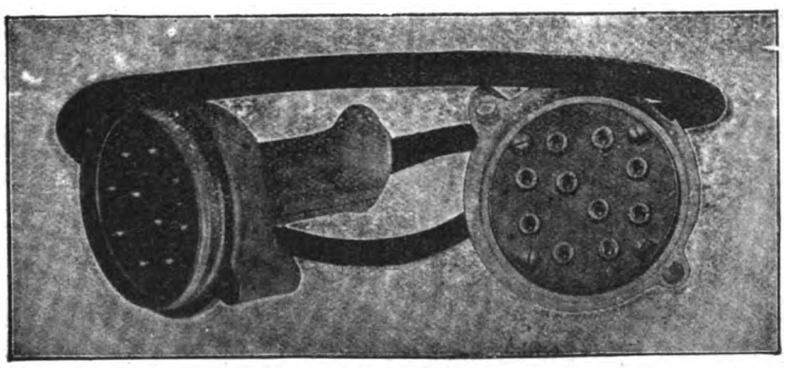

Fig. 3.—Couplings.

shows clearly the magnetic blow-out, and to the left the reverse cylinder. The main circuits of the various motor cars of each train are self-contained and end in special shoes, which can be connected to one another or left independent. On a line in which the current is distributed by a third rail, interrupted at numerous points to facilitate points and crossings, the interruption of the current successively on all the carriages of the train may be inconvenient. This can be remedied by adding another conductor, making the tenth in the diagram, connecting all the contact shoes, thus enabling current to be taken from the motors on one car through the shoes on another car.

The controller circuits of the carriages are connected by special couplers, shown in Fig. 3, the cable with nine conductors running the whole length of the train. These couplers are provided with spring catches which ensure their remaining in contact under normal conditions, but permit them to release automatically in case the train breaks. On each of the motor-car platform is placed the master controller, which is of small dimensions, and into which the nine conductors of the circuit are branched. The operating of this controller is very easy, as the motions are similar to that of the ordinary tramway controller.

Fig. 2 shows the general arrangement of a two-motor equipment. Nos. 1 to 13 represent the electromagnetic switches, opposite to which are grouped symmetrically the regulating resistances, and in the middle, beneath the car body, the air compressor to work the brake.

A number of trains on this same train control system have been built for the Orleans Railway. These differ from the others by the fact that the motor cars have each four motors grouped in pairs in parallel. On each of the four axles a GE 51 motor is fixed, rated at 18 H.P. at 500 volts. The two parallel groups of motors are put successively in series and in parallel by the controller, just as in the case of a series-parallel controller for two motors.

Fig. 4 shows the construction of an automatic switch. It consists of a cast-iron box in which is placed the coil of he electromagnet. In the lower part of this box (which is shown open in the figure) are two contacts, normally apart by the action of gravity, but which are closed by the action of the electromagnet in the control circuit when required. The horn-shaped projections at the ends of these contacts facilitate the breaking of the current, which is further aided by a magnetic blow-out obtained by means of a secondary coil through which the main current passes, a part of which is seen on the figure between the box and the door. The door forms part of the magnetic circuit of the blow-out, one of the poles being shown at the extreme right of the figure, whilst the other is behind an insulating partition that separates the switch contacts from the solenoid. The door is provided with insulating non-combustible partitions, and the contacts themselves are enclosed by these to prevent any danger of the arc spreading. As a matter of fact, however, the arcing is very slight. It is only the bottom contact that moves, and this has a rubbing forward motion along the upper contact. The attracting force of the electromagnet is so great that the contacts cannot be effectually separated by hand. The working of these switches has, it is said, given no trouble, but nevertheless every precaution was taken to render them easily accessible. They are, in fact, even more accessible than are the contacts of an ordinary tramway controller. With this object in view the boxes containing the switches are arranged on one side of the car underneath the car-body in the space between the two bogies.

Fig. 5 shows the reversing switch. The changes in position of the reversing cylinder can only take place when the main current is interrupted, the reversing switch being locked when the controlling handle is in any but the off position. The plunger electromagnets turn it round from the position of "forward" to the position of "backward" travel, and it was not found necessary to have blow-out coils. This figure also shows on the right of the main contacts two smaller contacts by means of which the coil is put out of circuit as soon as the cylinder has commenced moving. This apparatus is fixed next to the other magnetic switches, and is equally accessible. The regulating resistances are similar to those on ordinary tramways. They can be arranged as shown in Fig. 2, or in special cases more suitable arrangements may be found. The small

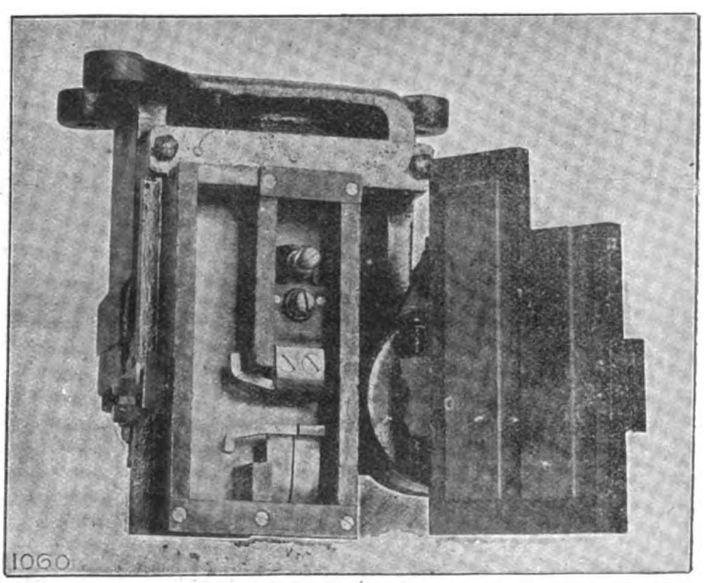

Fig. 4.—Electromagnetic Switch.

distance separating the trucks of the carriages on the Orleans Railway has necessitated these switches being placed under the platforms. The apparatus in the main circuits does not differ from the ordinary equipments except by the fact that they are controlled from a distance. As already explained, in addition to the electromagnetically-

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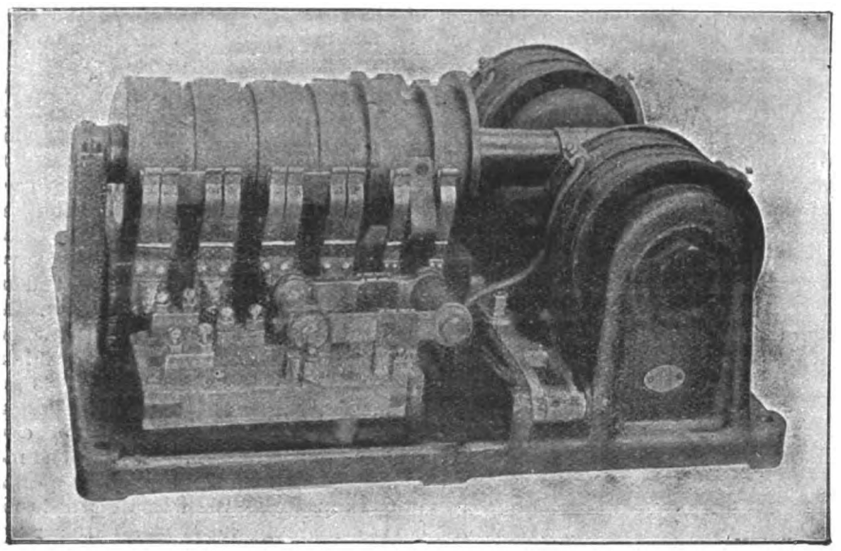

Fig. 5.—Reversing Switch.

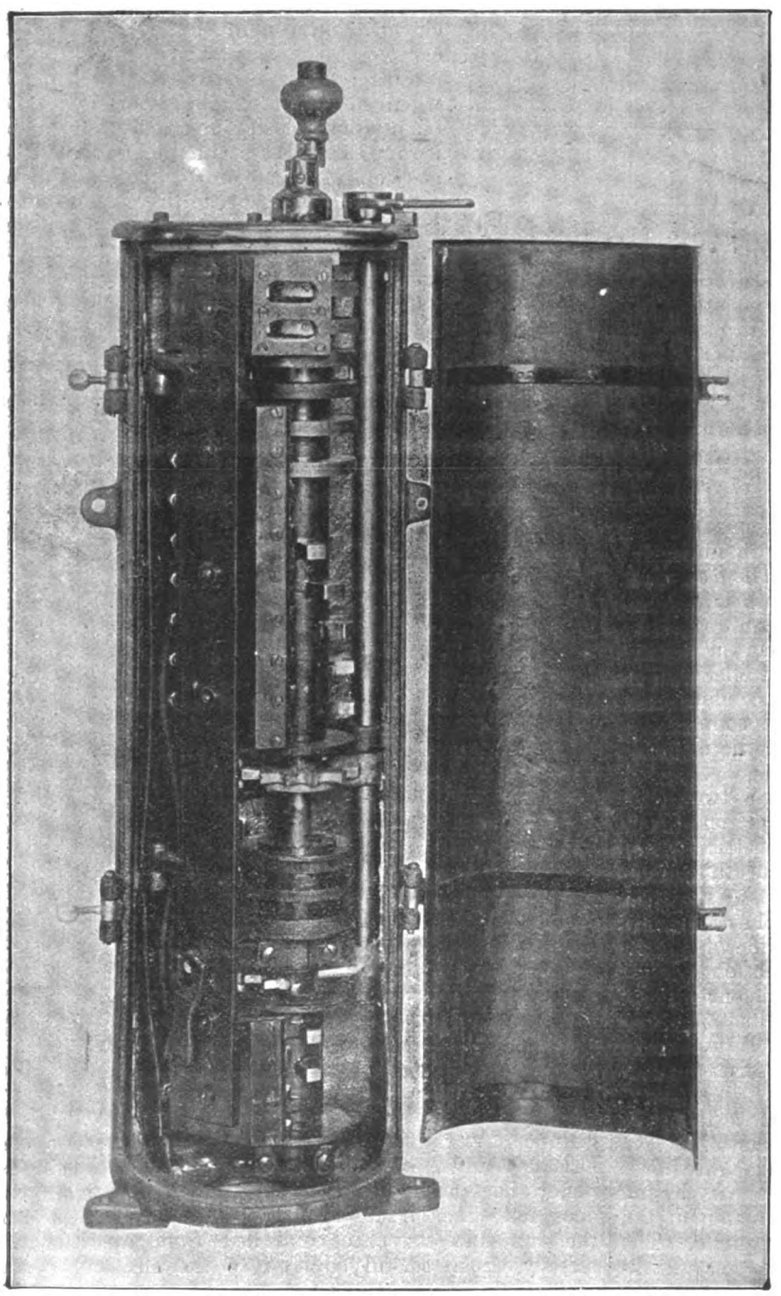

Fig. 6.—Master Controller.

worked switches, there is the master controller. One of these is shown open in Fig. 6. The arc deflectors prevent the fixed rubbing contacts from being seen, but one can see the corresponding moving segments, mounted on the main cylinder, and the blow-out coil placed on the prolongation of the main cylinder. In the lower part, and also on this prolongation, one can also see the reversing cylinder, which is moved by means of a spindle seen at the side, and which is worked by a handle shown to the right at the top of the controller. In this apparatus, between the reversing cylinder and blow-out coil, are also the locking arrangements, which prevent the current being reversed without turning the controller handle back, and which also provide against the car being started independently of the motorman. A locking arrangement has been added to ensure that the train shall stop automatically if, for any reason, it escapes from the control of the motorman. The circuit is then interrupted in two places at the two upper contacts of the controller. These are fixed on a sleeve, through which the spindle of the principal cylinder passes. In order to make this sleeve move with the spindle, *i.e.*, with the handle, the two have to be clamped together by pressing lightly on a button placed at the top of the handle, and they fall out of gear if the pressure of the motorman's hand ceases, for any reason, when the lower part of the cylinder still remains in position, but the sleeve above is pulled back by a spring and breaks the circuit.

Automatic circuit breakers are provided for protecting each motor, and a small one is also used in series with the master control circuit in each car.

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**The Literature of Technical Societies.**—Mr. William Whitwell in his presidential address to the Iron and Steel Institute (whose annual general meeting is now being held at Glasgow in connection with the International Engineering Congress) said that the eight societies taking part in this Congress published last year among them no less than 6,805 pages, distributed as follows:—Institution of Civil Engineers 1,981, Institution of Mechanical Engineers 644, Iron and Steel Institute 1,178, Institution of Naval Architects 305, Institution of Mining Engineers 1,255, Institution of Electrical Engineers 975, Institution of Gas Engineers 219, Incorporated Association of Municipal Engineers 258. In this overwhelming mass of published matter there was a certain amount of overlapping that the conference might tend to obviate in the future. Some of the Papers, too, at first sight appeared to be of little practical importance. This criticism had frequently been applied to many of the Papers read before the Iron and Steel Institute, but it must be remembered that this had been from time immemorial the favourite objection to the work of pioneers of thought.

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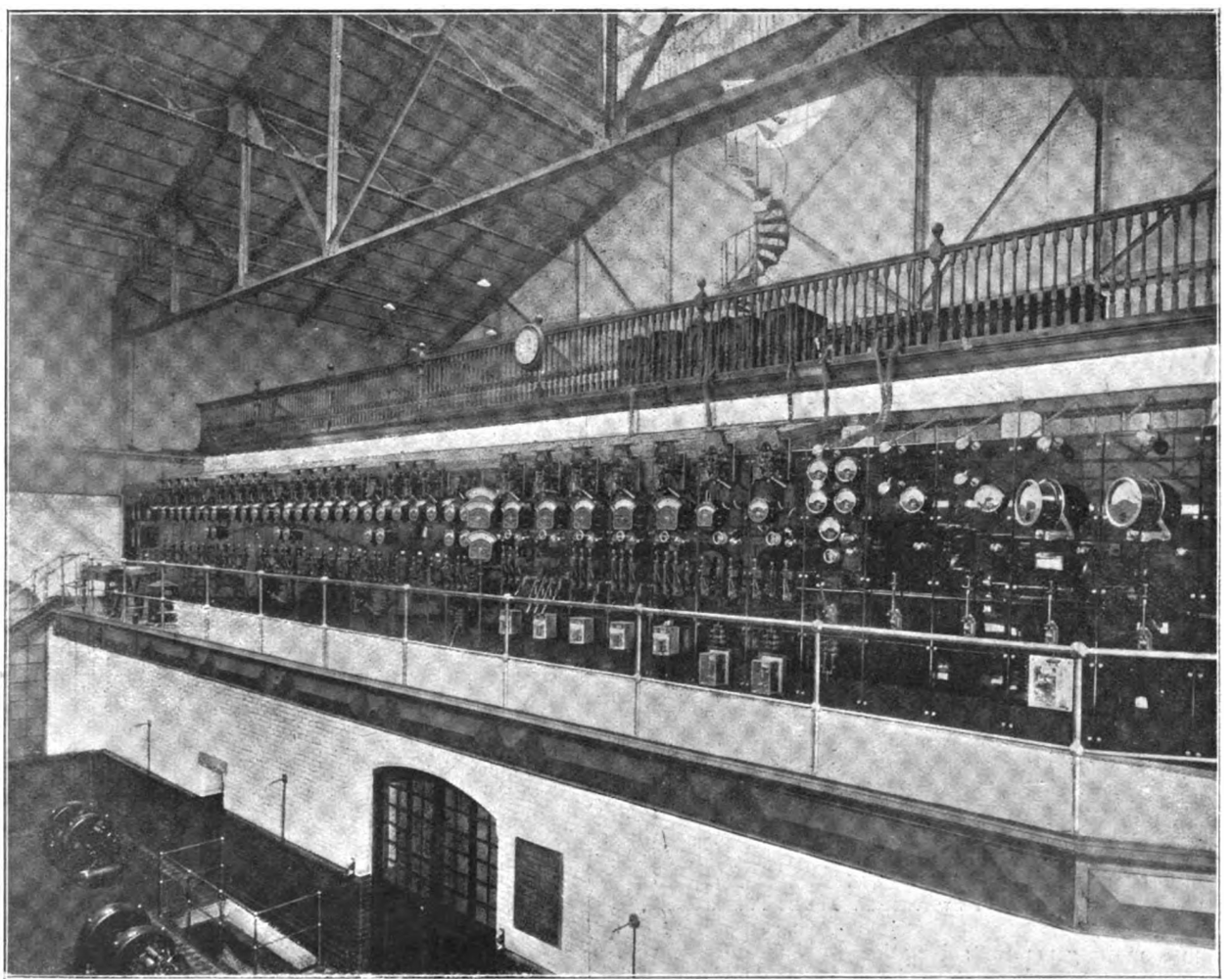
# THE DUBLIN UNITED TRAMWAYS SYSTEM.

(*Concluded from page 671.*)

The imposing main switchboard, which was supplied by the British Thomson-Houston Co., is placed on a gallery at one end of the engine room, and occupies nearly the whole width of the room. It is constructed in panels of enamelled slate. There are five direct-current generator panels, one three-phase generator panel, two rotatory converter panels, two transformer panels, five high-tension feeder panels, 19 tramway feeder panels, four booster panels, one Board of Trade panel and one lighting panel. The direct-current generator and feeder panels are equipped with magnetic blow-out circuit breakers, quick-break switches and Weston instruments.



Photograph by Lafayette, Dublin

FIG. 22.—FRONT VIEW OF SWITCHBOARD AT THE POWER HOUSE.

The three-phase part of the switchboard is somewhat of a novelty, in that all the high-tension 'bus bars and switches and instrument transformers are located in a fireproof chamber below the level of the switchboard floor.

The switches are of the oil-break type, the entire switch being immersed in a box filled with oil. These switches are operated from the switchboard by means of levers, and all the instruments on the panels are connected to the secondaries of transformers located in the high-tension chamber, so that there is no high-tension apparatus of any kind on the board itself. The alternating instruments are of the Hartmann and Braun hot-wire type, and were supplied by Messrs. Johnson and Phillips. Figs. 22 and 28 show a front and back view of the switchboard.

Leaving the Ringsend generating station we will now visit the various sub-stations distributed over the system. The Dublin United Tramways Co. have in connection with their system three sub-stations, which are supplied by three-phase currents from Ringsend generating station. Referring first to the Blackrock sub-station, the location of which is shown in Fig. 1, this sub-station serves the main portion of the suburban line running southwards along the coast from Dublin to Dalkey. The equipment of the sub-station consists of two rotatory converters, each of 200kw. capacity, and two groups of transformers, with three transformers in each group, the capacity of each of these transformers being 80kw. There is a margin of power in the transformers over that of the rotatory converters, this being provided with the intention that two of the transformers shall take the load should an accident happen to the third transformer. The whole of this sub-station was equipped by the British Thomson-Houston Co. The rotatory converters have six poles with a capacity of 200kw. and a speed of 500 revolutions, and are compounded for 520 volts at full load. The efficiency at full load is 92¼ per cent., and at half-load 94 per cent. The diagram of connections of this sub-station was shown in Fig. 9. The switchboard is in white polished marble, and is shown in Fig. 25. The high-tension three-phase switches connecting the incoming feeders to the 'bus bars are of the double-break type, designed by Mr. Parshall. The alternating instruments are of the hot-wire type, made by Hartmann and Braun. The rotatory converter panels and the traction feeder panels were equipped by the British Thomson-Houston Co. Views

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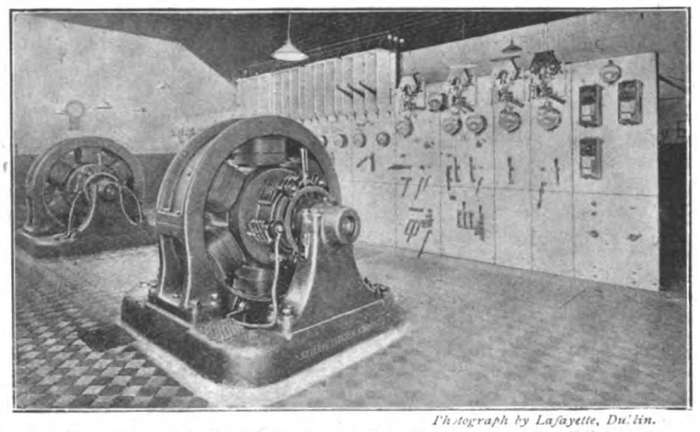
of the rotatory converter and switchboards are shown in Figs. 24 and 25.

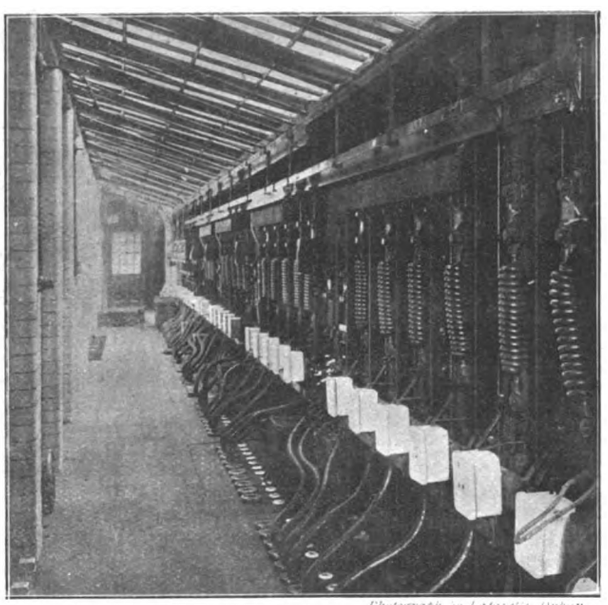
The next sub-station to be described is that at Dalkey, this being located at the distant end of the Dublin and Dalkey line. This sub-station is worked as an auxiliary to that of Blackrock, and is only in service at periods of heavy load. At the present time this sub-station is in progress of conversion from a motor-generator sub-station to a rotatory converter sub-station. The old plant consisted of two motor-generators, each of 50kw. output, and each motor generator was made up of a three-phase synchronous mosor supplied directly from the high-tension 'bus bars at a voltage of 2,500 volts, the motor being direct-connected to a direct-current generator which supplied the line at 500 volts. In order to save the losses due to this system of conversion, Mr. Parshall disconnected the motor from the generator and connected the armature windings of the generator to three collector rings placed on an extension of the generator shaft, the shaft being bored for bringing the connections from the armature to the collector rings. In connection with these two converter generators, there is one bank of three transformers, each transformer having a capacity of 50kw. The voltage is now transformed from 2,500 to 320 volts, which latter is the voltage on the collector rings, and finally converted to direct current at 500 volts. The conversion from motor generator to rotatory converter has turned out to be a complete success, the same machines which were rated at 50kw. as generators being now rated at 75kw. as rotatory converters. The two machines are found to run in parallel without any trouble and in perfect synchronism with each other and with the generating station.

The last sub-station to be described is that of Clontarf, which serves the lines running between Annesley Bridge and the terminus in Howth, a total length of 8 miles. This was originally a generating station with three 150kw. sets. It is now converted to a sub-station, and is of particular interest



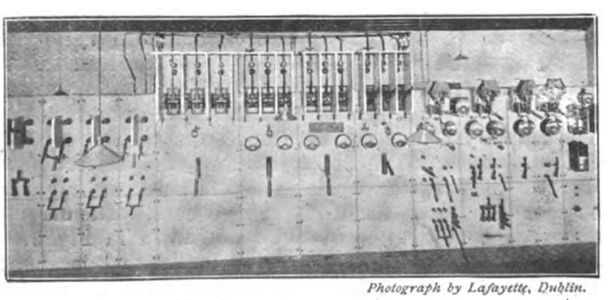
Photograph by Lafayette, Dublin.

FIG. 24.—ROTATORY CONVERTERS AND SWITCHBOARD AT THE BLACKROCK SUB-STATION.



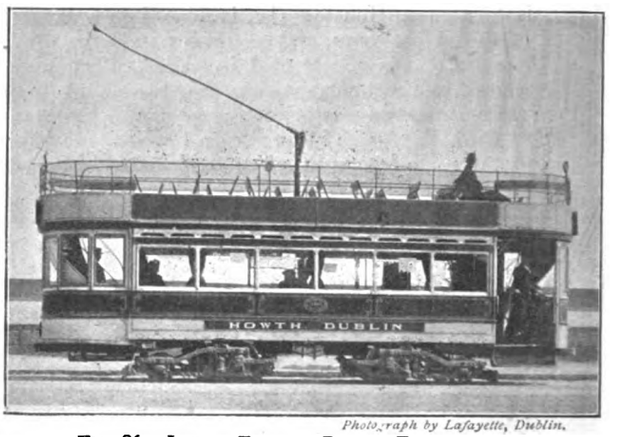
Photograph by Lafayette, Dublin.

FIG. 23.—BACK VIEW OF SWITCHBOARD AT THE POWER HOUSE.



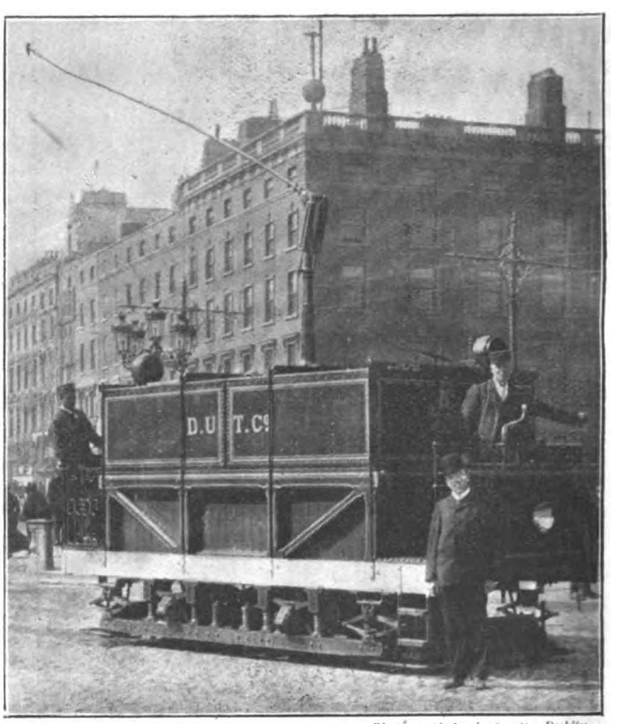
Photograph by Lafayette, Dublin.

FIG. 25.—SWITCHBOARD AT BLACKROCK.




Photograph by Lafayette, Dublin.

FIG. 26.—LATEST TYPE OF DUBLIN TRAMCAR.




Photograph by Lafayette, Dublin.

FIG. 27.—WATER MOTOR LORRY.

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as it is equipped with rotatory converters with a total capacity of 480kw., the rotatory converters being adapted from the old four-pole direct-current generators originally in use on the Dublin Southern District line. The plant consists of two 150kw. rotatory converters adapted from four-pole machines, which were rated as 100kw. as generators, and were located in Ballsbridge generating station, being there rope driven from Willans engines, where they had been in service for five years. These two take 50 per cent. more load as rotatory converters than as generators, and run perfectly in parallel. There are also in the same substation two rotatory converters adapted from 4-pole 50kw. generators, previously connected to synchronising motors and in use in Blackrock sub-station before its conversion to a rotatory converter station. These are also rated at 50 per cent. above their capacity as generators, and run well in parallel with each other, but these two machines did not run readily in parallel with the two machines described above, as they were of the direct type of construction. However, by adjustment of the pole arcs the two types of machines are now made to run perfectly in parallel. The equipment of Clontarf as a sub-station has thus cost very little in the way of machinery, existing machines of old type, which had been running five years, being utilised in the way described above.

For the tramway line equipment the overhead trolley wire system has been adopted throughout, the trolley wire being supported from span wires, side poles and centre poles according to circumstances. The cables used throughout the system are paper insulated and lead-covered, and are drawn into cement-lined ducts laid in concrete, with manholes about 300ft. apart. The manholes vary in size according to the number of pipes, the largest being 10ft. by 10ft. by 6ft. 6in. deep, and the smallest 4ft. by 4ft. by 6ft. 6in. deep. Over a million feet of duct have been laid for the tramway system.

The cars are of the double-deck pattern and for the greater part have been built by the tramways company. A photograph of the latest type of car is shown in Fig. 26. It has enclosed ends and reversible stairways. A few of the cars have been supplied by Messrs. Milnes & Co. and by the British Thomson-Houston Co. All cars, with the exception of the Howth cars, are mounted on single trucks, both Peckham and Brill trucks being used. The Howth cars are mounted on two maximum traction trucks, and are constructed to carry 68 passengers.

In conjunction with this article we publish in our Electricity Works Accounts, p. 752, this week, an analysis of three half-yearly statements of accounts of the Dublin United Tramways Co. From this analysis, taken together with previous accounts, the financial position of the undertaking will readily be learned.

## FARNWORTH MUNICIPAL ELECTRIC TRAMWAYS AND LIGHTING.

The Urban District Council of Farnworth has now embarked on the commercial supply of electrical energy. The district has a population of 30,000, and the Council thought that a good electric lighting and tramways system was essential. They appointed Messrs. Lacey, Clirehugh and Sillar consulting engineers, and on their advice a combined lighting and traction scheme was decided on as being the most economical. After a Local Government inquiry in April of last year a loan of £22,000 was granted, to be spent on the combined scheme. Since then the work has been successfully carried out by the respective contractors under the direct supervision of the consulting engineers, whilst Mr. J. D. Pember, the resident engineer, has also given valuable assistance in the work.

The works are conveniently situated in Albert-road. The provisional plans of the buildings were supplied by Messrs. Stones and Stones, of Blackburn, the work being carried out by Mr. S. J. Hodgkiss, builder, Farnworth. The buildings comprise boiler and engine room, test room and offices, adequate provision being made for extensions. The accumulator room is in the basement, and the regulating cells are under the back of the switchboard, thereby simplifying connections to the board and also dispensing with mechanical transmission gear from the switch in the accumulator room to the switch on the board. Near the works a reservoir has been constructed for condensing purposes.

The steam generating plant comprises three Lancashire type boilers supplied by Edwin Danks & Co. Each boiler is 30ft. in length and 7ft. 6in. in diameter, measured inside the inner rings of plates, and having a heating surface of 1,001 sq. ft. working at a pressure of 150lb. per square inch. They are provided with the necessary safety, high steam and low water safety valves, and two accessible check feed valves. The economiser, supplied by the same firm, is of the Green type, placed in the main boiler flue. It consists of 192 pipes 9ft. long, $4\frac{3}{16}$in. diameter, arranged in rows of eight tubes wides, the whole being forced by hydraulic pressure into longitudinal top and bottom boxes in sections, forming metal to metal joints. The pipes are arranged in two groups, and fitted with deflectors at the back. The blow-off from the economiser is carried to a reservoir. The boiler feed pumps, supplied by Datsons, comprise two single cylinder direct-acting vertical feed. Each pump is capable of delivering 1,500 gallons per hour against the boiler pressure.

The generating sets comprise three 120kw. steam dynamos. The engines supplied by Browett and Lindley are of the two-crank vertical compound type, enclosed and self-lubricating, capable of developing 200 I.H.P. at a speed of 480 revs. per min., with a steam pressure of 140lb. per square inch in the steam chest, and working condensing with a vacuum of 24in. They are direct coupled to dynamos supplied by the Lancashire Dynamo and Motor Co. Each dynamo has an output of 120kw., the current output as a shunt machine being 250 amperes at a voltage variable between 440 and 480 by means of a shunt resistance, and as a compound machine a constant potential of 525 volts maintained at constant speed. The dynamos are six polar with bar-wound barrel type armatures. The above outputs are the normal maximum outputs, but each set is capable of developing 240 I.H.P. on emergency.

The balancer-booster set, supplied by the same firm, consists of four separate armatures mounted on two-coupled shaft, supported on four bearings from one base plate. The balancer works with one armature on each side of the three-wire network, each armature running as either motor or generator, at a difference of potential of 220 to 250 volts, and a current of 50 amperes. Each booster armature is capable of raising the charging voltage by 100 volts at a current output of 120 amperes.

Both the lighting and traction switchboards were supplied by Mr. Bertram Thomas. The lighting board is built up of panels of enamelled slate, on which the various necessary instruments are mounted. The measuring instruments are of the Evershed and Vignoles type. The traction board had three dynamo panels, one feeder panel, one centre panel, and the usual Board of Trade panel. The measuring instruments on this board are of the Weston type, and the automatic circuit-breakers of the I.T.E. type. The accumulators, supplied by the Tudor Accumulator Co., consist of 252 cells, including four spares, and are capable of giving a discharge of 40 amperes for a period of 10 hours, or 160 amperes for one hour, the E.M.F. of each cell being not less than 1·8 at end of discharge. The mains, supplied by the British Insulated Wire Co., were put down under the supervision of Mr. A. J. Macphail, the feeding points terminating in two pillars, whence several distributors are taken. The class of cable is five-cored lead-covered and armoured, with a layer of bricks laid on the top as a protection. The distributors are three cored, and and already an order has been given for an extension cable.

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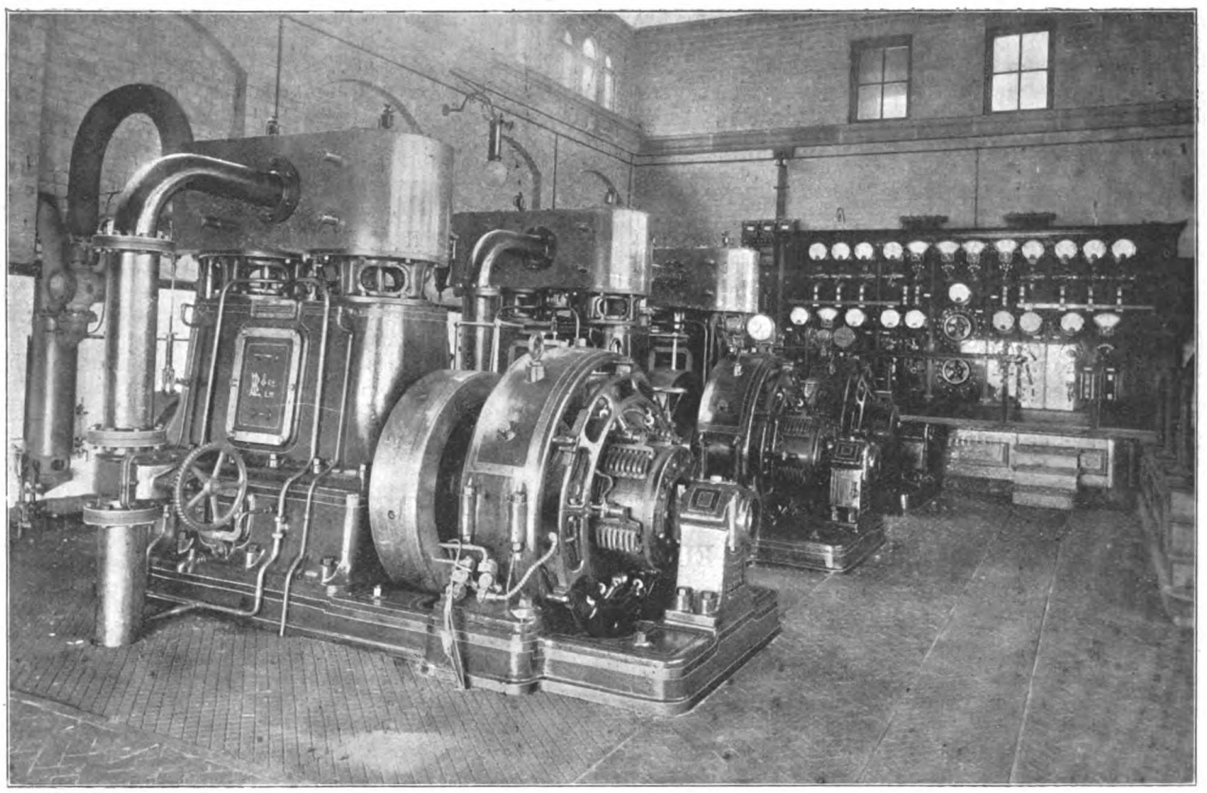
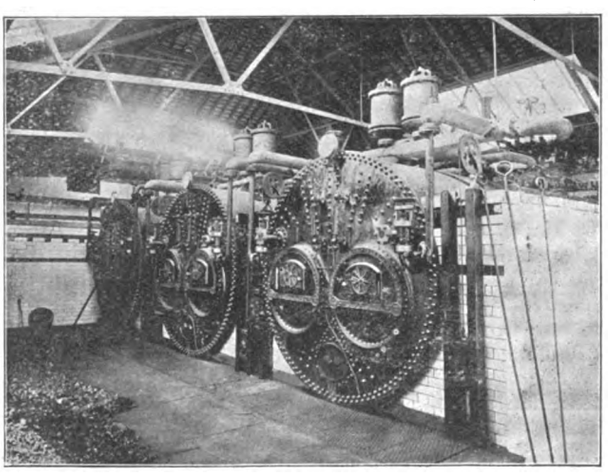
There is about 1 mile of double track being operated by the Bolton Corporation under a lease which will expire in the spring of next year, but in addition to this the Farnworth Council are laying about 3 miles of single track in the town. The overhead equipment for the old track has been put up by George Hill & Co., of Manchester. The British Insulated Wire Co. have obtained the contract for the overhead equipment for additional track. Eight new cars are now on order, the car bodies are being supplied by G. F. Milnes & Co., and the trucks and motors are of the Westinghouse manufacture. The car shed is situated close to the works and is being erected to the design of the surveyor of the Council, Mr. W. J. Lomax. It will accommodate about 15 cars and has four lines of track with an outside traveller traverser similar to that used at the Denton car sheds, near Manchester. It will be fitted up with the usual complement of offices, stores and workshop.

The committee have adopted the principle of letting out motors on hire, and they are considering, but have not finally settled on, a system of easy payment for the wiring of premises. There are 20 consumers at present taking light, but before the end of next month there will be between 40 and 50 connected to the mains. Until the opening ceremony the consumers connected were provided with free lighting. The street lighting will consist of 45 Brockie-Pell arc lamps, each taking 10 amperes, and will be supplied and erected by the British Insulated Wire Co. They will be fixed on the top of nearly every alternate pole. For lighting after midnight two incandescent lamps on each pole used for arc lighting will be used, being fixed on brackets about half-way up.

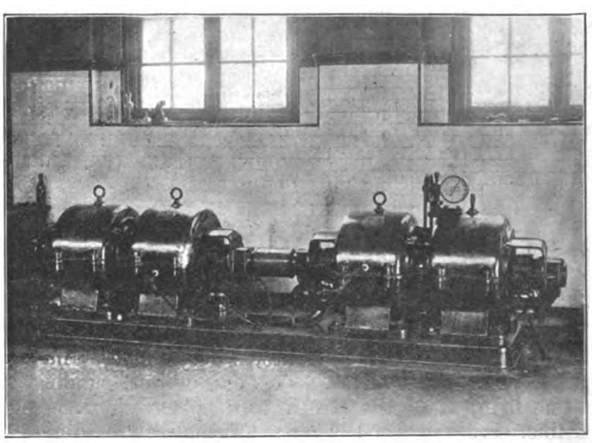
The electricity works were formally opened last week by Mr. William Boyes Richardson, chairman of the electricity committee, who has taken a very keen interest and displayed great abilities in discharging the duties of chairman.



General View of Engine Room in Farnworth Supply Station.



Boilers in Farnworth Supply Station.



Booster-Balancer Set in Farnworth Supply Station.

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## THE NEW TELEPHONE EXCHANGE AT MUNICH.*

(*Continued from page 709.*)

COMMUNICATION BETWEEN THE LOCAL EXCHANGES.

In the system of communication between the local exchanges, the arrangement of which is shown in Fig. 8, the conversations of the operators and those of the subscribers are carried on by means of entirely separate lines—"speaking wires" for service communications and "junctions" for the subscribers' use. There are nine speaking wires from exchange I. to exchange II. and vice versa. These wires go from the speaking keys on the subscribers' board at the one exchange and terminate in the induction coils or operator's telephone connector springs of the junction board at the other exchange. On the subscribers' boards the speaking wires are multiplied in such a way that three of them are available at each operator's position. The speaking set of each operator's position is connected with springs 2 and 3 of the speaking keys, and may, therefore, be placed in circuit on a speaking wire by merely pressing the corresponding key. At the other end the wire is permanently connected with coil 1 of the head telephone when the corresponding operator's position is occupied.

Near each speaking key is placed a 24 volt lamp. At each depression of the key the lamps belonging to that particular speaking wire light up, and, as they are teed off to the remaining subscribers' boards, it can be immediately seen which operators at the junction-board at the other exchange are engaged. The duty of establishing a connection, therefore, never falls to any but a disengaged operator.

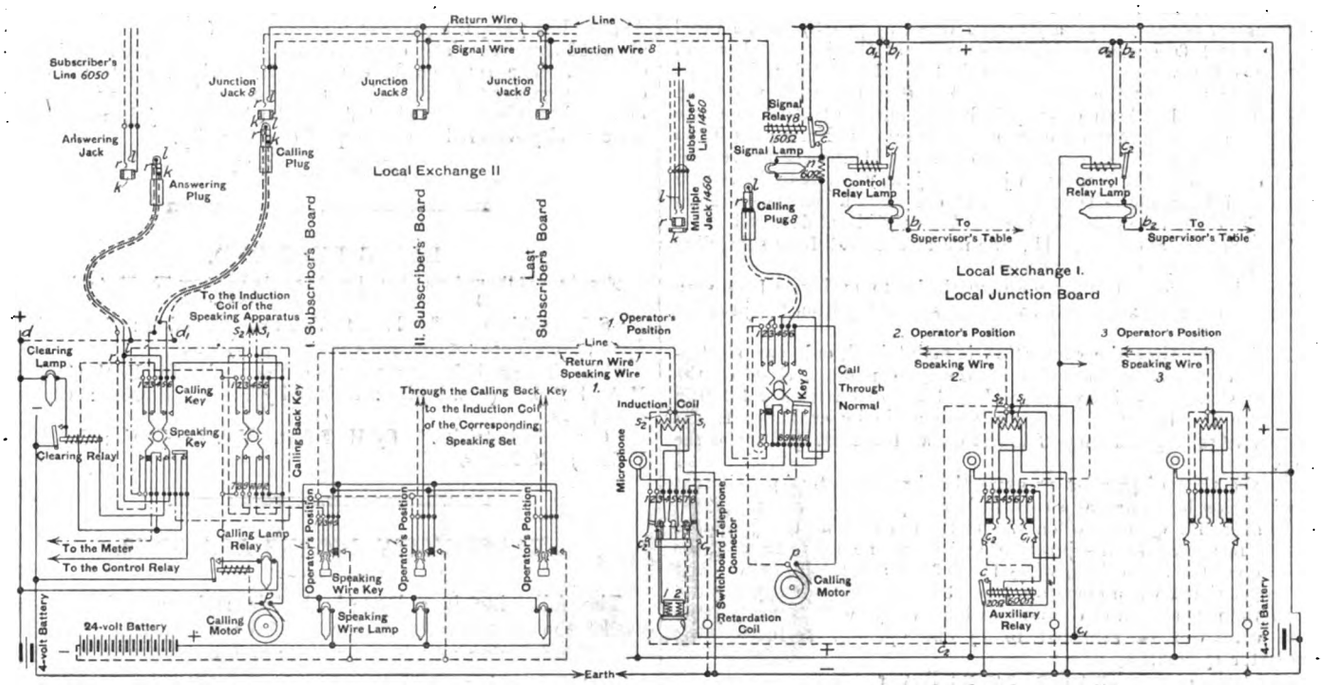


FIG. 8.—JUNCTION CONNECTIONS.

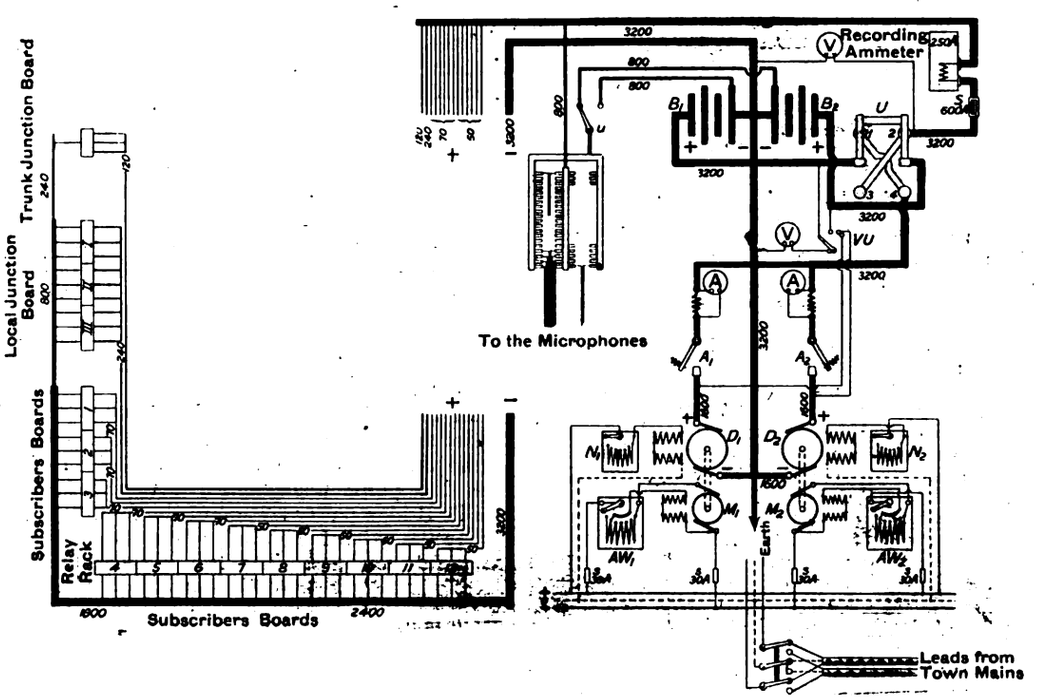


FIG. 9.—CONNECTIONS OF GENERATING PLANT.

Each junction line contains three wires—two for the speaking loop and the third for the automatic clearing signal. There will ultimately be 270 junction wires in each direction. Each subscriber's board has, therefore, 270 junction jacks, which are multipled on to the remaining boards, and from these the junction lines pass out.

* Abstract from the *Elektrotechnische Zeitschrift*.

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In the other exchange the loops of the junction lines which are used for speaking terminate directly in the cords or pegs of the three junction boards, so that an operator will have a maximum of 30 junction lines to attend to. The corresponding jacks and plugs in the two exchanges are similarly numbered from 0 to 269.

The operation of making a connection between the exchanges is performed in the following way:—Suppose that subscriber 6050 of exchange II. wishes to speak with subscriber 1460 of exchange I. The operator at exchange II. makes use of the speaking line and obtains the connection on a junction line (say No. 3) in the usual manner if 1460 is disengaged, the operator at the junction board of exchange I. inserting plug 8 in the jack No. 1460, and pulling forward for a moment the combination key 8 to call this subscriber. After the call has been given this key remains in the intermediate position, and in consequence the signal lamp near No. 8 plug lights up and glows until the operator of exchange II. inserts the second plug of the pair she is using in junction jack 8. The extinction of the signal lamp shows the operator at exchange I. that the number of the junction wire given by her has been rightly understood.

The operator at exchange II., who receives the call from subscriber 6,050, sees the connection through.

The clearing signal is given automatically to exchange I. as soon as the operator at exchange II. withdraws the plug from the junction jack.

During the time the connection is maintained, only two electromagnet coils remain in bridge on the loop, namely, those of the clearing signal relay in exchange II. and the call indicator 1,460 in exchange I. In connections which are made by exchange I. the respective calling and ring-off indicators at I. are bridged across the loop.

At the time of greatest pressure the three operators' positions at the junction board are, as a rule, fully occupied. Provision is, however, made for working when the traffic is slight all the junctions which terminate at the junction board by one operator from the middle position. Speaking wires 1 and 3 are automatically switched on to position 2 when operators 1 and 3 withdraw their apparatus.

In the new system of communication nearly twice as many junction wires can be attended to by one operator as in the drop indicator system.

### The Generating Plant.

The general arrangement of the machines, accumulators, switchboard, &c., for supplying current to the installation is shown in Fig. 9. The whole of the lamp relays, microphones, &c., with the sole exception of the signal lamps on the speaking wires, are supplied with current from one accumulator battery of 4 volts electromotive force. The use of one large battery, instead of several small batteries for the various circuits, is to be recommended on account of its smaller first cost and more economical working. A second battery is necessary, as the 4 volt lamps will not stand the rise of electromotive force during charging; and it is desirable to provide a spare battery. The cells at the time the article was written were only about half fitted up, and in this condition have a capacity of 2,900 ampere-hours at a discharge-rate of 290 amperes. Their full capacity is calculated upon an average of 12 calls per subscriber per diem. Alongside the four large cells stand 13 small cells for supplying the signal lamps on the junction wires. Their capacity is 72 ampere-hours at a discharge rate of 7·2 amperes.

For charging the 4 volt batteries two dynamos directly coupled to their respective motors are provided. As a rule, only one set of machines is used for charging; but both transformers can be worked in parallel to deliver 1,270 amperes if it appears necessary to charge up a battery as quickly as possible. The dynamos are built to give a potential difference of 3·6 to 6 volts, and at 1,250 revs. per min. furnish 635 amperes; with the same number of revolutions the motors connected with the town mains (which supply continuous current at 220 volts) have an output of about 6·7 H.P.

To provide alternating calling currents for the local traffic each exchange is furnished with a rotatory transformer, which is fed from the town mains with a continuous current of 110 volts, and furnishes alternating currents of about 100 volts and 1,000 periods per minute. In addition to the alternating currents the machine furnishes intermittent currents at a potential of 75 volts. A similar arrangement is much used in America in working "party lines." Each of the transformers furnishes alternately the calling current for the two exchanges.

The negative poles of the dynamos and of the 4 volt batteries are permanently connected with each other and with the common return wire, and are put to earth (Fig. 9). The return wire is consequently left bare, and only the positive side is provided with a fuse. This is a matter of some importance since relatively large losses of potential are unavoidable in the fuses. The earthing of the battery renders unnecessary a large number of cable wires as return leads, since in the system of communication adopted between the two exchanges the battery has also to supply current to the other local exchange; the switch arrangements are also thereby simplified.

Each of the leads from the brushes of the dynamo first of all passes through an automatic cutout for 900 amperes, and an ammeter, and the two then run together to a special switch, by means of which the poles of the 4 volt batteries can be alternately switched to charge or to discharge; a battery which is being charged, however, can never supply current at the same time to the multiple switchboard. In the positive lead, after it leaves the switch, is inserted a safety fuse and a recording ammeter measuring up to 250 amperes. The diagrams furnished by this instrument give an accurate representation of the extent of the traffic and an interesting record of disturbances from lightning, tramway currents, &c. In August last year, the greatest consumption of current amounted to about 90 amperes. The details of the connections are seen in the diagram. The common bare return lead which starts from the earthed negative pole of the battery and runs along the whole series of switchboards, is formed of flat copper bars, the joints of which are carefully soldered to ensure perfect continuity.

(*To be concluded.*)

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Science Abstracts." Part 8, Vol. IV. (London: E. and F. N. Spon; New York: Spon and Chamberlain.) 2s.

"The Thermal Measurement of Energy." By E. H. Griffiths, M.A., F.R.S. (Cambridge: University Press; London: Clay & Sons.) 2s.

"Cours d'Electricite." By H. Pellat. Vol. I. (Paris: Gauthier-Villars.) 10 francs.

## ELECTRICITY WORKS ACCOUNTS.

The following is a list of electric railway and tramway works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Blackpool Corp. Trams. (Mun.) | Oct. 5, 1900 | Douglas Southern (Co.) | May 27, 1898 |
| Blackpool & Fleetwood (Co.) | Mar. 1, 1901 | Glasgow Corporation (Mun.) | Aug. 11, 1899 |
| Brighton & Rottingdean Sea-shore (Co.) | May 25, 1900 | Isle of Man (Co.) | May 27, 1898 |
| | | Leeds City (Mun.) | June 2, 1899 |
| Bristol Tram. & Carriage (Co.) | Feb. 17, 1899 | Liverpool Overhead (Co.) | Aug. 23, 1901 |
| Br'mpt'n & Picc'dilly Cir. (Co.) | July 8, 1898 | New General Traction (Co.) | May 27, 1898 |
| Central London (Co.) | Mar. 1, 1901 | Oldham, Ashton & Hyde (Co.) | July 5, 1901 |
| City & South London (Co.) | Aug. 23, 1901 | Waterloo & City (Co.) | Mar. 1, 1901 |

### Dublin United Tramways Co. (1896) Ltd.

This week we present an analysis of the accounts of the Dublin Tramways Company for the three half-years ended Dec. 31, 1898, 1899 and 1900. During these years the greater portion of the company's lines has been converted from horse to electric traction. The Dublin-Dalkey section—about 7¾ miles of double track—was opened for traffic in the early part of 1896. The 3 miles of the Clontarf line from Dollymount to Annesley Bridge have been worked electrically since November 11, 1897, and were extended to Sackville-street in March, 1898, to a total length of about 4 miles of double track. In November, 1898, 2½ miles (double) of the Donnybrook line were opened, and a similar length of the Phœnix Park section in 1899. The conversion of the whole of the company's lines was completed at the beginning of the present year.

In the official accounts the figures of the Dalkey line—under the Dublin Southern District Co.—are kept apart from those relating to the lines of the old Dublin United Co., but since power was supplied to the latter company from the Ball's Bridge power station of the former, it was necessary to group the costs of the whole system together in order to arrive at a fair analysis. The full advantage of supply from the large central power station at Ringsend does not appear in the present accounts, as it was not until Jan. 1 last that it was possible to save the cost of operating the Ball's Bridge as a separate station. In studying the figures and costs set forth in our table it is necessary to take account of the above fact, and of the dislocation of system introduced during the period of conversion.

It will be noticed that in the 1898 half-year the ratio of the car mileage run electrically to the total was 88·2 per cent., in the latter half of 1899 this ratio was 74·1 per cent., and in the last completed half-year 99·8 per cent.

The respective cost and revenue figures in these circum-

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stances are extremely interesting. The revenue has crept up from 10·9d. per car mile to 8·83d. last year, while in spite of the higher coal expenditure the total expenses have dropped from 7·31d. to 5·59d. per car mile.

It may be interesting to record that the number of passengers per car mile on the lines of the old company in the latter half of 1898 was 7·98, in the 1899 half-year 7·62, and in the 1900 half-year 7·44. On the Dublin Southern Co.'s line (worked wholly electrically) in the latter half of 1900 the ratio was 5·07, while on the whole system of the two companies it was 6·81.

## DUBLIN UNITED TRAMWAYS.

| | |
|---|---|
| *Worked by* | Dublin United Tramways Co. (1896). |
| *Date of Commencement of Electrical Working* | 1896. |
| *System* | Overhead trolley at 500 volts. |
| *Tramway Manager* | J. W. Towle. |
| *Engineer* | S. W. Nugent. |

| Half-year ended | December 31, 1898. | | | December 31, 1899. | | | December 31, 1900. | | |
|---|---|---|---|---|---|---|---|---|---|
| **QUANTITIES.** | | | | | | | | | |
| Car mileage | 1,473,007 horse, 909,827 electric | | | 730,245 horse, 2,091,992 electric | | | 23,557 horse, 3,425,364 electric | | |
| **Passengers Carried** | 14,152,099[a] | | | 16,608,243[a] | | | 23,467,449[b] | | |
| Length of tramway (Total) | 41·9 miles | | | 42 miles | | | 46·4 miles | | |
| Rolling stock, number of cars | 208 horse, 30 motor | | | 108 horse, 231 motor | | | 292 motor | | |
| **CAPITAL.** | | | | | | | | | |
| **Authorised (Total)** | — | | | — | | | — | | |
| Authorised (share) | £1,200,000 | | | £1,200,000 | | | £1,200,000 | | |
| Authorised (loan) | — | | | — | | | — | | |
| **Received (Total)** | 1,057,760 | | | 1,426,070 | | | 1,699,870 | | |
| Received (share) | 973,260 | | | 1,199,870 | | | 1,199,870 | | |
| Received (loan) | 84,500 | | | 226,200 | | | 500,000 | | |
| **Capital Expended (Total)** | 1,202,825 | | | 1,608,806 | | | 1,779,749 | | |
| **REVENUE.** | **Total.** | **Per car mile.** | **Per total car mile.** | **Total.** | **Per car mile.** | **Per total car mile.** | **Total.** | **Per car mile.** | **Per total car mile.** |
| **Total** | £108,422 | — | 10·920d. | £113,572 | — | 9·660d. | £126,850 | — | 8·830d. |
| *Traffic receipts (Total)* | *102,950* | — | *10·370d.* | *108,692* | — | *9·235d.* | *121,919* | — | *8·485d.* |
| Horse traction | 65,672 | 10·71d.* | 6·616d. | 29,397 | 9·670d.* | 2·500d. | 746 | 7·595d.* | 0·052d. |
| Electric traction | 37,278 | 9·840d. | 3·754d. | 79,195 | 9·090d. | 6·735d. | 121,173 | 8·485d. | 8·430d. |
| *Parcels delivery* | *2,465* | — | *0·248d.* | *2,514* | — | *0·214d.* | *2,525* | — | *0·176d.* |
| *Other Receipts* | *3,007* | — | *0·303d.* | *2,467* | — | *0·210d.* | *2,406* | — | *0·167d.* |
| **EXPENDITURE.** | | | | | | | | | |
| **Total Costs** | £72,573 | — | 7·310d. | £68,562 | — | 5·830d. | £80,368 | — | 5·593d. |
| **Power or Generating Expenses** | 22,307 | — | 2·246d. | 17,576 | — | 1·495d. | 14,147[h] | — | 0·985d. |
| *Horse traction* | *18,070* | *2·946d.** | *1·820d.* | *8,575* | *2·818d.** | *0·729d.* | *nil* | — | — |
| *Electric traction* | *4,237* | *1·118d.* | *0·427d.* | *9,001* | *1·033d.* | *0·766d.* | *14,147* | *0·991d.* | *0·985d.* |
| Fuel | 2,608 | 0·688d. | 0·263d. | 6,093 | 0·699d. | 0·518d. | 10,566 | 0·741d. | 0·736d. |
| Wages and Salaries | 1,272 | 0·336d. | 0·128d. | 2,102 | 0·241d. | 0·179d. | 2,911 | 0·204d. | 0·202d. |
| Water, oil and stores | 358 | 0·095d. | 0·036d. | 792 | 0·091d. | 0·067d. | 1,154 | 0·081d. | 0·080d. |
| **Maintenance, Repairs and Renewals** | 12,829[c] | — | 1·292d. | 7,240 | — | 0·616d. | 10,573 | — | 0·736d. |
| Buildings | 97 | — | 0·010d. | 500 | — | 0·043d. | 780 | — | 0·054d. |
| Permanent way | 2,625 | — | 0·264d. | 757 | — | 0·064d. | 2,975 | — | 0·207d. |
| Overhead line and cables | 151 | — | 0·015d. | 291 | — | 0·025d. | 1,492 | — | 0·104d. |
| Cars, trucks and equipments | 4,097[d] | — | 0·412d. | 4,448 | — | 0·378d. | 4,528 | — | 0·315d. |
| Steam and electric plant | 1,425 | — | 0·144d. | 1,147 | — | 0·098d. | 799 | — | 0·056d. |
| **Traffic Expenses** | 24,028 | — | 2·420d. | 27,151 | — | 2·310d. | 33,313 | — | 2·319d. |
| *Horse traction* | *16,286* | *2·655d.** | *1·641d.* | *10,956[e]* | *3·603d.** | *0·932d.* | *951* | *9·68d.** | *0·066d.* |
| *Electric traction* | *7,742* | *2·043d.* | *0·780d.* | *16,195* | *1·858d.* | *1·377d.* | *31,342* | *2·231d.* | *2·216d.* |
| Wages | 6,647 | 1·754d. | 0·670d. | 11,394 | 1·308d. | 0·969d. | 27,824 | 1·949d. | 1·936d. |
| Car cleaning, inspection, lubricating and lighting | 540 | 0·143d. | 0·054d. | | | | 1,733 | 0·121d. | 0·121d. |
| **General Expenses** | 13,409 | — | 1·350d. | 16,595 | — | 1·411d. | 22,335[j] | — | 1·554d. |
| Salaries and directors' remuneration | 2,335[f] | — | 0·235d. | 2,488[f] | — | 0·212d. | 2,439[f] | — | 0·170d. |
| Rents, rates and taxes | 5,498 | — | 0·554d. | 8,957[g] | — | 0·762d. | 12,745[i] | — | 0·887d. |
| Stationery and printing | 519 | — | 0·052d. | 940 | — | 0·080d. | 381 | — | 0·027d. |
| Law compensation and insurance | 2,478 | — | 0·250d. | 2,268 | — | 0·193d. | 3,518 | — | 0·245d. |
| **FINANCIAL RESULTS.** | **Total.** | **Per cent. to mean capital expended.** | | **Total.** | **Per cent to mean capital expended.** | | **Total.** | **Per cent. to mean capital expended.** | |
| **Working Profit** | £35,849 | 3·17% | | £45,010 | 3·20% | | £46,482 | 2·74% | |
| Sum carried to depreciation fund | — | — | | — | — | | 183 | 0·011% | |
| Net interest on loans | 4,231 | 0·374% | | 7,510 | 0·53% | | 11,258 | 0·664% | |
| Sum carried to sinking fund | — | — | | — | — | | — | — | |
| Balance from last account | 3,261 | 0·289% | | 569 | 0·040% | | 1,600 | 0·094 | |
| **Balance available for distribution** | 34,879 | 3·09% | | 38,069 | 2·71% | | 36,641 | 2·16% | |
| Ordinary dividend paid | 5% | — | | 6% | — | | 6% | — | |
| Percentage of total expenditure to revenue | 66·9% | | | 60·3% | | | 63·4% | | |
| **Revenue per Mile of Tramway** | £2,587 | | | £2,704 | | | £2,734 | | |
| Expenditure per mile of tramway | £1,732 | | | £1,631 | | | £1,731 | | |
| **Revenue per Passenger from Fares** | 1·34d.[l] | | | 1·23d.[l] | | | 1·25d.[m] | | |
| **Revenue per Passenger (Total)** | 1·43d.[l] | | | 1·29d.[l] | | | 1·30d.[m] | | |

REMARKS.—* Per horse car mile. *a* Exclusive of passengers carried by Dublin Southern District Co. *b* Including Dublin Southern Co.'s traffic. *c* Includes £4,360 horse renewals. *d* Includes £2,519 horse car repairs. *e* Wages, £8,567. *f* Directors, £950. *g* Wayleaves, £4,418. *h* After deducting £844 for current supplied to Howth Co. *i* Wayleaves, £6,715. *j* Includes advertising, £316; parcels delivery expenses, £1,676, and office expenses, £643. *k* Loss on horses. *l* Ratio of revenue of Dublin United (old) Co. only to their number of passengers (excluding revenue and passengers of Dublin Southern District Tramways). *m* Ratio of revenues of the whole system (including Dublin Southern Tramways) to the total number of passengers.

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The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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## THE BOARD OF TRADE EXTRA HIGH PRESSURE REGULATIONS.

Under the Electric Lighting Acts of 1882 and 1888, the Board of Trade issues regulations for the purpose of securing the safety of the public and of safeguarding their interests in the way of ensuring a constant and proper supply of electrical energy. A stereotyped code of regulations is issued by the Board, which, while applying to all general cases of electric supply works, specifies that special regulations will be issued for certain particular cases. Foremost among these cases is the employment of electrical pressures of over 3,000 volts between the conductors of the system or between any part of a conductor and earth. These "extra high" pressures, although inaugurated by Mr. FERRANTI more than a decade ago, have not come into much use until recently, but the various large supply schemes which have been sanctioned during the past two years will depend on the employment of high voltages for their successful realisation. Thus the contents of each successive set of regulations for these high pressures is a matter of extreme interest to the electrical profession, for it is in the direction of the large wholesale power supply business that the expansion of the electrical industry must now trend; and while a certain amount of regulation is salutary it is important that progress should not be impeded by too severe restrictions. A committee of gentlemen interested in these power schemes, appointed, not as one might reasonably have expected by the Institution of Electrical Engineers, but by the Electrical Section of the London Chamber of Commerce, has examined the special regulations issued so far, and is attempting to have them modified in certain respects, and the representations made to the electrical adviser to the Board of Trade with this object, together with two of the recent sets of the Board's extra high pressure regulations, were published in our last issue.

In this manifesto, although we sympathise generally with its object, there are some misconceptions at which we are surprised, and one or two matters of detail whose importance we think is over-estimated. In the first place, it is difficult to see why the petitioners do not address the Board of Trade directly on what is purely an official matter.

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As we have pointed out above, all the regulations issued by the Board for extra high pressure deal with specific cases, each of which is considered on its merits. If the committee is of opinion that the time has come for a standardisation of these, and a standardisation to a less stringent code than the individual sets of regulations issued, it should have approached the Board of Trade in this sense; if, on the other hand, the members of the committee prefer that each scheme should be considered separately, as hitherto, they must be content to support each of their colleagues in endeavouring to obtain amendment of the regulations which affect him. We fear that this error in procedure may delay the consideration in the proper quarters of the matters at issue; and this would be regretable, for an expression of views by an authoritative body of men such as those who form this committee should receive the utmost attention. Another matter for criticism is the conception that because certain details of schemes have been disallowed in particular instances they will be forbidden in other schemes in which more is to be said in their favour. For instance, we fully agree with the committee that no limit should be fixed to the pressure which the Board of Trade is prepared to sanction. If it can be shown that circumstances warrant the employment of 15,000, 20,000 or even 30,000 volts, these pressures should certainly be allowed; but no one will deny that the risk of accident is increased the higher the pressure, and therefore it is only reasonable that considerable economical advantages should be shown before an increase from 10,000 to 20,000 volts in populous districts is considered. As a matter of fact, the committee is wrong in supposing that the Board of Trade has fixed any arbitrary limit of pressure at all; we happen to know that only one instance has occurred in which permission to employ 20,000 volts has been applied for. Similarly, there is the question of overhead wires. The useful cases in which these could have been employed with any degree of safety are, so far, very limited. Districts in which power is required are usually populous, and the few patches of a sufficiently rural nature in the areas covered by these electric power schemes would seldom make it worth while to introduce the extra complication of employing both overhead and underground wires. But if, in any particular instance, there are wide stretches of country over which a high-pressure power distribution by overhead wires would be desirable and economical, whilst the distances would render the employment of underground cables an impossibility from the commercial point of view, we are confident that the Board of Trade would not prohibit the cheaper mains.

As to the undesirability of limiting the power conveyed in one main and of specifying for the cable a dielectric thickness proportional to the pressure, we are entirely at one with the committee. Whether or not the sparking distance be proportional to the two-thirds power of the pressure, as suggested in an article by Herr Baur in this issue, we are convinced that a straight-line law is quite erroneous. If, however, rule A9 of the Board of Trade Regulations may be interpreted to apply only to high pressure, and not to extra high pressure, according to the definitions at the commencement of the regulations, it might reasonably be assumed that this straight-line law was originally only intended to serve as an approximation between the pressures of 2,000 and 3,000 volts, and that the Board proposed, in accordance with rule A8, to lay down a special regulation for each case of extra high pressure. The question of a continuous metal sheathing being prescribed in addition to the lead covering is a more debatable one, but it seems in this case no great hardship, even if the undertakers have to err on the side of safety, for a large number of engineers have voluntarily preferred iron-armoured cables or iron pipes, even for low-pressure networks. As to the last recommendation of the six suggested by the committee, this is not of supreme importance either way. While on the one hand there should be no possible objection to sub-stations on consumers' premises if these are made absolutely inaccessible to anyone but the supply undertaker's servants, on the other hand the undertakers would, wherever possible, prefer to have the extra high-pressure sub-stations entirely on their own property. Nevertheless, the need of sub-stations on consumers' premises must have been felt by at least one member of the committee or else the recommendation would hardly have been made, and it is not unreasonable to anticipate the Board of Trade's acquiescence to such solitary sub-stations when an advantage can be gained by employing them.

The appendix to the committee's memorandum, containing as it does extracts from laws, bye-laws and regulations of foreign countries, calls for little comment. Its arrangement—or, rather, its want of arrangement—makes it rather tiresome reading, and little of utility can be learned from it except, perhaps, in regard to the foreign overhead regulations. In all cases, with the exception of parts of the United States, electrical work in other countries is liable to be inspected no less than here, and every particular extra high-pressure installation has to be "passed" by those in authority. In France, in fact, this power would appear to be invested in the Prefect of the district, and those who have carried on any business in France will know how intolerable the officialism is there. In underground work we need hardly look abroad. Through the enterprise of Mr. Ferranti, England has been the pioneer in extra high-pressure work, and through the action of Parliament and the Board of Trade we have acquired better experience than any other nation in the manufacture and laying of underground cable systems. Whatever the bars legislation has placed in the way of electrical progress, the technical regulations of the Board of Trade have always been framed and enforced in a broad-minded and impartial manner, and we have every confidence that the representations now being made, although somewhat informally, by those interested in the large electric power supply projects will be carefully weighed and receive the attention they deserve.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

**Handbook for the Electrical Laboratory and Testing Room.** Vol. I. By J. A. Fleming, F.R.S. (London: "The Electrician" Printing and Publishing Co., Ltd.) 12s. 6d.

Dr. Fleming's literary industry is truly astonishing, and he is anything but a mere bookmaker. He is one of the few electrical writers who deals with difficult subjects, and is yet so well above his work that the reader feels that the author not only explains everything as clearly as possible, but that he knows a great deal more than he writes. This is perhaps one secret of the clearheadedness of Dr. Fleming's exposition and the readability of his books.

The present work is nominally for people who put up and use elaborate electrical laboratories. Unfortunately, such people are as rare as makers of smoked glass for watching eclipses, and the number of available readers at first sight seems small. But the book, the first volume of which is now before us, is of interest to every engineer who has to make electrical measurements.

Dr. Fleming describes very fully the ascertaining of original standards, and goes on to describe the ordinary methods of doing accurate work with secondary standards

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and commercial instruments. Taking the book as a whole, there can be nothing but praise. It is full of information; it is clear and intelligible; it is accurate; it is thorough; and it has copious reference notes to original Papers. We may, therefore, leave the book as a whole and discuss a few details.

There is mention of most of the various resistance alloys. One is struck, however, with the fact that inventors do not seem to know what is really wanted, and are apparently striving in a wrong direction. The aims of an inventor of a resistance alloy seem to be high specific resistance and low temperature coefficient. Now, high specific resistance is of little importance in making bridges and rheostats, as fine wires can be used. If the bobbins are of a given size, with given facilities for getting rid of heat, the permanent temperature curve is the same with a fine wire as with a thick one. The capacity for heat can be controlled by the length of wire used. But resistances are not nearly so important as an application of wire as the attention given them in books leads people to suppose. The real demand for such wires is for the shunt coils of meters and for voltmeters. In these cases low specific resistance coupled with low temperature coefficient is wanted. Generally, a little temperature variation is less hurtful than high specific resistance; yet as each inventor produces a high resistance alloy, he trumpets forth the very quality that ought to be avoided.

By far the most important consideration for many purposes is permanence. It is in this respect that resistance wires are at present unsatisfactory. If the resistance boxes in ordinary use are examined they are nearly always considerably out. The variation is erratic, so that the coils do not even agree among themselves, and the errors are far greater than could have been made by the adjusters. Permanent resistance coils are the crying want in the laboratory. One feels that a resistance coil ought to remain as it was made, but the only safe attitude is scepticism as to the accuracy of all coils, no matter how often tested. By the way, the chances of failure are increased by the usual method of winding in a single loop with the ends together. If the wire is wound single and the bobbin reversed in the lathe after winding each layer, the same low self-induction is obtained, and capacity and leakage are very much reduced.

When one reads the account of ten or a dozen standard cells one after the other, he is struck with the vitality of that apparatus. The Clark cell must be blessed with an astonishingly robust constitution to give any sort of uniformity, in spite of the precautions of the numerous godfathers who have given names to small modifications of it. The standard cell people seem to be mostly purely electrical, and to pay little attention to the chemistry of the subject. It is most remarkable that though great trouble is taken to get the metals pure to start with—a small matter, as the mercury is in contact with mercury solution which extracts any more electro-positive metal, and leaves in any electro-negative metal, which would not matter anyhow—and as zinc is not the least likely to contain any impurities that would hurt, little care is taken as to the two sulphates. The mercurous sulphate is generally a grey mess bought from a shop with a childlike faith in the legend "puriss." By "puriss" the makers only meant that it does not contain lead, or sulphates of other metals. Pure mercurous sulphate is quite easily made. The zinc sulphate used is generally basic, as the godfathers either add carbonates or boil it with zinc. Neutral zinc sulphate is decomposed by zinc when hot. Cells made with pure mercurous sulphate and neutral zinc sulphate free from iron with the diffusion error avoided, give incomparably greater accuracy than the ordinary cell with zinc sulphate of variable basicity, and a collection of different sulphates of mercury, and a page of precautions.

In connection with the relative merits of galvanometers it is usual to discuss the sensitiveness in terms of the current producing a deflection. This is incorrect. Given a galvanometer not wound, any winding can be put on, and the more turns the more sensitive to current; but this is a mere matter of winding. What is really important is the power needed to give the deflection. Given, for instance, a bridge, or a system of wires and instruments with a place for a galvanometer. In practice you put in any galvanometer you are fortunate enough to possess, but in theory you make an elaborate calculation to find the best resistance of the galvanometer. An infinite resistance would take no current and give no deflection. Zero resistance would take all the available current, and give no deflection. What you really calculate, though it is not so stated in orthodox text-books, is the resistance that, under the circumstances, will get most power. The best galvanometer winding is that which takes most power under the circumstances. The figure of merit of the galvanometer should therefore be given in terms of the power absorbed. At a galvanometer merit discussion at the Physical Society I once pointed this out, but was answered by some rather supercilious pedagogue that, under modern conditions of electrical generation, energy costs so little that the power absorbed by a galvanometer did not matter much. It is evident, therefore, that this point is not easy to make clear. Strictly speaking, the figure of merit should be taken for bare copper, as it takes more power to give a deflection with fine insulated wire. For this reason the orthodox calculations for the best galvanometer resistance may be wrong, and in the case of high resistances very considerably wrong. The logarithmic decrement is of greater importance in null methods than generally realised. If the period is reasonable and the needle free, a timed commutator or contact will give readings that are otherwise unobtainable. The fact is, that galvanometers are so exceedingly sensitive that they now deserve less attention than other electrical apparatus. It is human nature to take more interest in improving a really first-rate instrument like the galvanometer than in such things as resistances or photometry.

Power measurement is the least satisfactory part of the book. The non-inductive reflecting wattmeter is not mentioned. Neither is the compensated wattmeter, which does not include the power in either of its own coils. Methods of measuring power with three voltmeters, or three amperemeters, or split dynamometers, where they are not disguised wattmeters, are of no real value.

All this is, perhaps, rather giving way to temptation to discuss interesting questions than reviewing Dr. Fleming's first volume. It describes laboratory equipment generally in a way that makes one's mouth water, and also makes one long for a place where there is no dust or damp, and where even junior assistants are tidy and methodical. Then the author discusses measurement of resistance, current, pressure, and power. The next volume will deal with capacity, induction, quantity, and energy, and with heavy electrical engineering measurements.

Dr. Fleming is an enthusiast about the electrical laboratory. It was he who first pointed out the need of a Governm ent laboratory. The Board of Trade place is to some exten t a result of Dr. Fleming's enthusiasm, but we owe him more than this. The National Physical Laboratory is a fuller realisation of his ideals. It is not a little remarkable that so little credit has been given to him in this connection, and that the National Physical Laboratory authorities have availed themselves so little of his services. JAMES SWINBURNE.

**Rapports presentés au Congrès International de Physique,** réuni à Paris en 1900 sous les auspices de la Société Française de Physique. Collected and edited by CH. ED. GUILLAUME and L. POINCARÉ, General Secretaries of the Congress. (Paris: Gauthier-Villars.) Three vols. 50fr., or 18fr. each.

As a rule, the Papers read at international congresses are of a very mixed character. Miscellaneous they must be, for international congresses usually aim at covering a large field; but, apart from the variety of subjects, the quality of the individual Papers varies between wide limits, there being, as a rule, a few good Papers by good men, a large number of very ordinary ones from members of the multitude, and the remainder is supplied by those unhappy specialists who have specialised in subjects uninteresting enough to retain them on the wrong side of the wide borderland which separates the crank from the genius. When a physicist or an engineer makes a new discovery, or develops a long research into the practical result known as an invention, he does not await an

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international congress before announcing it; he naturally prefers to communicate it to his own society or institution at home, the channel through which he has published his previous work. Moreover, the discussions at these congresses are, as a rule, partly of a congratulatory and partly of a discursive and conversational nature, in keeping with the whole holiday character of the proceedings, and the very fact of their being international militates against good reporting. Thus it happens that, however well edited, the *Transactions* of these international congresses are usually not attractive reading; and the excellence of the three volumes before us lies in the fact that they are neither *Transactions*, *Comptes Rendus*, nor *Sitzungsberichte*—they are *Rapports*. The French Physical Society had the excellent idea of celebrating the Paris Exhibition of 1900, not only by inviting physicists of all countries to meet one another in the French capital, but also by "attempting to draw up a sort of balance-sheet of the knowledge definitely acquired in the domain these *savants* cultivate." Certain leading physicists—no matter of what nationality—were invited to write monographs on the particular subjects on which they have devoted the greater part of their time and thought, and instead of the report of a few hastily-written Papers and impromptu speeches, we have one of the finest books which has ever been published in the domain of physics, viz., an account of the actual state of physical science at the close of the 19th century written by the highest authorities.

The *Rapports* fill three volumes, and space will only permit us to give a brief indication of their contents. The first volume opens with a well-written essay by M. H. Poincaré on the relation between experimental physics and mathematical physics, concluding with a short summary on the present state of science. The remainder of the volume deals with meteorology and mechanical and molecular physics, among the articles being one on national physical and technical laboratories by M. H. Pellat, a review of the progress of pyrometry by Prof. C. Barus, and a chapter on Bjerknes' theory by Bjerknes himself. M. Jean Perrin writes on osmosis, and M. Gabriel Lippmann four pages on the kinetic theory of gases and the Carnot principle.

It is, however, the second and third volumes that interest us principally. Vol. II. is devoted to optics, electricity and magnetism; and of its 25 articles every one is of value. Lord Kelvin occupies the place of honour with his theory of the motion of an elastic solid, and he is followed by Prof. W. Wien, whose contribution is on the theoretical laws of radiation. Determinations of the velocity of light, the ratio between the electromagnetic and the electrostatic units, and the velocity of the propagation of electrical oscillation have always been viewed with particular interest by French physicists, and MM. A. Cornu, H. Abraham, and R. Blondlot (assisted by C. Gutton) have been selected to write on these subjects. Prof. T. H. Poynting's article on the method of propagation of energy and electric strain in the magnetic field is most interesting reading, and a feature of Prof. Auguste Righi's review of the progress up to the present day in the study of Hertz waves is the complete bibliography afforded by the footnotes. This is followed by a summary of M. Branly's experiments on "radio-conductors" written by this eminent physicist himself. Then come articles by Prof. E. Bouty on "Gases as Dielectrics," Prof. Arrhenius on "Electrical Dissociation of Solutions," M. Lucien Poincaré completing this subject by "Some Remarks on the Theories of the Voltaic Cell." The contributions on magnetism are from the pens of Profs. Du Bois, Warburg, Van 'T. Hoff, Nagaoka, and Hurmuzescu.

The third volume contains monographs on several subjects that have been particularly in the foreground recently. Of these we may mention Prof. H. A. Lorentz's discussion of the experimental work done and theories put forward as a result of the discovery of the Zeeman effect; articles by M. Becquerel and M. and Mdme. Curie on the so-called "radio-active" substances; Prof. J. J. Thomson's essay on his own particular subject of the constitution of matter as indicated by the phenomena of electric discharges through gases; Prof. André Blondel on oscillographs; and Prof. J. C. Bose's theory of response in living and non-living matter.

**The Telephone System of the British Post Office.** By T. E. Herbert, A.M.I.E.E. 2nd edition. (Whittaker & Co.) 3s. 6d.

This cheap and useful handbook, which was reviewed in these columns some two years ago, has now reached a second edition, and is issued with some of the improvements—notably the addition of an index—suggested by us when the book was first published. The illustrations, though numerous, are still far from satisfactory—a defect due to smallness of scale and inferior drawing. In other respects the work, brought up to date as it is, can be recommended as one of the best of its kind—certainly the best as relating specially to the British Post Office system.

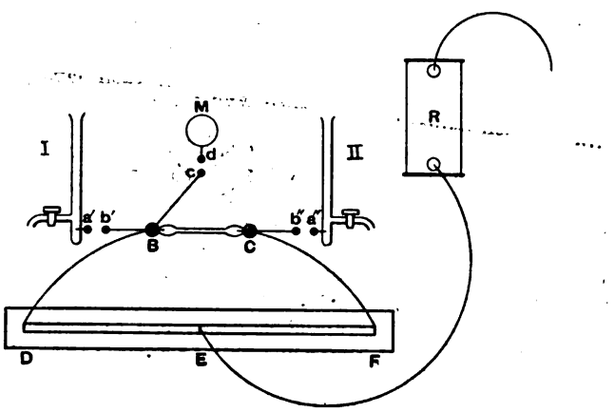
**The Induction Motor.** By B. A. Behrend. (New York: "Electrical World and Engineer.")

This volume deals very fully with the graphic treatment of the single-phase and three-phase alternate-current motor. The substance of the book is taken from lectures delivered by the author in January, 1900, before the University of Wisconsin, Madison, Wis. We are glad to notice that the theory is constantly checked by experimental data taken from induction motors, which have been designed on the principles laid down in the treatise, and which were built at the Oerlikon Engineering Works, Switzerland, where the author was formerly assistant chief electrician. A good book dealing with this special subject was wanted.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Measurement of Small Capacities by Means of Vacuum Tubes.*—The following useful observation was made by J. Borgmann. One pole of an induction coil R was put to earth, while the other was connected with a platinum electrode E by means of a long, thin wire. E was inserted in a groove made in a




paraffin block and filled with some electrolyte of high resistance. At D and F there were other electrodes, and these were joined to the terminals BC of a vacuum tube. The latter becomes luminous as soon as the induction coil is set to work. The luminosity shows no trace of polarity, and remains the same on reversal. But a great effect is produced by altering the position of E or by attaching a capacity to B or C. If E is in the middle, and the capacities at B and C are equal, a dark patch appears in the centre of the vacuum tube. The patch is displaced as soon as the ratio of the capacities varies. The author works out a method of measuring small capacities based upon this fact.

[J. Borgmann, *Physikal. Zeitschr.*, August 10, 1901.]

*Magnetic Effect of Moving Charges.*—Crémieu's negative result, constituting, as it does, a glaring contradiction of Maxwell's theory, has already been severely handled, both theoretically and experimentally. Harold Pender proved the magnetic effect of electric convection by means of a slight modification of Crémieu's own apparatus. E. P. Adams has since attacked the problem by a new method—that of moving charged spheres—and has obtained a positive result which confirms the previous work of Rowland, Röntgen, Hutchinson

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and Himstedt. Two sets of spheres, 16 to the set, were made of sheet copper and mounted on a shaft insulated from each other. The spheres moved with a velocity of 8 miles a minute, and great difficulty was experienced in taking magnetometer readings owing to the wind created by them. But this was obviated by encasing them in a shield. The results show that deflections were obtained in the direction anticipated—*i.e.*, a positively charged sphere gives rise to a magnetic force such as would be due to a current flowing in the direction of motion.

[E. P. ADAMS, *Phil. Mag.*, Sept., and *Am. Jour. Science*, Aug., 1901.]

*A Physiological Photometer.*—A novel kind of photometer, which has the great advantage of extreme simplicity, is described by G. M. Stanoievitch. It is based upon the fact that a certain quantity of luminous energy is required to produce a visual impression upon the retina. Thus a triangular or circular patch, to be distinctly visible, requires a certain constant minimum illumination. This minimum differs with different eyes, and with different conditions of the same eye, but is, on the whole, constant within, say, 10 per cent. The author's photometer has the form of a small telescope, 10in. long and 2in. in diameter. At one end is a piece of ground glass which is turned towards the source. Some 4cm. behind it is fixed an iris diaphragm, whose aperture is at the principal focus of a convex lens. The latter produces a parallel beam of rays which illuminates another diaphragm, and the latter again is observed through another lens. In using the instrument, the iris diaphragm is screwed down until nothing is seen, and then gradually opened until the round aperture is clearly defined. The instrument is calibrated empirically. It has the advantage of not depending upon the calmness of the atmosphere, and it is also very portable. A number of luminosity determinations may be made in the streets in a single evening. But care must be taken to have the eye in the same state of fatigue.

[G. M. STANOIEVITCH, *Comptes Rendus*, August 5, 1901.]

*Telephone Receivers in Space Telegraphy.*—E. Ruhmer shows that no coherers are absolutely necessary for space telegraphy, an ordinary telephone answering the purpose well enough for considerable distances. He used a Righi oscillator with induction coil and turbine interrupter. One ball of the oscillator was earthed, while the other was attached to a mast wire 25 metres long. The receiver consisted of a mast wire 5 metres long, earthed through an ordinary postal telephone. The distance was 2km. Morse signals were easily read. It was found that the telephone answered only to the first of the damped oscillations proceeding from the oscillator. It is, therefore, desirable to increase the capacity of the oscillator as far as possible. It was found advantageous to insert a condenser in parallel with the oscillator. As regards the receiver, it was found best to put a condenser in the receiving circuit, and read off the signals by means of a transformer. Such was the loudness obtained that it seems quite feasible to convey signals in this manner over 20 miles or so. This would mean a great simplification and extension of space telegraphy. Automatic records could be made by telephone relay or by the Pollák-Virag system, and syntonism could be obtained by using Mercadier mono-telephones.

[E. RUHMER, *Physikal. Zeitschr.*, August 24, 1901.]

*The Structure of Spectra.*—W. Sutherland shows, in the course of a masterly Paper, that the atoms of the different elements are all equipped with the same, or nearly the same, electrical apparatus, whereby the mechanical energy of the atom is made communicable to the ether for radiation. The atom, with the kinetic energy assigned to it in the kinetic theory of matter, exercises no direct mechanical effect on the ether, but is like a flywheel driving the dynamo, to which we may liken the electrical equipment of the atom. The structure of spectra is traced to the two facts, first that atoms vibrate as deformable, but practically incompressible, bodies of finite calculable rigidity, so that their surfaces have stationary waves corresponding to the fundamental mode of vibration and its harmonics, and second that electrons in describing nearly circular orbits round an atom, out of an infinity of such orbits possible, have orbits of certain frequencies made predominant by resonance. An electron can make 1, 2, 3. . . . $m$ revolutions between two occasions when it gets its energy renewed by striking the atom at the middle of one of its vibrating internodes, or it can make $1+\mu$, $2+\mu$ . . . . $m+\mu$, where $\mu$ is generally an harmonic fraction. The orbits for a positive electron are different from those for a negative, and, therefore, a relative motion between positive and negative electrons is set up. This is the direct cause of the vibrations of light. This relative motion can be represented by giving the positive and negative electron different angular velocities round the circumference of a circle. By such motions Balmer's and Rydberg's formulas can be explained, and Rydberg's laws lead to the conclusion that the fundamental angular velocity of all electrons associated with all atoms is a constant representing a frequency of $33\times10^{14}$ per second. From the rigidities of the metals at absolute zero the mechanical periods of vibration of the atoms are calculated and proved to exhibit simple harmonic relations, and probably to possess a common harmonic of a frequency of the same order as that of ordinary light. It is probable that the common harmonic of the atoms and the fundamental mode of motion of the electron are identical or harmonically related. The spectra of different elements thus appear to be caused by practically one and the same form of electrical appliance (pair of electrons) which is supplied with energy by the atom at various internodes. One spectrum is only a slight kinematical variation of another. The principles of the kinetic theory of gases and of the electromagnetic theory of light are brought into natural relation. Rigidities at absolute zero, calculated according to the kinetic theory of solids, are shown to be connected with the structure of spectra, and molecular resonance is shown to play a striking part in the melting of the metals. The atoms in a compound molecule are more intimately united than is usually supposed.

[W. SUTHERLAND, *Phil. Mag.*, September, 1901.]

## ON THE ELECTRIC STRENGTH OF INSULATING MATERIALS.

BY C. BAUR.

Mr. O'Gorman's very interesting Paper on the insulation of electrical cables brought back to my mind some experiments I made 10 years ago which were made the subject of a Paper read before the Institution of Electrical Engineers by Mr. A. Siemens.* One of the most striking results of those experiments was the fact that a cable, when made long enough, breaks down with a definite potential difference, when this is applied between the conductors or conductor and lead. On p. 188† of the above-mentioned Paper a curve is traced, relating to cables insulated with impregnated jute, which gives for thicknesses of the insulations varying from 2mm. to 24mm. the corresponding potential difference which will break it down.

On reconsidering this curve again lately, I found it was easy enough to express it by means of a mathematical formula.

Let $d$ be the thickness of insulation of a cable measured in millimetres, V the potential difference of the alternating current measured in volts, and $c$ a constant. The curve is represented by the formula,

$$V = c\sqrt[3]{d^2}.$$

Assuming for the constant $c$ the value of 2,200 volts, the calculated and observed curve agree very well with each other, as shown in the following table :—

| Thickness of insulation ... | $d=3$ | 6 | 12 | 24mm. |
|---|---|---|---|---|
| Observed P.D. ..... | V = 4,800 | 7,200 | 12,000 | 19,000 volts. |
| Calculated P.D. ..... | V = 4,600 | 7,200 | 11,400 | 18,300 „ |

The constant $c = 2{,}200$ volts is the potential difference which will break an insulation of 1mm. in thickness.

In the same way the formula was applied to some other breakdown tests, as yet not published, but made at about the same time, relating to calico impregnated with indiarubber of

* See *Journal* Inst. E.E., No. 97, 1892; or *The Electrician*, Vol. XXVIII., pp. 431, 461, 492 and 521.

† *The Electrician*, Vol. XXVIII., p. 492.

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a thickness of 0·8mm., of which different layers, to the number up to 10, were tested for breakdown between plane surfaces. It was surprising, not only to find that the curve obeyed the same law, but also that the constant was the same. In fact, the calico curve is the continuation of the jute cable curve for small thicknesses of the insulation.

Here follow the data of the original observed curve and those of the calculated curve :—

| | | | | | |
|---|---|---|---|---|---|
| Thickness of insulation ... | $d$=0·6 | 0·9 | 1·8 | 3·0mm. | |
| Observed P.D. ..... | V=1,550 | 2,000 | 3,050 | 4,400 | volts. |
| Calculated P.D. ..... | V=1,550 | 2,050 | 3,250 | 4,560 | „ |

The agreement between the two curves is very close.

Encouraged by this success I have extended my investigations to other substances. On p. 179 of the above-mentioned Paper* curves are given for the striking distances in air of a temperature of about 16°C. and 80 per cent. humidity. Of these I have selected the one relating to tests made between plane surfaces. If the constant $c$ is assumed to be 8,800 volts, the observed and calculated curves compare as follows :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Thickness of ins. | $d$=0·67 | 1·59 | 2·53 | 3·60 | 4·80 | 6·46 | 10·2mm. |
| Observed P.D. | V=2,000 | 4,000 | 6,000 | 8,000 | 10,000 | 12,000 | 15,000 volts. |
| Calculated P.D. | V=2,500 | 4,500 | 6,100 | 7,800 | 9,400 | 11,500 | 15,500 „ |

The differences are more noticeable than for the other two substances, but not so considerable as to induce one to reject the stated law for air as dielectric.

On p. 640 of Mr. O'Gorman's Paper† I find the following note :—

> We may suppose the insulating material has a *constant volt-resisting quality* per centimetre thickness measured between plane surfaces. Trowbridge (1898) has proved this true for large thicknesses of air, and T. Gray (1898) for all thicknesses of paraffined paper. It is not true for small thickness of substances like paper impregnated with oil, empire cloth, mica, &c., but the law is known, having been investigated by T. Gray and others.

As regards air, these statements are at variance with my own, in which the ratio $\frac{V}{d}=\frac{c}{\sqrt[3]{d}}$ is never a constant. If, however, the range of the striking distance is small, say from 7mm. to 10mm. as on curve p. 645 of Mr. O'Gorman's Paper, one might be induced to consider the ratio as a constant. For 7mm., 8mm., 9mm., and 10mm. striking distance the ratios compare as the figures 52, 50, 48 and 47, when calculated from the formula.

As regards the substances and thicknesses for which the constancy law is not true, it is easy enough to show that they obey my formula or law. If we take, for instance, the curve for mica in Mr. O'Gorman's Paper (p. 641),‡ and assume the constant $c$ to be 58,000 volts, the observed and calculated curve will be represented approximately by the following figures :—

| | | | | | | |
|---|---|---|---|---|---|---|
| Thickness of ins. | $d$= 0·1 | 0·2 | 0·5 | 0·8 | 1·0mm. | |
| Observed P.D.... | V=11,500 | 19,000 | 37,000 | 52,000 | 61,000 | volts. |
| Calculated P.D.. | V=12,500 | 19,800 | 36,600 | 52,000 | 58,000 | „ |

"Full board," from p. 639, curve A, calculated with $c$=19,000, shows greater differences than found in former comparisons :—

| | | | | | | |
|---|---|---|---|---|---|---|
| Thickness of ins. | $d$= 0·2 | 0·6 | 1·0 | 2·0 | 2·6mm. | |
| Observed P.D. ... | V=4,000 | 12,000 | 19,000 | 34,000 | 42,000 | volts. |
| Calculated P.D.... | V=6,400 | 13,500 | 19,000 | 30,000 | 38,000 | „ |

The mean of curves A and B, p. 639, too, does not agree better with the formula.

"Empire cloth," curve No. 1, p. 648, however, agrees again very closely with $c$ = 12,500 :—

| | | | | | |
|---|---|---|---|---|---|
| Thickness of ins. ... | $d$= 0·2 | 0·6 | 1·0 | 2·0mm. | |
| Observed P.D. ..... | V=4,000 | 8,000 | 12,500 | 20,000 | volts. |
| Calculated P.D. ... | V=4,300 | 8,900 | 12,500 | 22,500 | „ |

Finally, I recurred to my own tests on the breakdown of *indiarubber insulated cable*, see p. 184 of Mr. Siemens' Paper.§ From these I have plotted a curve, which, however, is not very correct owing to an insufficient number of observations, but quite good enough for the use of a cable engineer. This curve, too, obeys the formula very fairly. With $c$=10,000 volts the curves are approximately the following :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Thickness of ins. | $d$= 1 | 2 | 4 | 6 | 8 | 10mm. | |
| Observed P.D. | V=10,500 | 17,000 | 26,000 | 32,500 | 37,000 | 40,000 | volts. |
| Calculated P.D. | V=10,000 | 16,000 | 25,000 | 33,000 | 40,000 | 46,000 | „ |

These investigations seem to indicate a new law which may be put into the following terms: *Every dielectric, whatever its thickness be, requires a certain voltage to break it, and this is proportional to the two thirds power of its thickness.*

The constant $c$, *i.e.*, the potential difference necessary to break a thickness of 1mm. of a dielectric, should be called its *electrical breaking strength*, analogous to the term mechanical breaking strength. It can be considered as a new addition to the property of matter. If the law is proved to be true for all substances, it is only necessary to make a test of a piece of 1mm. in thickness to obtain the whole curve for any dielectric. Thus, if tests were made for air over-saturated with water vapour, an estimate might be obtained as to the E.M.F. necessary to produce lightning.

The electrical breaking strengths, as determined in the foregoing, have approximately the following values :—

| | |
|---|---|
| Impregnated jute ..... | 2,200 volts. |
| Impregnated calico ..... | 2,200 „ |
| Dry ordinary air ..... | 3,300 „ |
| Vulcanised indiarubber of good quality ..... | 10,000 „ |
| Empire cloth ..... | 12,500 „ |
| Full board ..... | 19,000 „ |
| Mica ..... | 58,000 „ |

These figures should be more accurate for comparison than those given by Mr. Gray.*

I wish scientists, who have more time on their hands than an overworked engineer, would take the matter up again and investigate it thoroughly for all possible substances. The question is an extremely important one for the cable engineer as well as for the scientific man.

* *The Electrician*, Vol. XXVIII., p. 463.
† *Journal* Inst. E.E., No. 150, 1901. *The Electrician*, Vol. XLVI., p. 830.
‡ *The Electrician*, Vol. XLVI., p. 830.
§ *The Electrician*, Vol. XXVIII., p. 492.

## MR. MANSERGH'S PRESIDENTIAL ADDRESS TO THE INTERNATIONAL ENGINEERING CONGRESS.†

Standing here, in virtue of my position as President of the Institution of Civil Engineers, to open the first General International Engineering Congress held in Great Britain, I am conscious of owing my elevation to this eminence to the accident of office, and not to personal desert. I feel very keenly myself—and I am sure the feeling must be shared by many present—that it is an act of the greatest presumption on my part to occupy this position in the presence of the Grand Old Man of Glasgow's ancient University. I desire, therefore, to explain that the position has been forced upon me, notwithstanding my very earnest remonstrance, and by the desire of Lord Kelvin himself. My words will, therefore, be few, and will be restricted to tendering a very cordial welcome to all engineers—especially to those hailing from foreign and distant lands; to thanking the authors of the Papers contributed to the various sections; and to making the briefest reference to certain matters of interest to us, as engineers working under modern conditions.

It has long been impossible for any individual to give adequate expression to the fulness of the combination of temporary science, art, knowledge, and practice which we recognise for engineering. Engineers constitute more than a profession: they amount to a "race"; and it is upon them more than any other class of the civil population of the world that falls the heaviest share of the "White Man's Burden." There have been framed many definitions of engineering and of the engineer, but none that I can esteem adequate, and at the same time sufficiently exact and exclusive. My reason for holding this opinion is based on two considerations. The first is the persistence of much popular ignorance of the nature of our work, and some lack of appreciation of our class; and the second is the stubborn refusal of the English spirit to admit the necessity of any formal qualification on the part of those who claim to be of the profession. With us—odd as such a state of things must seem to our more highly organised foreign colleagues—an engineer may hold a diploma, or he may *not*. He may be associated with our Institution, and be entitled to append a string of capital letters to his name, or he may not possess a single title to nominal distinction. This is because engineering with us does not consist in *being*, but in *doing*. The public's unformed, vague idea of an engineer is that of a man who can *do* things—a great and constantly increasing *number* of things—all falling within a wide but fairly recognised category. His quality seems to lean more to the side of invention than to that of scholarship. For my part, I am content to have it *so*. Not that an engineer can ever be too deeply instructed, or too well trained in all the elements of knowledge and skill required for the effective pursuit of his calling; but the really great engineer is *born*, not *made*. So subtle is the influence of words upon thought that I could wish the name of our avocation were spelt in English as it is

* See Mr. O'Gorman's Paper, p. 619, and *Phys. Review*, Vol. VII., pp. 199-209, 1898.
† Read at Glasgow on Sept. 3.



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in languages of a more pronounced Latin derivation, with a capital "I" instead of "E"; "Ingeniering," say, in place of "Engineering." Thus the nature of our work would be better recognised among the people who are careless of etymologies. The suggestion of the name would be removed from association with the word "engine" (a good enough word in its degree, and one that once had a wider significance than is now left to it), and would be placed where it rightly belongs, with the root idea which gives us the words "ingenious," "ingenuity," &c. We must, however, go no further in this direction for the missing definition of engineering, or we shall get into the clouds, where, although I am not sure but that we might find some colleges of engineering, we should miss the substance of the thing itself. For engineering is the only high art which depends as much on its cheapness for its excellence as upon any other item in the sum of achievement.

All other things being equal—adaptability, soundness, efficiency—the engineering work which costs the least money is the best. I do not know of any other product of man's creative and adaptive powers, of which the same can be so truly said. The "cash" basis is the real foundation upon which the engineer builds, and this consideration draws us at once from judging engineering as merely something cleverly done by an ingenious person. It also very often serves to distinguish between college, text-book, or rule-of-thumb engineering and the *real thing*. There is an American definition of an engineer which states that "he is a man who can do *well* for *one* dollar things that anybody could do *somehow* for double the money." This is getting very near the truth. It is not the whole truth, of course, but that, for reasons I have already indicated, is unattainable. At any rate, it places in due prominence a quality which those who regard engineering studies from the college standpoint are apt to ignore. I have heard a legend of a professor of applied mechanics who was shocked at the thought of steam-engines being made for money to sell—like *cakes*. A good deal of wasted ingenuity would be saved if those who engage in every kind of engineering work would remember to use the money standard, as well as the foot-rule and the higher mathematics. Real engineering must be mastered as it is realised on works in progress. It has no authoritative text-book. The working engineer's library is sometimes largely composed of ephemeral manufacturers' catalogues, and lists of prices current of materials. Like the perfect artist described by Longfellow, the engineer must learn to work with the means that lie readiest to his hand. He must cherish his ideals or he will sink into the routineer, but he, *of all men*, cannot afford to indulge in hobby-riding. He leaves as little as possible to chance, and, if he is wise, he will not rely upon his best mathematics any further than he can see them. If he starts with aptitude, plods on with patience, observes with insight, records with careful exactitude, and adapts with wisdom, in the fulness of time he will find himself, almost to his surprise, in possession of *judgment*, and that is the glory of an engineer, fitting him for his highest employ as man-of-all-work to civilisation. Material civilisation owes much to this faithful servant. Others may plot, scheme, invent, discover wants and their proper supplies; the engineer, as a rule, does chiefly what he is told *wants doing*. By strict attention to his own business, he helps to make the crooked ways straight and the rough places plain for *all*. The engineer must have great power of concentration. His solicitude is to make every job a little better than the last. The newest steam engine shows a fractional economy of steam; the latest steamship carries her freight with a scarcely distinguishable saving in coal consumption *per ton*, the selected railway metal lasts a little longer than the previous purchase, the main line is straightened here and there, and incidentally—as it were—the remote ends of the earth are brought closer together, and plague, pestilence, and famine are driven back. The wiseacres who declare on political platforms that the effect of modern civilisation is to make the rich richer, and the poor poorer, forget all about engineering. The engineer is the chief of the modern democratic Civil Service. Civilisation is admitted to have had its birth with the Romans, and they were the first to recognise a change of purpose in engineering from the idle aims of Egyptian pyramid builders to the useful purposes of road-making and the provision of ample supplies of pure water to their cities. Down to the dawn of the century that has just closed civil engineering did not surpass the works of the Romans, which, indeed, in some respects remained unequalled. It may be said with respect to the elemental need of the modern world for improved means of transportation, that the civil engineering first broke out its own line with the notable discovery of the Scotsman, Macadam, that good roads could be made with stones broken small. The distinguishing note of modern engineering is that it subserves in the main the interests of the mass of the people. The greater comfort, better feeding, higher healthfulness, freer movements of the people to outside the congested urban areas to-day, as contrasted with the state of the populace of this and other countries a century ago, are chiefly attributable to the triumphs of our professional work.

An alarm has been sounded in our ears of late, warning us that we, the inhabitants of the United Kingdom of Great Britain and Ireland, have touched our high-water mark in respect to the prosperity derivable from the prosecution of those manufacturing industries which are based upon engineering, or served by it with the means of transport and communication. This may be so. Our nation has no royal secret for arresting the revolution of Fortune's wheel. When merchants first sought our shores to trade with the aborigines, their attraction was the native tin. The development of the country, however, was not arrested by the substitution of iron for bronze implements and weapons. Wool became in turn the staple product of the land, and carried its diversified fortunes bravely down almost to within living memory. We have long ceased to produce enough wool, or corn, or meat for our teeming population. It is almost as much as we can do to find enough water to drink. The wisest man that graced the court of the British Solomon who first united the kingdoms of Scotland and England, would be sorely puzzled—if he were to re-visit this realm—to understand how we all contrive to live. The industrial development of the world has proceeded along the lines that the profoundest mind of the nineteenth century—Charles Darwin—traced for the life history of the planet.

The course of economic progress is from the simple to the complex, from one-ness to infinite differentiation. In the history of Britain, the mining of a semi-precious metal for exportation was succeeded by pastoral pursuits, and these, again, were followed by agriculture and manufacturing enterprises. Good government kept order in the land and saved it from devastating invasions. Margins realised over the cost of living formed capital, which went into fresh enterprises at home and eventually overflowed into adventures for the conquest of markets abroad. All the time engineering dogged the way, making roads and inland waterways and harbours, and supplying tools and mechanical motive powers. A vast multiplication and diversification of employments for money, ingenuity and toil has resulted from the free play of the national genius, and been carried to such a height by the indomitable spirit of the race, that now the waxing and waning of particular trades and interests from accidental influences does not alter the balance of the great account which the nation has opened with Fate. An illustration in point is spread before our eyes. Mark the difference of the conditions governing the prosperity of, say, a *mining* camp, and those prevailing over a vast and varied emporium, a manufacturing centre, such as this noble city. Glasgow flourishes, not by reason of the vogue of any particular trade that finds specially favourable situation on the banks of the Clyde, but because it is a microcosm of the universal activities which yield wealth. Its engineers can point with pardonable pride to the material framework and setting of this community—the artificially-improved river, the system of railways, the magnificent water supply, which have given Glasgow elbow-room for its expansion, as the gains of engineering; but it is the peculiar diversity of Glasgow's energies that have won for her the rating of "Second City of the Empire."

The question of moment to Britishers is: Shall we maintain our ground; to say nothing of increasing our lead? I cannot tell; but this I do believe, that the character of the future of the country, and the fruitfulness of our common calling, depend chiefly upon the preservation of that freedom for the play of all the talents, all the energies, all the force of human initiative for the subjugation of the powers of Nature, and their direction in the service of mankind, which has enabled us to do so much in this regard in the past. Favoured simply by secured peace at home and the confidence of the masters of accumulated capital, engineering has showered its first fruits over our land. To-day these advantages have become internationalised. Gold flows daily to and from the capital cities of the earth for the smallest balance of gain—or, as engineers would describe the movement of a mobile fluid—under the slightest head of an ever-shifting pressure. Brains are no particular possession of our nationality. The cosmic forces are the same everywhere. Economic conditions tend to wear down to a uniform level. Science knows no frontiers. The engineer is the truest free trader. He goes whithersoever he is wanted and finds most to do. Will he in future flourish best in Britain or abroad? One hears much talk nowadays about the British need for more technical education for workers, and of better instruction in the art of living for the people generally, and I am not disposed to disparage this desire for more light. *There cannot be too much of it.* Nevertheless, I hold liberty to be more precious than learning. The fullest freedom for the exercise of the inborn spirit of initiative, enterprise, and adventure is the next essential to the occurrence of this spirit in the *individual* members of a race, for the *whole* to make headway in the universal struggle for life and a leading position.

I fear that only too good a case could be made out for the allegation that a mistaken statutory system has discouraged in this country—for the time being at least—the naturalisation and development of electrical engineering on the largest scale. In other words, the Electric Lighting Acts had the broad result of chopping up the business of electricity supply in this favoured land into morsels reduced to the parochial needs of local authorities. There was no freedom in the business. Instead of the electrical and mechanical development of lighting and power plant being undertaken in this

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country upon a scale proportional to its early promise, the work had to be done by "sample"—every small specimen differing from the others. Long years passed before any English engineer was in a position to give out an electrical power contract amounting to £100,000. Meanwhile our friends in America and on the Continent of Europe were forging fast ahead. So we lost our chance, and shall probably have to take other people's electrical plant for some time, instead of striking out our own leading line, as our *less governed* forefathers did in railway work and shipbuilding years ago.

I should like to remark here, in parenthesis, how much of the real essence of economical engineering is contained in the work of settling standard sections of important constructive materials. This matter has been taken in hand by a joint committee of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects and the Iron and Steel Institute. It is my privilege to be ex officio chairman of this committee, and we have already taken the evidence of representative men among makers, merchants and users of steel and iron bars of all shapes and scantlings, and received many written communications, all of which go to prove the great desirability of doing very thoroughly the work of standardising which the committee have taken up. Sir Benjamin Baker, with a specially-selected sub-committee, has charge of bridge and general building construction; Sir John Barry, with similar assistance, of railways; Col. Denny, of shipbuilding; and Sir Douglas Fox, of rolling stock. In the hands of these eminent engineers you may rest assured the work will be well handled; but we desire very earnestly the active and cordial assistance and co-operation of all our brethren interested in this important matter.

In all the various sections to which you will now go to perform the real work of the Congress, you will, I think, find something that will serve to *focus* your attention upon the great engineering problems of our time. I have no wish to discriminate among the Papers, but it is plain that in Section I. Prof. Carus-Wilson has undertaken the treatment of a matter of extreme interest in writing of the "Economy of Electricity as a Motive Power on Railways at present driven by Steam." Some very important Papers are to be read in Section II., and it is a matter of peculiar gratification that we have been able to enlist the help of so distinguished a band of engineers from the United States of America and the European Continent, to give true international importance to the deliberations of this section. I am pleased to find that one of the most interesting of all inventions since the age of Watt in the domain of prime movers—the steam turbine—is to be discussed in Section III. It is impossible to overrate the value of the section of metallurgy, and the number of Papers promised testifies to the technical interest of the questions which await answers in this sphere of engineering energy. In Section VII. two of the most pressing problems of municipal engineering—the disposal of sewage and the housing of the poor—will, I am sure, be adequately treated. In Section VIII.—gas engineers—sufficient proof will be given of the influence on the industry of that invaluable invention incandescent lighting, to which the exhibition (of which our hosts may justly be very proud) owes so much of its evening brilliancy. The applications of electricity to various purposes will be described by Section IX., among them the wonderful "three-phase" system of power transmission, which promises so much in this connection.

Time forbids my going further into the various matters that crowd one's mind on such an occasion as the present. I can, therefore, only commend you heartily and sincerely to the despatch of the important business you have undertaken, and trust that the fruit of increased knowledge that may be gathered from interchange of ideas will amply repay your trouble in coming here at the invitation of our Glasgow friends and confrères.

## INTRODUCTORY ADDRESS TO THE ELECTRICAL SECTION (SECTION IX.) OF THE INTERNATIONAL ENGINEERING CONGRESS.

BY W. LANGDON.*

Inasmuch as within a very short time it will be my privilege to deliver before the members of the Institution of Electrical Engineers my inaugural address, it was not my intention on this occasion to have encroached upon your time by anything in the shape of an address; but other sections of the Congress having elected to follow that course, I fear I may be thought wanting in courtesy if I fail to comply with that which has proved so generally acceptable with others. I therefore propose to approach you, very shortly, upon a subject which, at the present juncture, I feel to be one of the highest importance. Just 50 years since, London, under the auspices of the nation's lamented Prince Albert, gave birth to the first International Exhibition. Followed by numerous others, at home and abroad, none, it is pleasing to note, have proved more successful financially, or more fully met the object for which they were established, than those inaugurated by the enterprise of Glasgow's citizens—the last and most successful of which forms one of the attractions incidental to the assemblage of this Congress and of the inauguration of the new century.

There can be no question that the result of these great undertakings has been for good; that they have been a stimulus to manufacture and trade; and that—greatly beyond all else—they have been a means making for peace. Whether we, as a nation, have been the gainer or the loser, the world has richly reaped. Exhibitions, railways, steamboats, education, the ready intercourse between peoples, have told, and are daily telling their tale. Few articles remain the privileged product of any one place. Manufacture has become cosmopolitan, and the rivalry of the future between the most advanced nations of the earth will be that of manufacture—the power to apply the products of the earth to the exigencies of life at the least cost, and with the least loss of time. The supremacy of a nation may be attained by force of arms, but war cannot be carried on without the sinews of war, and the sinews of war means the wealth of the nation. Whence comes this national wealth? Surely by the industry and intelligence of its people—the power to observe, to apply and to produce.

Lord Rosebery, when speaking recently at the Mansion House, remarked "we are coming to a time of stress and competition, for which it is necessary that we should be prepared," and later on he observes, "It is necessary for a nation in these days to train itself by every valuable method to meet the stress and the competition that is before us." The question whether England, in comparison with other nations, is becoming retrograde in her industrial achievements must prove one of peculiar interest to all who seek this country's welfare. There are grave reasons to fear that in some paths, especially in the more modern applications of science, and notably in that development with which this Institution is so closely allied, we have not retained that prominent position which has characterised this country for so long a period. Twenty years back, British manufacture stood on level ground with other countries in the production of electrical machinery, yet, if we may judge by the following figures, for which I am indebted to Mr. Philip Dawson, member of this Institution, it would appear that we have from some cause failed to meet even our home demands. From these figures, which are approximate, it appears that of some 300,000 I.H.P. of steam engines laid down for lighting and traction, 73,000 have been imported from the United States of America; and that, of some 200,000kw. capacity of generators, 71,000 were derived from the same source. It will be understood that this does not mean that the residue was British production.

It is not my intention, nor would the time at my disposal admit of my attempting to enter into details why this is so. I take the bald fact as illustrated by the figures I have quoted. England did not meet the demand! Can it be that the British manufacturer lacked confidence in the permanency of this new electrical development? I quote again from Mr. Dawson. The capital invested in European countries and the United States in electric lighting, power, and traction works, amounts to £367,000,000. Of this sum the United States contributes £200,000,000 and Great Britain £35,000,000. The number of miles of single track equipped for electric traction in the two countries is, relatively, 21,000 and 900. Of motor cars, 68,000 and 2,600. Germany, where the power employed for lighting work approaches closely that of England, has 2,300 miles of track, and 5,400 cars, although the invested capital is but £29,000,000, as against £35,000,000 for an enormously less mileage and smaller equipment.

The population of Great Britain is approximately 40,000,000 as against 70,000,000, that of the United States. The area in square miles is, relatively, 121,115, and 3,581,885. Too much stress must not be laid upon territorial comparison, although it would seem an evident corollary that the more dense the population the greater must be the demand for means of locomotion. These figures should, at all events, prove effectual in disposing of any doubt that electrical development is staple. That it is only at the beginning of its era, and that an enormous field lies before it in almost every path of commercial and social life, must be evident to every observant person. It is not, however, with its utility that I desire to deal so much as with the means for its production: the production by our own country of all that is needed to meet not merely the wants of our home demand, but that of our colonies as well.

Two important factors—cost and promptitude of delivery—attend successful competition in manufacture. Inspired with confidence in the future of electrical work, with, as it were, a prescience of those demands which must arise, and unencumbered with many of those restrictions and regulations which attend similar undertakings in England, other nations have seen and have seized their opportunity, gained experience, standardised their productions, and have thus, in advance of this country, prepared to meet any ordinary demand that may arise. Cost depends much upon our labour conditions. Within a very short period rivalry in manufacture will be far more acute than is even now the case, and in it labour will play the chief part. America, as well as England, has her labour troubles. Trade unions

* Chairman of the Section and President of the Institution of Electrical Engineers. Delivered September 3rd.



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exist there as well as here, but the principles which govern them differ from those which prevail here. There the man works unrestricted with all his might. Of what avail is education to the child if manhood fails to take full advantage of it. In the following comment of the *New York Sun* we have an expression of opinion that may well be laid to heart: "When the British workman is willing really to work for his wages, then, and not till then, Great Britain may hope to survive in the great revolution which has begun to sweep through the modern economic world. There is no indication that that willingness will be shown until the bitterness of dire adversity has wrung it from the misguided labour unions of Great Britain."

The artisan should not lose sight of the fact that this question of cost is one which affects the employé as well as the employer. In the long run the master may be thrust to the wall. He may spend his last penny in keeping his works going, but when he closes those works the workman's means of livelihood are also, so far as the industry there dealt with affects him, closed. Unhappily, identity of interest, so necessary to both master and man, is more frequently marked by its absence than its presence. Until the employé can be induced to recognise in a practical manner the fact that his employer's interest is also his interest, those labour regulations which have been fruitful of so much harm to the manufacturing interests of this country, and which must in the end prove disastrous to the workman, will continue. So long as the production of a certain commodity is peculiar to a given locality the question of cost is not so material; but where its production is world-wide, labour conditions must subscribe to those attaining elsewhere, otherwise the market for that commodity will be lost.

We are speedily approaching a condition in the industrial progress of the world that will test to the utmost, not merely our means of production and our skill, but our position as a nation; for the pre-eminence of a nation will in future be largely determined by its progress in manufacture, and from it mainly shall we have to look for the means by which the nation's power will be maintained. A people may trade. Articles may be bought and sold, but food for the worker lies not there. The wealth of a land is to be found in that which it produces, whether from the soil or by the handicraft of its citizens. In such a rivalry—however friendly and generous that rivalry may be—it behoves us to consider how our manufacturing industry is placed in relation to that of other countries with which we have to compete; whether the conditions of production—labour, legislative enactments, or other restrictions, are such as give our rivals an initial advantage. The question is one of unexampled importance. We see and feel that the manufacture of any one article is no longer the privilege of any one country. The ready means of intercourse between nations—the feverish haste to exploit that which is new—all tend towards the establishment of a common knowledge of the productions of the day. Certain advantages remain to the locality from which the natural product is derived, but if this is submerged—lost in other directions—lost, for instance, in the cost of production—wherein is that country the richer? We have seen that England, once the chief source of iron and steel rails, has in that industry met with serious rivalry. How long will our position in textile fabrics remain even as at present? Is it not time we should look within ourselves and ask, Why is this so? To what is it due? Are our means of production at fault; are they too costly, too much restricted; or where are we to look for the reason?

Gentlemen, I plead no excuse for having ventured to address you upon a subject which might, perhaps, more properly have been approached through the medium of some other branch of science, for the reason that it is one which so materially affects the future prosperity of this country, and amongst other industries none, perhaps, more so than that embracing electrical development, that I have felt impelled to avail myself of this opportunity to urge the importance of its consideration. We see other countries prepared, and preparing to take advantage of every new development in industrial progress. We see vast sums of money embarked in it, and especially in the use and advancement of electricity in its various modes of application, and we see that here in England—the pioneer of mechanical power and progress—we are indebted to a foreign source to meet a great portion of our wants. There is a cause, and if our country is to retain her rank as a nation it is necessary that this cause, whatever it may be, should be ascertained, and, if possible, removed ere it is too late. Are we sacrificing the substance for the shadow? Are we, in our recognition of the liberty of the subject, in making provision for his welfare, so handicapping the source of his livelihood as to reduce its power of affording him that support? Are we, on the other hand, fostering manufacture and that which leads to manufacture? We have sternly to face the fact that manufacture is daily becoming cosmopolitan: that the production of a land must form its staple source of revenue; and in this sense to emphasise the need to consider those liabilities to which the British manufacturer has, in relation to the conditions attaining in other countries, to subscribe. The subject is one which may, I humbly and earnestly submit, claim the most careful consideration of every branch of our Legislative Administration, our labour organisations, and of every citizen of the British empire.

## THE BOILER EXPLOSIONS AT SARDINIA STREET STATION.

**The report of the Board of Trade Commissioners who inquired into the boiler explosions which took place last winter at the Sardinia-street station of the Metropolitan Electric Supply Co. has just been issued. The inquiry took four days, from June 10th to June 18th last. The following is the substance of the report referring to the first explosion, which took place on November 17, 1900:—**

The boiler is of the water-tube type. It is 18ft. 6in. long, 8ft. 6in. wide, and 14ft. high. It was fitted with 126 wrought-iron lap-welded heating tubes, each 14ft. long, 4in. in external diameter, and No. 9 W.G., or $\frac{1}{4}$in. thick. They were divided into 14 sections, with nine tubes in each section. They were each expanded at either end into cast metal headers. Circular cast metal removable covers were fitted on these headers opposite the ends of each tube to provide access for examination, cleaning, or removal. Two steel cylindrical steam and water drums 3ft. in diameter and 18ft. 1$\frac{1}{4}$in. long were placed horizontally above the tubes, and connected to the back and front headers by circulating pipes. The bottom ends of the back headers were connected to a cast metal mud drum to which a pipe leading to the blow-off cock is attached. A manhole 15in. by 11in. was fitted in each drum, and there were three sludge holes, each about 8in. by 6in.

The mountings consisted of:—Two dead-weight safety-valves; one breeches pipe, with stop-valve and soot-cleaning cock attached; two feed pipes, with check valves; two glass water gauges; one steam-pressure gauge; one blow-off cock.

The boiler was made by Messrs. Babcock and Wilcox (Ltd.), of London and Glasgow, and was 11 years old.

A tube was renewed in the bottom row in April, 1899. Ten of the back circulating tubes were re-expanded in May, 1900. Eleven tube caps at the back end of the boiler were changed on July 30, 1900. All the mud drum nipples and three circulating tubes were renewed, and all the other circulating tubes were re-expanded in September, 1900. These repairs were effected by the employés of the Metropolitan Electric Supply Co. The boiler was examined periodically by inspectors in the employ of the National Boiler and General Insurance Co., and sometimes by Mr. Spencer, the superintending engineer.

*Nature of the Explosion.*—The fourth tube from the bottom in the seventh header from the left side facing the boiler front burst open along its right side for a length of about 3ft. 8in. and both ends of the tube were loosened in the headers. The front end of the rupture was rather more than 2ft. from the front header, and the tube was practically opened out flat for a length of 3ft. 6in. Through the opening thus formed the contents of the boiler escaped, as well as a quantity of steam from 12 other boilers which were connected with the one that exploded. The rush of steam and water blew off both tube doors and one of the fire doors, and also displaced a quantity of brickwork at the front of the boiler.

*Cause of the Explosion.*—The explosion was caused by the tube having become so weakened by overheating as to be unable to resist the steam pressure, and this overheating was caused by an accumulation of deposit in the tube, which prevented the proper circulation of water through the tube.

*Remarks.*—Messrs. Stewart and Menzies, of Glasgow, supplied the tubes to Messrs. Babcock and Wilcox, and in the evidence of Mr. Robert Balantine, the London manager of the former firm, the method of the manufacture of the tubes was described as follows:—The plate was first of all drawn through a machine with cutting tool on each side to scarf the edges. It was then put into a heating furnace, and in a temperature of about 1,500°F. it was drawn through a die and bent round and lapped about $\frac{3}{4}$in. The iron plate, which was then known as skelp, was put into a welding furnace and heated all over. When it attained the necessary heat it was drawn through a pair of rolls with a mandril in the inside of the skelp and welded along its entire length. Each tube was carefully examined after passing through the rolls in its hot state, and those that showed defects were put aside. The tube was cut to the required length when cold, and was again examined for surface defects, and it was afterwards tested by hydraulic pressure to 1,000lb. per square inch.

The boiler was supplied to the Metropolitan Electric Supply Co. at their station in Sardinia-street, Lincoln's Inn Fields, where it was placed in position and fitted up by Messrs. Babcock and Wilcox, and formed one of a group of 16 boilers, being known as No. 1, and was set to work in September, 1889. On completion the boiler was tested to 225lb. per square inch by hydraulic pressure, it having been constructed to resist a working pressure of 150lb. per square inch, with a factor of safety from 5$\frac{1}{2}$ to 6. Messrs. Babcock and Wilcox supplied with the boiler a card containing directions as to the management of it.

The boiler was insured with the National Boiler and General Insurance Co., the pressure as stipulated in the policy being that of 170lb. per square inch; but the boiler was not worked at a pressure exceeding that of 160lb. per square inch, to which the safety valves were loaded.

Mr. Reginald R. Todd is chief engineer to the Metropolitan Electric Supply Co., having held that position for a period of rather more than two years; he is a gentleman of very considerable experience, especially as an electrical engineer. To him were sent the reports of the insurance company, and they were forwarded by him to the superintending engineer at the Sardinia-street station, with pencil notes, if necessary, to direct his attention to such portions of the reports which seemed to be important, or to call his attention as to what should be done agreeably to any of the reports. Mr. Todd has told us that it was his invariable custom to carry

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out any suggestion that was made by the insurance company. The last report received was dated June 7, 1900, when several of the boilers were thoroughly examined by the inspector.

With regard to No. 1, the report reads:—"Internally, the feed back pressure valves of No. 1 were leaking, causing the interior of the boiler to be very hot;" there was "leakage from the safety-valve, waste has been running down the left side of the second ring seam of left drum of No. 1, and leakage past a cock drops on to the tubes, causing oxidation. There had been leakage past three of the circulating tubes at back, and also from nipple at the bottom."

Under the heading of remarks, the report goes on to say:—"We would recommend that the various leakages receive attention if not already seen to. Otherwise than above the boilers appeared in order. The mud drum of No. 1 was not opened out. We shall be glad if you will have this opened out for future thorough inspections."

Mr. William Edward Spencer is the superintendent engineer at the Sardinia-street station. He has received a training as an engineer, and has had some practical instruction in boiler making. He was appointed to his present position in 1897, that is, before the appointment of Mr. Todd, but he has remained therein with the latter's sanction and approval. Mr. Spencer is responsible for the safe working of all the plant and machinery at the Sardinia-street station, under the direction, if necessary, of Mr. Todd. The orders as to the cleaning and examination of this and the other boilers were left to him. Since 1897 he has caused a record of repairs and cleanings to be kept, and this record, we understand also, was kept before this time. From this it appears that some of the tubes have been renewed. We should mention here that 28 were renewed prior to August, 1897, and since that date a steel tube was renewed in the bottom row in April, 1899, and 10 of the back circulating tubes were re-expanded in May, 1900; 11 tube caps at the back end of the boiler were changed on July 30, 1900. All the mud drum nipples and three circulating tubes were renewed, and all the other circulating tubes were re-expanded in September, 1900.

The boiler was fed with water supplied by the New River Co., and the analysis of this water before us reads as follows:—

Silica, 0·39; oxide of iron, 0·25; sulphate of lime, 3·40; Carbonate of lime, 14·20; carbonate of magnesium, 0·88; nitrate of magnesium, 0·66; chloride of sodium, 3·28. Total 23·06 grains of inorganic matter in solution per gallon."

It is obvious that this water was not of a good quality for feeding purposes, but in order to soften the scale which might form certain fluids were from time to time introduced into the boiler: but the water itself was not treated by filtration or otherwise, so as to free it from the solid matter which it contained.

Mr. Spencer told us that he found it necessary to clean the internal feed pipes every six or eight weeks, and at the same time the drums were cleaned; and from their condition an opinion could be formed as to the state of the boiler, more especially as some of the front caps would be taken off the headers to allow a current of air to enter the drums through the tubes. These operations were called partial cleaning, but the tubes were thoroughly cleaned out every year. They were so cleaned on November 4, 1898—the operation was continued for some days—and on June 19, 1899, and May 11, 1900. Each time the boiler was off for a few days. On the latter date Mr. Spencer examined the boiler before it was cleaned, and found that there was not much scale in the tubes. The deposit, such as there was, was thicker at the back ends, while in some of the tubes it was as much as ¼in. thick. To get rid of it the scraper would have to be used; but in his opinion there was not sufficient accumulation in the tubes to make him apprehensive of any danger with regard to its effect upon the circulation of the water.

On November 17, 1900, 13 of the boilers were connected and supplied steam to three engines. The fire of this boiler was banked up, and it was not supplying any steam to the engines. The boilers were being worked at a pressure of about 150lb., and at 3:20 p.m. this was the pressure as registered by the steam gauge, and at the same time the glass water gauge was half full.

At 3:25 p.m. the boiler exploded. The fourth tube from the bottom in the seventh header from the left side facing the boiler front burst open along the right side for a length of about 3ft. 8in., and both ends of the tube were loosened in the headers. The front end of the rupture was rather more than 2ft. from the front header, and the tube was practically opened out flat for a length of 3ft. 6in. Through the opening thus formed the contents of the boiler escaped, as well as a quantity of high-pressure steam from the 12 other boilers. The rush of steam and water blew off both tube doors and one of the fire doors, and also displaced a quantity of brickwork at the front of the boiler.

After the explosion the tube which gave out and other portions of the boiler were examined by Mr. Joseph Williams, engineer surveyor to the Board of Trade, by Mr. Hiller, chief engineer to the insurance company, by Mr. Todd, and also by Mr. Spencer. Mr. Williams told us that, having opened out for examination several of the tubes, he found a considerable amount of sedimentary deposit therein. The internal surfaces were covered with scale of an average thickness of about $\frac{3}{16}$in., being about ¼in. thick at the back, and not more than ⅛in. thick at the front, ends. In addition to the scale, a quantity of more easily removable sediment was seen near the back ends of nearly all the tubes, and in some of them the accumulation was sufficient to close more than one-half the cross-sections of the tubes. The exploded tube was cut in two about the middle of its length in order to withdraw it from the boiler for examination, when it was seen that the inside of the tube near the back end of the rupture was coated with a hard scale about $\frac{3}{16}$in. thick at the front end. Mr. Williams told us that the fractured parts presented a very brittle appearance, with a large number of longitudinal cracks distributed over the internal surface where the tube had opened out, and many shorter circumferential cracks were seen at many parts of the fractured edges. A number of small pitholes, caused by corrosion, were also observed, and in one place, near the front end of the fracture, a circumferential flaw due to corrosion was observed to have penetrated through the metal for a length of ⅜in., which is shown on the plan. Indications of an inside lap showed that the welded part was at the top of the tube when it was in its position in the boiler. The line of fracture marked A on the plan followed the line of the inside lap for a length of about 23in. There were indications of an imperfect union of the metal along the extreme edge of the lap, and the slight flaw thus produced assisted to determine the line of fracture along A, but Mr. Williams concluded that this fracture was an effect, and not the cause, of the failure of the tube, which first opened along line B, and caused the facture at A by the metal striking against and bending back over

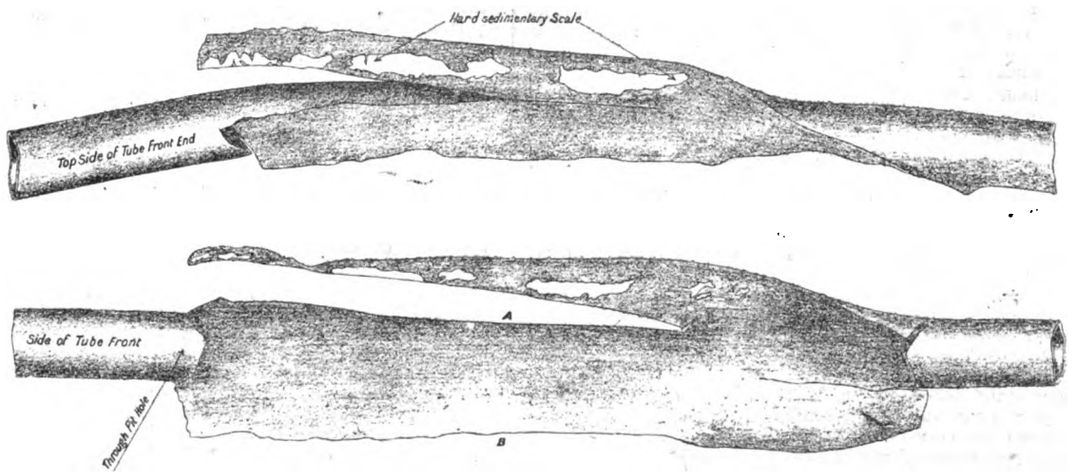


FIG. 1.—Burst Tube of No. 1 Boiler.

the adjacent tube. The average thickness of the tube along the line of primary fracture was was barely $\frac{3}{32}$in., and the minimum thickness was 0·074in., or exactly one-half of what it was supposed to have been originally. If the metal was sound the reduction in its thickness, considered alone, was insufficient to account for its disruption under normal conditions of temperature, and the evidence given with respect to the inactive condition of the fire for some time previous to the explosion, the distance of the tube from the fire grate, the appearance of the scale on parts of the tube which failed, as well as the fact that no appreciable circumferential extension of the metal along the line of fracture could be detected, seemed to negative the supposition of the tube being seriously overheated when it exploded, although the scale in it was sufficient to prevent the free transmission of heat to the water. Mr. Williams gathered, from the burnt appearance of some parts of the fractured edges of the tube, that it had been unsound originally, or that it had been repeatedly overheated until the iron had become rotten, and that for some time past it had been in an unsatisfactory condition, which it was impossible to ascertain by inspecting it when among the other tubes in the boiler.

Mr. Hiller made an examination of the tube shortly after the explosion when it was in position, and he also examined some of the other tubes, on which he found a moderate covering of deposit generally, but at the back ends found that there was considerable accumulation, varying in different tubes, in some ⅜in. in height, in others one-half the tube, and there were one or two tubes that were practically blocked up by these local accumulations, thus preventing the circulation of the water. He was of opinion that this was the condition of the tube in question before the explosion; that it had become overheated, and in consequence had given out. He, therefore, practically agrees with Mr. Williams, the only difference

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between them being that, according to the latter, the tube had been gradually weakened by partial overheating, and by the former that the overheating on the day in question was of itself sufficient to produce the explosion. Neither of these gentlemen, however, would insist on his opinion in opposition to the other, as they both agreed that overheating was the cause of the explosion.

Mr. Todd and Mr. Spencer, on the other hand, were of opinion that there was no sign of overheating, but they attributed the explosion to a defect in the metal, and that, in consequence of that defect, the tube had deteriorated by natural wear; or, in other words, that the original defect was developed by the ordinary working. Now we have been unable to detect this alleged original defect, and in any case we should rely on the evidence of Mr. Hiller and Mr. Williams rather than on that of Mr. Spencer and Mr. Todd, both of the former having had very great experience in investigating the causes of boiler explosions; and we have also formed an independent opinion from our own examination of the tube. We find that the explosion was caused by the tube having become so weakened by overheating as to be unable to resist the steam pressure; and that this overheating was caused by an accumulation of deposit in the tube which prevented the proper circulation of water through the tube.

In answer to the questions asked us by the Board of Trade, we have to state that the iron used in the construction of the tube was of good quality, and that it was properly welded. We have already stated the test to which it was subjected.

Messrs. Babcock and Wilcox did supply to the Metropolitan Electric Supply Co. instructions as to the management of the boiler, and these instructions were observed by the engineers in charge of the boiler; but with regard to these instructions, we desire to say that we understand that Messrs. Babcock and Wilcox supplied them to be used by persons who themselves understood the management of boilers, namely, engineers. They were not to be carried out by any person, but by gentlemen of experience.

Suitable water was not used for feeding the boiler, and the boiler was not thoroughly or properly cleaned or examined at sufficiently frequent intervals. We have to answer this question in the negative, because, having regard to the way in which the boiler was used—sometimes standing with its fire banked and not supplying steam—it was very likely that deposit would rapidly form, especially having regard to the nature of the water that was used. Having regard to both these considerations, we think it ought to have been cleaned out at more frequent intervals.

The boiler was not periodically tested by hydraulic pressure for the purpose of examination. Such test as it was subjected to, after repairs had been executed, was not sufficient.

Proper and sufficient measures were not taken to ensure that the boiler was being worked under safe conditions, inasmuch as proper and sufficient care was not taken to see that it was provided with proper feed water, and properly cleaned, having regard to the feed water that was used.

We have been asked to say whether the explosion was caused by the neglect of Mr. Reginald R. Todd, the chief engineer, and Mr. Wm. E. Spencer, superintendent engineer, or by the neglect of either of these gentlemen, and if so, whether the Metropolitan Electric Supply Co. is responsible for such neglect.

We consider this to be a case of very considerable importance, as it shows beyond all doubt the necessity of using good feed water for boilers of this description especially, and we have formed the opinion that this type of boiler cannot be safely used unless great care is taken that the water should be as free as possible from solid matter. We are of opinion that the New River Co.'s water is quite unfit to be used in its natural state; and although boiler fluid was introduced into the boiler for the purpose of softening the scale which might form, and thereby preventing undue accumulation, this precaution was not sufficient, as the event has proved. The water, if better could not have been found, should have been treated by filtration and otherwise so as to free it of solid matter before it was introduced into the boiler. In one sense there was neglect on the part of Mr. Reginald R. Todd and Mr. William E. Spencer, probably greater on the part of the former as being the head, inasmuch as there was an act of omission on their part in not taking steps to purify the feed water before it was introduced into the boiler. We do not, however, think that there was such neglect as compels us to pronounce them to blame; or, in other words, we do not think that the explosion was caused by blameable negligence on their part.

In the first place, the system of feeding had been in use for many years before either of them became connected with the company; secondly, they had never found such an accumulation of scale in any of the boiler tubes as to induce them to believe that the water was unfit for feed; and, thirdly, we have not heard that any fault was found with the feed in any written reports of the insurance company.

We are glad to hear that the Electric Supply Co. are now taking steps to purify the water before it is introduced into the boilers, and we have no doubt that they will not in future use this water without that precaution. If they do so, and in consequence an explosion occurs, it will be a very serious matter for themselves and their advisers.

In answer, therefore, to the last question, we have to state that the explosion was not caused, in the sense we have indicated, by the neglect of Mr. Todd or of Mr. Spencer, and it follows, therefore, that no responsibility attaches to the Electric Supply Co.

HOWARD SMITH, J. H. HALLETT, Commissioners.

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In the case of the second explosion, which took place on January 8, 1901, the boiler was of similar construction, differing only slightly in dimensions. It was also made by Messrs. Babcock and Wilcox, and was 10 years old. Two tubes had been renewed in January, 1899, three in February, two in September, and one in October of the same year. Two tubes were also renewed in July, and one in September, 1900. Two other important repairs had recently been executed. The boiler had been periodically examined by inspectors in the employ of the National Boiler and General Insurance Co. The report continues:—

*Nature of the Explosion.*—The second tube from the bottom on the right-hand header burst open along its left side for a length of 3ft. 7½in. The front end of the rupture was about 18in. from the front end of the tube, and the aperture formed by the explosion was more than twice the diameter of the tube for a considerable portion of its length. Through the opening thus formed the contents of the boiler escaped, as well as a quantity of steam from 13 other boilers which were connected to it at the time. The rush of steam and water blew off both tube doors and displaced some of the brickwork of the boiler.

*Cause of the Explosion.*—The explosion was caused by the tube having become overheated, and thereby so reduced in strength as to be unable to resist the working pressure of 150lb. per square inch. This overheating resulted from an accumulation of sedimentary deposit in the tube, which impaired the circulation of water through it.

*Remarks.*—The boiler was constructed to resist a steam pressure of 150lb. per square inch, and on completion was tested by water pressure to 225lb. per square inch. While it was being made, Messrs. Babcock and Wilcox were engaged in the construction of six other boilers of the same type, the tubes for which were supplied by various makers, and in consequence we have been unable to ascertain by whom the tubes fitted in this boiler were made, but we have been assured by Mr. Kollé, the manager at the London office of Messrs. Babcock and Wilcox, that they received certificates from the different makers that all the tubes supplied had been tested to 1,000lb. per square inch.

The boiler was known at the Sardinia-street station as No. 7, and was insured with the National Boiler and General Insurance Co., the pressure as stipulated in the policy being that of 175lb. per square inch. The safety-valves were, however, loaded to 160lb. per square inch, and in general the working pressure did not exceed that of 150lb. per square inch. It was fed with water supplied by the New River Co., which contained a considerable amount of solid matter in solution. For the purpose of obtaining a proper boiler fluid to counteract the effect of this, the company has caused the water to be analysed. Analyses were made both on April 7 and 12, 1899.

That made on April 7th shows:—Calcium carbonate, 8·63; calcium sulphate, 4·40; magnesium carbonate, 4·99; silica, iron and aluminæ 0·51; sodium chloride, 3·37; organic matter, 3·71.

That made on April 12th shows:—Silica, 0·39; oxide of iron, 0·25; sulphate of lime, 3·40; carbonate of lime, 14·20; carbonate of magnesium, 0·88; nitrate of magnesium, 0·66; chloride of sodium, 3·28. Total matter in solution 23·06 grains per gallon.

We must refer to another analysis which was made at the Chemical Laboratory, Liverpool, on January, 29, 1901, which is as follows:—Carbonate of lime, 16·450; sulphate of lime, 1·485; sulphate of magnesia, 1·429; chloride of magnesium, 0·665; chloride of sodium, 1·474; carbonate of soda, 0.350; silica 0·630; aluminæ, 0·070; water of hydration, 0·980. Total matter in solution 23·533 grains per gallon.

The boiler was partially opened out every six or eight weeks when the feed pipes and drums were cleaned, and we have been told that from the amount of deposit found in the drums, an idea could be formed of the amount that existed in the heating tubes. The latter were thoroughly cleaned out once a year. The following are the recent dates of such cleaning:—1897—May 10th, cleaned throughout. December 8th, cleaned internal feed pipes. 1898—January 1st, cleaned two bottom rows of tubes, mud drums, steam drums, and internal feed pipes of back circulating tubes. March 22nd, cleaned soot chambers. April 21st, cleaned feed pipes and drums. June 16th, ditto. July 18th, completed cleaning when the boiler was inspected. September 8th, feed pipes and drums cleaned. October 4th, ditto. 1899—January 5th, cleaned feed pipes, drums and soot chambers; back cock and caps on circulating tubes changed. January 9th, two bottom rows of tubes cleaned. March 9th to 14th, shut down feed pipes, drums, mud drums, back circulating tubes and boxes cleaned; cleaned soot chambers. May 6th, new forced draught dampers and fire-bars fixed. July 26th, renewed steam valves. August 31st, renewed blown-down valves. September 8th, shut down for complete cleaning, cleaned all tubes except top row with machine, rebuilt furnace, fitted forced draught dampers. October 25th, cleaned feed pipes, drums, and soot chambers; new back cock. November 16th, cleaned feed pipes, drums, and soot chambers. December 13th, changed back cock, and cleaned soot chambers. 1900—January 17th, cleaned feed pipes, drums, and soot chambers. February 13th, ditto. February 18th, new back cock. March 24th, cleaned feed pipes, drums, and soot chambers, three circulating tubes, new dampers; repaired brickwork. April 5th, cleaned external feed pipes. May 23rd, cleaned feed pipes, drums, and soot chambers. July 3rd, shut down for complete clean by hand; overhauled all valves and cocks; repaired brickwork. Subsequently there were some other partial cleanings of a like nature.

It will be observed that the last thorough cleaning was made on July 3, 1900, and this operation was, as usual, performed under the direction of Lewis Evans, the leading hand in the boiler room, who told us that he found a good deal of soft deposit in the tubes, most of which was got rid of, but scale or fur to the amount of $\frac{1}{16}$in. was left adhering to most of the tubes.

On July 13, 1900, the boiler was thoroughly examined by Mr. William Bernard Blakeley, an inspector in the employment of the Insurance Company. Mr. Blakeley found that the cleaning had been done in a very satisfactory manner, and that the scale in the tubes generally was only $\frac{1}{32}$in., though in some places it was as much as $\frac{1}{16}$in., and that some parts

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of some tubes were altogether free from scale. He noticed a slight bulge in one of the tubes in the bottom row on the left-hand side, and some slight oxidation in one of the drums, to which he attached no importance.

As a result of his examination, a report, dated July 27, 1900, was sent by the Insurance Company to the Metropolitan Electric Supply Co. It is as follows :—

"No. 7 thoroughly examined when at rest. I have to inform you that, on the 13th inst., one of the company's inspectors examined your boiler as above described, and, as far as could be seen, found it and the fittings as follows : *In order.* We note that two of the water tubes have been renewed."

This and the other boilers have on occasions been worked with forced draught, especially when inferior coal was used, or when foggy weather caused a call for an abnormal supply of steam ; but recently, as the company have opened a new station, the use of forced draught has not often been required.

On January 8, 1901, this boiler, in connection with 13 others, was at work, but the forced draught was not on. Mr. Alfred Edward Faver, the engineer in charge of the watch on the afternoon of that day, told us that at 8:20 p.m. the pressure was 150lb. per square inch, as indicated by the steam-pressure gauge, and that the glass water gauge was three-parts full. At 8:45 Mr. Faver went into the upper engine-room, from whence he was signalled to return to the boiler-room. This he was unable at first to do, as it was full of steam ; but on entering on the subsidence of the steam in about a quarter of an hour, he found that No. 7 boiler had exploded.

The second tube from the bottom in the right-hand header had burst open along its left side for a length of 3ft. 7½in. The front end of the rupture was about 18in. from the front end of the tube, and the aperture formed by the explosion was more than twice the diameter of the tube for a considerable proportion of its length. Through the opening thus formed the contents of the boiler escaped, as well as a quantity of steam from the 13 other boilers. The rush of steam and water blew off both the doors and displaced some of the brickwork.

After the explosion, the boiler was examined by Mr. Hiller, chief engineer of the Insurance Company, by Mr. Blakeley, and also by Mr. Joseph Williams, engineer surveyor to the Board of Trade, as well as by the engineers of the Electric Supply Company.

FIG. 2.—Burst Tube of No. 7 Boiler. Side View.

Mr. Hiller told us that he went into the furnace, saw the tube which was ruptured, and found that it had ripped open longitudinally, the rupture commencing about 1ft. 3in. from the front header for a length of about 3ft. 6in., the edges of the rupture being clearly visible to him. They showed that the metal had not materially deteriorated, being only a little below ½in. generally in thickness, which, in his opinion, was ample. The rupture had proceeded along the weld, and a small portion of the lap of the weld was visible. The weld, however, was, in his opinion, sufficiently good for ordinary purposes, and the rupture indicated that under normal conditions no failure would have occurred. The tube itself was partially drawn out of the front header, and was bent sideways. Mr. Hiller then examined other tubes ; he found that the caps had been removed from a number of them at each end near the one which had exploded, and also from a number on the left-hand side of the lower row. On the water side these tubes were covered with a general incrustation about ⅛in. to $\frac{3}{16}$in. thick ; and at the back end on most of the tubes there were local heaps of deposit. In some of the tubes these heaps filled about half of the tube, in others about three-quarters, and in about one in each five or six wholly choked the tube, so that an electric light held at the back end could not be seen through. On examining these tubes at the back end, Mr. Hiller found that the deposit was rather thicker than in the case of the boiler which was known as No. 1, into the circumstances attending the explosion of which we recently held an investigation, and that the heaps close to the back end were clearly visible. These heaps suggested to Mr. Hiller, in the first place, that the tubes had been cleaned by pushing the deposit towards the back end instead of taking the back end caps off, but he was assured by Mr. Spencer and by the foreman that this was never their practice. The deposit seemed to consist mainly of carbonate of lime with a little sulphate of lime hardening it up in places. The heaps consisted of a mass of soft deposit covered over with a crust of smooth irregular form, and Mr. Hiller came without doubt to the conclusion that the explosion was caused by overheating.

Mr. Williams told us that the tube was cut through in two places to remove it from the boiler. Where it was cut at a distance of 12⅝in. from its front end a hard and firmly adhering scale a little more than $\frac{1}{16}$in. thick covered the inside surface of the tube, and a similar scale about $\frac{3}{16}$in. thick covered the internal surface where the cut was made 11in. beyond the back end of the fracture. Mr. Williams only observed slight indications of localised corrosion, but he found that the general corrosion of the surfaces had reduced the tube to a minimum thickness of 0·11 in. near the back end of the fracture.

The average thickness of the metal along the line of rupture was about ⅛in. At a distance of 12½in. from the front end of the fracture, there were indications of an imperfect weld which could be distinctly traced for a length of 1ft. 11⅝in. over which the thickness of the metal actually ruptured averaged barely $\frac{3}{32}$in. At one part, 1½in. in length, the defect in the weld appeared more pronounced than elsewhere, and in a portion of that part situated 8½in. from the back end of the rupture, a defect appeared to be traceable through the whole thickness of the metal, while external indications of local corrosion in the immediate vicinity indicated the probability of slight leakage having occurred at that point some time prior to the disruption of the tube, which leakage Mr. Williams thought might have escaped the detection of the Insurance Company's inspector when the boiler was examined under steam in October last. A large proportion of the internal surface exposed by the rupture exhibited to Mr. Williams a perfectly clean bluish coloured surface which, taken in conjunction with the general appearance of the tube and the condition of the boiler induced him to come to the conclusion that the explosion resulted from an accumulation of sedimentary deposit in the tube, which impaired the circulation of water through it, and caused it to become overheated and too weak to resist the steam pressure.

All the other witnesses have agreed as to the cause of the explosion, it being common ground, and to the same conclusions we have also arrived. We find that the explosion was caused by the tube having become overheated, and thereby so reduced in strength as to be unable to resist the working pressure of 150lb. per square inch, and that this overheating resulted from an accumulation of sedimentary deposit in the tube, which impaired the circulation of water through it.

In answer to the questions that have been asked us by the Board of Trade, we have to state that the tube which failed was originally somewhat defective at the weld, but such defect did not cause or contribute to the explosion, and we have no doubt that when originally made it successfully resisted a water pressure of 1,000lb. to the square inch.

Messrs. Babcock and Wilcox did furnish the Metropolitan Electric Supply Co. with instructions as to the management and cleaning of the boilers, and these instructions were observed by the engineers in charge of the boilers, but in our opinion the boilers were not cleaned sufficiently frequently.

The boiler was not cleaned at sufficiently frequent intervals considering the nature of the feed water, and was never properly examined at any time except by the inspectors of the Insurance Company. Those examinations, in our opinion, would have been made at proper intervals but for the fact that the boiler was not fed with proper water. No other examination was made because such as were suggested to have been made were made by Mr. Evans, who, in our opinion, is incompetent to make an examination, as his answers to our questions fully proved.

The boiler was partially examined in September, October and December last ; the examinations then made were not sufficient to determine whether the tubes required cleaning. The tubes themselves should have been thoroughly inspected, especially at the latter date, when, without doubt, it would have been found that they were very dangerously dirty.

The boiler has not been tested by hydraulic pressure at any time during the last two years for the purpose of ascertaining its condition, although it may have been tested for the purpose of seeing that repairs were tight.

Proper measures were not taken to ensure that the boiler was being worked under safe conditions, as proper attention was not paid to the feed water and to the cleaning.

**As in the preceding report, the Commissioners find that the explosion was not caused by the neglect of Mr. Todd or Mr. Spencer and that the company is not responsible.**

The report concludes as follows :—

We have been requested to favour the Board of Trade with our views as to the desirability of subjecting boilers of the water-tube type to hydraulic pressure. We assume that this question is asked with a view to obtain our opinion as to the desirability of the application of such a test as a means, although perhaps not the sole one, of examination. It is conceded that it is impossible to detect every blemish that may perchance exist in the inside of the tubes without withdrawing them. We gather from what we have learnt in these two recent investigations that the main risk of explosion in boilers of this type is from the existence of deposit in the tubes rendering them liable to become overheated, or from corrosion ; and we have already pointed out that in our judgment it is necessary, for the purpose of ensuring the safe working of such a boiler, that it should be fed with water from which such an accumulation of deposit could not be formed, and it follows, also, with water that would not produce corrosion. We have formed the opinion that the water test, which of course should always be applied after repairs to ascertain that the joints, &c., are tight, although a useful adjunct to other forms of examination, should always be used with great care, and, moreover, by competent persons, and should never be used higher than at twice the working pressure of the boiler lest in attempting to discover a defect the boiler might be overstrained and weakened. It seems to us that the same consideration with regard to the application of the water test to boilers generally applies to those of the water-tube type. The main danger to be apprehended in the tubes is that which arises from defective circulation owing to the presence of scale. This danger a water test would not reveal, and we fear that if such a test was recommended as an examination, there would be danger of neglect in opening and thoroughly cleaning the tubes. We, therefore, do not think it is desirable to subject boilers of this type to periodical tests by hydraulic pressure as a method of examination, although we certainly recommend that such a test should be applied to not less than one and a-half times the working pressure after the boiler has been opened out for cleaning and thorough examination.

HOWARD SMITH, J. H. HALLETT, Commissioners.

**The following memorandum is appended to the second report :—**

To the Assistant Secretary Board of Trade.

We desire, in order that our observations as to the desirability of the application of water test as a means of examination of boilers of this type

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may not be misunderstood, to add that, when a boiler has been carefully examined, and the elastic limit of the material has been ascertained by a properly qualified person, the application of the hydraulic test as an additional security may be safely left to his discretion; but we are of opinion that in no other circumstances should it be used, as in the hands of an unqualified person it might be a fruitful source of danger.

As before stated, we regard this test, when properly and judiciously applied, as a useful adjunct to examination, but we feel that to subject all boilers of this type to periodical hydraulic tests as a means of examination might lead to the adoption of such a test to the exclusion of other means which should, in our opinion, be taken to ensure the safe working conditions of these boilers.

The means which we recommend are as follows:—

The use of suitable feed water.

Frequent examination of the tubes until proper periods for thorough cleaning have been ascertained.

The cleaning of all the tubes at these periods, and their examination after such cleaning by a competent person.

Abstention from forcing the fires, so that the natural circulation of the water in the boilers may not be interfered with.

Withdrawal of some of the tubes, and cutting them for examination from time to time.

The substitution, as opportunity offers, of solid-drawn steel tubes for lap-welded iron tubes.

With regard to the intervals at which the tubes should be cleaned out, we desire to call attention to the fact that water in a boiler, when standing or under banked fires, is liable to deposit the same, or even a larger quantity of solid matter, than in a boiler at work under steam pressure.

## CORRESPONDENCE.

### EDISON'S ALKALINE STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Lucas was right in thinking that I had his criticisms on Edison's views regarding local action in my mind when writing on the subject, and I am afraid I must still differ from him both on the point of theory and that of fact.

Although, of course, the actual medium through which the electrolysis of a solution of caustic alkali takes place is the dissociated alkali itself, yet the ultimate result is the decomposition of water with the liberation of oxygen and hydrogen at their respective electrodes. In addition to this, there may be gaseous polarisation, the formation of peroxides, and perhaps other reactions not yet ascertained, taking place as well, but all these would tend to increase the E.M.F. required for electrolysis, and I find it impossible to conceive of any alternative reaction which would proceed with a smaller E.M.F. than that necessary to decompose water.

I have tried the "simple experiment" suggested by Mr. Lucas, using electrodes of iron in about a 20 per cent. solution of potassic hydrate, and as far as my experience goes it requires nearer 2·2 than 1·2 volts before it will electrolyse freely, and there is scarcely any action below 2 volts.—Yours, &c.,

E. J. WADE.

Streatham, August 31.

## LEGAL INTELLIGENCE.

### Trades Unions and Picketing.

In the Chancery of Lancashire, on Tuesday, Mr. F. W. Taylor, sitting as deputy vice-chancellor, heard an application by Mr. Grant, on behalf of Messrs. Banister Bros. and Moore (Ltd.), Blackburn, for an injunction against the officials and members of the Blackburn and District Weavers', Winders' and Warpers' Association, to restrain them from picketing near plaintiffs' mills, where a strike is proceeding.

Mr. MANSFIELD (for the defendants) said the writ raised an important question, and he asked for an adjournment for a week. The case would be fought step by step, if necessary, up to the House of Lords, in accordance with the decision of the Trades Union Congress then sitting at Swansea.

Mr. Mansfield having given an undertaking, the case was adjourned until Tuesday next.

### Liverpool Corporation v. M'Cullough.

In the Chancery of Lancaster, on Tuesday, an order was made for the continuance of an injunction obtained in August against Mr. M'Cullough, until recently assistant manager of the Liverpool electric tramways, restraining him from dealing with letters and reports relating to the working of the tramways. The motion stands over till Tuesday, the interim injunction being continued to that day.

### Registration of Debentures.

On Wednesday Mr. Justice Joyce, in the Vacation Court, made an order under sec. 15 of the Companies Act, 1900, extending the time for the registration of certain debentures of the Blackpool Electric Tramways (South), Ltd. The application was made on behalf of the secretary of the company, who pleaded inadvertence in the matter.

### Re Isle of Man Tramways and Electric Power Co. (Ltd.).

In the Manx Chancery Court, on Wednesday, the liquidator and receiver of the above company petitioned for the appointment of trustees for the debenture-holders in place of Messrs. F. G. Callow and John Shimmon, who desired to relinquish the trust. Shimmon is serving a term of imprisonment in connection with Dumbell's Bank frauds.

The Court appointed Messrs. W. F. Price and G. R. Cookson as new trustees.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

A clerk-in-charge is required for the telegraph department of the Government of the Gold Coast, to take entire management of the post office. The commencing salary is £200 per annum. Particulars of the requirements for the post, &c., will be found in an advertisement, and applications have to be sent in to the Crown Agents for the Colonies, Downing-street, London, S.W., by Sept. 16.

Edinburgh Corporation require a superintendent of mains. Applications to the resident electrical engineer (Mr. F. A. Newington), 5, Dewar-place, by 21st inst. See advertisement.

There are vacancies for a shift engineer and an improver at the Dundee electric lighting and traction station. Applications to the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, by Sept. 16. See advertisement.

The Isle of Wight Electric Light and Power Co. have vacancies for two pupils. Particulars from the engineer and manager (Mr. A. E. Mayes, A.M.I.E.E.), electricity works, Newport-road, Ventnor, I.W. See advertisement.

Stepney Borough Council require a shift engineer and a junior meter room assistant. Applications to the engineer and manager (Mr. Wm. C. P. Tapper), 27, Osborn-street, E. See advertisement.

An electrical engineer is required by the municipality of East London, Cape Colony. Applications to town clerk by noon of Oct. 10.

Nuneaton Council require a resident electrical engineer. Applications by 11th inst.

An assistant is required in the porcelain switch and holder department of the Edison and Swan Co. See advertisement.

The post of assistant lecturer and demonstrator in physics is vacant at the University College of North Wales, Bangor. Salary, £120. Applications by Oct. 12 to Mr. John E. Lloyd, M.A., secretary and registrar.

Mr. W. Wyld, electrical engineer to the Patent Shaft and Axletree Co., Wednesbury, has been appointed borough electrical engineer at Doncaster at £250, to be increased to £300 per annum at the end of 12 months. Mr. Wyld was formerly chief assistant engineer at Salford.

Mr. Arnold G. Livesay has been appointed assistant engineer to the tramways department of the Leeds Corporation, at a salary of £200 per annum.

Mr. A. C. Seaton has been appointed assistant engineer at the Worthing Electricity Works at £110 per annum.

Mr. W. J. Proctor, of Nuneaton, has been appointed electrical clerk of works at Horsham.

Mr. John E. Jagger, M.Sc., Wh.Sc., has been appointed lecturer in mechanical engineering at the Harris Institute, Preston.

**Aberdeen.**—Last week the Tramways committee considered an account from the electrical department for the services of the engineer (Mr. J. A. Bell), &c., amounting to £366, or 2½ per cent. upon capital outlay (including £10,264 for cars) in connection with the Bathing Station and Great Western-road tramway route. The convener (Councillor Wilkie) objected to the percentage, and particularly in connection with the purchase of cars, as he thought the purchase should be made by the tramway department. It was decided that 2 per cent. be charged for this year, as the tramway department contribute £50 to the salary of Mr. Bell. In future all work required for the maintenance of the tramway plant, including overhead equipment, is to be undertaken by the tramway department, and the electrical engineer is to be relieved of all responsibility in regard to it, but when new work is being done the engineer and his staff are to be available, if required, at a charge of 2½ per cent. on capital outlay.

The charge for current supplied for street lighting is in future to be 6d. per unit for the first hour and 2d. after, instead of 6d. and 3d. now charged.

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**Battersea Polytechnic.**—A prospectus of day and evening schools and classes for the session 1901-2 of the Battersea Polytechnic, Battersea Park-road, London, S.W., is now ready. Numerous classes are held in subjects of interest to our readers. The session opens on 23rd inst. The Polytechnic at Battersea has an excellent reputation amongst teaching establishments. The physics and electrical engineering departments are under the supervision of Mr. A. G. Cooke, M.A., A.I.E E, with a large staff of assistants. The electrical engineering department is provided with three separate laboratories, fully equipped for experimental work, electrical and magnetic measurements, workshop practice, &c. The electrical testing room and workshop have been entirely refitted and considerably extended. Six units of electrical plant, of from 4 H.P. to 8 H.P. capacity, are installed for experimental work, and the large plant used in lighting the building is available for teaching purposes. The prospectus can be obtained at the Polytechnic, price 1d., or will be sent post free for 3d. on application to Mr. J. Harwood, secretary.

**Belfast.**—The accounts of the electricity department for the year ended March 31 show the capital expenditure to be £173,889. 4s. 5d., an increase of £23,282. 1s. 8d. in the year. The total receipts were £14,898. 4s. 1d., expenses £7,133. 4s. 11d., leaving a gross profit of £7,764. 19s. 2d., which, with £2,655. 9s. 7d. from the previous year, left £10,420. 8s. 9d. to meet interest, sinking fund, &c. The balance of £3,131. 18s. 9d. is to be carried to next year's account. 908,067 units were sold, and the average price per unit was 3·758d., against 622,486 units and 4·359d. in the previous year. The total maximum supply demanded was 1,308kw. The equivalent number of 8 c.p. lamps connected was 79,000, compared with 51,500 in 1900.

**Birkenhead.**—The tracks of the Park-road South and the Dock tramway routes are to be doubled, at an estimated cost of £9,000.

**Blackpool.**—The relations between the borough electrical engineer (Mr. R. C. Quin) and the Electric Lighting committee were the subject of discussion at the Council meeting on Tuesday. The chairman of the committee (Ald. Grime) stated that Mr. Quin was enjoying a month's holiday, as his health had completely broken down. He wished to leave Blackpool, as he could command more money with less anxiety in other towns. Ald. Grime thought they were greatly indebted to Mr. Quin, who had put the electricity works on a basis which would bring in profitable returns in a few years. After his holiday Mr. Quin would be approached with a view to extending his stay in Blackpool until the works in hand were completed.

**Blyth.**—The Northern Counties Electricity Supply Co. have commenced cable laying and a supply of current is expected to be available early in October. One result has been a notification by the gas company of a reduction of 20 per cent. in the price of gas from Oct. 1.

**Bolton.**—The discussion of the minutes of the Electricity and Tramways committees occupied some time at the Council meeting on Wednesday. The chairman of the former committee (Dr. Panton) replying to questions as to a further loan of £125,000, said the money would not be spent recklessly. If the committee did not contribute large sums to the relief of rates, it was because they were putting large sums to repayment and depreciation accounts.

The question of the erection of centre poles in the Chorley New-road led to a lively debate, but eventually side poles were decided upon. The chairman of the Tramways committee (Mr. T. Smith) pointed out that objection had been taken to centre poles on the ground that if any accident occurred it would mean a complete stoppage of the tram traffic, because there would not be a second wire on which to work. The mayor said his mind had been largely influenced against centre poles by a letter from the general manager at Sheffield, who wrote strongly advising the committee not to erect centre poles. An unsuccessful attempt to postpone the Brownlow Fold district tramway extension was afterwards made. Mr. Smith asked the Council to support the committee in having the work prosecuted. They proposed to spend £6,000, and he anticipated a profit, as the district was populous. The tramways were making a bigger profit to-day than ever.

**Bradford.**—The Idle and Thackley tramway routes will be officially inspected on 10th inst. The Tramways committee have decided to order 100 additional cars, making the total 250.

**Cheltenham.**—The Corporation have entered into an arrangement to supply electric current in the neighbouring district of Prestbury. Arc lamps are to be substituted for incandescent lighting in Montpellier-street.

**Colchester.**—The period for repayment of loans for land and buildings in connection with the electric lighting undertaking has been extended from 25 to 40 years.

**Compulsory Certification.**—A resolution was passed at the Trades Union Congress at Swansea yesterday calling for the compulsory certification of all persons in charge of boilers and of all factories where machinery is used, or where steam or electricity is generated.

**Crieff.**—The Council obtained a provisional order this year, but no decision has yet been come to as to whether municipal electricity works will be established or a contract entered into with a company for erecting and maintaining works. The matter is under the consideration of a committee.

**Doncaster-Barnsley Tramway Scheme.**—Doncaster and Wath District Councils have conditionally approved the scheme for an electric tramway between Doncaster and Barnsley, for which Mr. J. N. Shoolbred is consulting engineer.

**Dunstable.**—The Council have given notice of their intention to apply for provisional order for Dunstable, Houghton Regis, Totternhoe, Kensworth and Caddington; but the Houghton Regis Parish Council have already intimated their opposition.

**Enfield.**—The General Purposes committee have been entrusted with the task of investigating and reporting upon the terms of the North Metropolitan Electrical Power Distribution Co.'s proposals for the supply of electric current in this district.

**Exhibition.**—There is to be an international exhibition at Cork from May to November, 1902, and prospectuses and forms of application for space are available from Mr. R. A. Atkins, hon. sec., Municipal-buildings, Cork. The exhibition is under distinguished patronage.

**Haslingden.**—The revocation of the Council's provisional electric lighting order has been deferred for 12 months.

**Inverness.**—A report on electric lighting has been prepared by Mr. Jas. Fraser, C.E., who recommends a water-power scheme. It is proposed to utilise the Caledonian Canal at a point immediately above Muirton Wharf, where there is a head of 40ft., and 600 H.P. can be obtained. The cost, exclusive of the electrical plant, is estimated at about £15,000. An electrical expert is to be consulted.

**Japan.**—Very large quantities of telephone cable have for some years past been imported into Japan, and at one time this was almost a monopoly in the hands of American makers. German makers have, however, now secured a considerable share, while, according to latest reports, British manufacturers have been unsuccessful in tendering for these supplies. It is only right to say, however, that contracts have for some time past been filled at a very low schedule of prices.

**Leeds.**—The Corporation propose to electrically equip the Armley and Wortley tramway routes. Lines are also to be constructed in West and Bishopgate streets.

**Leyton.**—A special meeting is to be called to consider a resolution to purchase the undertaking of the North Metropolitan Tramways Co. within the district.

**Light Railways.**—The Dartford Light Railway order has been submitted to the Board of Trade for confirmation. Objections by 27th inst.

Application has been made to the Board of Trade to authorise the transfer of the Sheerness and District Light Railway Order, 1901, to the County of Kent Electrical Power Distribution Co.

The Board of Trade have further considered the order of the Light Railway Commissioners authorising the construction of extensions of the light (electric) railway system of the Middlesex County Council including the line from Upper Holloway to Whetstone, and the opposition of the Finchley District Council has been over-ruled.

**Liverpool.**—The question of the cost of generating electric current supplied to the tramways department has caused much heated discussion in municipal circles here, and the local press has been inundated with letters on the subject. At the Corporation meeting on Wednesday, Councillor Utley moved, as an amendment to the adoption of the minutes of the Electric Power and Lighting committee :—

That the consideration of the recommendation of the committee, that £300,000 be placed at their disposal for purposes connected with the supply of electrical energy, be postponed until a statement showing the receipts and expenditure of the committee for the last six months has been submitted to the Council, together with a statement showing the amount of energy supplied from Lister Drive station for the last six months (1) for the tramway service, (2) for private and public lighting, and the cost of production for those purposes.

Mr. UTLEY contended that the accounts for the last year, upon the basis that energy for tramways costs 1·2d. per unit, and for lighting 3·2d. per unit, showed a loss of £5,964, although only £3,964 was placed to depreciation and reserve. The expenditure for 1901 was put at £201,715. Taking Mr. A. Bromley Holmes' figures of the estimated output at the charges of 1·2d. and 3·2d. there was a loss on production of £22,400, without carrying anything whatever to depreciation or reserve. He would give £50 to charity if Mr. Holmes could prove that the actual cost of generating current for lighting was 3·2d. per unit, and for tramways only 1·2d. per unit.

Mr. R. DART said that, presuming Mr. Utley was right, it would be absurd for the Council to refuse the Lighting committee the £300,000, because £200,000 had already been spent in building, &c. The charge for electric energy for the trams running to Bootle was fixed by the Local Government at 1¼d. per unit. The Tramways committee was charged 1·2d. per unit, so the whole thing was as close as possible. The Lighting committee would not knowingly charge the Tramways committee too little, but they were guided by their electrical engineer, who had the confidence of the whole of the Council.

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Ald. F. SMITH said Mr. Utley had taken the wrong figures as to the cost of electric energy. The correct figure was not 1·98d. for private lighting in 1897, but 3·764d.; in 1898 it was 3·267d., in 1899 2 603d., and in 1900 it was 2·161d., showing, notwithstanding the increase in the cost of coal, a steady diminution in the cost of generation. When the Corporation acquired the electricity undertaking consumers were paying 7d. per unit, now they paid 4d. That was a record they could feel proud of. Mr. Holmes, their electrical engineer, had built up a reputation, and had built up a splendid municipal undertaking.

Mr. BURKE inquired if it was not the fact that practically all the electrical energy from the Lister-drive station was for the tramways, and if so, what committee was charged with its cost and upkeep—the Tramways or the Electric Power committee?

Mr. TAYLOR said greater capital outlay was needed to produce electric energy for lighting than for traction, and besides, in the latter case, there was a steady load for 17 or 18 hours, against four or five hours for lighting. It was not possible to compare the cost of the two kinds of energy. Last year the Electric Lighting committee saved over £12,000 upon estimated expenditure—£126,990, against £139,293 estimated. Bootle Corporation was supplying electricity for the Liverpool trams in Bootle at 1·25d. per unit. As their own producers, he believed the Tramways committee could generate energy at less than 1·2d. Formerly that committee got its energy for 0·9d., but it had had to bear the whole of the increased cost of coal,

Mr. JAPP said at Pumpfields station the machinery was said to be equal to 13,500 H.P. He visited the station the other day and found four engines only working, producing 2,400 H.P. At Paradise-street, out of 14 engines only three were working, but at that and their other stations they had vastly more machinery than they could use. There was not among the lot a single surface-condensing nor one jet-condensing engine. They had very inferior engines, which in a few years would only be worth scrap. By way of comparison, he took the cost of generating current on the overhead railway, where they used surface-condensing engines. The difference between the cost of using these engines and the cost of using engines of equal power of the types installed at the corporation stations was great, and, multiplied by all the stations, came to a very large sum per annum.

Ald. PETRIE contended that the charge to the Tramways committee for electric current was a just and fair one.

Mr. HIGGINBOTTOM (chairman of the Lighting committee) said the two questions raised were: Was the committee to have this £300,000? and, Were they charging the Tramways committee too little for current? With the approval of the Council, the committee up to the end of 1900 had spent £148,000 of the amount voted, and only £72,000 remained. They had had a rather bad year in 1900, about £20,000 having had to be taken off the lighting profits for extra cost of coal and interest on unproductive capital. But this, notwithstanding, they closed the year with a profit of £3,700, after voting £2,000 in reduction of rates. The statements of the electrical engineer that the cost was 3·2d. and 1·2d. per unit for lighting and traction were, he believed, accurate.

The amendment was rejected by 57 votes to 20.

A recommendation of the Tramways committee that £319,000, borrowed for tramway purposes, should be placed at the disposal of the committee, was afterwards agreed to.

**Long Eaton.**—Tenders for the supply of electricity generating plant were accepted by the Council on Tuesday, and it was decided to apply for sanction to a loan of £15,000 to cover the cost of the plant.

**Manchester.**—At the Corporation meeting on Wednesday the chairman of the Electricity committee (Dr. Bishop), in moving the adoption of the minutes of the committee, said:—

Most interest centred in the paragraph relating to the acceptance of a tender for switchboards required at the Stuart-street station and the several substations in connection therewith. The letting of that contract had given rise to a great deal of discussion, and he wished to state the reasons why the committee did not see their way to place the contract with firms at home. Some persons thought that the tenders were not sufficiently advertised, but the advertisement appeared in some of the best papers in the country. It was also incorrect to assume that the committee invited any particular firm to tender for the work. They did nothing of the sort. Twenty-seven firms were supplied with specifications, but when they came in it was discovered that seven could not quote for any part of the work. Of the remaining 20 the lowest tender was that of the Electrical Company, of London and Berlin, amounting to £39,306, which the committee had accepted. The next lowest tender was that of the British Westinghouse Co., which amounted to £42,551. The difference was small, but had it been accepted the work would have been done in America. The third tender was that of Messrs. Siemens Bros. & Co. for £50,004, and in that case the work would have been done in Berlin. The lowest English tender was between £19,000 and £20,000 higher than the accepted tender. In only two of the tenders, if the committee had accepted them, would the work have been done in this country. He held, therefore, that it was impossible, under the circumstances, for the committee to have considered either of these two firms. It had been suggested that if the switchboards were made abroad there was no reason why the instruments could not be made in this country. As a matter of fact, the instruments were being made in this country, and a considerable proportion of the money would not go abroad. So far as possible, the committee endeavoured to get their work done in this country. Prof. Kennedy, who was their adviser, recommended that the tender of the Electrical Co. should be accepted, and in his letter to that effect expressed his regret that the lowest tender from any British manufacturer was very high in the list, and there was no justification for passing over the lowest tender, which was for work at least as good as those at higher prices. Since the tender had been placed a circumstance had come to his knowledge which was of some interest. He had seen a letter from a well-known electrical engineer—a member of one of the oldest firms in England, and he stated that the prices of his tender for the work required by the committee had been made out while he was away. On his return he had personally revised the prices, and was surprised to find that, had he himself been drawing up the tender, he could have done the work for £35,000! He followed that up by saying that he had determined upon a thorough reorganisation of his switchboard staff. The company that had obtained the order could point to very large stations in various parts of the Continent where switchboards erected by them were working satisfactorily.

Mr. JENNISON said he had been appointed by the committee to go to Berlin to inspect the work and see that it was being properly carried out. He asked that the chairman of the committee and their engineer should accompany him on so important a matter.

Mr. BROCKLEHURST considered the consulting engineer was the person responsible for the proper execution of the work, for which the contract had been let in Germany, and that to send Mr. Jennison was to relieve the consulting engineer of his responsibility.

The minutes of the committee were adopted.

Afterwards Dr. Bishop move that the charge for electric current be increased ½d. per unit to all consumers. He said:—

The committee had been placed in a peculiar financial position in recent years, and unless they adopted the resolution they would require financial assistance. In Manchester the charges for electric current had been reduced sooner than they should have been, and consequently there was to be faced in the next 12 months an estimated loss of £5,000. If they could stop there it would not matter, but their capital expenditure was at present so enormous that next year they would have to meet an increase of £20,000 in the sinking fund. They could not look to any increase in the number of consumers until the end of the year, and the £5,000 estimated loss would have to be taken out of reserve, which now amounted to only £13,000. Therefore in another year, when their payments to sinking fund would be much heavier, they could not again fall back on the only money they had with which to meet emergencies. The charge for current in Manchester had hitherto been the lowest in the country.

Mr. ROYLE disapproved of the committee's proposals. The advance in the charge for current for motive power would be 30 per cent. and on lighting 10 per cent., which seemed unjust after manufacturers had changed their motive power on the strength of the Corporation's promises. Other means of driving had been taken out to allow for the adoption of electric power, mainly on the natural anticipation that the charge for current would be likely to be reduced rather than increased.

Mr. BRADLEY considered it would be better for the committee to come to the Corporation for assistance than to jeopardise the prosperity of trade in the city by adding to the cost of production.

Dr. BISHOP, in reply, said the committee had been supplying current for power at prices below actual cost of generation. The Tramways committee were paying for current at the same rate at which it was supplied to private consumers.

The motion was then adopted.

**Municipal Telephony.**—The Manchester Corporation discussed on Wednesday a report from the joint sub-committee on telephones. The chairman (Ald. Southern) said the scheme which had been prepared by the Town Clerk of Salford was a reasonable one. The joint board would consist of 18 members, 10 representing Manchester, five Salford, and the urban district councils within the proposed telephone areas would have three. The report was adopted.

Ald. Cronk called the attention of the Tunbridge Wells Council on Wednesday to the unwisdom of the total disuse of the old National Telephone Co.'s system now that the municipal system was in use. He maintained that the police and the Town Hall, and the Fire Brigades should be in touch with the districts covered by the National system. He instanced recent fires in the locality, also a serious accident on the Sussex side of the town, when it was impossible to reach the police, who were now not on the company's system. Councillor Gain said the borough system, as soon as complete, would meet all the needs instanced by Ald. Cronk. Councillor Nicholson, chairman of the Telephone committee, defended the Corporation's policy, pointing out the advantages accruing to the town and district, and urging the need of all burgesses giving their hearty support to their own system.

On Wednesday the Leeds City Council discussed the proposal to appoint a committee to visit towns where municipal telephone exchanges are in operation, but the matter fell through owing to the voting resulting in a tie. The Lord Mayor declined to give a casting vote.

The Stockport Council have appointed a committee to report as to establishing a municipal telephone service, and an expert is to be engaged to advise.

Accrington Corporation have appointed a committee to collect information on the proposal to establish a municipal telephone service. An attempt will be made to obtain the co-operation of Blackburn and other neighbouring authorities.

**Nairn.**—Messrs. Crompton & Co. having notified their intention to apply for a provisional order, Bailie Mackenzie, of Edinburgh, is to be consulted on the question of the Council applying for an order.

**Nelson.**—Application has been made for sanction to a loan of £0,700 for the reconstruction and electrical equipment of the tramways in the borough. In future the charges for electric current will range from 4½d. per unit for 1,000 units consumed for lighting per annum to 3d. for over 10,000, the charge for power being 2½d. per unit.

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**Newburn.**—Messrs. James Patterson and W. D. Hunter, of the Newcastle and District Electric Lighting Co., attended the Council meeting on Wednesday to explain the company's proposals as to the the supply of electric current in the district. The company have already obtained the consent of the Ryton Council, and negotiations with Blaydon are proceeding. The Newburn Council's decision will be given in one month.

**Northampton Institute.**—In an advertisement elsewhere some particulars are given of the evening courses in mechanical and electrical engineering at this institute. The annual publication of the announcements for the session 1901-2 is ready, and can be obtained at the Institute, Clerkenwell, London, E.C., and the principal (Prof. R. Mullineux Walmsley) will forward any further information desired. In the prospectus full particulars are given of the classes, and some excellent illustrations show views of the electrical engineering laboratories (junior and senior), the engineering workshops, drawing and designing rooms, electro-deposition laboratory, &c. The electrical and physical branches of study have particular attention at this institute, and in the workshop instruction includes electric light, wiring and fitting, telegraph and telephone wiring, instrument making (elementary and advanced), and general electrical engineering, special attention being paid to telegraph instrument making for general and railway telegraph work. Both day and evening classes are available for students in electrical and mechanical engineering, Principal Walmsley being assisted by Dr. C. V. Drysdale.

**Newcastle-on-Tyne** —The Corporation have decided to promote a bill to construct tramways to Walker, Benwell and Gosforth.

**Obituary.**—We regret to record the death of Mr. E. J. Palmer, one of the African Direct Telegraph Co.'s oldest and most trustworthy operators, who died of small pox on the 30th ult. on one of the hospital ships in the Thames, whither he had been removed from London when he was attacked. He was buried in Darenth Cemetery on the 2nd inst. Mr. Palmer was a native of Accra (Gold Coast), and was visiting England for the first time. He leaves a widow and family.

**Presentation.**—Mr. Stephen E. Bastow, chief engineer of the Barnsley Corporation electricity works, was recently presented by the staff with a silver tea service on the occasion of his marriage to Miss Aline Edna Squire. Mr. E. A. Barker, chief assistant engineer, made the presentation.

**Rotherham.**—Although the electricity works have only been in operation about four months, the question of extensions is under consideration. The equivalent of 7,520 8 c.p. lamps is connected, and the capacity of the present plant is only 6,600 lamps, extensions are, therefore, urgent. The engineer (Mr. E. Cross) recommends the immediate purchase of an additional 250 I.H.P. steam dynamo at an estimated cost of £2,400 to meet the winter's demand, and the Electric Light committee endorsed Mr. Cross's recommendation. Application has been made for sanction to borrow £12,000 for the plant and additional mains and feeders. The Town Council approved the scheme on Wednesday.

**Royal Technical Institute, Salford.**—This institute re-opens on Sept. 11 for day classes and on Sept. 16 for evening classes. A short prospectus, just issued, gives particulars of the courses of study. Special courses of lectures are to be given in dynamo design, electric traction and motive power, electric distribution and central stations, engineering estimates and specifications, machinery design, &c.

**St. Helens.**—The South Lancashire Electric Traction and Power Co., who are constructing a system of electric tramways in South Lancashire, have asked the Council to sanction the connection of their system with the municipal lines at the Newton-road and Haydock boundaries.

**St. Pancras (London).**—The Borough Council has resolved to promote a bill to obtain compulsory powers to acquire sites for generating stations. Powers are to be sought to acquire four sites—two for extensions of existing generating stations and two for new stations.

**Singapore.**—We referred last week (p. 729) to the voting of £15,000 by the Municipal Commissioners for electricity supply. It would appear from later information from our correspondent, that the Municipal Commissioners have purchased the gas company's undertaking complete, and will continue to light the streets by gas. Having regard, however, to the demand for electricity supply the Commissioners have voted the £15,000 referred to, to be devoted chiefly to the installation of plant for private lighting. As previously stated, Messrs. Burstall and Monkhouse have been asked to prepare a scheme within this sum.

**South Shields.**—A proposal to construct a tube railway under the Tyne, between North and South Shields, is under the consideration of a committee of the South Shields Corporation. Mr. C. H. Gadsby is engineer to the promoting syndicate.

**Spennymoor.**—The erection of the electricity station buildings has been commenced by the Northern Counties Electricity Supply Co.

**Stalybridge.**—The Town Council on Tuesday elected the six representatives of the Council on the Stalybridge, Mossley, Hyde and Dukinfield joint electricity board. The election was, we regret to record, fought on political lines. The six elected members were Aldermen Simpson (the mayor), Fentem, Ridyard and Norman, and Messrs. Thompson and Wood.

**Sunderland.**—All the technical arrangements for the Sunderland District and Houghton-le-Spring Tramways Co. have been completed, and the local authorities will apply for powers to extend the line through the Washington district. Messrs. Dick, Kerr & Co. have obtained the contract for the first part of the work. The consulting engineers are Messrs. Handcock and Dykes, in collaboration with Messrs. D. Balfour & Son.

A controversy has arisen between the Electric Lighting and Finance committees in regard to the disposal of the profit on the electricity undertaking for the present half year. This profit was, it appears, sufficient to justify a reduction of 1d. in the pound on the rates, but the Electric Lighting committee decline to hand over the amount to the town's exchequer as they consider it should be placed to reserve. The Finance committee refuse to recommend a rate until the money is paid, contending that, as capital was advanced out of the town funds to establish the lighting scheme, all profits should be immediately returned to the relief of the rates, and that no committee in charge of a municipal undertaking has power to put surplus profits to a reserve fund.

**Telephonic Communication in Ireland.**—At the meeting of the Associated Chambers of Commerce at Nottingham this week, a resolution was proposed by Mr. F. J. Usher (Dublin), and carried, calling attention of the Postmaster-General to the unsatisfactory state of the trunk telephone system of Ireland, and to the fact that many important mercantile towns in the country are without telephonic communication at all. Mr. Usher complained that since the trunk telephone system had been taken over by the Post Office it had been eminently unsatisfactory, and had proved a serious hindrance to the commerce of Ireland.

**Telephone Communication in Victoria.**—A deputation recently waited upon the Victorian Postmaster-General to urge the establishment of direct telephonic communication between Melbourne and Geelong and Ballarat, distances of about 60 and 120 miles respectively.

**Telephone Trunk Line Extension.**—Andover is now connected with the telephone trunk line system of the country.

**Trade Union Congress.**—Usually the proceedings at the annual Trade Union Congress have only an indirect interest for our readers, but the recent decisions of the House of Lords in the important cases of "The Taff Vale Railway Co. *v.* the Amalgamated Society of Railway Servants and others" and "Quinn *v.* Leatham and others" give to this year's gathering a more general interest. It will be remembered that the effect of the judgment in the first-named case established the fact that a trade union can be sued in its corporate capacity for tort, and that its funds may be attached. It was reported to the meeting of the Congress at Swansea on Monday that the Taff Vale Railway Co. was proceeding with its action against the Amalgamated Society and Messrs. Bell and Holmes. The company allege that Mr. Bell, as an officer of the union, induced men to break their contracts with the company by picketing at Cardiff, and it is stated that they claim £20,000 damages, the amount at which the company estimates the cost entailed upon them by last year's strike. A somewhat similar action has been commenced (as reported under "Legal Intelligence" in this issue) by a Lancashire firm, at whose mills a strike has been proceeding for the past 11 weeks. This latter action is, we understand, being brought at the instance of the North-East Lancashire Employers' Association, and damages and costs are asked for. It will thus be seen that employers are taking advantage of the weapon of defence put into their hands by the decision of the Law Lords in the cases referred to. On the other hand, trade unionists throughout the country have become alarmed at the prospect of losing their funds owing to the action (frequently unauthorised) of their officials. A report on the subject presented to the Congress by the Parliamentary committee contains the following comments upon the House of Lords decisions :—

> During the last 20 years or more large sums of money have been spent, and the deepest interest taken by trade unions with the object of keeping intact and safeguarding trade union funds; especially has this been the case in connection with some of the larger trades, because it is contended by all trade unions leaders that the real object and intention of the Trade Union Act was to give the fullest protection to these funds. This view was held by many able lawyers, and it naturally came as a great surprise when the decision of the Law Lords was announced to the world, upsetting, as it did, all previous and well-thought-out decisions given in the Law Courts upon this technical, yet important, point of law.

Owing to the gravity of the situation, counsel's opinion was obtained, and the report states that the committee are now advised that "it will be exceedingly difficult to conduct a strike with any degree of success without doing illegal acts," and counsel recommended that the first case where an injunction is sought to restrain persons from picketing should be fought up to the House of Lords, so as to prevent the possibility of anything happening similar to that in "Lyons *v.* Wilkins," where it will be recollected an injunction was granted to restrain picketing. Counsel also advised that the unions should amend their rules so as to prevent, as far as possible, actions being

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taken against the unions in their collective capacity. The recent case of "Quinn *v.* Leatham" does not appear to have been directly referred to in the report, but the decision in that action of course greatly modifies the authority of "Allen *v.* Flood," and confines the action of unionists in regard to strikes to more reasonable limits. In the words of a distinguished jurist "Quinn *v.* Leatham" means that "a combination to coerce a man in his lawful business by persuading others not to deal with him, although no contract is to be broken and no indictable offence committed, and though it is not actionable if done by one person, becomes civilly actionable, though not criminally punishable, when it is done by agreement amongst several." In an *obiter dictum* the present Master of the Rolls gave it as his opinion that picketing could be abated as a nuisance in common law. Should this prove to be so, it is difficult to understand how any strike can be effectively carried out. At all events, the decisions of the House of Lords seem likely to bear good fruit and to render necessary the exercise of some discretion on the part of trade union leaders before embarking their members upon contests with employers which may jeopardise the union funds.

On Tuesday the Congress resolved that in view of the decision in the Taff Vale case the Parliamentary committee be empowered to take a test case to the House of Lords to ascertain how far picketing may be carried on without infringing the law and rendering the funds of the unions liable for damages; that a fund should be established for that purpose; and further, that each society should so amend its rules that, as far as possible, protection may be obtained against some of the consequences of the decision in the Taff Vale case.

**Tunbridge Wells.**—The Council on Wednesday resolved not to allow the borough electrical engineer (Mr. Horace L. Boot) to act as consulting engineer for other local authorities while in the employ of the Council. Mr. Boot had been engaged to prepare a report on electric lighting at Camberwell, and a request for permission has resulted in the above resolution being passed by 16 votes to two.

**Warrington.**—The consulting engineers (Messrs. Preece and Cardew) have been authorised to prepare estimates for the construction of three additional electric tramway routes, and parliamentary powers are to be applied for to construct further extensions of the tramway system.

**West Bromwich.**—The charges for electric current here have been revised as follows:—4½d. per unit for one hour's use per day per quarter; 3d. for two hours, 2½d. for three hours, 2¼d. for four hours, and 2d. for five hours. This is equivalent to 4½d. for the first 91 hours' use per quarter, and 1½d. per unit after. The charge for power was previously 3d. per unit for the first hour and 1d. after, but it is now recommended that a uniform rate of 1d. per unit be charged.

**Worthing.**—Extensions of the electric lighting mains estimated to cost £1,691 have been authorised by the Council.

**Dinner.**—On Saturday, to celebrate the opening of the Glasgow Corporation telephone system, the Glasgow staff of the British Insulated Wire Co. spent a pleasant day at Ayr, the proceedings including an excellent dinner and a visit to the Ayr Corporation electricity station. The party, numbering about 50, were shown over the station by Mr. A. J. Fuller, the borough electrical engineer. Mr. J. Venn presided at the dinner.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Poplar* (London) Electricity committee require multiple core lead-covered feeder and network cables and accessories for mains extensions. Specifications, &c., from the borough electrical engineer (Mr. Alfred Blackman), Electricity Works, Glaucus-street, Bromley-by-Bow, E., and tenders to the town clerk (Mr. Leonard Potts), Council Offices, High-street, Poplar, E., by 10 a.m., Sept. 18. An advertisement contains further particulars.

*Oldham* Corporation Electricity committee invite tenders for two electric overhead travelling cranes. Specifications, &c., can be had from Mr. Arthur Andrew, Gas and Water Offices, and specifications, &c., can be seen at, but not obtained from, the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W. Tenders to Mr. Andrew by Sept. 10. An advertisement gives additional particulars.

*Willesden* Guardians invite tenders for economisers, dry-back marine boilers, piping, pumps, heaters, &c.; steam dynamos, boosters, accumulators, switchboards, &c.; wiring for about 1,000 lights on the conduit system; cranes, motors, electric fans, &c. The work is to be carried out to the specification of Mr. Morgan Williams, M.I.C.E., and applications must be made to the clerk (Mr. J. Hutton Haylor), 329, High-road, Kilburn, N.W. See advertisement.

*Hull* Electric Lighting committee require two high-speed three-crank compound steam engines of 800 I.H.P. each, and four steel Lancashire boilers. An advertisement contains additional particulars. Forms of tender, &c., from the city treasurer, Mr. T. G. Milner. Tenders to chairman, Town Hall, Hull, by noon Sept. 26. Further information can be obtained from the city electrical engineer (Mr. A. S. Barnard), Sculcoates-lane, Hull.

*Kirkcaldy* Corporation invite tenders for the supply and erection of arc lamp posts, wall brackets and switchboxes. An advertisement contains further particulars. Specifications and drawings from town clerk (Mr. Wm. L. Macindoe), and can also be seen at, but not obtained from, the office of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to Mr. Macindoe by Sept. 16.

*Kirkcaldy* Corporation also invite tenders for overhead construction for electric tramways. Tenders to Mr. Macindoe by 10 a.m. Sept. 13.

*Salford* Health committee invite tenders for a 55kw. steam dynamo at the Ladywell Sanatorium. An advertisement contains further particulars. Specifications from the borough electrical engineer (Mr. C. D. Taite), Strawberry-road electricity works. Tenders to town clerk (Mr. L. C. Evans) by Sept. 14.

*Whitehaven* Water and Lighting committee invite tenders for six months' supply of incandescent lamps. Further particulars from the borough electrical engineer (Mr. P. J. Watts), Electricity Works, Whitehaven. Tenders by Sept. 16. See advertisement.

*Sheffield* Corporation invite tenders for boilers, economisers, motors, fans, iron chimneys, brickwork or iron flues, &c. Tenders to the general manager and engineer (Mr. S. E. Fedden), Commercial-street, Sheffield, by 30th inst. See advertisement

*Maidenhead* Corporation invite tenders for the supply and erection of three 60kw. steam dynamos, two Lancashire boilers with fittings, economiser with dampers, &c. Specifications of the consulting engineers (Messrs. Burstall and Monkhouse), 14, Old Queen-street, Westminster, S.W. Further particulars are given in an advertisement, and tenders must be delivered to the town clerk (Mr. John Kick), Guildhall, Maidenhead, by noon 23rd inst.

*Salford* Corporation invite tenders for the lighting of the new Strawberry-road generating station. Specifications, &c., can be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and can be obtained at 78, King-street, Manchester. Tenders to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by noon 20th inst. See advertisement.

*Hammersmith* (London) Borough Council invite tenders for the supply and erection of pipework and tanks in connection with condensing plant at their electric light station. Specifications, &c., from the consulting engineers (Messrs. Preece and Cardew), 13, Queen Anne's Gate, S.W., and tenders to the town clerk (Mr. H. Thompson), Town Hall, Hammersmith, before 5 p.m. 13th inst. See advertisement.

*Newport* (Mon.) Corporation invite tenders for the supply and erection of winches for outside coal handling, cables, overhead construction, complete electric motor car and repair shop equipment. An advertisement contains further particulars. Specifications, &c., of the consulting engineer (Mr. H. F. Parshall), 8, Prince's-street, Bank, London, E.C. Tenders to the town clerk (Mr. Albert A. Newman) by 5 p.m. Oct. 21.

*Ashton-under-Lyne* Corporation invite tenders for a surface condenser of about 1,000 sq. ft., with pumps. An advertisement contains further particulars. Tenders to Mr. John Neal, Town Hall, Ashton-under-Lyne, by noon Sept. 18.

*Reading* Corporation invite tenders for the construction of new tramways and the reconstruction of existing tramways, including the electrical bonding of the rails, provision and laying of conduits and drawing-in boxes for the underground work, &c. Specifications, &c., may be obtained and the drawings inspected on application to the borough engineer and surveyor (Mr. John Bowen), Town Hall, Reading. Tenders (addressed Chairman Tramways Committee) by noon of 28th inst. An advertisement gives further particulars.

*Blackpool* Corporation invite tenders for 30 arc lamps, switches, &c., suitable for rectified current. Specifications may be obtained from the borough electrical and tramway engineer (Mr. R. C. Quin). See advertisement.

*Blackpool* Corporation also require tenders for 40 arc lamp canopies. Particulars from the electrical engineer.

*Blackpool* Cleansing committee invite tenders for the erection of six additional cells to the refuse destructor, new boiler, &c. Tenders by 28th inst.

*Blackpool* Tramways committee require tenders for 550 tons of rolled steel girder rails, 27 tons of fish plates, 10 tons of bolts, nuts and washers, 21 tons of crucible cast steel points and crossings, &c. Tenders by 21st inst.

*Bournemouth* Town Council invite tenders for steel-grooved girder rails, &c., conduit, permanent way construction and rail bonding, ploughs and carrying attachments to cars, and wood-block, tar, macadam and granite sett paving. Tenders to town clerk by noon Sept. 17.

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*Ross Electric Light and Power Co.* invite tenders for generating plant. Tenders to secretary, Bank Offices, Ross, by noon Oct. 21.

*London County Council* require tenders for electric lifts, pumps fans, &c., for the electrical equipment of the Greenwich footway tunnel and its approaches. Tenders by Oct. 8.

*London County Council* also invite tenders for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

*Dundee* Town Council invite tenders for the overhead equipment of the Constitution-road and Victoria-road and Ferrymuir tramway routes. Tenders to town clerk by Sept. 14.

*Manchester* Tramways Committee invite tenders for trolley wire, line materials, span wire, brackets, &c. Tenders to chairman by 1 p.m., Sept. 14.

*East Ham* District Council invite tenders for construction of permanent way of tramway extensions. Tenders to chairman of Works committee by noon 17th inst.

*Glasgow* Corporation invite tenders for the supply and laying of cables. Tenders to town clerk by 5 p.m. Sept. 25.

*Batley* Corporation require tramway rails, points, crossings, bonds, &c. Tenders by Sept. 14.

Tenders are invited until Oct. 1 by the *French* Post and Telegraph authorities for the supply of a multiple telephone switchboard for the telephone exchange at Lille. Tenders to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

## TENDERS RECEIVED AND ACCEPTED.

Eastbourne Corporation have received the following tenders for plant for their electricity works :—

*Steam Piping, Economiser, Heater.*

| | |
|---|---|
| Babcock and Wilson (Green economiser) (*accepted*) | £1,920 |
| John Spencer & Co. (Green economiser) | 2,874 |
| Mechan & Son (Lowcock economiser) | 2,395 |
| Sir Hiram Maxim Co. (Green economiser) | 2,333 |
| James Carter & Sons (Pimbley economiser) | 1,953 |

*Water Storage Tank.*

| | |
|---|---|
| Mechan & Son (*accepted*) | £265 |
| Sir Hiram Maxim Co. | 369 |
| Babcock and Wilcox | 364 |

*Crane.*

| | |
|---|---|
| John Hitchin (*accepted*) | £295 |
| Jessop and and Appleby Bros. | 587 |
| Thomas Smith | 515 |
| Carrick and Ritchie | 486 |
| Thomas Broadbent & Co. | 463 |
| James Spencer | 395 |
| J. Carrick & Sons | 382 |

For *Incandescent Lamps* 28 tenders were received, varying from 6d. to 1s. 3d. for each 16 c.p. lamp, and the tender of the General Electric Co. for Robertson lamps at schedule rates was accepted.

Eight tenders were received for *Meters*, and that of Messrs. Geipel and Lange was accepted for Vulcan meters at schedule rates.

Burnley Corporation have accepted the tender of Messrs. Körting Bros. for five injectors and that of Messrs. G. and J. Weir (Ltd.) for the feed pump for the electricity works.

St. Anne's-on-the-Sea District Council have accepted the tender of Messrs. Dick, Kerr & Co. for steam dynamos with Willans engines.

Warrington Corporation have accepted the tender of Messrs. R. W. Blackwell & Co. for the overhead equipment of the Wilderspool electric tramway route.

The tender of Messrs. A. Krauss & Son has been accepted by the South Lancashire Electric Traction and Power Co. for the construction of the permanent way of about 30 miles of tramway.

Dartford District Council have accepted the following tenders :—two-wire meters, Venner & Co. ; three-wire meters, British Thomson-Houston Co. ; cutouts, Keighley Electrical Engineering Co.

## BUSINESS NOTICES.

We are asked to announce that the agreement between Mr. Frederick Bathurst and the Conduit and Insulation Co. (Ltd.) has expired, and that Mr. Bathurst has now no connection with the company.

Mr. Fred Bathurst informs us that he has recently returned from the States, and is at present attending the Glasgow Congress. His private address is 6, Loudoun-road, St. John's Wood, London, N.W.

Messrs. A. Pollock and G. Bellgowan, trading as the Pollock Electric Alarm Co., Middlesbrough, and as the National Electric Alarm Clock Co., Hull, have dissolved partnership. Mr. Pollock will continue under the style of the Pollock Electric Alarm Co. and Mr. Bellgowan as the National Electric Alarm Clock Co.

The Pulsometer Engineering Co., the well-known makers of pumping, ice making, and refrigerating machinery, have removed their works and offices from Nine Elms, London, S.W., to the Nine Elms Ironworks, Reading, Berks. New works have been built, the company having acquired some 12 acres of land.

## BANKRUPTCY.

Claims against Herbert Sewell, electrician, &c., Clifton-place, and 63, Birklands-road, Shipley, must be in by 14th inst. to Mr. J. A. Binns, 31, Manor-row, Bradford.

**Sale by Auction.**—Messrs. Fuller, Horsey, Sons & Cassell, 11, Billiter square, London, E.C., will offer for sale by auction, in one lot, at the Mart, Tokenhouse-yard, London, E.C., on Wednesday, Sept. 11, at 12 noon, the works, patents and assets of the Berrenberg Electric Lamp Syndicate (Ltd.). The sale will include the large factory premises at Wandsworth. Some further particulars are given in an advertisement.

**B.T.H Plant.**—Pamphlet No. 108, issued by the British Thomson-Houston Co., illustrates and describes small current direct motors.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Aug. 28 to Sept. 3, with the ports of destination :—

*Aden*—£50 (telegraph material). *Africa*—Cape Town, £214 ; Durban, £88 ; East London, £46 ; Port Elizabeth, £153 (including £75 telegraph material). *Australasia*—Fremantle, £6,240 (including £6,114 telegraph material) ; Hobart, £14 ; Melbourne, £107 ; Perth, £273,084 (including £272,924 telegraph material) ; Sydney, £1,036. *Belgium*—Ghent, £159 (telegraph cable). *British Guiana*—Demerara, £529 (telegraph material). *Burma*—Rangoon £335. *Ceylon*—Colombo, £22. *Channel Islands*—£257 (including £207 telegraph material). *Denmark*—Copenhagen, £48 (telegraph wire). *Germany*—Hamburg, £247. *Holland*—Amsterdam, £50 (including £30 telegraph material). *Hong Kong*, £39. *India*—Calcutta, £289. *Malta*—£126 (including £100 telegraph material). *North Sea*, £13,000 (telegraph cable). *Norway*—Christiania, £110 (submarine cable). *Santa Cruz*, £27. *Straits Settlements*—Penang, £18. *Sweden*—Gothenburg, £933. Total £298,013, against £27,935 in the corresponding week last year (Aug. 29 to Sept. 4).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. Mewburn, Ellis and Pryor *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

May 15, 1901.

10,062. A. Eckstein and F. Panter. Manchester. Improvements in moving coil electrical measuring instruments.

10,063. M. F. T. Deane. Dublin. An appliance preventing trolley wheel from leaving overhead wire in electric traction.

10,080. H. R. B. Hickman. London. Improvements in or connected with apparatus for wireless telegraphy.

10,088. J. Timar. London. Improved apparatus for treating affected parts of the body with heat, light or electricity in certain cases simultaneously.*

10,102. Evered & Co. (Ltd.) and C. Holt. London. Improvements in electrical switches.

10,120. A. Muirhead. London. Improvements in electric telegraphy.

May 16, 1901.

10,130. T. J. Kendrew. Liverpool. Improvements in life guards for electric tramcars or similar vehicles.

10,166. A. J. Boult. London. Improvements in printing telegraph receivers. (The Joy Printing Telegraph Co., United States.)*

10,188. C. M. Jacobs. London. Improvements in electric indicators for use in sectional telephone circuits.

10,191. A. d'Arsonval and G. Vaugeois. London. Improvements in and in apparatus for the manufacture of the plates of electric accumulators. (Date applied for under Patents, &c., Act, 1883, sec. 103, Dec. 27, 1900, being date of application in France.)

10,202. A. Rutherford, Jun. Liverpool. Improvements in safety devices for electric tramcars and other motor-driven vehicles.

10,206. B. Cruvellier. London. Improvements in electric railway systems.*

10,215. J. H. Golding and C. A. James. London. Improvements in and connected with casings or coverings for electric conductors in buildings.

May 17, 1901.

10,228. C. C. Metcalfe. Cheshire. A new or improved combined system of electric lighting and fire alarms and appliances connected therewith. (H. C. Blackwell, Russia.)

10,238. J. W. Littler and R. W. Creary. Cheshire. (The Littler and Creary) Safety device for overhead electric wires.

10,249. C. A. Hamilton. Coventry. Improvements in or relating to electrical ignition apparatus for internal combustion motors.

10,275. The British Thomson-Houston Co. (Ltd.). London. Improvements in controlling electric motors. (M. W. Day, United States.)*

10,294. W. Sumner. Liverpool. Improvements in switches for use with lamp-posts for street lighting and the like.

10,295. C. Schwabe. Liverpool. Improvements in electrically-operated desk fans.

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## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

5,585. ARNO. Measurement of electric power and energy in three-phase alternating-current systems. (Date applied for under International Convention, Aug. 26, 1899.)
11,264. HIRST. Switchboards for electric distribution.
11,340. FISCHER. Electric clocks.
11,358. WOLLASTON and SHERRIN. Secondary batteries.
11,519. NICHOLSON. Frogs to be used in connection with overhead conductors of electrical tramways and railways.
11,787. HICKLEY. Electrical starting and regulating switches.
11,835. HILL. Electro-pneumatic controlling apparatus. (Date applied for under International Convention, Jan. 13, 1900.)
11,840. SHERRIN. Electric switches, commutators, current conductor contacts, contact-breakers and other electric devices for preventing sparking.
12,160. THOMAS. Manufacture of filaments for electric incandescence lamps.
12,977. FRANCKEN. Electric battery.
13,020. VAN HAANEN. Apparatus for generating dynamical electricity by means of the direct influence of steam.
13,106. HOLLINS. Safety devices for electric interlocking or block signalling apparatus.
13,482. BEDE. Collectors, conductors and conduits for electric traction.
13,656. JAMES (Heilmann). Electrodes of accumulators and the manufacture thereof.
14,906. MILNES. Sectional conductor street or road electric railways.
15,473. BOULT (Andreas). Process for the forming of electrodes.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27d. per oz. (Sept. 5). Consols (2¾ per cent.) 93 1/16—93 3/16 for money, 93¼—93⅞ for account; 2½ per cent. 94½—95 (Sept. 5). Consols Pay Day, Oct. 2; Stocks and Shares Continuation Days, Sept. 10 and 25; Ticket Days, Sept. 11 and 26; Pay Days, Sept. 12 and 27; Mining Share Carry-over Days, Sept. 9 and 24.

**COMMERCIAL CABLE CO.**—A quarterly dividend of 1¾ per cent. on the capital stock has been declared payable Oct. 1 out of the net earnings of this company. The transfer books will be closed from 20th inst. to Oct. 1 inclusive.

**ELECTRICAL CO. (LTD.)**—The balance-sheet for the year to June 30, 1901, was approved at the recent annual general meeting; a dividend of 15 per cent. was declared and a substantial amount added to reserve, &c. The largely-increased business, the establishment of additional branches, and the many important contracts in hand (including the complete equipment of Stuart-street station for the Manchester Corporation) have rendered it necessary to increase the capital to £100,000.

**HOVE ELECTRIC LIGHTING CO. (LTD.)**—An interim dividend at the rate of 7 per cent. per annum has been declared, payable Oct. 15.

**MATHER AND PLATT (LTD.)**—At the meeting last week the chairman (Mr. W. Mather, M.P.) moved the adoption of the report given in our issue of 23rd ult., and said that it would be observed that the assets, after deducting amounts due to trade creditors, and without reckoning fixed assets in the shape of plant and buildings, were nearly sufficient to pay off the whole of the preference shareholders' capital, were that desirable. The modest dividend of 7 per cent. per annum on the ordinary shares was recommended because the directors felt that it was better to save largely rather than to spend too freely out of earnings. The directors, notwithstanding they themselves would be the chief recipients of larger dividends, proposed to maintain the 7 per cent. this year as heretofore. That was important, as they were living in times of great development in engineering science. Rapid changes were taking place in all branches of the profession in methods of construction, and increasing competition among nations required that all engaged in large, well-established undertakings should prepare for the future. Therefore, they thought it desirable to husband their resources in order to increase the facilities of their business and to maintain a strong position in the industrial world. With that object they had begun to build new works, on a spacious site within the city of Manchester, admirably adapted for the purposes of developing any branch of their business. There was feverish anxiety on the part of foreign manufacturers who had at last attained to the position that England had long occupied in the industrial world, to add rather to their own business enterprises by getting a share of whatever work might be given out in England. It was a curious fact that in a contract that came within his own knowledge for work to be done for one of the English corporations there were 140 tenders from all parts of the world, and local authorities, with few exceptions, very gladly received offers from America and Germany and elsewhere if there should be the slightest advantage in price. Therefore, English manufacturers had no advantage, except in so far as their intelligence might be superior to that of their competitors, and their facilities for carrying out work such as would enable them to accomplish what they had to do with not less economy than that which others showed. The present position of England was trying from many points of view, industrial and commercial, but with strong heads and sound hearts he did not see why all those engaged in the staple industries of Great Britain should not feel they had a wider field open for their enterprise and for their legitimate profits in the future than they had had in the past. The report and accounts were adopted.

**PERSONAL.**—Mr. W. M. Brigg and Mr. J. B. Atherton have resigned their positions as directors of the British Insulated Wire Co. (Ltd.). Mr. Atherton, at the unanimous request of the board, has agreed to remain general manager of the company.

**SOUTH LONDON TRAMWAY CO.**—The half-yearly report of this horse-driven line of London tramways shows that, notwithstanding an additional 8,187 miles run, there was a decrease in the number of passengers carried of 384,113, and on the gross receipts of £1,342. Cost of working has increased by £2,501. The London County Council are in negotiation for the purchase of a portion of this company's system, which, if concluded, will involve the conversion of this portion of the line to electric traction.

**STOCK EXCHANGE NOTICE.**—Application has been made to the Stock Exchange committee to appoint a special settling day in, and to grant a quotation to, £200,000 5 per cent. mortgage debentures of £100 each of the *New General Traction Co. (Ltd.)*.

**THE ELMORE GROUP.**—Little has been heard of late of the Elmore group of copper depositing and wire manufacturing companies, and the general public would not, probably, have been surprised to learn that they had ceased to exist. But from time to time the public are edified by reports of internal squabbles between the companies, the vendors, and others. Sometimes it is the turn of the debenture or preference shareholders, at other times the ordinary shareholders have a cut in; more recently Messrs. F. E. and A. S. Elmore have been stilt of the directors of Elmore's Trust (Ltd.), complaining of the action of the directors in certain matters. This has extracted from the directors a categorical reply, from which we learn that no greater success has attended recent developments of the Elmore "process" (which, by the way, have been christened the "Rapid" process) than has attended previous attempts to improve the condition of affairs at the Leeds works. The directors' communication concludes with the following comment upon a complaint made by Messrs. Elmore of a difficulty in communicating with the shareholders. The directors state: "We have no wish to debar Messrs. Elmore from communicating with the shareholders, as the more the latter know of the inside working at Leeds the better they will be able to appreciate the difficulties which have had to be faced by the other directors of the Elmore companies, and to form their own opinions as to the causes of the unfortunate results to the shareholders." The remainder of the directors' communication is a general traversal of the statements made at various times by Messrs. Elmore as to the value of the new processes and alleged improvements in the working of the Elmore system of copper depositing. Meantime the shareholders wait in vain for any adequate return upon their "investments."

**WEST RIDING TRAMWAYS AND ELECTRICITY SUPPLY CO.**—The first meeting of the directors of this company, which will supply electric current for lighting and power over an area of about 40 sq. miles and work a system of tramways about 12 miles in length, was held on Thursday last. Messrs. Handcock and Dykes were appointed consulting electrical and mechanical engineers to the company, with Messrs. Le Maitre and Parker to collaborate locally, for the construction of the track and road improvements. Major Tulloch, C.B., R.E., was appointed general advisory engineer.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Aug. 31 | 848 | + 40 | 13 | 11,535 | + 1,318 |
| *Birmingham Tramways. | „ 31 | 4,626 | + 147 | 8 | 38,521 | + 2,124 |
| *Blackburn Corporation.. | ... | ... | ... | ... | ... | ... |
| Blackpool Corporation... | „ 29 | 1,768 | + 265 | †22 | 25,589 | + 6,404 |
| Blackpool and Fleetwood | „ 31 | 1,154 | − 366 | 9 | 12,979 | − 146 |
| Bolton Corporation ..... | Sept. 1 | 1,446 | + 73 | 22 | 34,047 | + 3,479 |
| Bradford Corporation... | „ 1 | 1 185 | + 617 | 22 | 24,017 | +12,976 |
| Brisbane Trams ..... | July 17 | 1,871 | + 240 | ... | ... | ... |
| *Bristol Trams & Carriage | Aug. 30 | 3,759 | + 304 | 8 | 33,537 | + 4,757 |
| *Buenos Ayres & Belgrano | „ 4 | 2,528 | + 629 | 5 | 12,980 | + 2,584 |
| Calcutta Trams. Co. ... | „ 31 | R20,294 | +R 878 | 9 | R24,575 | + R9,867 |
| Carlisle Trams. Co. ..... | ... | ... | ... | ... | ... | ... |
| Central London Railway | „ 31 | 5,412 | + 912 | 9 | 51,027 | ... |
| City & South London Ry. | Sept. 1 | 1,952 | + 424 | 9 | 16,560 | + 3,024 |
| Cork Elec. Trams ..... | Aug. 29 | 527 | + 34 | 34 | 16,234 | + 2,039 |
| Dover Corporation ..... | „ 31 | 307 | + 18 | 22 | 5,579 | + 324 |
| Dublin & Lucan Rly. ... | Sept. 1 | 153 | + 44 | 9 | 1,341 | + 261 |
| Dublin United ..... | Aug. 30 | 4,121 | − 136 | ‡9 | 36,007 | + 1,745 |
| Dublin Southern Dist.... | „ 30 | 1,521 | − 109 | ‡9 | 10,679 | |
| *Dundee Corporation ... | „ 28 | 685 | + 238 | 9 | 6,404 | + 2,167 |
| *Glasgow Corporation ... | „ 31 | 13,086 | +3,817 | 12 | 144,834 | +33,294 |
| Halifax Corporation..... | ¶Sept. 1 | 2,829 | +1,174 | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ..... | Aug. 31 | 1,651 | + 344 | 9 | 15,776 | + 3,738 |
| Liverpool Corporation... | „ 24 | 10,182 | +1,557 | 34 | 301,387 | +40,881 |
| *Liverpool Overhead Rly. | Sept. 1 | 1,670 | − 65 | 9 | 15,754 | + 59 |
| *Manchester Corporation | Aug. 31 | 2,170 | ... | §12 | 23,548 | − 179 |
| Perth (W.A.) Elec. Trams | „ 30 | 693 | + 329 | ‡9 | 8,023 | + 4,738 |
| Portsmouth Corporation | „ 31 | 1,132 | − 23 | ... | ... | ... |
| *Sheffield Corporation ... | Sept. 1 | 3,685 | +1,123 | 9 | 34,242 | +10,962 |
| Southampton Corporat'n | Aug. 29 | 1,085 | + 331 | 9 | 9,051 | + 2,945 |
| Southend Corporation... | ... | ... | ... | .. | ... | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Fortnight

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 28. | | Price Wednesday, Sept. 4. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Sept. 4. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | | | | | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 | 100 | 95 | 100 | ... | ... | 99½ | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ | 10 | 9⅝ | 10⅛ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 6 9 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7¾ | 8¼ | 7¾ | 8¼ | 4 6 2 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¼ | 8¾ | 8¼ | 8¾ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅛ | 8 | 7⅛ | 8 | 2 3 9 | ... | 7⅛ | ... |
| 50,000 | 5 | 4 0 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 5 0 | February and August | 9¼ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 5⅝ | 5¼ | 5⅝ | 3 18 3 | ,, ,, | 5 1/16 | 5 1/16 |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 103 | 105 | 103 | 105 | ... | ... | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5½ | 6 | 5⅝ | 6 | 4 11 8 | March | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 107 | 110 | 107 | 110 | 4 2 0 | June and December | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 120 | 125 | 120 | 125 | 4 0 0 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 100 | 102 | 101 | 103 | 4 7 10 | ... | 101½ | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8 | 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 13 4 | March and September | 12½ | 12½ |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | 105½ | 104 |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5⅛ | 5½ | 5½ | 5⅝ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | ... | 102⅜ | ... |
| £100,000 | Stock | 4% | Kensin. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 5 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13 | 14 | 4 5 9 | April and October | 13⅜ | 13⅜ |
| 13,769 | 10 | 4/6 | Do. (85,001 to 98,769) | 13 | 14 | 13 | 14 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 111 | 114 | 3 19 6 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 19 3 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15 | 16 | 4 7 6 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | 1 5/16 | 1 9/16 | 1 1/8 | 1 3/8 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 60 | 70 | 60 | 70 | ... | January and July | ... | ... |
| £107,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 9 1 | April and October | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary | 14½ | 15½ | 15 | 16 | 4 10 8 | February and August | 15⅝ | 15½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 109,518 | 5 | 5 0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 12 1/16 | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4½ | 4 | 4½ | 4 14 2 | April and October | 4 1/16 | 4 1/16 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 124 | 129 | 4 13 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 9 | 8 | 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 95 | 100 | 95 | 100 | 5 0 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways xd | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2 | 3 | 2 | 3 | ... | ... | 2⅜ | 2 1/16 |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ | 4⅝ | 4½ | 5 | ... | ... | 4⅝ | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 102 | 104 | 102 | 104 | 4 7 0 | ... | 104 | 103⅜ |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary ex div | 21½ | 22½ | 21½ | 22½ | 3 13 4 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 | 115 | 112 | 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 | 6½ | 6 | 6⅛ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9½ | 9⅝ | 9½ | 9⅝ | 5 2 7 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅝ | 102⅞ | 100⅞ | 102⅞ | 4 8 11 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 13¾ | 14¼ | 14 | 14⅛ | 6 6 4 | ... | 14⅜ | 14 1/8 |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11⅞ | 12¼ | 11⅞ | 12¼ | 4 18 0 | February and August | 12⅛ | 11⅞ |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 122 | 125 | 122 | 125 | 4 0 10 | ... | 125 | 123¾ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5⅜ | 5¼ | 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5¼ | 5⅜ | 5¼ | 5⅜ | 2 3 6 | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 103 | 103 | 103 | 106 | 4 14 10 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 97 | 100 | 97 | 100 | 5 0 9 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11½ | 12⅛ | 11½ | 12⅛ | 2 8 0 | ... | ... | ... |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 105 | 107 | 105 | 107 | 4 4 8 | ... | 107 | ... |
| 400,000 | 1 | 1½ | Cape Electric Tramways Shares | 1⅞ | 2⅛ | 1⅞ | 2⅛ | 2 16 6 | ... | ... | ... |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock | 103 | 106 | 102 | 105 | 3 16 2 | June and December | 104⅜ | 103½ |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 105 | 108 | 105 | 108 | 3 14 1 | ... | 107⅜ | ... |
| £440,100 | Stock | ... | Do. Deferred Stock | 95 | 101 | 98 | 101 | ... | ... | ... | ... |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2 6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ | 5⅜ | 5¼ | 5⅜ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 102 | 105 | 102 | 105 | 3 17 1 | ... | ... | ... |
| £855,000 | Stock | 1¾% | City and South London Railway Con. Ordinary | 52 | 54 | 52 | 54 | 2 15 7 | February and August | 53 | ... |
| 47,500 | 10 | 2/0 1/16 | Do. Ordinary (Nos. 22,501 to 70,000) | 5¼ | 5⅜ | 5¼ | 5⅜ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 | 134 | 129 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 123 | 127 | 123 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 | 118 | 113 | 118 | 3 8 0 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 12 | 13 | 12 | 13 | 3 16 11 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15⅝ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 3¼% | Do. 3½ per Cent. Mort. Debs. (red.) xd | 98 | 102 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5¼ | | 5¼ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 22 | 22⅝ | 21⅝ | 22⅛ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14⅛ | 15 | 14⅛ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 111 | 113 | 3 19 8 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 7 1/16 | 7 3/16 | 7 | 7⅛ | 3 16 1 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference xd | 13 | 13½ | 13⅜ | 13 | 3 16 11 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 104 | 103 | 104 | 3 16 11 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | 106½ | 105⅜ |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 7 9 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) xd | 102 | 104 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 100 | 102 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 12 | 13 | 11½ | 12½ | 1 12 0 | ... | ... | ... |
| 20,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 9⅜ | 10⅜ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 106 | 109 | 106 | 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 92 | 95 | 93 | 96 | 3 2 8 | June and December | ... | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Aug. 28. | Price Wednesday, Sept. 4. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Sept. 4. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 9 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3½ 4½ | 3½ 4½ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 51 54 | 53 56 | 5 11 9 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 97 99 | 98 100 | 6 0 3 | ,, ,, | 100 | 97½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 10½ | 10½ 11½ | 2 4 6 | ,, ,, | 11 | 10½ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 103 | 101 103 | 3 17 9 | ,, ,, | 102½ | ... |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 6 | 5 6 | 7 10 0 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14 15 | 13½ 14½ | 6 17 11 | ,, ,, | ... | ... |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 7 0 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10½ 11½ | 10½ 11½ | 5 13 1 | Jan., Apr., July, Oct. | 11 | 10½ |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 143 148 | 143 148 | 4 14 7 | Jan., Apr., July, Oct. | 145½ | 143 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 99 | 97 100 | 3 10 2 | ,, ,, | ... | ... |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 114 117 | 115 118 | 3 8 7 | May and November | 115 | ... |
| 300,000 | 10 | 2/6 | Eastern Extension | 13¾ 14¼ | 13¾ 14¼ | 4 15 0 | Jan., Apr., July, Oct. | 14½ | 14 |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 119 | 115 120 | 3 6 10 | February and August | 118 | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 103 | 100 103 | 3 17 8 | February and August | 1 2 | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101% 104% | 101% 104% | 3 17 7 | May and November | ... | |
| 150,000 | 10 | 5.0 | Great Northern of Copenhagen | 31 33 | 31 33 | 4 10 11 | January and July | 31 5/8 | 31½ |
| £78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (w thn Nos | 100 103 | 100 103 | 4 7 10 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red.) | 41 45 | 41 45 | 5 11 1 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 xd | 105 103 | 103 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 1 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) xd | 101 104 | 99 102 | 4 17 10 | March and September | 100½ | ... |
| 30,008 | 2½ | ... | West Coast of America | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 101 103 | 100 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | ... | West India and Panama | ½ ¾ | ½ ¾ | ... | May and November | ... | ... |
| 31,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 6 | 5 6 | ... | ,, ,, | 5 7/8 | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | ... | ,, ,, | 5 1/8 | ... |
| £81,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 16 2 | January and July | ... | ... |
| 20,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 14 14½ | 14 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14⅝ | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 105 | 102 105 | 4 15 10 | June and December | ... | ... |
| £318,777 | Stock | 4% | * Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 7 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) | 3¾ 4¼ | 3½ 4 | 6 5 0 | August | 3⅝ | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 2/9 | 2/6 3/6 | 8 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¾ ⅞ | ¾ ⅞ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, ,, | ... | ... |
| 590,000 | 5 | 2/6 | National xd | 3⅜ 4⅛ | 3⅜ 4 | 6 5 0 | February and August | 3⅝ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference xd | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference xd | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. xd | 4¼ 5 | 4⅜ 4⅞ | 5 2 7 | ,, ,, | 4½ | ... |
| £700,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 92 95 | 95 98 | 3 11 10 | June and December | 97½ | 95½ |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 1 | ... | 98½ | 96½ |
| 171,504 | 1 | 0/8½ | Oriental | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5½ | 5 5½ | 6 7 3 | July | 5⅜ | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅝ 5¼ | 4⅝ 5¼ | 4 15 3 | June and December | 4⅝ | ... |
| £ 79,247 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 15 11 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅝ ¾ | ⅝ ¾ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅝ ¾ | ⅝ ¾ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅝ ¾ | ⅝ ½ | 8 14 6 | March and September | 1/16 | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 8 9 | 8 9 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ 5¾ | 5½ 5¾ | 5 4 4 | January and July | 5 1/16 | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ 5¼ | 4¾ 5¼ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅝ 1¾ | 1⅝ 1¾ | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. xd | 2 2¼ | 2 2¼ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock xd | 103 108 | 102 105 | 4 5 9 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 18 | 15 16 | 4 13 9 | ,, ,, | 15½ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¾ 6¼ | 5¾ 6¼ | 4 0 0 | ,, ,, | 6 1/16 | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 108 112 | 110 114 | 3 19 6 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 95 | 94 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 5 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3¼ 3¾ | 3¼ 3¾ | 6 0 0 | January and July | 3 3/16 | 3 1/16 |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 105 | 100 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ½ | ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ 2½ | 1½ 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 86 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 85 90 | 85 90 | 5 13 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5¾ 6¼ | 5¾ 6¼ | 5 12 0 | Half-yearly | 5⅞ | ... |
| 20,000 | 5 | 1/6¼ | Do. 6% Cumulative Preference | 5½ 6 | 5½ 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 107 | 101 107 | 4 4 4 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. | 1½ 2 | 1½ 2 | 6 0 0 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ 2¾ | 2½ 2¾ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 102 | 98 102 | 3 18 5 | January and July | 103½ | 100 |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9¾ 10¼ | 9¼ 10¼ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 102 | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary xd | 16½ 17½ | 16½ 17½ | 6 11 5 | February and August | 17 | 15 1/16 |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference xd | 5½ 6 | 5½ 6 | 3 15 0 | ,, ,, | 6 1/32 | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) xd | 110 114 | 110 114 | 3 19 0 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 22 | 21 22 | 4 13 0 | ,, ,, | 21⅝ | 21¼ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 33 42 | 33 42 | 5 0 0 | March and July | 33½ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 106 | 104 106 | 3 15 10 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11½ | 5 4 4 | ... | 11¼ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6¼ | 5½ 6¼ | 4 0 0 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6¾ 7½ | 6½ 7 | 4 5 9 | ,, ,, | 6¾ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 10½ 11 | 10½ 11 | 4 15 5 | Jan., Apr., July, Oct. | 10⅝ | 10⅛ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 13¾ 15½ | 14½ 15½ | 3 18 8 | ,, ,, | 15½ | 14½ |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 126 131 | 127 132 | 4 11 8 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,217. [No. 21. Vol. XLVII.] FRIDAY, SEPTEMBER 13, 1901. PRICE SIXPENCE (by post, 6½d.).
Abroad, 8d., or 15 cents, or 80c., or 70pf.


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## NOTES.

THE British Association inaugurated its seventy-first annual meeting at Glasgow on Wednesday last, when Prof. A. W. RÜCKER, F.R.S., principal of the University of London, delivered his Presidential address before an immense audience in St. Andrew's Halls. The recent engineering congress and the exhibition have combined to attract a larger number of foreign visitors than usual to the Association; but oddly enough the total attendance of members is remarkably small, being yesterday only 1,725. Fortunately the weather prospects appear good, so that the assemblage of mingled scientists and pleasure-seekers will probably be able to enjoy to the full the elaborate programme prepared for their amusement and edification.

PROF. A. W. RÜCKER'S presidential address to the British Association at Glasgow on Wednesday evening was worthy of the occasion and of the man. There have been many presidents in the past who have braved the task of defending, against expert criticism or ignorant bigotry, the orthodox position of the science of their time; there have not been wanting also presidents of an iconoclastic type of mind who have dealt a swift and unexpected blow at some one or other of the main outworks of science. Prof. RÜCKER has chosen the more gracious task, and, with consummate skill and incisive logic, has defended one of the most precious of the legacies of the past century to the physical science of the new century from the stigma that its value is fictitious. Reviewing the progress of physical science during the nineteenth century, he goes to the root of the matter and considers the grounds upon which it may justly be claimed that the foundation theories of physics are "an aspect of the very truth," and not merely "convenient fictions." He scorns the assertion of a certain school of theorists that we can never hope to go below the surface or to obtain anything more than a mathematical specification of Nature; and, proving his claim up to the hilt, he maintains that ether and atomic theories are "a copy, and not a mere diagram, of the truth." "Atoms," he exclaims, "are not merely helps to puzzled mathematicians, but physical realities." We commence our reprint of this address elsewhere, and there is not an individual interested in physical science who would not derive benefit and pleasure from its careful perusal.

A TECHNICAL description of the arrangements at the recently-opened municipal telephone exchange at Tunbridge Wells appears in this issue. Of the 400 subscribers connected to this exchange, a large number also subscribe to the National Telephone Co.'s system, to compete with which the municipal exchange was erected. Canvassing is going on actively on both sides. The officials of the municipal exchange are using every endeavour to win over subscribers from the National Company, and the company has cut down its rates to an extremely low figure. Inspired articles and signed and anonymous letters on the subject fill the columns of the local press, and the contest has altogether many points of external resemblance to an electioneering canvass. In fact, telephonic competition, conducted on what has been called "purely business lines," as in Tunbridge Wells, does not impress the onlooker as a particularly dignified occupation for a municipal corporation.

AN animated discussion, which certainly had its amusing side, took place in the Eastbourne Town Council last week. A short time ago a temporary stoppage of supply occurred at the electricity works in that town, and on people (town councillors even!) telephoning to the works to make inquiries, they could not "get through." Considerable time was occupied at the meeting in discussing seriously why proper provision was not made for such a case. It transpired that the office



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boy had left for the night and that the engineering staff at the station were too busy remedying the breakdown to pay attention to the telephone; but the general idea in the Council seemed to be that the retention of an office boy in the evening, or the erection of an extension line to the police office, would provide for a future contingency of the kind. No one seems to have realised that if each one of the 450 consumers at Eastbourne employed the telephone to inquire the cause of the stoppage, and explain the inconvenience caused to them or offer advice, it would take exactly 15 hours before the last had been finished with, taking the low average of two minutes per conversation. In this instance one of the councillors rang up to inquire from a hotel telephone and had no patience to wait longer than half an hour, —a time that would only have sufficed to reassure 15 subscribers, allowing two minutes to each.

It is, of course, one of the accompanying inconveniences of a breakdown at an electricity works that the consumers should be in the dark, and metaphorically in the dark as to how long the darkness will continue. Although accidents in connection with electricity supply works are of infrequent occurrence, every capable engineer-in-charge makes provision for dealing with one promptly should it occur, and it is not altogether unreasonable to ask that he should include in his preparations a scheme for notifying to consumers how long it will be before the supply is resumed. Probably it would save inconvenience both to the works staff and to the telephone exchange if this information could be supplied by telephone to enquiring subscribers directly from the telephone exchange, as appears to have been done to some extent even in the Eastbourne case. The exchange staff would find it much easier to reply to everyone who wanted the electricity works after a breakdown that the supply would be resumed in an hour, than to be rung up repeatedly by every subscriber awaiting his turn to get through.

University College, London.—The session of the faculties of arts and sciences (including the departments of engineering and architecture) will begin on October 2nd. Prospectus may be obtained from the secretary.

Heriot-Watt College, Edinburgh.—Instruction in mechanical and electrical engineering and technical chemistry are given at this college. The next session opens on October 1st. Further particulars may be obtained from Mr. David Lewis, 20, York-place, Edinburgh.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cadiz—Teneriffe | Aug. 6, 1901 |
| Bolama—Bissao | Aug. 16, 1901 |
| Trinidad—Demerara | Aug. 27, 1901 |
| Curaçoa—Cora | Sept. 11, 1901 |
| Bolama | Sept. 12, 1901 |

Lightning Research.—The Lightning Research Committee of the Royal Institute of British Architects having invited the assistance of the Institution of Electrical Engineers in the collection of information bearing on the subject in question, papers are being sent to the local honorary secretaries of the Institution abroad, in the hope that members resident in these several districts may be willing to co-operate.

The Electrical Engineers Volunteers.—In a despatch, dated September 4, 1901, from Earl Roberts to the Secretary of State for War, published in last Tuesday's *Gazette*, the following officers and men of the Electrical Engineers (R.E.) Volunteers are mentioned as having rendered special and meritorious service:—Lieut.-Col. R. E. B. Crompton, Capt. A. Bain, Sergeant W. S. Entwistle, Sappers R. W. Holliday and J. Rook.

Accident at the Tunbridge Wells Electricity Works.—An accident, fortunately unattended with serious consequences, took place at Tunbridge Wells electricity works on Tuesday, at about 4 o'clock. The cast-iron top of one of the Musgrave superheaters in the boiler house blew off, doing damage to the roof and some of the steam piping. Mr. Boot, the borough electrical engineer, informs us that four men were cut with falling glass from the roof, but none were seriously injured. The supply was upset for a short time.

A Large Water Power Scheme for San Francisco.—We are informed that the Mammoth Power Co. is now completing preliminary work in connection with a scheme for transmitting 50,000 H.P. to San Francisco. The main drainage area is 1,000 sq. miles and the location of the power house is 21 miles from the intake on the San Joaquin river, 180 miles from San Francisco; 45 8ft. to 9ft. tunnels through solid granite will have to be cut. The fall allowed will be 7½ft. per mile. The reservoir will be 1½ miles by 250ft. wide. From a point on the mountain about 1 mile from the power house the water will be conveyed down the mountain slope to the power house 1,780ft. below through an inclined tunnel instead of pipes. It is estimated that the work of construction will take two years.

Electric Tramcar Accident at Stockport.—The second accident within a fortnight occurred last Tuesday on the newly-constructed tramway system of Stockport. A car containing passengers was descending Lancashire Hill, and at the steepest part the brakes, it is said, failed to act, and the car, jumping the metals, dashed into a bootmaker's shop. One side of the shop was wrecked, and the persons inside had a narrow escape. The driver had his arm broken and his leg injured, and some of the passengers were cut about the head by broken glass. A singular incident was the escape of a woman who was standing in the road when the tram left the line, and for safety ran into the shop. The vehicle dashed into the wall and pinned her between the partitions forming the doorway. When rescued, however, she was found to be practically unhurt.

Personal.—Consequent on the appointment of Dr. Stanton as superintendent of the engineering department in the National Physical Laboratory, Mr. R. M. Ferrier has been appointed his successor to the Chair of Engineering at the University College, Bristol. Mr. Ferrier, who from 1891 until the present time was lecturer in mechanical engineering at the Durham College of Science, Newcastle-on-Tyne, was awarded the Sandeman gold medal in 1885 at Anderson's College, Glasgow, and in 1886 a Whitworth scholarship. At Glasgow University he took his degree with honours in engineering, and previously to his appointment at the Durham College of Science had a good deal of practical experience both at home and on the Continent.

Mr. G. Marconi was, on the 5th inst., presented with the gold medal by the principal scientific society in Italy for his eminent services in connection with wireless telegraphy. The presentation was made by the Marquis Solari di Loreto, an Italian naval officer, by command of the Italian Foreign Office.

The Metropolitan and Metropolitan District Railways.—The resignation of Mr. J. S. Forbes and the appointment of Mr. R. W. Perks, M.P., as chairman of the Metropolitan District Railway Co. were confirmed at a directors' meeting held last week. As the result of the visit of Mr. Yerkes and his technical advisers to Budapest, the Metropolitan District Railway Co. has decided that it entirely disapproves of the introduction of the Ganz system on the "Underground" so that the deadlock between the Metropolitan Company and the Metropolitan District Company as to the electrical equipment is complete. The month allowed by the Board of Trade for the companies to come to an agreement expired on Wednesday, and we may now expect that an arbitrator or arbitrators will be appointed. It has not yet been announced who will have to perform this delicate task, but we learn that Mr. Trotter, the electrical adviser to the Board of Trade, was recently at Budapest. A board meeting of the directors of the Metropolitan District Railway Co. was held yesterday, but

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up to the time of going to press we were unable to learn anything further with regard to the matter.

The American Institute of Electrical Engineers.—We are glad to learn that the meeting of the American Institute of Electrical Engineers at Buffalo was a decided success, in spite of most unseasonable weather. On August 14th Mr. Steinmetz delivered an address of welcome at New York to the foreign guests, who were headed by M. Paul Janet. On the 15th the Crocker-Wheeler works and telephone exchange were visited. On the 16th members were transported by special steamboat to a number of power houses. The members left by river on the 18th for Albany, and on the 19th they visited the works of the General Electric Co. at Schenectady. The Convention was opened on the 20th on the grounds of the Pan-American Exposition, and a trip was made all round the Niagara Falls and rapids in the afternoon. Papers were read, and a large number of places were visited on the succeeding days, the adjournment taking place on Saturday the 29th. A number of foreign visitors were present, and the French sent official delegates, but there were no official representatives from Great Britain, and seven Englishmen only were present. All were most hospitably received, and had the same liberality extended to the unofficial visitors as to the official delegates from the Continent. The names of the Englishmen present were:—Mr. Cottam (Hampstead), Mr. Cooper (Reading), Mr. Gamlen (Bromley), Mr. Sawers (Silvertown), Mr. McNaught (Silvertown), Mr. Denham (electrical engineer to the Cape Government Railway), and Mr. Pott (of Messrs. Preece and Cardew).

Magnetic Survey of India.—According to *The Times*, Lord Curzon's Government have adopted the suggestion of the Royal Society for the carrying out of a magnetic survey of India. Sun spots are believed to be closely connected with the perturbations of the magnetic needle, and, as Sir Norman Lockyer's inquiries are held by him to establish some association between sun spots and Indian droughts, the survey, besides subserving the cause of science, may prove to be of some practical utility from the administrative standpoint. The existing magnetic observatories at Bombay and Calcutta being inadequate as base stations for the vast area the survey will cover, similar observatories are in course of construction at Dehra Dun, below the Himalayas, at Kodaikanal, in the Madras Presidency, and at Rangoon. The Dehra Dun observatory will be under the supervision of Col. Gore, R.E., the Surveyor-General of the Indian Survey (whose headquarters are located there); but the other four will be in charge of Mr. John Eliot, the meteorological reporter to the Government. The Survey and Meteorological Departments will, in fact, be jointly responsible for the investigations. The field observations will be carried out by six or seven detachments of the Survey Department, and these will be controlled by Capt. Fraser, R.E. Sind and the Punjab will first be taken in hand; and, as the country is now intersected with railways in all directions, enabling field detachments to quickly cover the distances from one observing station to another, it is anticipated that five years will suffice to complete the field work of the preliminary magnetic survey.

High-Tension Switches.—From the *Electrical World* of New York we learn that for voltages up to 10,000 the oil switch is proving the most satisfactory in the United States. In the majority of high-tension plants there, the high-tension switching arrangements are admitted to be not ideal. That greater perfection has not been required and developed, says our contemporary, is because it is seldom that any necessity arises for opening the high-tension circuits under severe conditions. The low-tension circuits are opened first, and this makes opening the high-tension side easy. Opening the high-tension side of a transformer when it is burning out, or opening the high-tension line with a short on the line, are the conditions which really put high-tension switches to a severe test, and these conditions do not exist often enough to give much chance to test the switches. It is only in case two high-tension lines are being operated in multiple off the same transformers that it is necessary to open the high-tension line switches on short circuit. The great majority of the high-tension switches in use are long break stick switches, in which dependence is placed entirely on the length of the break for opening the circuit. At Los Angeles, on the 33,000 volt lines, the circuit is opened with a 10in. break between a pair of copper wire horns, which gradually spread apart as they extend up. The arc travels up and breaks itself. This works well under ordinary conditions. In connection with the subject of opening high-tension alternating circuits, the article continues, there is a decided tendency in the larger and more important plants where continuity of service is of great importance to do away with fuses and automatic circuit-opening devices of every kind on the generators and main transmission lines, fusing only the distribution lines from the sub-station. That fuses and circuit-breakers introduce an element of uncertainty in a supply circuit which is not pleasant to contemplate on a large system must be admitted by all. The only question is as to whether the evil is a necessary one or no. Some generators will give only 50 per cent. in excess of full-load current on short circuit when backed by the limited torque of a water-wheel, and will drop voltage tremendously. This fact furnishes an element of safety in running without automatic circuit-opening devices. It is even maintained by some that suddenly opening the circuit on a polyphase generator at full load is more detrimental than short-circuiting it.

German Electricity Works Statistics.—The *Elektrotechnische Zeitschrift* of September 5th contains the statistics which our contemporary publishes annually with regard to the electricity works in Germany. These are made up to April 1, 1901, and show that 768 electricity supply works were then in operation in the country, as compared with 652 works in the preceding year. In its tables our contemporary has added a new column this year, relating to the capital expenditure. 318, or 40 per cent. of the works, have sent in the total of their capital expenditures, and an average of these shows that the expenditure has been at the rate of 1,628 marks (about £81) per kilowatt of generating plant installed. A further estimate shows that the total capital expenditure of public electricity supply works, exclusive of tramways, in Germany, must be about 540,000,000 marks. 81·3 per cent. of the works generate nothing but continuous current, as compared with 80·4 per cent. last year. However, this only represents 43·8 per cent. of the total kilowatt capacity of all the works, a decrease of 3·6 per cent. since last year. This is explained by the fact that there is a large number of small works with outputs below 100kw. supplying continuous current, while the larger works usually lie at a distance from the supply areas, and generate three-phase or single-phase current which is led to the sub-stations. The number of three-phase continuous current sytems has increased from 38 to 43 (41,757kw. to 86,985kw.), and the number of combined single-phase current systems from 6 to 10 (1,599kw. to 6,874kw.). The number of purely three-phase works has increased from 39 to 45 (35,150kw. to 40,759kw.), and of works employing nothing but single or two-phase from 42 to 44 (21,572kw. to 27,547kw.). In two works, with an aggregate capacity of 950kw., monocyclic generators are employed. Nearly all the continuous-current stations are equipped with batteries, only 24, or 33·8 per cent. of the whole, being without them. An interesting figure is obtained from the total capacity of the accumulators, from which it is calculated that on the average their capacity is 36·2 per cent. of the capacity of the generators in the works in which they have been erected. Of the total 768 works 56·4 per cent. have a smaller capacity than 100kw., and there are in all 38 works with capacities of over 2,000kw. The largest of these is the huge water power station at Rheinfelden, the capacity of whose generators is 12,000kw.; and next in order comes the Oberspree station, near Berlin, with a capacity of 10,770kw., both these figures being exclusive of sub-station equipment. The connections to the mains of all the 768 stations represent an aggregate of about 352,500kw., an increase of 28·8 per cent. over last year. No less than 38·6 per cent. of the total kilowatts connected is represented by motors. 90 additional works are being constructed or definitely projected.

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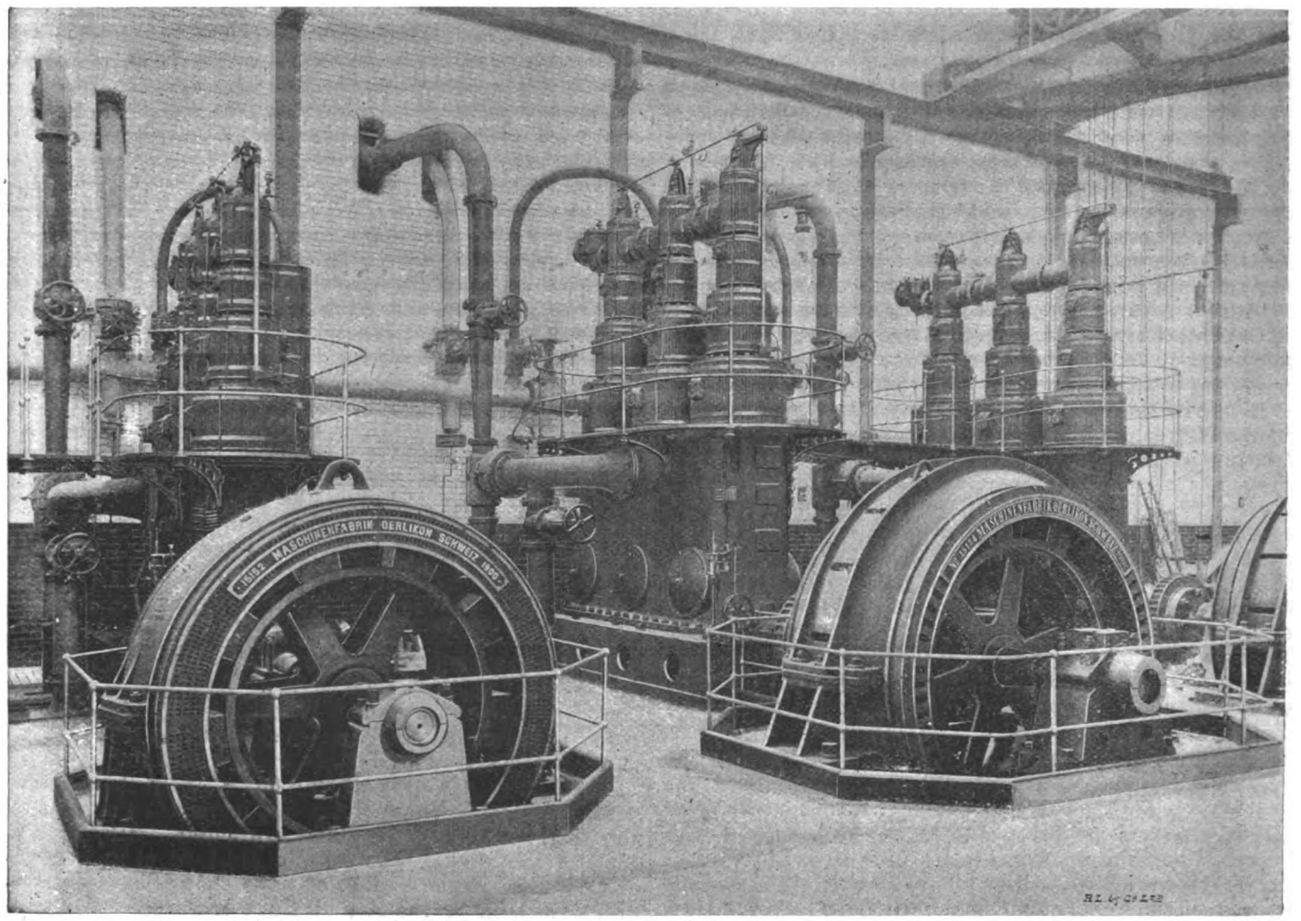


FIG. 11.—GENERAL VIEW OF ENGINE ROOM AT THE KENSINGTON AND NOTTING HILL JOINT ELECTRICITY WORKS.

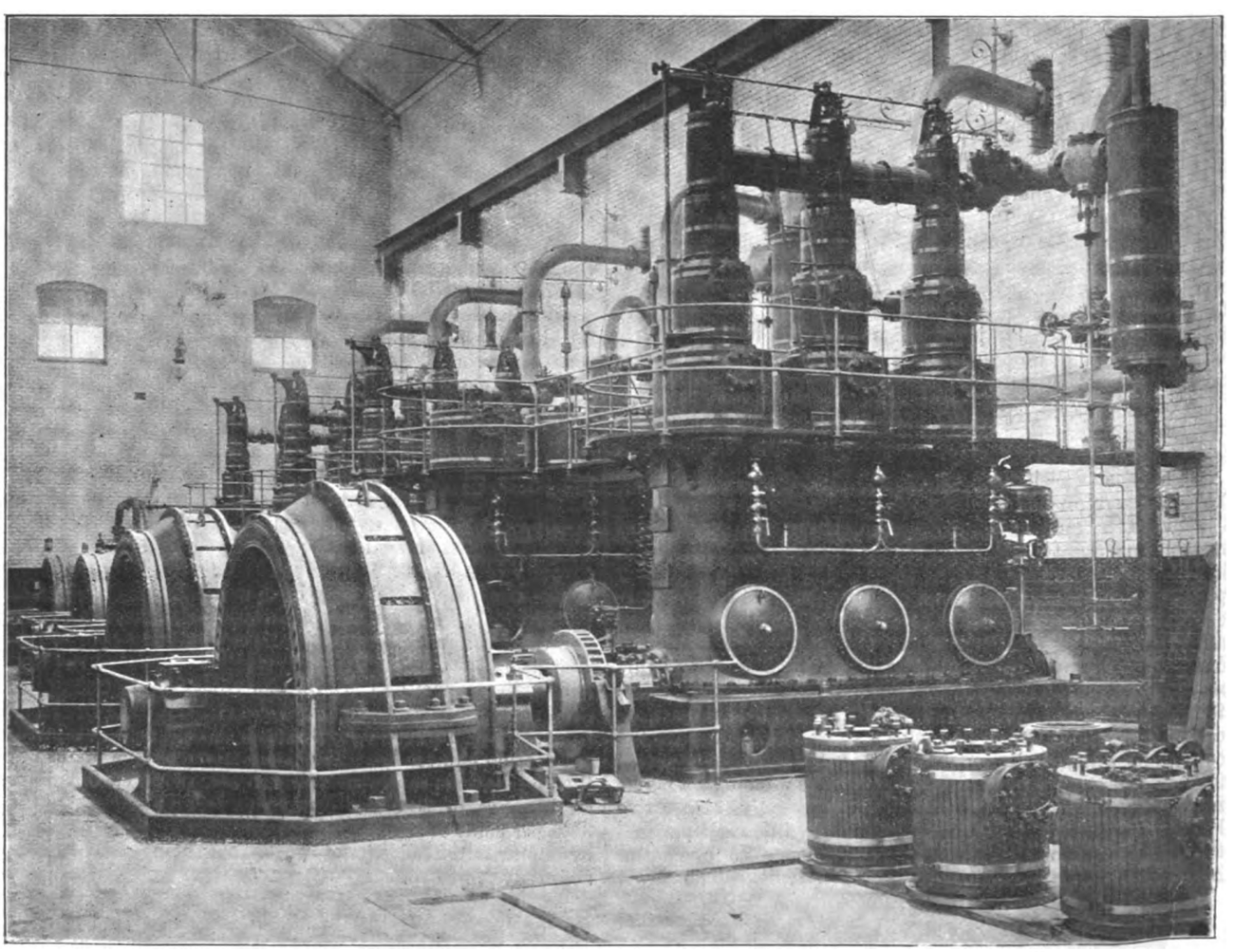

FIG. 12.—ANOTHER VIEW OF ENGINE ROOM AT THE KENSINGTON AND NOTTING HILL JOINT ELECTRICITY WORKS.

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# THE KENSINGTON AND NOTTING HILL COMPANIES' JOINT ELECTRICITY SUPPLY WORKS.

(*Continued from page 743.*)

Steam-Dynamos.—The arrangement of the engines and dynamos has been shown on Figs. 1 and 3, whilst the general appearance of the engine room may be seen from Figs. 11 and 12 (p. 778). Five sets have so far been installed, and there is still space in the existing building for two larger sets. The smallest unit adopted consists of a 575 I.H.P. Willans engines coupled to a 330kw. Oerlikon alternator, which runs at 300 revs. per min. Three of this size have been fixed, as well as two larger sets. These latter indicate 825 H.P., and

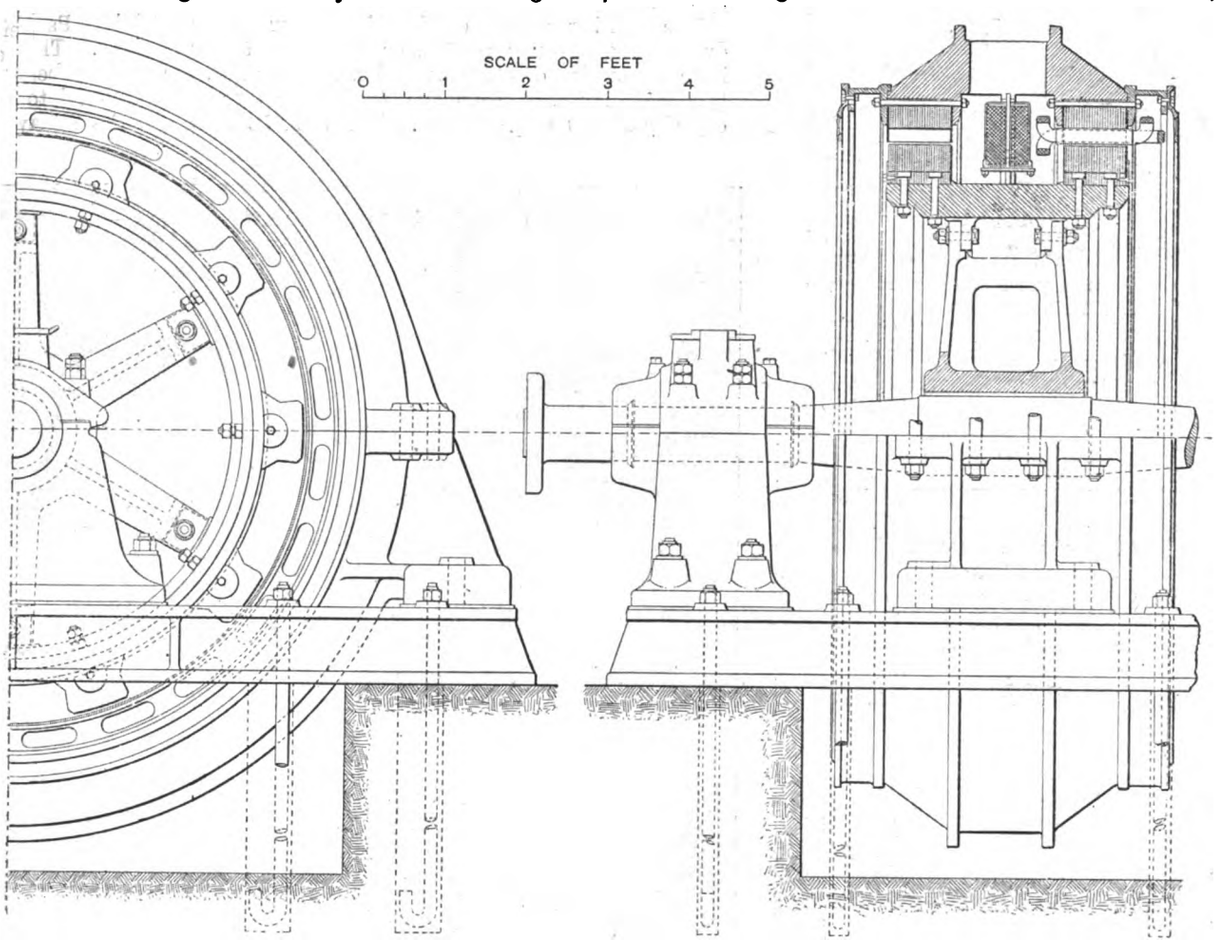


FIG. 13.—THE 550KW. ALTERNATOR.

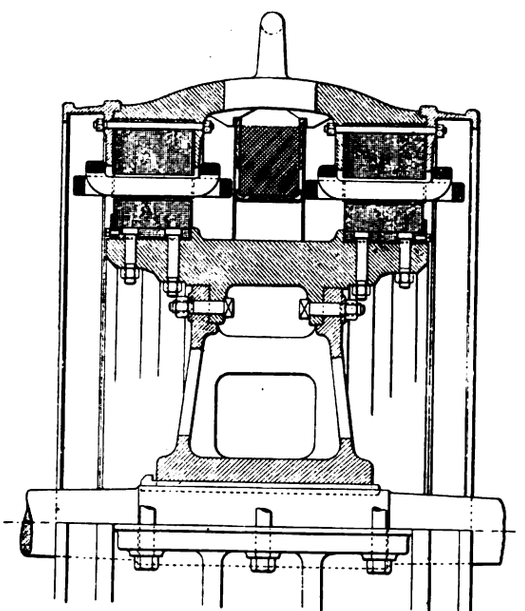

FIG. 14.—SECTION THROUGH 330KW. ALTERNATOR ($\frac{1}{10}$th full size).

are coupled to 550kw. alternators running at 270 revs. per min. All the engines are of the three-crank triple-expansion type, and each engine is fitted with a Körting ejector condenser, the condensers taking their water from the tanks over the boiler house. The discharge is taken through a 20in. cast-iron pipe through the pump room to the cooling pond.

The engine cylinders are lubricated by means of pure powdered graphite mixed with a small quantity of cylinder oil to form a thick paste. This mixture is put into a grease lubricator, such as is used for forcing grease along pipes to the bearings of engines. The piston of the lubricator is forced down by means of a worm wheel and worm geared to a ratchet wheel, the ratchet of which is given a reciprocating movement from a speed reducing gear driven by belt from the crank shaft. The speed is set so as to give one drop per minute to the engine, the graphite being fed through small copper pipes. One of these lubricators will last for two months without refilling.

The alternators are of the three-phase inductor type working at a pressure of 5,250 volts at 45 ~ per sec. Fig. 13 gives a half elevation end on of the 550kw. alternator, and a side view half in elevation half in section of the same machine, and Fig. 14 is a section through the 330kw. machine.

In the case of the smaller machine the inductor is 1,814mm. in diameter, and the stator is bored out to a diameter of 1,820mm., giving a clearance of 3mm. between rotor and stator. The poles are of laminated charcoal iron. The hub and spokes of the rotor are of cast-iron, and the rim is of steel.

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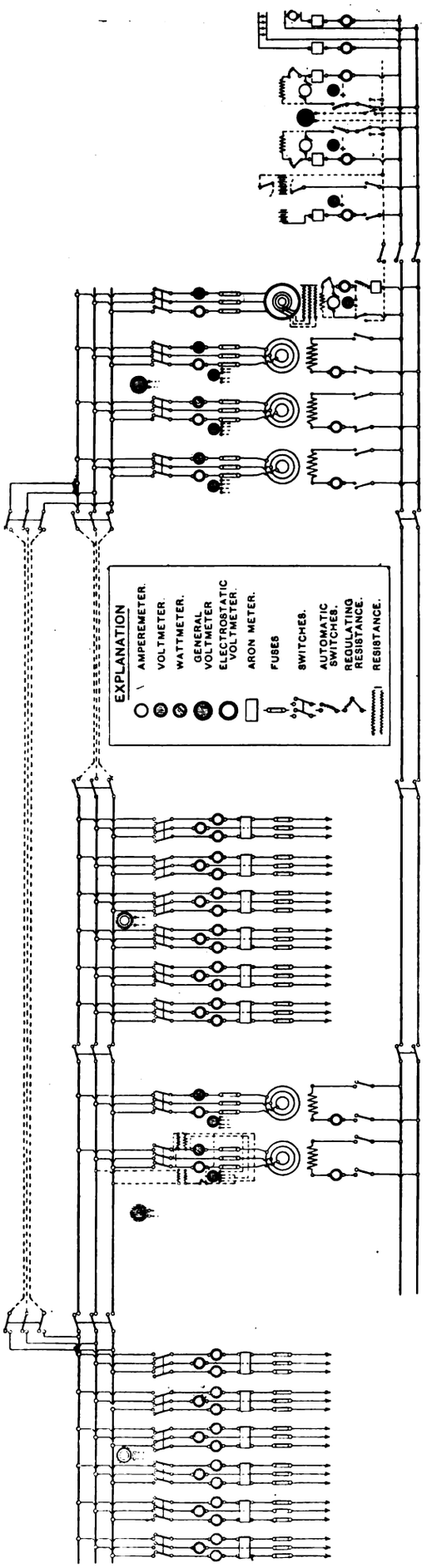


FIG. 15.—GENERAL ARRANGEMENT OF SWITCHBOARDS AT WOOD LANE.

The outer rim of the stator is of steel, and the magnet spool is of cast-iron. The steel shaft is 220mm. diameter, tapering to 160mm. at the bearings. The diameter of machine over-all is 2,500mm., the length is 2,960mm., and the width 3,000mm.

The 550kw. machine is very similar in construction, with the exception that the outside rim of the stator is of cast-iron, and the field-magnet bobbin is divided by a wrought-iron separator. The floor space occupied is 2,930mm. by 3,940mm.

The exciting current can be taken either from two Willans-Parker steam dynamos, a motor generator, or a battery of accumulators. The exciters have an output of 40kw. at 450 revs. per min., the engines being of the two crank triple-expansion and condensing type. The accumulators have a capacity of 600 ampere-hours. There are 56 cells, and these may be used

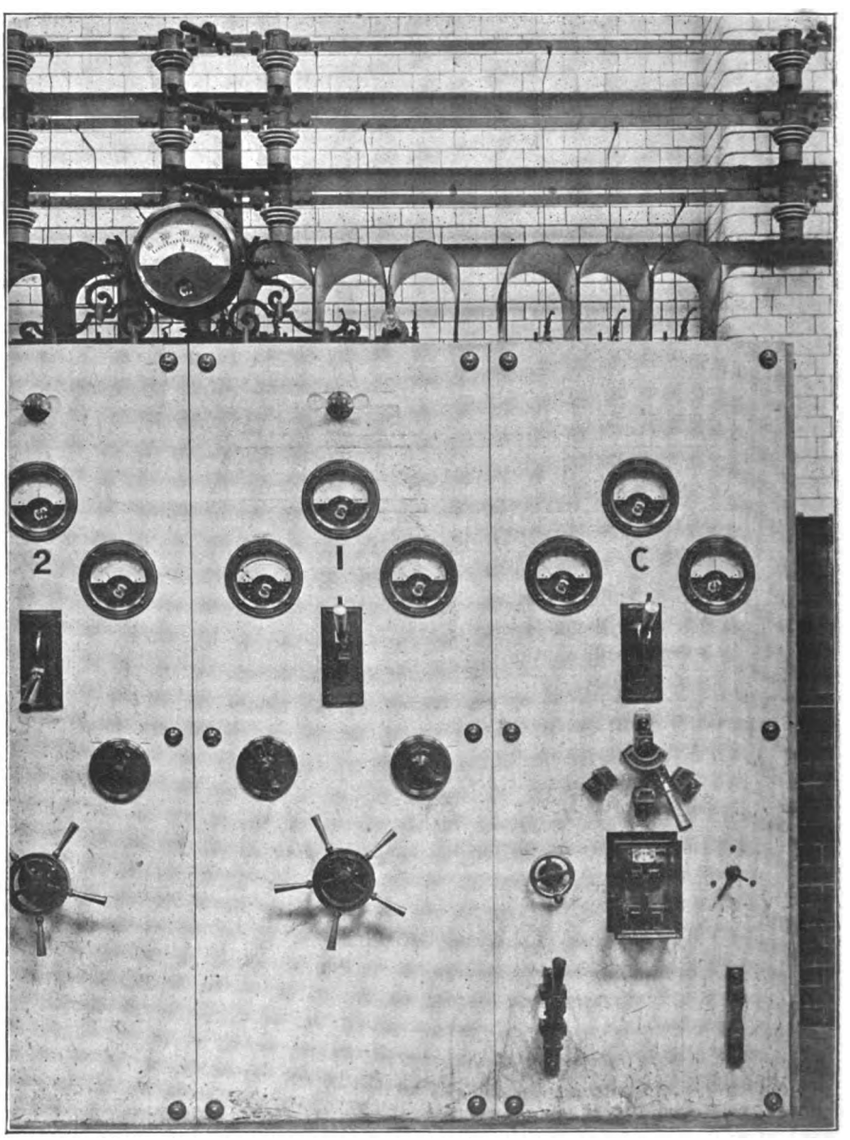


FIG. 16.—FRONT VIEW OF AN ALTERNATOR AND MOTOR-GENERATOR PANEL AT WOOD LANE.

also for lighting or working the auxiliary motors in the station. The motor-generator has an output of 600 amperes at 100 volts, and is similar to those we are describing in the sub-stations.

Switchboards.—The switchboards are in five separate sections and consist of (1) the low tension board, for the exciters, lighting, power and accumulators; (2) the panels for the three 330kw. alternators and the motor-generator; (3) the panels for the trunk mains to the Notting Hill Company's district; (4) the panels for the two 550kw. alternators and two spare panels for extensions; (5) the panels for the trunk mains to the Kensington Company's district. The general arrangement of the boards is clearly shown on Fig. 15, and Fig. 16 illustrates a portion of section (2), two of the 330kw.

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alternator panels being on the left and the motor-generator panel on the right. This view also shows a part of the high-tension switch (see Fig. 17) immediately above the board,

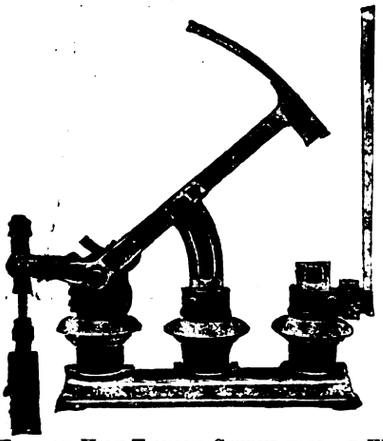

FIG. 17.—TYPE OF HIGH-TENSION SWITCH USED AT WOOD LANE AND KENSINGTON SUB-STATIONS.

the arrangement of 'bus bars, which form a ring main, and the isolating switches.

In designing the switchboards an endeavour was made to render them safe from accidental contact with any live part.

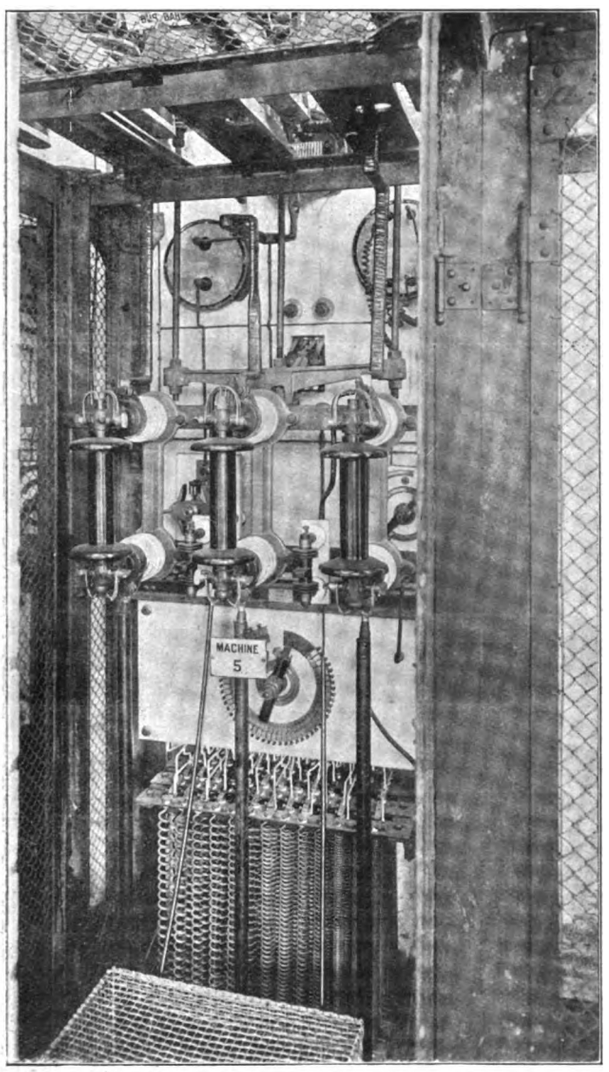


FIG. 18.—BACK VIEW OF 550KW. ALTERNATOR PANEL.

It will be seen that on the front of the high-tension panels and exposed to view are only the instruments and switch handles. The dials of the instruments are seen through holes cut in the marble panels; the glass covering the dial is the only part that can be touched, and this is surrounded by a metal ring connected to earth, as also is the three-pole main switch handle. At the back of the boards the iron framework is formed into cages, one for each panel, and provided with iron doors fitted with Yale locks; but it is possible to go into the space at the back of the boards and look at the apparatus through the iron meshing. The switches and 'bus bars overhead have similar ironwork guards to stop anyone reaching up to them. In the event of any of the apparatus at the back of the panels requiring adjustment, it is the duty of the engineer-in-charge to cut off the current from the particular panel by means of the main switch, and lock it with a Yale lock, as shown on the main switch in the middle panel of Fig. 16. The door of the cage may then be opened.

Fig. 18 illustrates the interior of a cage of a 550kw. alternator panel. At the very bottom may be seen a smaller cage which contains the synchronising transformer; above this on the picture is the resistance and 50-contact rheostat controlling

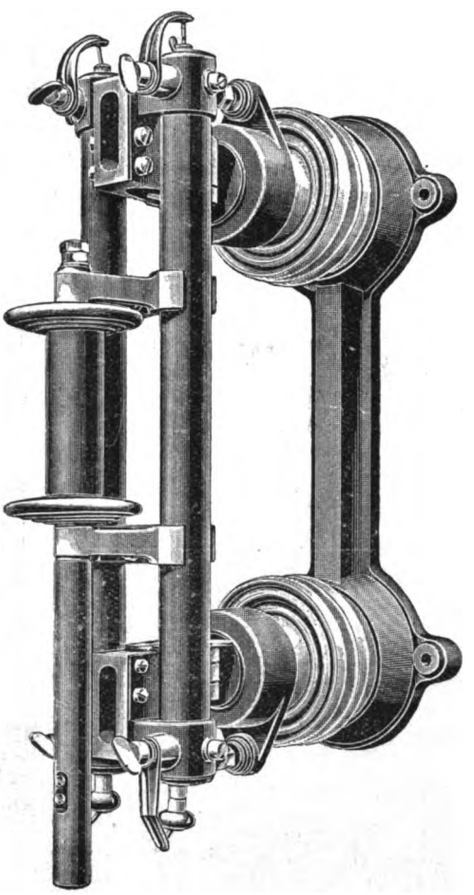

FIG. 19.—TYPE OF HIGH-TENSION FEEDER CUT-OUT USED AT WOOD LANE AND KENSINGTON SUB-STATIONS.

the current through the field magnet. In the centre are the three main fuses, synchronising switch fuses and the voltmeter switch. The main three-pole switch is in the cage above. The feeder panels are separated in a similar manner, but in these the fuses are of a somewhat different pattern (*see* Fig. 19). Both types consist of weighted copper wires in asbestos tubes with ebonite handles. With the exception of a few electrostatic Kelvin voltmeters, the instruments are mostly of the Hartmann and Braun hot-wire pattern, supplied by Messrs. Johnson and Phillips, In the case of the synchronising voltmeter there are two scales, one showing the pressure of the 'bus bars, the other of the in-coming alternator. A Thomson three-phase voltmeter is fitted in each circuit panel and is provided with a needle to indicate the load on the feeder. The whole of the insulators on the boards have been tested up to 20,000 volts.

(*To be concluded.*)

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## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 705.*)

§ 24. **E.C.C. Staffordshire Motor.**—This is one of a new line of multipolar motors and generators. The particular example exhibited is rated at 15 H.P., 440 volts, and 950 revs. The same excellence of detail which characterises the company's large generator work is to be found in these motors. The yoke is of the circular type and of cast-iron, the bottom half being cast solid with the base-plate and pedestals. The poles are of high permeability rolled steel, and this feature, with cast-iron yokes, is one of the leading features in most E.C.C. machines, and has the advantage of giving a symmetrical magnetic distribution, and at the same time substantial construction. The armatures are slot-wound with E.C.C. barrel type winding, each coil being former-wound, separately insulated, and shaped. The mild steel core plates are keyed to the shaft and clamped up under a pressure of several tons. The commutators are of hard copper bars, mica insulated throughout. Fixed position of the brushes is provided for all loads up to at least 30 per cent. beyond normal load in shunt-wound machines and much beyond this in compound and series-wound. The brushes are of carbon, which are of ample section for a low-current density. The bearings are of phosphor bronze and of the self-oiling self-aligning type. Thorough ventilation is provided, giving cool running and a margin for heavy overloads of long duration.

§ 25. **E.C.C. Stationary Bipolar Shunt-wound Dynamo.**—This machine is of the E.C.C. standard upright bipolar type supplied by them for battery charging work, &c., in connection with private house installations. The output is 150 volts, 45 amperes, at a speed of 1,160 revs., and the maximum temperature rise after a full load run on the armature and magnets respectively does not exceed 60°F. and 50°F., the commercial efficiency being 87½ per cent. The general construction of the machine, which exhibits the usual E.C.C. characteristics, both of design and finish, does not call for special comment, the only important point of departure from usual bipolar construction being that the armature is barrel wound, the coils being machine formed; thus the mechanics of the winding are improved and the effectiveness of the heat radiation increased, as shown by the low temperature rise. The machine is mounted upon a massive bed-plate of the usual E.C.C. construction, and provided with two white metal lined self-oiling bearings, the exhibit forming an illustration of a type of machine of which several thousands have been supplied by the E.C.C.

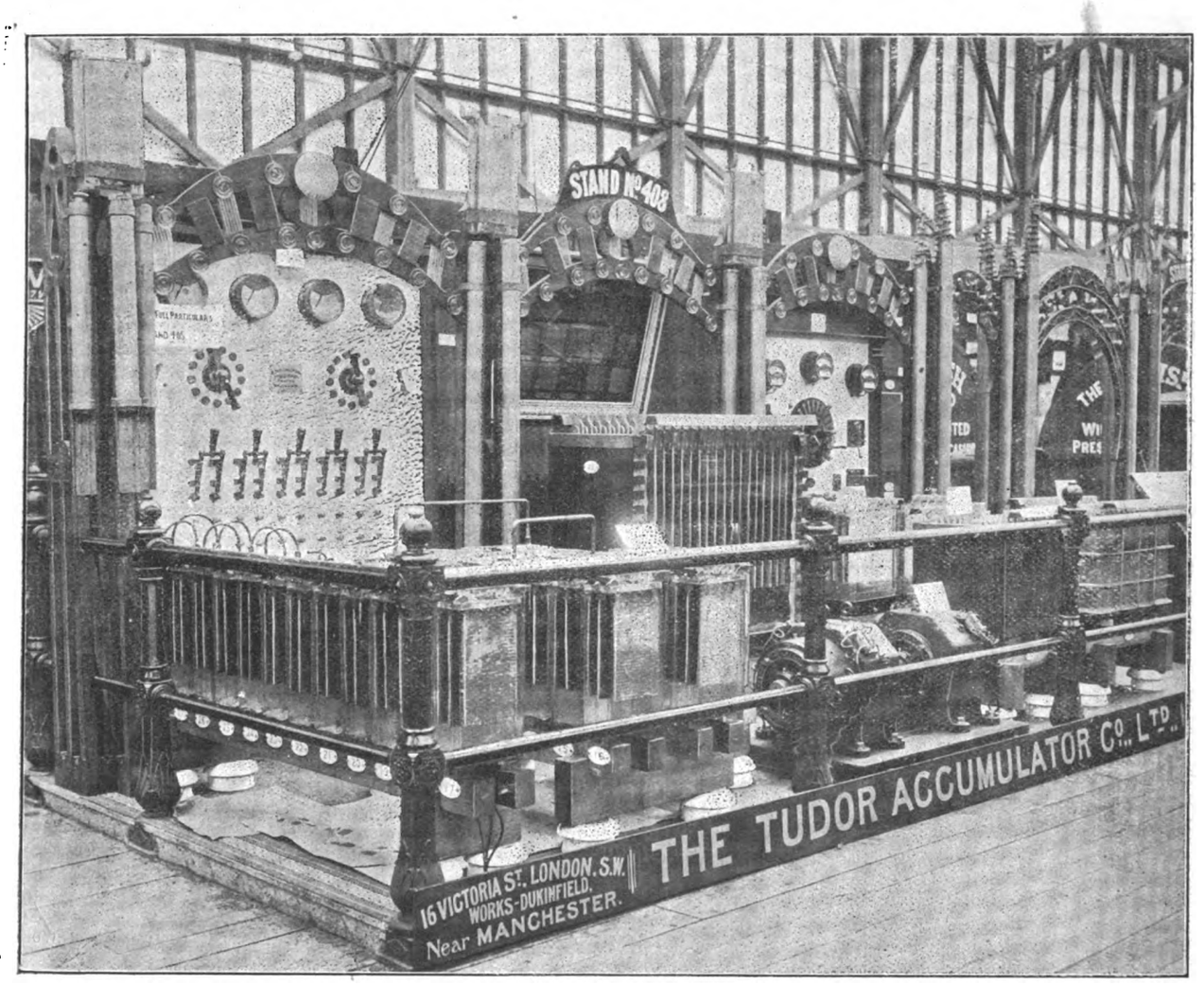


FIG. 20.—THE TUDOR ACCUMULATOR CO.'S STAND.

§ 26. **The Tudor Accumulator Co.'s Stand.**—A view of this stand is shown in Fig. 20. One of the principal features of the Tudor Accumulator Co.'s exhibit is a complete battery composed of 28 Tudor cells, type No. 102 LA 5, having a capacity of 140 ampere-hours. This battery is in working condition, and is an example of the smaller batteries supplied by the company for isolated plant and of their method of mounting. The battery is regularly worked, being charged by a Bruce Peebles motor-generator running off the exhibition mains. In addition to an ordinary complete switchboard, by Messrs. McAulay, Clark and McLaren, which is used for working the battery at the exhibition, there is a complete switchboard provided with an automatic regulating switch. It

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would be too long to give here a full description of this switch, but we understand that it has been used with great success in many private installations, where it keeps a perfectly constant voltage at the lamps without the presence of any attendant during the discharge.

Among the various sample cells exhibited, the most interesting is one of the type No. 130 LC 37, of which one side has been removed to show more clearly the internal arrangement. This cell is capable of giving an output of 1,000 amperes for four hours, and weighs, complete with acid, over 1½ tons. Four batteries, each composed of 102 cells of this type, are already working in sub-stations of the Charing Cross and Strand Company in London, and four more batteries of the same size are to be supplied to the same company before the end of the year, forming by far the largest battery plant in this country.

Samples are also exhibited of all the other types of cells manufactured by the company, both stationary and portable. An example is given of each different sort of box they use—the lead box, which is noticeable for its extremely solid design; the wood box lead-lined, which, while cheaper, is, owing to its careful finish, almost as durable; the moulded glass box, which has the advantage of being very solid and mathematically exact in its dimensions; and for small cells the ordinary clear glass box. There are also shown some portable cells in ebonite boxes for tramcars, motor-cars, and launches, as well as others in teak boxes, with acid-tight lids, for ship lighting and similar work. Samples of the different types of plates are shown, but, except in size and shape, these plates all closely resemble each other. The positives are cast plates, with fine ribs, the large surface being covered with a thin Planté formation. The largest plate shown, known as the "G" type, of which the dimensions are 21in. by 17in., is quite a new type. Hitherto it was found impossible to cast plates of this size with large surface in one piece, and two plates joined up together were used instead, but by recent improvements in the moulds used for casting it will be possible to make plates even larger.

There is an interesting collection of sample Tudor plates, showing their gradual development from the first plates made by Mr. Tudor in 1882 to the present day. Examples are shown of two of the first plates made which had worked for 16 years. It will be noticed that as time goes on the surface of the plates gradually increases, this being the result of improved methods of casting. The earlier plates, down to 1893, were only partially Planté-formed, the capacity being made up by paste on the Planté formation, to the peroxide of which it adhered much better than to an ordinary metallic plate. About then great improvements were made in the Planté process, which, while the essential feature of formation with sulphuric acid only, without the help of other corrosive acid or salts, was greatly quickened and cheapened; from that date all Tudor plates have been formed in this way, the only further developments being in the surface, which has steadily increased.

(*To be continued.*)

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 703.*)

### THE BERLIN ELECTRICAL ELEVATED AND SUBWAY RAILWAY.

Messrs. Siemens and Halske are building a new elevated and subway railway in Berlin which will, when it is completed, afford a most important link of communication in that city. It runs from west to east through the central part of Berlin, but making a slight curve, so that it almost corresponds in position to the District Railway portion of the Inner Circle in London, the existing elevated Ringbahn, which is steam-driven, supplying the outer circle as well as a curved line about equivalent to the Metropolitan or northern portion of the London Inner Circle.

The line starts as an underground, or rather as a subway railway only a very few feet below the surface of the roadway right at the west of Berlin, north of Charlottenburg, and only ascends to the surface after about one-third of the distance is traversed. Fig. 50 is a section of the tunnel as it will be when completed, and Figs. 51 and 52 are from photographs taken shortly before our visit. Fig. 52 is particularly interesting in view of the proposal to build some of these subway railways in London, and suggests that the tube system may be well worth the extra expense in the central parts of the town. The floor of the tunnel will be ballasted, and wooden cross sleepers will be employed. The third rail will be placed at the side of the track. The water is drained off by a gutter between the rails, this leading to a well at the end of the line, from which it is pumped off.

The same trains run through from the viaduct to the tunnel and vice versa, and the grade at the junction is 1 in 38. Figs. 53 and 55 show the general appearance of the girder construction on two different parts of the elevated railway, and Fig. 54 is a view of one of the stations. An interesting point on the line is the so-called "slit house," through which the overhead line passes. The line has to cross a row of houses, and for some reason the house in the direct line of route was not to be pulled down, so half of it is left standing, and a slit cut through the other half, the partition wall being strengthened, and means being taken to deaden vibration. A somewhat similar construction has been adopted at the generating works, a general view of which is given in Fig. 56.

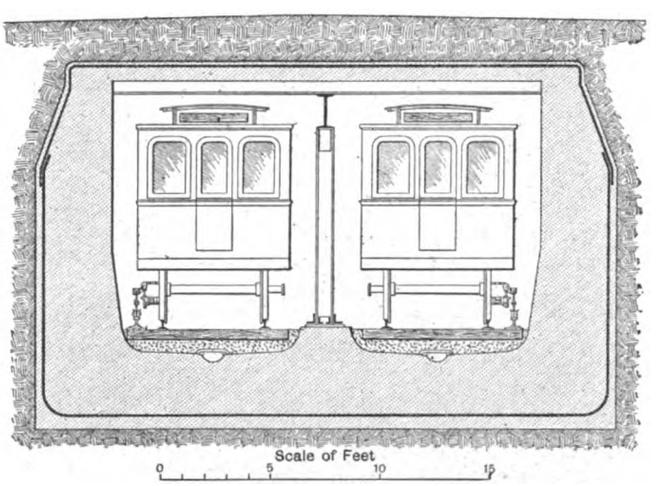


FIG. 50.—CROSS SECTION OF TUNNEL.

On the other elevated portions of permanent way much attention has also been paid to the vibration question, a sort of pumice cement and gravel being employed to deaden the sound. Wooden cross sleepers are used, and the rail-joints are scarfed. The position of the third rails on the inside of the track is seen in Fig. 57, which also shows the detail of the insulating arrangements. The third rails are of iron and are supplied through copper feeders. On the western part of the line the track rails weigh 28kg. per metre, and there is 70cm. between the sleepers, while on the eastern portion a heavier weight of rail has been chosen, viz., 40kg. per metre, with sleepers 1m. apart and fixed directly to the ironwork.

At first the trains will consist of three coaches, the first of which will be a motor car. These will carry 130 passengers, and will weigh together about 75 tons. The trains will probably run at four or five minutes' headway.

Current is supplied from a generating station placed nearly at the central point of the line and near one angle of a triangular junction on two levels where the line meets the Ringbahn by the Potsdamer main railway station. Here are also car sheds and sidings. A section of the power house is shown in Fig. 58, and it must be read in connection with Fig. 56, which explains why it is advantageous to have the boilers and coal supply on the top floor. There are three generating sets, each rated at 800 H.P. for normal

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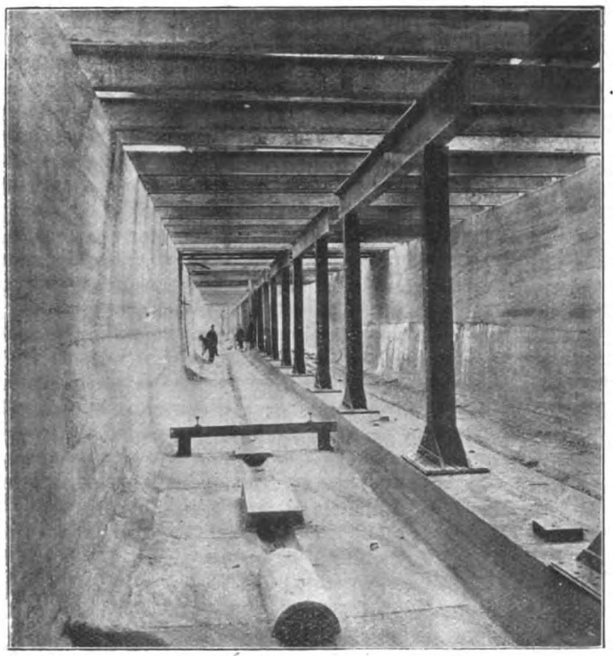

FIG. 51.—INTERIOR OF TUNNEL.

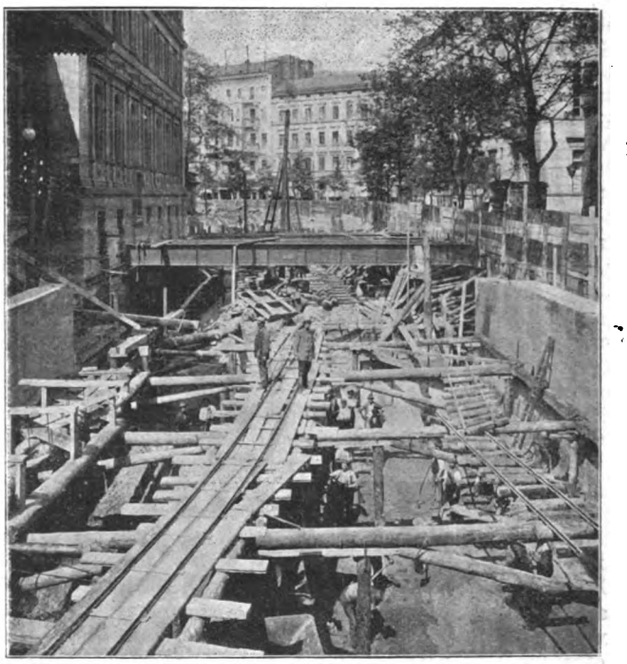

FIG. 52.—EXCAVATION WORK IN PROGRESS NEAR THE POTSDAMER PLATZ.

FIG. 53.—VIEW OF ELEVATED RAILWAY IN GITSCHINER STRASSE.

FIG. 54.—STATION ON THE ELEVATED RAILWAY.

FIG. 55.—VIADUCT ON THE WESTERN PART OF THE ELEVATED RAILWAY.

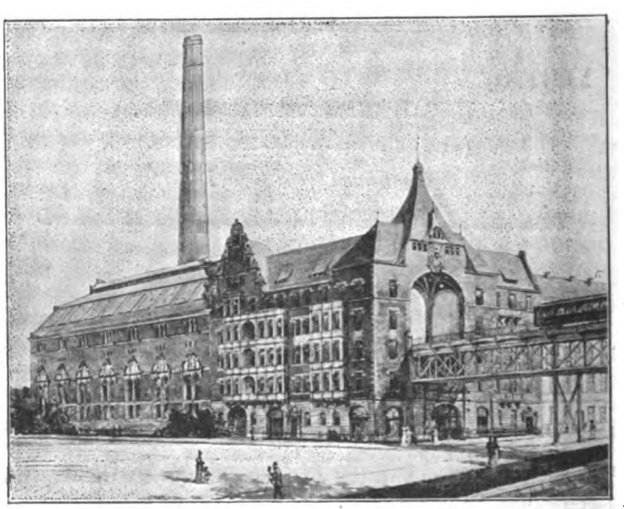

FIG. 56.—GENERAL VIEW OF POWER HOUSE.

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working and capable of supplying 1,200 H.P. on emergency. The engines are vertical cross-compound engines, and they are directly coupled to compound-wound dynamos of the internal pole pattern with ring armatures. These dynamos

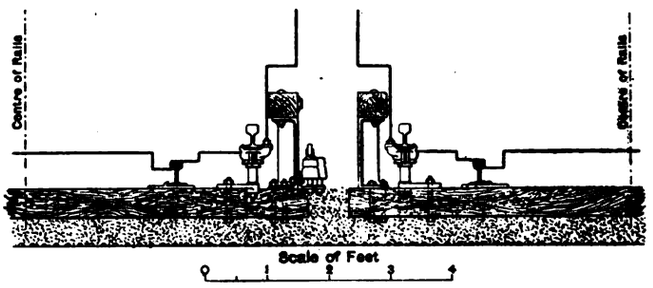


FIG. 57.—ARRANGEMENT OF THIRD RAILS ON VIADUCTS.

are a survival of the old type already referred to in these articles, although they are built specially for these works; the combined armature and commutator have not been adopted,

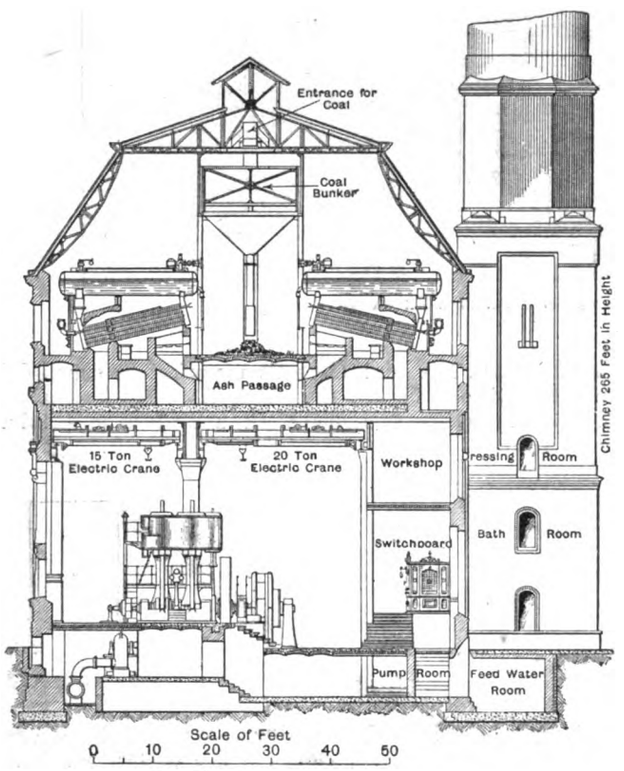


FIG. 58.—SECTION OF POWER HOUSE.

however, the commutator being large, but not the actual outer surface of the armature winding. A 1,200 ampere-hour "buffer" battery is employed, and is charged with the assistance of a booster.

**Electricity in Fire Extinguishing.**—At Rouen (France) the chief of the fire department has submitted a proposal to the municipal authorities on the subject of utilising the tramway trolley wires in connection with the extinguishing of fires. All the principal thoroughfares of the town are provided with electric tramways, and the proposal is that pumps capable of being electrically driven should be installed in a number of suitable positions on the tramway route, to be switched on to the trolley wires, so that the pumps can be used as occasion necessitates. The proposal is said to have been favourably received, and is now under the consideration of the authorities. It has been a cause of complaint against the trolley lines that they interfere somewhat with fire brigade working. The arrangement above foreshadowed, if equitable terms are made with the tramway owners and no undue use is made of the pumping plant, is a feasible development of the applications of electricity for the public good.

## TUNBRIDGE WELLS MUNICIPAL TELEPHONE EXCHANGE.

The municipal telephone exchange at Tunbridge Wells, which started operations with a few subscribers on July 27th, is gradually approaching completion. It is at present quite a small system—so small, indeed, that multiple working has not been introduced—but, as it possesses a few features differing more or less from usual practice, the technical detail of its equipment deserves to be described.

A general view of the switchboard, to which some 400 subscribers are connected at present, is given in Fig. 1, and the peculiarity of the board is the absence of speaking keys, although the ordinary indicator system of calling is employed and not a call-wire system. In place of the speaking key there is a switch beneath the calling plug, shown diagrammatically at S in Fig. 2, R being the ringing key. When the calling plug is in its socket the switch is in the position seen in the diagram, the plugs being connected straight through to the operator's telephone. This position remains unaltered when the answering plug is inserted in the calling subscriber's jack, as there is no switch contact beneath the socket of the answering plug. But, as soon as the plug is lifted, the springs *mm* break contact with the springs *nn* and make contact with the springs *pp*, with the result that the operator's set and ringing key are cut out completely, and the ring-off indicator is bridged across the line. The two coils of this indicator are so wound and connected that a current passing through the two in series does not actuate the indicator, but if a current passes through the two in parallel the indicator works and the flap drops. To ring off, the subscriber has a special key which puts his two lines in parallel to earth, thus closing the circuit of the two coils of the ring-off indicator in parallel, the ring-off battery of 32 cells, and earth. Thus it is seen that, after a connection is made, either subscriber can ring the other without any signal being received in the exchange, and this method of connection also leaves it to the calling subscriber to ring up the subscriber he wants himself instead of leaving it to the exchange operator to do this and see the connection through. Moreover, the exchange operator cannot cut in and hear the conversation without disconnecting the second subscriber. Against these advantages is, of course, the disadvantage that the operator cannot easily ring through to either subscriber once the connection is made, and probably in exchanges with a large number of junction connections other complications would prevail.

The connection to the local jacks on the board is the ordinary one. They are five-point jacks, but the fifth or testing connection is not used yet. The calling indicators are connected to the inner springs, and the two-line wires to the outer springs. The calling indicators are of the usual drop type with hand replacement. In connection with the ring-off indicators is a simple mechanical device by means of which the shutter of the indicator is restored as soon as the plugs are dropped back in their sockets on disconnecting.

As has already been mentioned, multiple connection has not yet been introduced and consequently a rather crude transfer system is at present employed. If a subscriber wishes to communicate with another subscriber out of his operator's reach, the operator switches the calling plug cord into a transfer line jack, at the same time calling out to the operator at the wanted subscriber's section to make a connection between her end of the transfer line and the wanted subscriber's jack.

The groups of 50 indicators seen below the shelf in Fig. 1 are the calling indicators. The ring-off indicators are just above the shelf, behind the plugs, and the row above is devoted to the transfer lines and the junction lines from other exchanges. The indicators on the latter are so combined with the jacks that on plugging the jack the indicaator flap is replaced.

Each panel is for 50 subscribers and has eight cords. The switchboard was made by the Telegraph Manufacturing Co., of Helsby, to the specification of Mr. A. R. Bennett, the consulting engineer to the Corporation. The operators have the usual

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type of head-gear receivers, and breastplate transmitters; they turn down the mouthpiece of the latter after attending to each call.

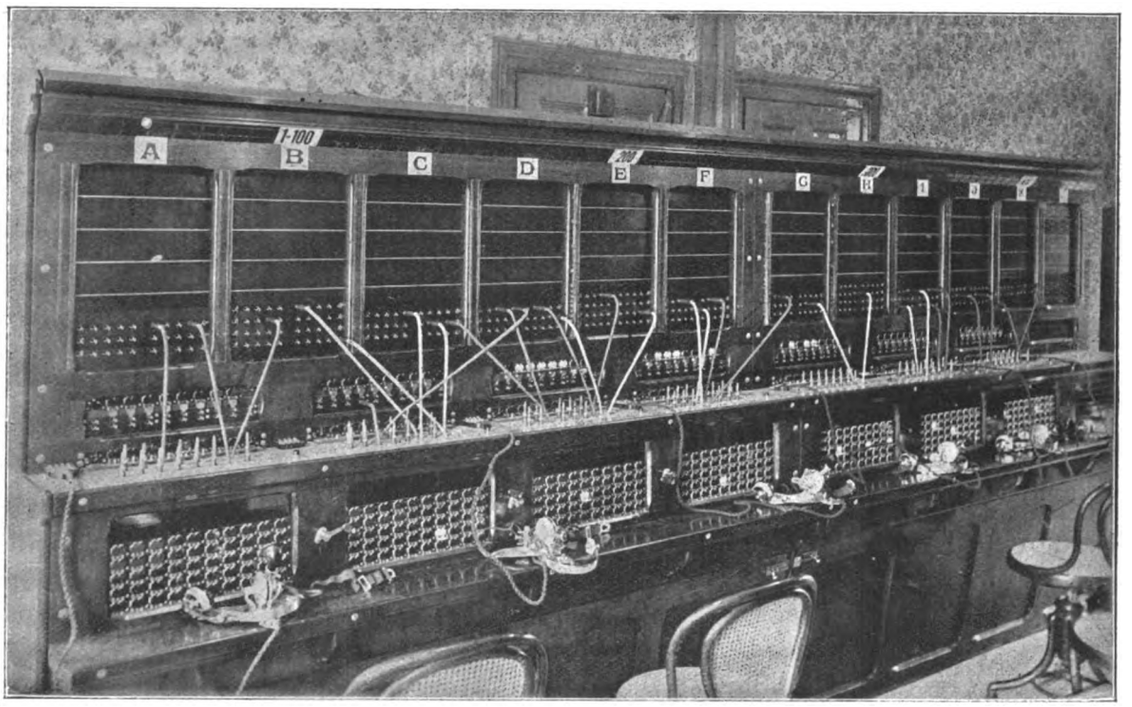


FIG. 1.—SWITCHBOARD AT TUNBRIDGE WELLS TELEPHONE EXCHANGE.

Owing to the absence of a cross-connection board and terminal cable-heads the back of the board looks somewhat untidy. One 312-pair, two 168-pair and one 48-pair underground cable come into the exchange, which is on the ground floor, and the connections between the cables and the switchboard are made in "pot-heads," paraffined cotton wires being connected at the end of the cable and the joint being enclosed in a lead sleeve filled with compound. The wires then go straight to the lightning arresters and thence to the switchboard, there being no test jacks. The lightning arresters are of Messrs. Mix and Genest's manufacture supplied by the International Electric Co. They have spark-gaps, with vulcanised fibre between carbon blocks and a fuse on each line, the clip which holds the latter being so arranged that if a fuse blows an alarm circuit is closed. The cables, which are paper insulated and lead-covered, were supplied by Messrs. W. T. Henley's Telegraph Works Co. Some have No. 22 S.W.G. conductors, and others No. 20 S.W.G., the capacities being 0·067 and 0·075 microfarads per mile respectively. The thickness of the lead-covering is $\frac{1}{10}$in. for the smaller sizes and $\frac{1}{8}$in. for the larger sizes, and the external diameter of the 312-pair cable is $8\frac{1}{2}$in. There is a distributing pole for each 48 pairs, from which overhead wires lead to the subscribers. The insulators used on these poles are of a corrugated type specified by Mr. Bennett; they look most substantial, but they have no inner lip. No. 18 bronze wire is employed for the subscribers' connections and No. 14 copper wire for junction wires. Arrangements are made for drying out the cables if necessary with compressed air, but the plant for this has not yet been put down.

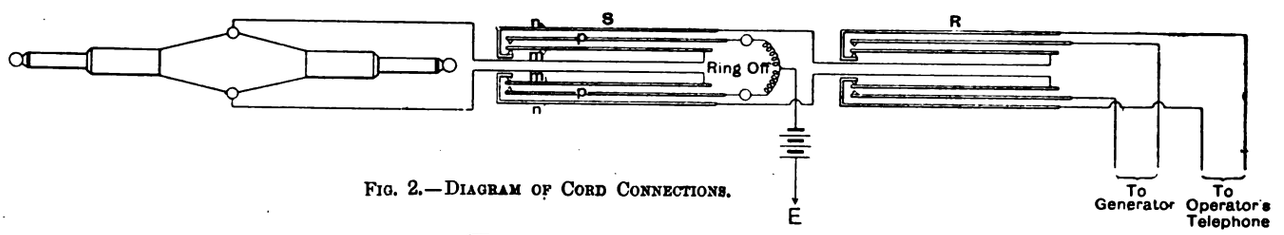


FIG. 2.—DIAGRAM OF CORD CONNECTIONS.

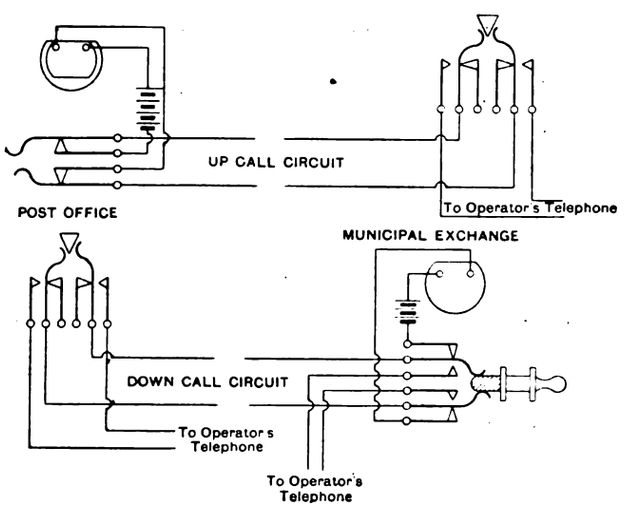


FIG. 3.—SERVICE CIRCUITS FOR TRUNK CONNECTIONS.

The subscriber's wall instruments have been made by the General Electric Co., and resemble the latest pattern with micro-telephones employed by the National Telephone Co., with the exception that the old serrated lightning protector is employed instead of the mica spark-gap type preferred by the company, and that the ring-off push button, which has already been referred to, has been added. The micro-telephones used differ from those given to the National

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Telephone Co.'s subscribers by the omission of the microphone switch in the handle. A large number of Ericsson-Bell table sets are also in use. Both of these sets have the Tunbridge Wells Corporation arms painted on them in vivid colours, so that they cannot be confused with the instruments of the National Telephone Co.

Figs. 3 and 4 show the trunk-line connections which are still to be put in, the trunk working at present being with temporary arrangements. Fig. 3 shows the call circuits and Fig. 4 the actual trunk circuits. In accordance with the system employed by the Post Office and previously described in our columns, all the trunk connections, whether originating from Tunbridge Wells or calling Tunbridge Wells, are treated as in-coming from the Post Office exchange. The Post Office trunk operator selects a junction wire and passes a demand on the call wire to the operator in the municipal exchange, who inserts the answering plug of a special cord into the junction jack and rings up the subscriber. When the subscriber rings off by momentarily earthing his circuit, a current flows through the relays R and R1, first by means of the bridging coils of the subscriber's line and earth, and immediately after, by means of the earth connection made by the relay R. The contacts R and R1 close simultaneously, throwing the clearing battery across the junction circuit and closing the circuit of the clearing indicator. A current at once traverses R2 and the galvanometer at the Post Office, the former thereby opening the circuit of the clearing indicator at the same instant in which it is made by R. At the same time the galvanometer needle is deflected. The Post Office operator thereupon withdraws her plugs causing the current in R2 to cease and thus closes the circuit of the clearing indicator. The municipal operator seeing this withdraws her plugs thus cutting the earth off the relays R and R1 and restoring the junction circuit to its normal condition.

The area over which the Corporation of Tunbridge Wells has powers to supply the telephone service is identical with that of the National Telephone Co. and extends beyond Tonbridge to Hildenborough and Hadlow in the north, to Penshurst, Speldhurst and Withyham in the west, to Lamberhurst, Kilndown and Goudhurst in the east, and southwards to Mayfield.

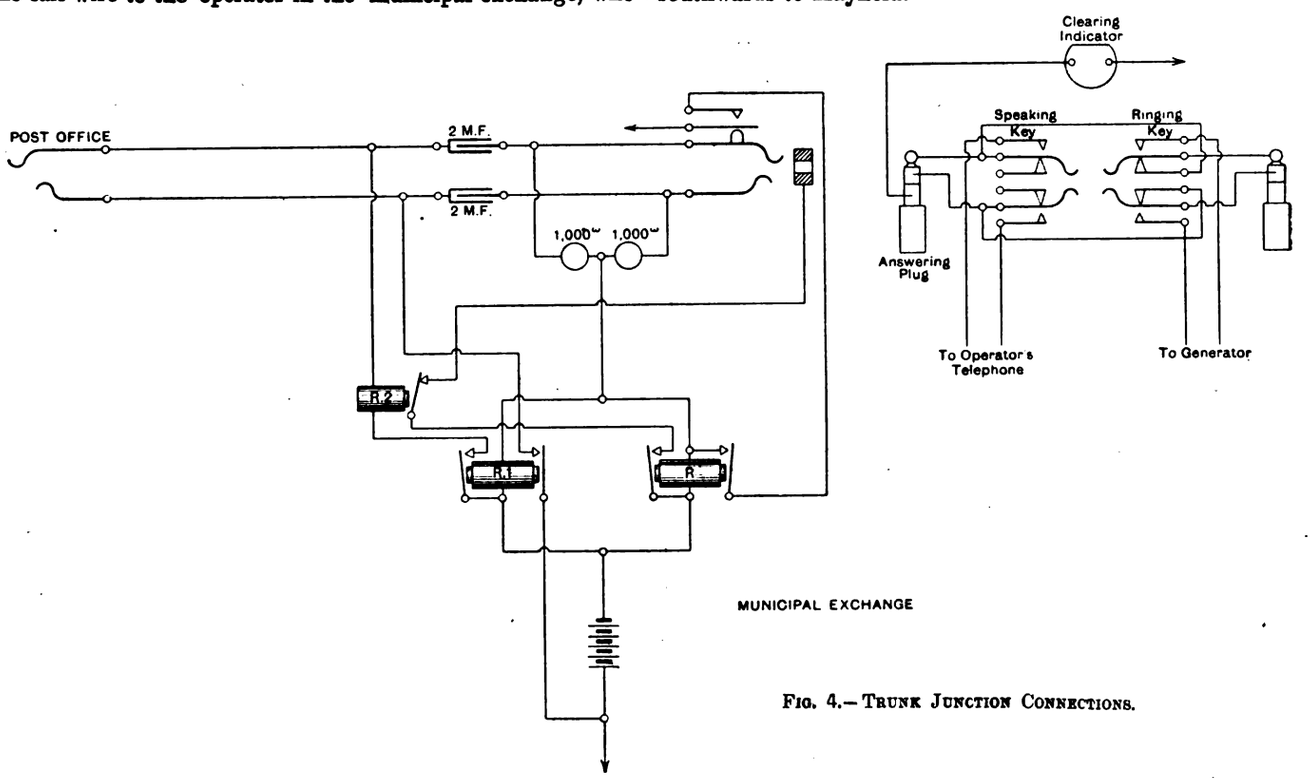


FIG. 4.—TRUNK JUNCTION CONNECTIONS.

Through the courtesy of Mr. Gardner, the engineer and manager, we were enabled to make a thorough inspection of the exchange and also to see some of the subscribers' instruments in use. The subscribers have no difficulty in remembering to ring up their correspondents when they have been put through, as when the connection is made the operator, instead of announcing "You're through," says "Ring No....." The advantages of the special ring-off key are also gradually being appreciated by the subscribers.

## LARGE GENERATORS MADE BY THE ENGLISH ELECTRIC MANUFACTURING COMPANY.

The English Electric Manufacturing Co., it will be remembered, began the manufacture of electrical machinery at their new Preston works in June of last year. Since then, they inform us, they have completed and shipped to their various customers nearly 1,500 tramway motors, varying in size from 25 H.P. up to 100 H.P., and have supplied the necessary controllers, rheostats and car equipment for about 750 cars. The company has not, however, confined itself entirely to the production of tramway equipments, and an important part of their factory is now fully employed in the production of continuous-current generators, both for lighting and power. The company tell us that they have received during the year orders for a large number of these machines, varying in capacity from 100kw. to 1,200kw. Some three months ago the first of these generators was shipped, and since then machines of varying sizes have been forwarded from Preston, not only to the several cities and towns in England, but to South Africa and India.

The Preston generators are extremely simple in design and the number of parts which constitute a complete machine is small. The magnet frame is circular in form and is made of a special quality of cast-iron having a very high magnetic permeability. It is provided with inwardly projecting pole pieces, and is divided horizontally so that the upper half of the frame can be removed for the inspection or removal of the armature. The lower half of the frame is provided with two large feet to ensure a firm footing upon the foundation girders. The poles are made of laminated steel, cast into the magnet frame with a cast welded joint. They are provided with detachable pole shoes which act as keepers or supports for the field magnet spools. Test pieces are taken from every frame casting and submitted to the most careful determination of its magnetic qualities; the sheet steel which is used in making the laminated pole pieces is also submitted to the same test, and any material which does not come up to the required standard is rejected.

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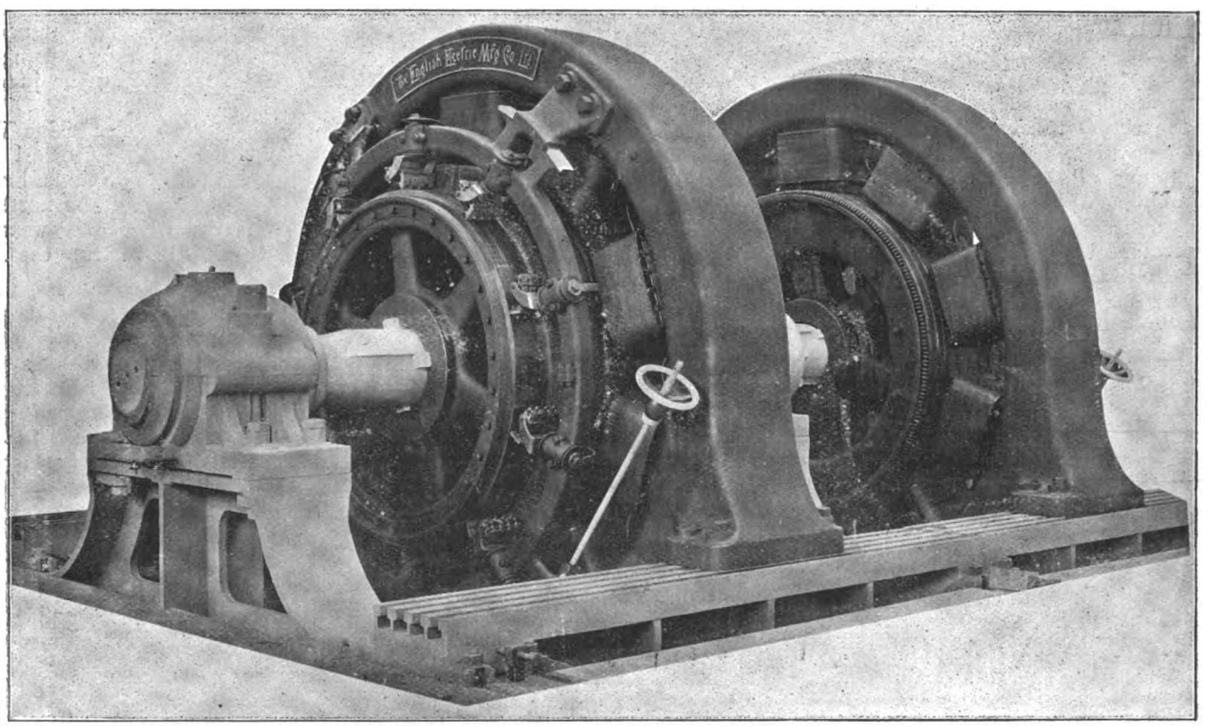
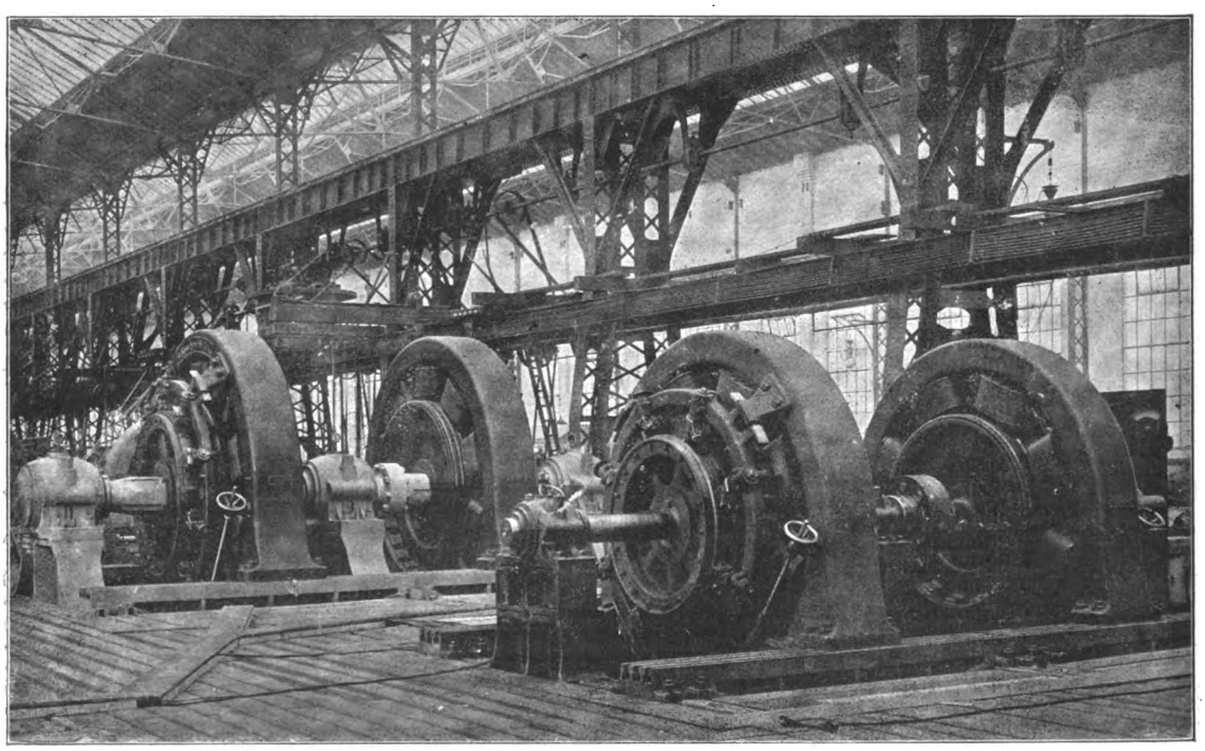
The field coils are wound upon spools made of steel with brass ends, one portion of the spool being occupied by the shunt winding, which consists of double cotton-covered copper wire of 100 per cent. conductivity. The other portion of the spool contains the series winding of ribbon copper, there being only one turn per layer, insulated with mica and cloth. The shunt coils and the series coils are insulated from each other by a combination of mica and red rope paper, and both coils are insulated from the spool by at least ¼in. The finished coils are then dried in a large high-temperature baking oven, where they remain for several days. The varnish in the insulation and that in the covering hardens during the baking process, so that there is no opportunity for moisture to re-enter. These coils, while hot, are subjected to an alternating pressure of 2,500 volts between the windings and the spool or frame of the machine. No joints are made in either the shunt wire or series copper, except at the surface of the coils, where they can be examined and kept tight of the same insulation. After the winding is completed, the surface of the coil is carefully covered with a heavy paper wrapping secured with a layer of braided rope covering, filled with insulating varnish. The pole faces of the magnet cores and pole shoes are bored out after the coils are in place, and the machine set in the position in which it is to run. This permits the frame to take on the form which it



LARGE GENERATORS COUPLED FOR HOPKINSON TEST.



TESTING BEDS AT THE ENGLISH MANUFACTURING COMPANY'S WORKS.

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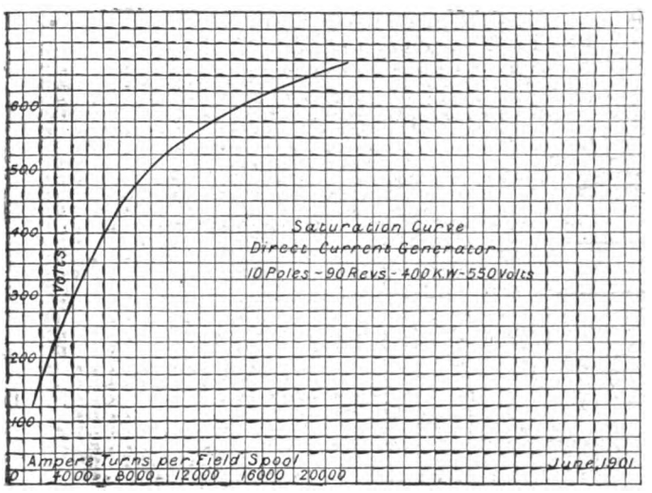
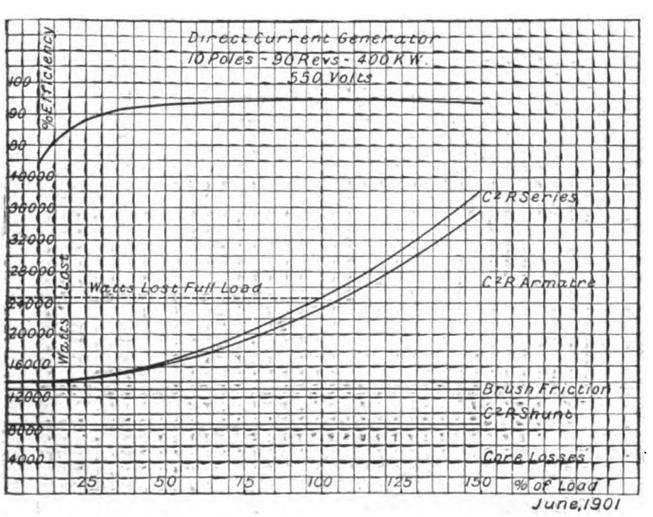
will have when finished ready for service, and ensures the bore being exactly circular to receive the revolving armature.

The armature spider is cast from strong, tough iron, and is so designed that all shrinkage strains are avoided; it is provided with a long bearing surface for the shaft of the engine to which it is to be fitted. It is bored accurately to a gauge supplied by the engine builder, and is made slightly smaller than the diameter of the shaft, so that it requires about 100 tons pressure to force it into position; it is then secured with two keys. The armature core is built on the ends of the arms of the hub, and consists of punchings made from the best electrical steel. Before assembling, the armature laminations are thoroughly annealed and japanned to prevent hysteresis and the


Saturation Curve
Direct Current Generator
10 Poles - 90 Revs - 400 KW - 550 Volts
Volts
Ampere Turns per Field Spool
4000 8000 12000 16000 20000
June, 1901

OPEN CIRCUIT MAGNET CURVE OF 400KW. GENERATOR.

formation of eddy currents. At intervals of 3in. or 4in. spacing discs are inserted between the laminations to form ventilating ducts for cooling the interior of the core and the windings. After a sufficient number of these armature laminations or discs are built together to form the armature ring or core, they are clamped in place by cast-iron flanges which are also made to support the armature windings which extend beyond the ends of the armature core. The periphery of the armature core is provided with open slots made to receive the armature coils. The coils are made by bending copper ribbon over a suitable former, making them all alike and interchangeable.




CURVES SHOWING EFFICIENCY AND LOSSES IN 400KW. GENERATOR.

It is, therefore, easy to wind the armature and to replace injured coils. The armature inductors are thoroughly insulated from the core and from each other with a special material, consisting largely of mica, rendered impervious to moisture by a superior varnish. Like the field coils, the armature coils are subjected to a baking process to dry them. The insulation of the entire armature circuit is subjected to a high-pressure alternating current test while hot.

An extension of the armature spider carries the commutator hub, to which it is securely keyed, thus preventing any relative motion between the commutator bars and the armature windings. On the periphery of the commutator hub the hard-drawn copper commutator bars are firmly clamped by means of steel end rings. The makers inform us that the insulation between the bars and the hub is made from India mica, while that between the bars is made from a peculiar quality of silver amber mica; and that this insulation is so carefully made that in testing between the commutator bars and the hub, the alternating pressure may be made so high that the current will creep over the edge of the mica rings, a distance of from 1in. to 2in., without puncturing. To the back end of the commutator bars, flexible copper leads are riveted, extending radially up to and connecting with the armature windings. The joints are all exposed and can be inspected at any time, so that if repair is required it is only the work of a few moments. The electric pressure between adjacent commutator bars is kept under 10 volts, so that there is no possibility of an arc standing between the bars over the $\frac{1}{32}$nd of an inch space between them. A balancing device is attached to the commutator to equalise any slight difference in the magnetic reluctance of the various magnetic circuits of the multipolar machine, thus checking the slightest tendency to spark.

The brushes used to collect the current from the commutator are made from the purest carbon; they are held in position by brush holders carried on laminated copper strips, having an easy, adjustable pressure which will follow any irregularities in the commutator. The brush holders are so designed that no moving joints carry the current, and are mounted on a massive rocker ring supported by four brackets attached to the generator frame. All of the brushes can be rocked simultaneously by means of a hand wheel and screw geared to the brush rocker ring. Two massive copper cross connecting bars, concealed inside of the brush rocker ring, collect the main current from the brush holders and deliver it to a connection board at the bottom of the machine.

The company has provided two large testing pits near the shipping department, where these large machines are erected and tested. They are run for 10 and sometimes 24 hours continuously, at full load, and are subjected to from 30 to 50 per cent. overload in addition to the all-day run at full load.

The makers give us the following excellent results of a test carried out on a 400kw. machine a few days ago. After running for 10 hours at full load, the machine was made to carry a 50 per cent. overload for two hours, and only showed a rise in temperature of 57°F. above the surrounding air. The commutators at the end of the test did not even feel warm to the hand. The tests which were made upon this machine were by the Hopkinson method, so that the losses in the various parts of the machine were determined and the efficiency arrived at most accurately. We give the curves showing the losses and efficiency and also an open circuit magnet curve.

## THE NEW TELEPHONE EXCHANGE AT MUNICH.*

(*Concluded from page 752.*)

### THE TRUNK LINE OFFICE.

Simultaneously, with the new work in exchange II., one of the boards of the old trunk office was transformed into a trunk junction board for local exchange I., and a new trunk exchange was installed, which in point of completeness in its technical details leaves little to be desired. The new trunk installation is intended to receive a maximum of 100 urban junction wires. At present it is fitted up for 48, and may be easily extended at any time. Lamp signalling is used throughout, and all the parts of the apparatus are of exceptionally solid construction. Fig. 10 gives a general view of the trunk line office.

The transfer board (Fig. 12) has two positions, and is provisionally fitted with 50 call lamps, 50 lamps for indicating whether trunks are engaged ("engaged lamps"), 50 answering jacks and 20 junction jacks. On the keyboard of each position 10 cords, 10 clearing lamps, one control and one call lamp, five speaking keys with five engaged lamps, and 21 combination keys are provided. The calculagraph in the centre for recording the time occupied by conversations is common to both positions.

The incoming trunk lines all pass through the jacks of the transfer board before they are distributed to the various trunk tables. The transfer board has a double function; in the first place, it serves to connect the trunk lines with each other; and, secondly, when there is but little traffic the whole of the trunk connections can be effected at this board by one operator. By this arrangement the multipling of the trunk lines to all the trunk tables is dispensed with. The trunk line tables (Fig. 11), which also have two operators' positions each, are similarly fitted.

The record tables, at which the demands for trunk connections are received and noted, have three operators' positions each. At one table demands for trunk connections are received from exchange I. and

* Abstract from the *Elektrotechnische Zeitschrift*.

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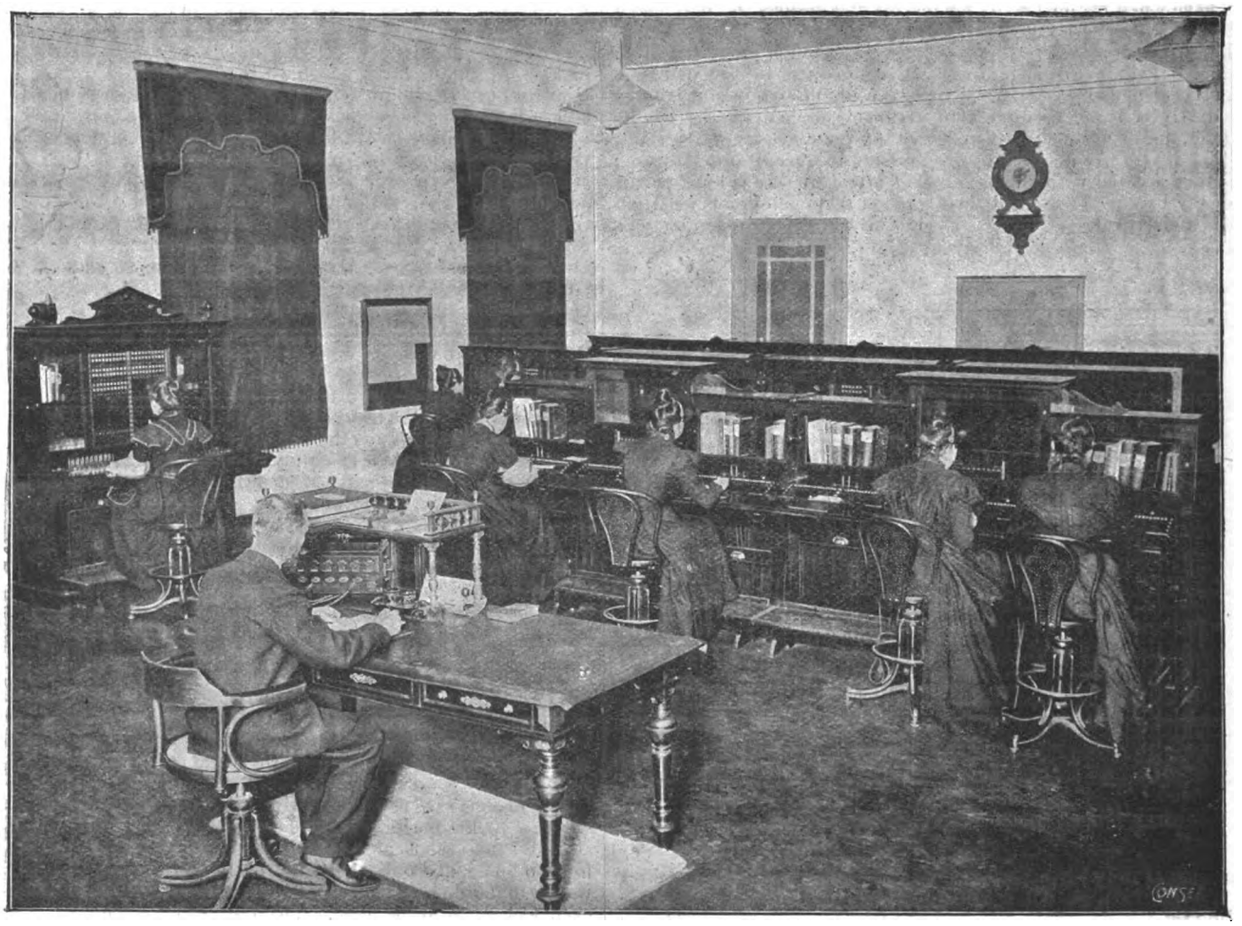

FIG. 10.—GENERAL VIEW OF TRUNK LINE OFFICES.

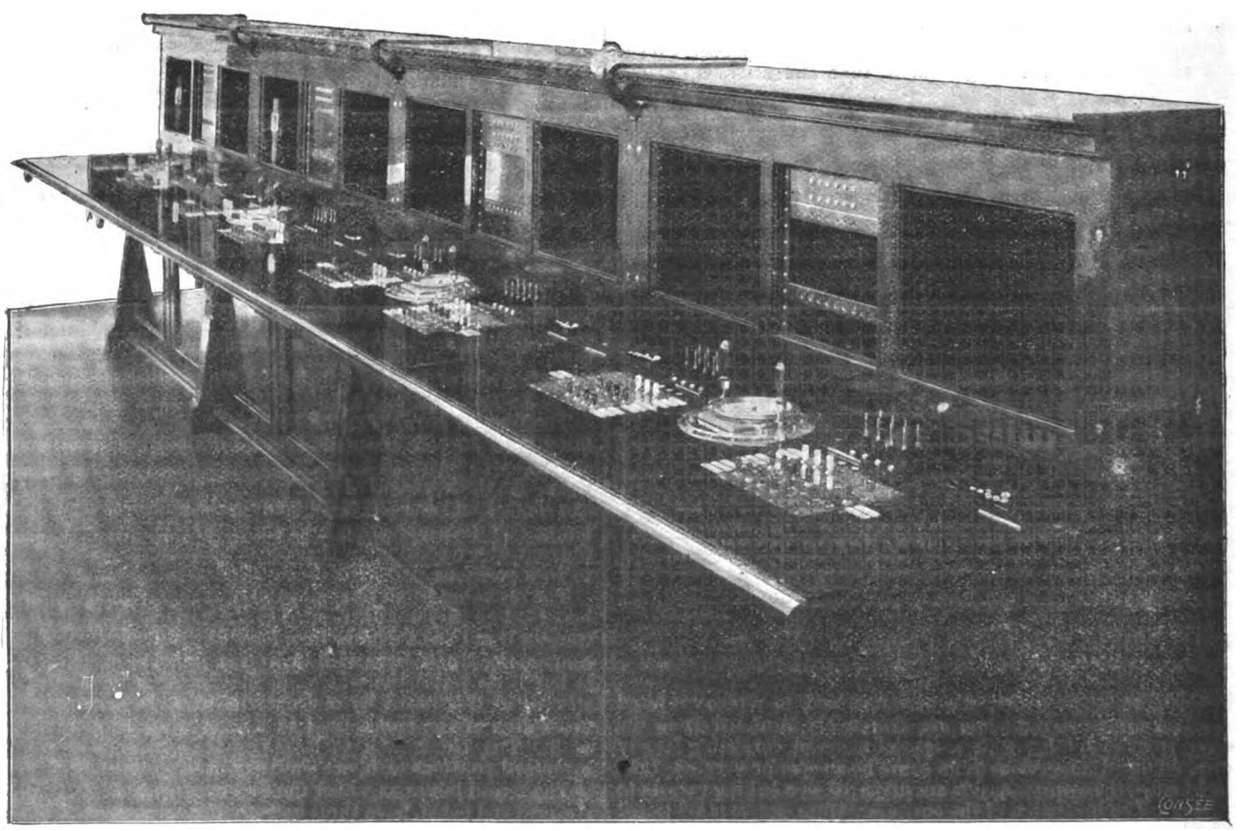

FIG. 11.—TRUNK LINE BOARD.

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at the other from exchange II. They are connected to jacks on the subscribers' board, and a system of automatic signalling indicates to the operator at that board when the subscribers' demand has been noted and his line can be disconnected. On the keyboard of each operator's position, at the record tables there are 30 signal lamps and 30 keys; over these is a control lamp which, in this case, has special importance. Two cords, with plugs, and two combination keys per operator's position, and 10 jacks with outgoing service lines at the central position of each table complete the equipment. If Munich be called up by a distant office—Berlin, for example—(Fig. 13) the calling current, after passing through the jack at the transfer-board goes to the particular trunk table to which the Berlin line has been allocated, and then passes through the jack and key 3 to the main coil of the line relay. The armature of the latter is attracted and the line lamp at the Berlin position lights up. Simultaneously a circuit through the control relay and the retaining coil of the line relay is closed. The control lamp at the Berlin position consequently also glows, and the armature of the line relay is prevented from falling back. The operator takes an answering plug, inserts it in the Berlin jack, pushes back the combination key to the speaking position, and is then connected with Berlin. By the insertion of the plug in the jack the contacts $l$ and $r$ are opened and contact $e_2$ is closed. The main coil of the line relay is thereby cut out of the trunk line and the cut-off relay is actuated. Circuit: Positive pole $e$, $e_1$, contacts $e_2$, $e_3$, $e_4$, coil of cut-off relay, negative pole. The cut-off relay attracts its armature, breaks the contact at $f$, and so interrupts the circuit of the retaining coil. On the insertion of the plug in the jack the Berlin call lamp and the control lamp, therefore, cease to glow; on the other hand, a lamp lights up at the Berlin position and at the transfer board, showing that the Berlin line is engaged. Circuit: Positive pole $e$, $e_1$, contacts $e_2$, $e_3$, the two engaged lamps in parallel, negative pole. The Berlin line is, therefore, cut off from the operators at the transfer board.

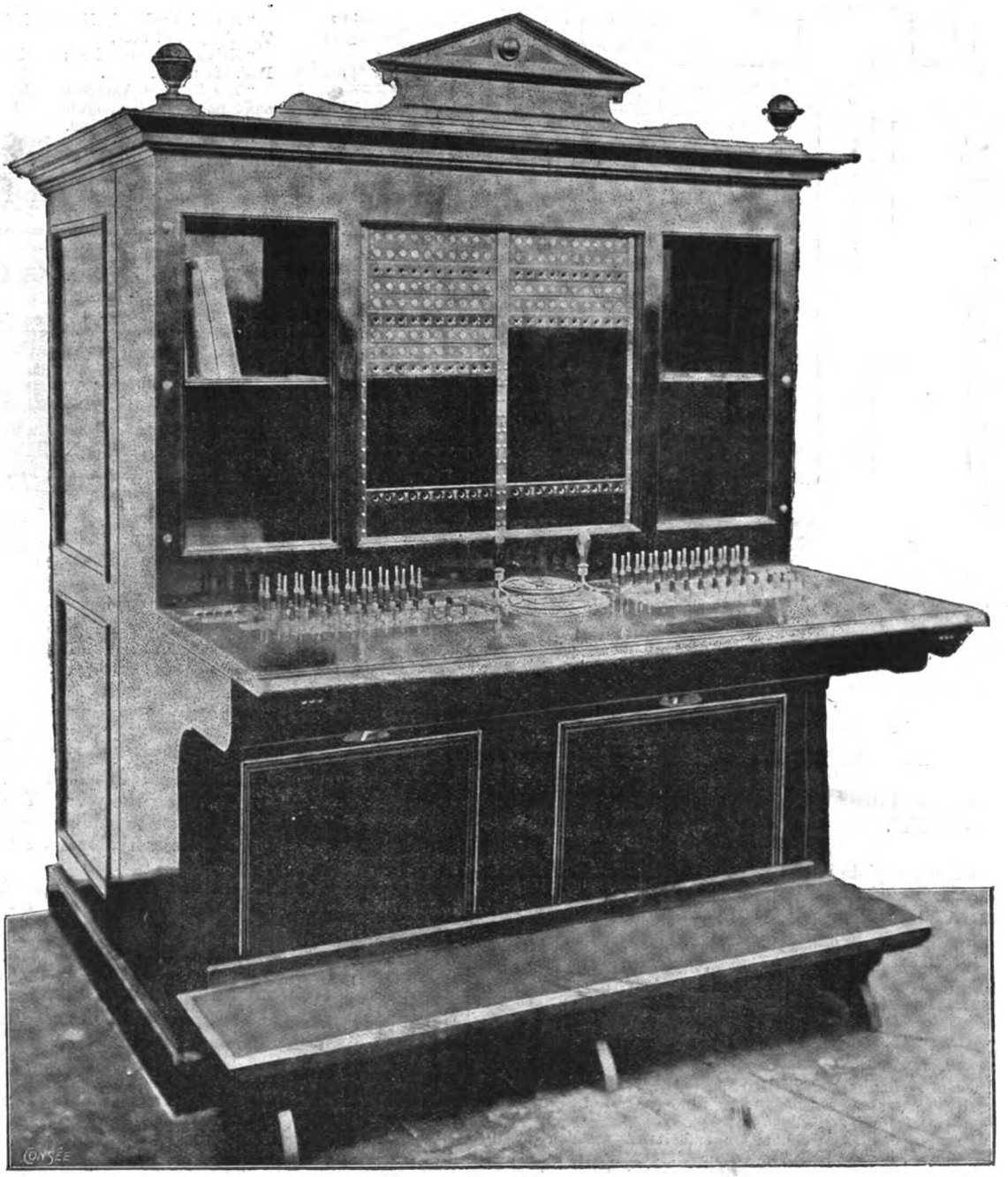

FIG. 12.—TRANSFER BOARD.

Berlin may desire to speak either to a subscriber of a third local exchange—Augsburg, for example—or to a subscriber of the Munich system. In the first case the operator at the Berlin position can herself directly make the desired connection if the Augsburg line is connected to the same trunk table and is disengaged. If this is not the case she passes on the demand to the transfer board by withdrawing her plug from the trunk jack and pulling forward key 3 for a moment, thereby calling the transfer board. She thus causes the Berlin line lamp and the control lamp at the transfer board to



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light up. Circuit: Call battery, B, springs 3 and 2 of the call-switch, $r$, springs $f$ and $e$ of combination key 3, main coil of the line relay for the transfer board and back. The operator at the transfer board receives Berlin's demand and makes the connection with Augsburg.

If Berlin desires to speak to a subscriber of the Munich system the operator at the Berlin position must make a connection with the

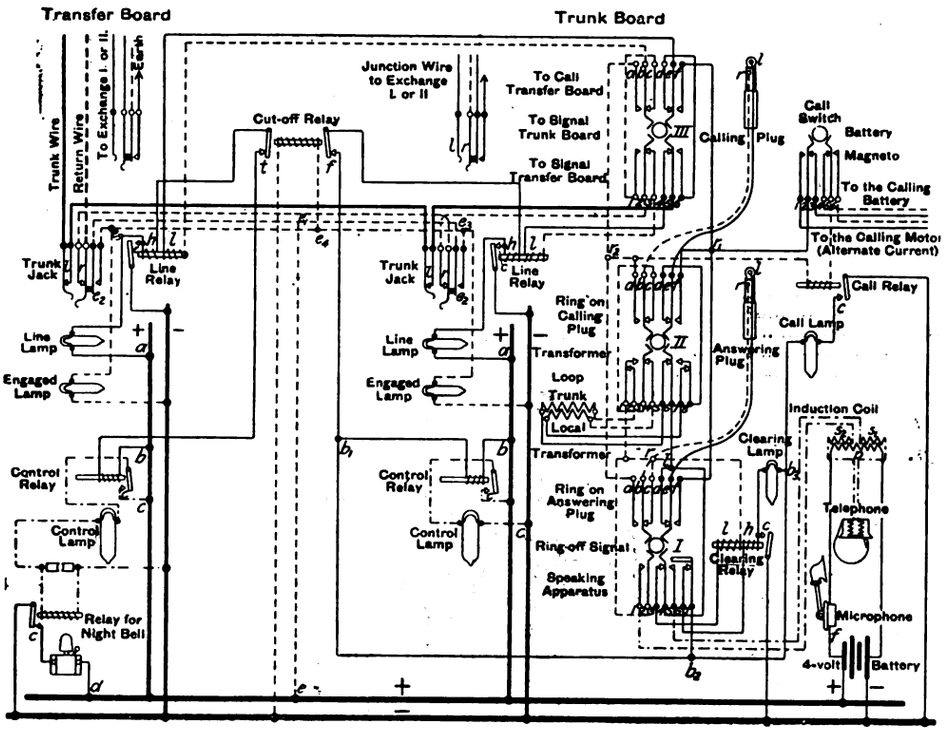


FIG. 13.—TRUNK BOARD.

trunk junction board of that local exchange to which the required subscriber is connected.

The communication between the trunk line office and the two exchanges is organised in a similar way to that between the two exchanges themselves—*i.e.*, by means of speaking wires and junctions.

## LIST OF THE ELECTRICAL PAPERS READ AT THE INTERNATIONAL ENGINEERING CONGRESS AT GLASGOW.

Below is a complete list of the Papers of electrical interest read at the International Engineering Congress, Glasgow, September 3 to September 5, 1901:—

*Section I.—Railways.*

"The Economy of Electricity as a Motive Power on Railways at Present Driven by Steam," by Prof. C. A. Carus-Wilson.

"Modern Practice in Railway Signalling," by I. A. Timmis.

*Section III.—Mechanical.*

"Trials of Steam Turbines for Driving Dynamos," by the Hon. C. A. Parsons and G. Gerald Stoney.

"Rating and Testing of Electrical Machinery," by Gisbert Kapp.

"Some Experiences and Results Derived from the Use of Superheated Steam in Engines," by R. Lenke.

"A Regenerative Steam-Accumulator and its Application to the Utilisation of Exhaust Steam," by A. Rateau.

"Experiments in the Escaping of Water Vapour," by A. Rateau.

"Application of Metric System to Workshops," by Arthur Greenwood.

"Power Required to Drive Marine Engine Works and for Electric Lighting," by James Crighton and W. G. Riddell.

"100-ton Universal Testing Machine, with Variable Accumulator, at the James Watt Laboratories, Glasgow University," by J. Hartley Wicksteed.

*Section IV.—Naval Architecture and Marine Engineering.*

"Notes for Discussion on Electrical Power Supply in Shipbuilding Yards and Marine Engine Works," by Robert Robertson, B.Sc.

*Section V.—Iron and Steel.*

"On the Profitable Utilisation of Power from Blast Furnace Gases," by B. H. Thwaite.

"On Internal Strains in Iron and their Bearing upon Fracture," by Arthur Wingham.

*Section VI.—Mining.*

"Alternating Currents and their Possible Application to Mining," Part 2, by Sydney F. Walker.

*Section VII.—Municipal.*

"Recent Tramway Practice," by James More.

*Section VIII.—Gas.*

"Electrolysis of Gas Pipes, &c.," by Dr. Leybold (Hamburg).

*Section IX.—Electrical.*

"Notes on the Electrical Exhibits in the Exhibition," by W. B. Sayers.

"High-speed Railways," by Herr Lasche (Berlin).

"The Protection of Trolley Wires," by Prof. A. Jamieson.

"Electricity Supply Meters of the Electrolytic Type," by J. R. Dick.

"Kelvin's Electric Measuring Instruments," by Prof. Magnus Maclean.

"The Relative Advantages of the Three, Two and Single-phase Systems for Feeding Low-tension Networks," by M. B. Field.

"Modern Commutating Dynamo Machinery with Special Reference to the Commutating Limits," by H. M. Hobart.

"Continuous-current Dynamo Design," by H. A. Mavor.

## ELECTRICITY WORKS ACCOUNTS.

### Manchester Municipal Electric Supply Works.

We are glad to see that notwithstanding the increased fuel item the aggregate costs for 1900-1 of this undertaking were reduced, although but slightly. A study of our analyses for the last three years will show that with considerable fluctuation in the total expenditure out of revenue the generating costs have, on the whole, improved, but that the chief centres of disturbance have been the management and property charges and the distribution costs. Owing to defective mains the expenditure under distribution in 1899-1900 was higher by 0·29d. per unit than in the preceding year, and while last year the expenses under this head were diminished, they are still comparatively high. The management and property charges have again risen—this time through the management costs. At 0·586d. per unit they are, we think, considerably higher than they should be considering the order of the output and the favourable load factor of 12·95 per cent. which averaged during the year. The total generating and works costs continue to exhibit excellent figures. The fuel item at 0·443d. was remarkably low considering the condition of the coal trade.

In consequence of the delay which has occurred in completing the Bloom-street generating station for supply, the electrical committee have had to decline applications for current. It is anticipated that a part of the first installation of 15,000 H.P. which is being installed in the Stuart street generating station will be ready to supply electricity by the end of next May. The committee will then be in a position to work most of the tram routes electrically.

### Crystal Palace District Electric Supply Co. (Ltd.).

In our second table we have summarised the accounts for 1900 of the Crystal Palace Company. Owing to the disastrous boiler explosion which occurred in July last year the supply of current was completely stopped for two months and the working of the station deranged for the rest of the year. In these circumstances a comparative study of the cost figures is out of the question. Besides the great indirect loss occasioned by the stoppage and dislocation a direct loss of £574 was sustained after crediting the amount recovered from the insurance companies. This amount we have shown charged on the net revenue and not included in the costs. One result of the reconstruction of the station will be probably lower costs arising out of the improvements introduced, and we are glad to learn that the demand for current is making progress in spite of the loss of confidence occasioned by the breakdown.

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| | MANCHESTER. | | Crystal Palace Dist. |
|---|---|---|---|
| *Undertaking Worked by* | Manchester Corporation. | | Crystal Palace Dist. Elec. |
| *Date of Commencement of Supply* | August, 1893. | | Feb. '93. [Sup. Co., Ltd. |
| *System of Supply* | Continuous-current 5-wire and 3-wire system. | | H.-P. con.-cur. trans. by dynamotors and accumulators in sub- |
| *Chief Engineer* | G. F. Metzger. | | A. L. Phillips. [stat. to 100 v. |
| **YEAR ENDED** | MAR. 31, **1900.** | MAR. 31, **1901.** | DEC. 31, **1900.** |
| **QUANTITIES—** | | | |
| Units generated | 6,927,396 | 9,639,973 | 464,961 |
| „ **SOLD (TOTAL)** | **6,355,872** | **7,794,098** | **268,657** |
| „ sold to consumers | 6,312,182 | 7,750,548 | 260,334 |
| „ sold for public lighting, &c. | 43,690 | 43,550 | none |
| „ used on works | 112,533 | 150,442 | 8,323 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | **34·6** | **34·4** | **10·1** |
| Maximum supply demanded | 5,607 kilowatts | 6,876 kilowatts | 329·6 kilowatts |
| Number of public lamps | 26 arc | 29 arc | nil |
| Number of consumers | 3,240 | 3,790 | 284 |
| Connections to mains in 8-c.p. lamps | 290,284[a] | 445,176[i] | 31,200 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | **183,700** | **226,300** | **26,700** |
| **CAPACITY OF PLANT IN KILOWATTS** | **5,880** | **7,250** | **855** |
| **CAPITAL—** | **Total. / Per kilowatt capacity.** | **Total. / Per kilowatt capacity.** | **Total. / Per kilowatt capacity.** |
| **AUTHORISED (TOTAL)** | **£694,121 / £118** | **£884,011 / £122** | **£150,000 / £175** |
| Share | — / — | — / — | 75,000 / 87·7 |
| Loan (including Debenture charges) | 694,121 / 118 | 884,011 / 122 | 75,000 / 87·7 |
| **RECEIVED (TOTAL)** | **605,511 / 103** | **790,111 / 109** | **103,519 / 121** |
| Share | — / — | — / — | 47,859 / 56·0 |
| Loan (including Debenture charges) | 605,511 / 103 | 790,111 / 109 | 55,660 / 65·1 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | **88,610 / 15·1** | **93,900 / 13·0** | **46,481 / 54·4** |
| Share (unissued) | — / — | — / — | 27,141 / 31·7 |
| Share (uncalled) | — / — | — / — | — / — |
| Loan (including Debentures) | 88,610 / 15·1 | 93,900 / 13·0 | 19,340 / 22·6 |
| **REPAID (TOTAL)** | **49,233 / 8 37** | **67,838 / 9·36** | **— / —** |
| **RESERVE OR SINKING FUND** | nil / — | nil / — | — / — |
| **DEPRECIATION FUND** | 13,696[b] / 2·33 | 13,172 / 1·82 | 300 / 0·351 |
| **EXPENDED (TOTAL)** | **641,822 / 109** | **863,293 / 119** | **107,876 / 126** |
| Lands and buildings | 132,368 / 22·5 | 165,441 / 22·8 | 10,253 / 12·0 |
| Plant | 169,225 / 28·8 | 214,081 / 29·5 | 52,414 / 61·3 |
| Mains | 338,890 / 57·7 | 482,332 / 66·5 | 43,552 / 50·9 |
| Miscellaneous | 1,338 / 0·227 | 1,439 / 0·198 | 1,658 / 1·94 |
| **BALANCE OF CAPITAL ACCOUNT** | **−36,311[c] / −6·18** | **−73,182[c] / −10·1** | **−4,357[b] / −5·10** |
| **REVENUE—** | **Total. / Per unit sold** | **Total. / Per unit sold** | **Total. / Per unit sold** |
| **TOTAL** | **£86,241 / 3·259d.** | **£101,481 / 3·122d.** | **£5,695 / 5·090d.** |
| Revenue from supply | 85,589 / 3·233d. | 100,888 / 3·106d. | 5,274 / 4·713d. |
| „ meters, &c. | 184 / 0·007d. | 231 / 0·007d. | 171 / 0·153d. |
| „ public lighting | 364 / 0·014d. | 363 / 0·011d. | — / — |
| „ sale of lamps, &c. | — / — | — / — | 250 / 0·223d. |
| „ miscellaneous sources | 104 / 0·004d. | — / — | — / — |
| **EXPENDITURE OUT OF REVENUE—** | | | |
| **TOTAL COSTS** | **£49,848 / 1·882d.** | **£59,138 / 1·821d.** | **£5,692 / 5·086d.** |
| **WORKS COSTS** | **35,197 / 1·329d.** | **40,094 / 1·234d.** | **4,220 / 3·772d.** |
| *Generation of electricity* | *23,103[d] / 0·873d.* | *28,652[j] / 0·883d.* | *3,257 / 2·913d.* |
| Fuel (including cartage, &c.) | 10,376 / 0·392d. | 14,315 / 0·440d. | 2,052 / 1·833d. |
| Oil, waste, water, stores | 3,208 / 0·121d. | 2,867 / 0·088d. | 199 / 0·178d. |
| Wages at station | 4,127 / 0·156d. | 4,138 / 0·127d. | 361 / 0·323d. |
| Repairs and maintenance at station | 4,308 / 0·162d. | 6,251 / 0·192d. | 644 / 0·576d. |
| *Distribution of electricity* | *12,094 / 0·457d.* | *11,442 / 0·352d.* | *963 / 0·861d.* |
| Wages, &c. | 2,226 / 0·084d. | 2,223 / 0·068d. | 227 / 0·203d. |
| Repairs, renewals of mains, &c. | 9,868 / 0·373d. | 8,607 / 0·265d. | 736 / 0·658d. |
| *Public lighting* | — / — | — / — | — / — |
| Attendance | — / — | — / — | — / — |
| Renewals | — / — | — / — | — / — |
| **MANAGEMENT AND PROPERTY CHARGES** | **14,651 / 0·554d.** | **19,044 / 0·586d.** | **1,472 / 1·316d.** |
| *Royalties* | — / — | — / — | — / — |
| *Rent, rates, taxes* | *6,564 / 0·248d.* | *6,947 / 0·214d.* | *881 / 0·789d.* |
| *Management* | *8,087 / 0·305d.* | *12,097 / 0·372d.* | *591 / 0·528d.* |
| Salaries | 4,856 / 0·183d. | 6,220 / 0·191d. | 290 / 0·259d. |
| Stationery, &c. | 862 / 0·033d. | 984 / 0·030d. | 44 / 0·039d. |
| Establishment charges | 1,093 / 0·041d. | 1,688 / 0·052d. | 151 / 0·135d. |
| Law charges, &c. | 1,276[e] / 0·048d. | 3,205[k] / 0·099d. | 106 / 0·095d. |
| **FINANCIAL RESULTS—** | **Total. / % to mean cap. exp'nded** | **Total. / % to mean cap. exp'nded** | **Total. / % to mean cap. exp'nded** |
| **WORKING PROFIT FOR YEAR** | **£36,393 / 6·41%** | **£42,343 / 5·63%** | **£3 / 0·003%** |
| Sum carried to Depreciation Fund | 1,193 / 0·210% | −135 / −0·018% | } 300 / 0·304% |
| Sum carried to Reserve or Sinking Fund | 12,935 / 2·28% | 18,605 / 2·47% | |
| Net interest on loans (including Debenture charges) | 14,265 / 2·51% | 19,873 / 2·64% | 2,110 / 2·14% |
| **BALANCE FROM LAST ACCOUNT** | **2,000 / 0·352%** | **— / —** | **— / —** |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | **10,000[f] / 1·76%** | **4,000[f] / 0·532%** | **— / —** |
| *Deficit* | — / — | — / — | *2,980[d] / 3·02%* |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 57·8% | 58·3% | 99·9% |
| Expenditure per kilowatt capacity | £8. 9s. 7d. | £8. 3s. 2d. | £6. 13s. 2d. |
| **REVENUE PER KILOWATT CAPACITY** | **£14. 13s. 2d.** | **£14. 0s. 0d.** | **£6. 13s. 2d.** |
| Expenditure per 8-c.p. lamp capacity | 5s. 5d. | 5s. 2¾d. | 4s. 3d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | **9s. 4½d.** | **8s. 11¾d.** | **4s. 3d.** |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | **5s. 11½d.** | **4s. 6¾d.** | **3s. 7¾d.** |
| Price charged for lighting, per unit | 5d.[g] | 5d.[g] | } 6d. to 4½d.[a] |
| Price charged for power, per unit | 5d.[h] | 5d.[h] | |
| Price charged for public lighting | 2d. per unit. | 2d. per unit. | — |

**MANCHESTER.**—REMARKS—*a* Includes 2,139, equivalent of arcs and 51,000, as equivalent of motors representing 2,050 h.p. capacity. *b* Including balance of renewals suspense account. *c* Over-expended. *d* Includes £409 for electricity and £121 for lamps for lighting of works. *e* £28 to insurance, £122 to Manchester Corporation Thrift Fund and £88 official clothing. *f* Paid to City Fund. *g* From October, 1899, with option of charge at 1¼d. per unit and £1. 15s. per quarter per unit of demand. *h* From October, 1899, as lighting charge with alternative of 2½d. per unit except where all motors run for 48 hours per week, when fixed charge of £1. 15s. per quarter is remitted and current charged at 1¼d. per unit. *i* Including 672 motors aggregating 6,560 h.p. and 2,316, the equivalent of arcs. *j* Includes £382 for electricity and £115 maintenance of lamps for lighting of station. *k* Inclusive of £28 insurance, £143 bank commission, £181 Manchester Thrift Fund, £495 commission on loans and £159 official clothing.

**CRYSTAL PALACE DISTRICT.**—REMARKS—*a* 6d. per unit for first six units per 8 c.p. lamp per quarter, 5d. for second six units and 4½d. per unit for all over 12 units per 8 c.p. lamp per quarter. *b* Over-expended. *c* Includes law £37, auditing £48 and trustees' fees £21. *d* After adding £574 loss arising from boiler explosion. This deficit is met "by interest waived on 6 per cent. mortgage debentures, £3,125," £145 being carried to balance-sheet.

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Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

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*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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## THE INTERNATIONAL ENGINEERING CONFERENCE.

Engineering has played such an important part in the material civilisation of the nineteenth century that it was eminently fitting, in connection with the commemorative exhibition at Glasgow, to hold an International Congress of Engineers. The points of contact with engineering in the civilisation of past ages have been very few, being confined in fact to such matters of civil engineering as the construction of roads, canals, and bridges, and, in military engineering, to the design of somewhat crude weapons of warfare and of defence. These earlier civilisations were, in their outward and more material aspects, far more closely associated with architecture and with art than with the practical applications of science for the use and convenience of man. It is, by the way, curious to observe that precisely in these respects has the civilisation of the nineteenth century been defective, originality either in architecture or in art not being at any time its characteristic feature. The points of contact of nineteenth century civilisation with the applications of science have carried engineering far beyond the limits of what is commonly known as civil engineering, and have brought into existence manifold separate branches of engineering, each, however, bearing an intimate relationship with every other branch. Civil engineering in its broadest sense —*i.e.*, comprising every branch of engineering except the military and naval—has done more than any other material influence during the past century to consolidate the peaceful relationships between nations; it has bound them together in manifold common interests, and has facilitated rapid interchange of ideas, tending always to make peaceful relationships more politic and desirable than aggressive militarism. It is claimed even for military engineering by some of its more enthusiastic admirers that this also tends indirectly to the preservation of peace; certainly, at any rate, the more terrible the consequences of war brought about by advances in military engineering, the greater must be the hesitation on the part of civilised nations to undertake so great a risk. Abundantly justified, therefore, was Mr. Mansergh's panegyric on engineering in his presidential address to the Congress.

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It is always interesting to trace to their origin events of such importance as the recent Congress. To the Council of the Institution of Engineers and Shipbuilders in Scotland is due the honour of having been the first to originate the idea, and to set in progress the formation of this Engineering Congress. Two years ago the idea was mooted, and, acting quite unofficially, the members of the Council approached the leading engineering institutions in Great Britain on the subject. Naturally, in the initiation of so great and original a scheme, many difficulties and some degree of opposition were met with, but gradually every obstacle was surmounted and a programme was drawn up with which it would be very difficult to find serious fault.

Considering the unanimity among members as to the striking success of the recent Congress, there can no longer remain any doubt, if any ever existed, about the utility of such conferences to engineers. We repeat the hope we expressed last week, that it will be found practicable for the leading engineering institutions of Great Britain to unite in arranging for similar conferences to be held regularly, at intervals of a few years. The value of such a congress to engineers is manifold. Firstly, its international character promotes a friendly relationship of a personal nature between engineers of different countries, who are thus led to understand better the principles and methods which each nation adopts. This tends to greater unification of the engineering practice of civilised countries, and there are few who will assert that existing differences in practice are not in most instances prejudicial to the commercial interests of all countries concerned. Secondly, the international discussion of important engineering topics, whether embodied in formal Papers or merely brought forward during conversation, broadens knowledge and reacts advantageously upon practice. In the next place it is to be observed that by means of the discussions each branch of engineering is enabled to note not only its own progress, but also that of its allies and of its rivals. Electrical engineers, for example, during the recent conference, have been enabled to listen to discussions affecting rival methods of lighting and of traction, as well as to attend the sectional meetings of those branches of engineering with which electricity is closely associated. We do not wish to imply that an engineer is unable to do this except he attend some such conference as that at Glasgow, but the great convenience of numerous branches of engineering being discussed simultaneously within the same building greatly facilitates this form of study. It may be mentioned, too, that the close proximity of the exhibition has given engineers many an interesting and useful object lesson over which to compare notes in the intervals between the meetings.

Turning now to the Papers read in the Electrical Section of the Congress we must certainly award the palm to that read by Herr LASCHE, of Berlin, on Wednesday, the 4th inst. Probably no more important question is occupying the attention of electrical engineers of all countries at the present moment than that brought forward by Herr LASCHE in his Paper on "High-Speed Railways." It is somewhat regrettable, however, that the trials of the locomotive described in the Paper have thus far been carried out only with the locomotive mounted on rollers, or, as Mr. ALEXANDER SIEMENS expressed it, "running stationary." Between the conditions thus established and the actual practical conditions when running on a track there is a great gulf fixed; many of the most vital considerations affecting high-speed working are ignored in the former arrangement, such, for instance, as the effect of the momentum of the locomotive itself and of the train drawn by it, as well as the influence of curves and gradients. The subject of Herr LASCHE's Paper, in fact, must be carefully divided into two distinct parts which have no necessary relationship with one another—viz., the use of high pressures, and the adoption of high speed. High pressures can be used on existing lines, and the burning question whether high-pressure alternating currents or continuous currents of lower pressure are the better for railway traction under ordinary conditions can as easily be settled on railways already constructed as upon specially built tracks. Such is not the case, however, with high speeds—*e.g.*, 124 miles an hour; we entirely agree with several of the speakers in the discussion on Herr LASCHE's Paper that the curves and gradients of ordinarily built railways would render these speeds prohibitory. Indeed, even on a straight portion of ordinary railroad track, such speeds would almost certainly require radical differences in track construction and in the shape and size of the rail. Fortunately, the experiments described by Herr LASCHE are on the eve of taking the more practical form, and we shall soon learn what are the conditions of running locomotives, on straight tracks at any rate, at the high speeds specified. Moreover, it is to be hoped that in our own country no great length of time will elapse before a similar experiment is tried on an actual commercial scale: we refer to the projected high-speed railway between Liverpool and Manchester. The next Paper in importance was that read by Mr. M. B. FIELD, of the Glasgow Corporation electric tramways. This Paper elicited a very useful discussion on the relative advantages of single-phase and polyphase systems for feeding low-pressure networks of mains. The two Papers by Mr. H. M. HOBART and Mr. H. A. MAVOR, on questions relating to the design of dynamos, led to a useful joint discussion. With regard to the other Papers, it is, perhaps, regrettable that a Paper so apparently alarmist as that by Prof. JAMIESON, on the dangers arising from trolley wires, should have been read in the Electrical Section; but, judging from the pleasant smile on the Professor's face throughout the time he was reading his Paper, we imagine that the alleged dangers are not to be taken very seriously, being more imaginary than real. Mr. J. R. DICK's Paper on "Electricity Supply Meters of the Electrolytic Type," although of interest to central station engineers, dealt with a subject insufficiently broad in its scope to merit being brought before an international congress of engineers. Prof. MAGNUS MACLEAN's Paper, describing "Kelvin's Electric Measuring Instruments," serves as an appropriate tribute to the genius of Lord KELVIN, the honorary president of the Congress, with whom the University of Glasgow will be indissolubly associated in the minds of every member of the electrical profession. With regard to the electrical Papers read in other sections of the Congress our readers are referred to the article, which we commence this week, giving a summary of the electrical proceedings, also to a complete list of electrical and allied Papers, which will be found in another column.

## OBITUARY.

### RICHARD SPILMAN CULLEY.

The annoucement of the death of Mr. Culley will come as a surprise to those who remember him many years ago, when he was then apparently an aged man and retiring disabled from the public service. He survived his retirement, however, for nearly a quarter of a century, although the immediate cause of it was an accident which might have shortened the life of any ordinary man. But Mr. Culley was by no means ordinary. A lifelong sufferer from an obscure and irritating ailment which left him no physical enjoyment of life, he yet contrived to prolong it to the ripe age of 83 by an abstemiousness of living so strict that, associated as it was

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with laborious study and untiring work, made him a singular and remarkable personality to all who came in contact with him. Joining the Electric and International Telegraph Co. at the age of 28 he speedily occupied a position of responsibility in the northern district of that company's system. Subsequently he took up the superintendence of the West of England; and it was from this position that he came to London as the company's chief engineer in succession to Mr. Cromwell Varley. Before that date, however, Mr. Culley had made himself famous in the electrical world by publishing the "Handbook of Practical Telegraphy," which will be ever associated with his name. Originally issued in 1867, it was the first work of the kind ever attempted, and has passed through many editions—greatly enlarged—since then, and has been translated into most of the Continental languages. It was one of the best handbooks ever written on that or any other subject, embodying as it did thorough practical knowledge with lucid literary exposition. From another point of view the work referred to constituted quite an epoch in the history of overland telegraphy. With a wisdom deserving of all credit, the Electric Telegraph Company caused the work to be distributed gratuitously among its principal officers and clerks in charge throughout the whole country; and whatever of technical and scientific electrical knowledge came over to the Post Office at the time of the transfer was mainly due to the educational influence of "Culley's Handbook."

Over and above his attainments as an electrician—at that time of a quite exceptional order—Mr. Culley had displayed great capacity as organiser and administrator. It is not surprising, therefore, that he was singled out by the Post Office authorities to engineer them through the stress and trials attending the preparations for, and final transfer of, the old electric telegraph companies to the control of the State. The debt which the country owes to him for his indefatigable labours during the period between 1869 and 1878 has never, perhaps, received the recognition it deserved—partly due to his self-sacrificing devotion, which courted no public acknowledgement; partly, no doubt, to personal idiosyncracies, to which allusion has already been made. An accident which occurred while on a surveying expedition with the Royal Engineers Telegraph Corps permanently disabled him from further continuance in his office; and in February, 1878, he was retired on a Government pension, hardly commensurate, it is thought, with the services he had rendered. Since that date he has lived in comparative seclusion, chiefly at Weston-super-Mare, where he interested himself in local affairs and was made a justice of the peace. He died at his residence, overlooking the Bristol Channel, on the 5th inst. Mr. Culley was a member of the Institution of Civil Engineers. In 1872 he became a member of the first Council of the Society of Telegraph Engineers—now Institution of Electrical Engineers—and was one of its vice-presidents down to 1876. His only surviving son, Mr. W. R. Culley, has followed up his father's profession, and is submarine cable superintendent at Woolwich in the service of the Post Office Telegraphs.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

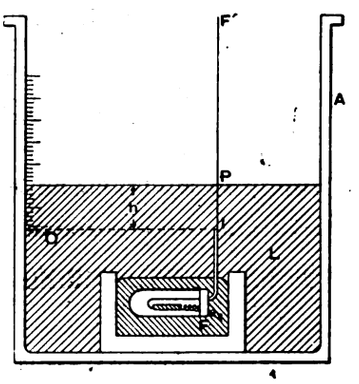
*Resistance of Bismuth.*—One of the many anomalous properties of bismuth is the change which the resistance of a filament undergoes when placed perpendicular to the lines of force in a strong magnetic field. Not only does its resistance very much increase, but, as discovered by Lenard, its resistance to alternating currents under these conditions is apparently different to its direct-current resistance. Lenard thought this difference only became manifest at frequencies of 10,000 per second and upwards, whereas Sadovsky observed a difference even at a frequency of three or four per second. G. C. Simpson attempts to discriminate between the two by means of experiments based upon the following principle:—As any small change in the resistance of a wire carrying a current may be considered as the result of an E.M.F. set up in the wire, whatever the changes in the bismuth may be due to, they can be regarded as arising from an E.M.F. set up in the bismuth itself. If on examination this E.M.F. (called in this Paper the "bismuth E.M.F.") should prove to be opposite in phase to and of the same wave-form as the—say simple harmonic—current causing it, it may safely be inferred that the change in the bismuth is really a change in the resistance pure and simple. But if the "bismuth E.M.F.," while still possessing the proper wave-form, should be displaced 90deg. ahead or 90deg. behind, it would be necessary to conclude that in the one case there exists something of the nature of capacity, in the other something of the nature of self-induction in the bismuth. The results of the experiments go to show that the latter alternative holds good for small frequencies, and that the rise of resistance is only apparent.

[G. C. Simpson, *Phil. Mag.*, September, 1901.]

*Disruptive Discharge in Electrolytes.*—Broca and Turchini found some time ago that a disruptive discharge may take take place in an electrolyte in very much the same way as it does in a dielectric. This, as K. R. Johnson points out, is the conclusion which he had arrived at independently. His experiments were made with Wollaston electrodes, which enabled him to make the spark issue from one electrode independently of the other, the explosive distance being furnished by the gas disengaged round the platinum point, and the spark passing between that point and the liquid. To produce the discharges, the author employed an induction coil, a Tesla transformer, and finally a Blondlot resonator. In the last case the discharge was entirely suppressed. In employing an induction coil the author observed that the disengagement of hydrogen and oxygen is solely due to the current at break, the current at make not exercising any electrolytic action. This may, in fact, be easily demonstrated by making and breaking the circuit by hand. It is evident that the electrolytic effects arise from the oscillations which accompany the induced current, and not from an alternative action of the two induced currents.

[K. R. Johnson, *Comptes Rendus*, August 5, 1901.]

*Transmission of Electric Waves through Liquids.*—It is known that Hertzian waves only penetrate a very thin layer of metal. The question as to how far they penetrate into a conducting liquid is investigated by C. Nordmann with the apparatus shown in the diagram. A very sensitive coherer is placed in




a test tube, and plunged below the surface of mercury contained in a box F. It is thus completely shielded from the influence of electric waves. One of the wires of the coherer circuit plunges into the mercury, while the other is taken upwards through the electrolyte, and its insulating envelope is removed at and above a point I. Any oscillations produced in the neighbourhood of the wire F travel along it, and encounter the resistance of the electrolyte L to the extent of the thickness H. The liquids experimented upon were sulphuric acid, sodium and potassium chlorides and magnesium sulphate solution. The maximum thicknesses traversed by the waves in the four liquids were 5mm., 18mm., 32mm. and 41mm. respectively. The general result is that transparency varies in the same sense as resistance, but not so rapidly.

[C. Nordman, *Comptes Rendus*, August 5, 1901.]

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*Capacity of the Human Body.*—Bordier placed the electric capacity of the human body at 0·0025 microfarads and Dubois at 0·1650 microfarads. Both these figures are much in excess of the true capacity according to the recent researches of G. de Metz. The latter measured the capacities of several persons under all sorts of conditions, and found that the capacities were the same in the nude and when dressed in close-fitting conducting material. The obvious conclusion is that the capacity of the human body is the same as that of a metallic body of the same dimensions, and this conclusion is fully substantiated by the other measurements. The capacity remains the same for any charge between 100 and 1,000 volts, but differs from one person to another in accordance with the volume and shape of the figure. It changes rapidly when the person is surrounded by metallic surfaces, and also greatly depends upon the pose. Thus the value of 87·8cm. was obtained in an upright position, 76·0cm. when crouched, and 91·2cm. when erect with one arm stretched upwards. When placed on a rubber mat and surrounded by a zinc cylinder 188cm. in diameter the capacity was 180·7cm., and it rose to 217·9cm. on reducing the diameter of the cylinder to 68cm. The normal value for an erect pose in the centre of a hall is 0·00011 microfarads for an individual of average stature.

[G. DE METZ, *Comptes Rendus*, August 5, 1901.]

*Magnetic Properties of Human Blood.*—Faraday found, much to his surprise, that blood, although containing a large proportion of iron, was diamagnetic, and was led to state that "if a man could be suspended with sufficient delicacy, after the manner of Dufay, and placed in the magnetic field, he would point equatorially; for all the substances of which he is formed, including the blood, possess this property." Plücker showed further that the blood corpuscles are more strongly diamagnetic than the liquid in which they float. A. Gamgee has now proceeded a step further, and examined the magnetic properties of the crystalline blood-colouring matter itself, in the condition of utmost available purity. He comes to the conclusion that the blood-colouring matter, oxy-hæmoglobin, as well as carbonic-oxide hæmoglobin and methæmoglobin, are decidedly diamagnetic bodies. The iron-containing derivatives hæmatin and acethæmin are, however, powerfully magnetic bodies. The differences in magnetic behaviour between the blood-colouring matter and acethæmin and hæmatin point to the profound transformation which occurs in the hæmoglobin molecule when it is decomposed in the presence of oxygen. The preliminary study of the electrolysis of oxy-hæmoglobin and CO-hæmoglobin renders it probable that, in the blood-colouring matter, the iron-containing group, on which its physiological properties depend, is (or is contained in) an electro-negative radical; according to analogy, the iron in such a compound would possess diamagnetic and not paramagnetic properties.

[A. GAMGEE, Communicated to *Roy. Soc.*, June 20, 1901.]

## THE INTERNATIONAL ENGINEERING CONGRESS AT GLASGOW.

The first International Engineering Congress in Great Britain was held at Glasgow from the 3rd to the 6th inst., the various sections being accommodated in the lecture theatres of the University. The festal part of the proceedings commenced on Monday evening with a banquet held in St. Andrew's Hall.

### TUESDAY, SEPTEMBER 3RD.

The entire Congress assembled in Bute Hall in the University Buildings at 10 o'clock, when the Lord Provost and the President of the Congress (Mr. James Mansergh) received the numerous foreign delegates from all parts of the world. The presence of these distinguished engineers and the part they took in the debates, &c., imparted to the Congress a truly international character. After the reception the President delivered his inaugural address, which we have already reprinted in our columns. After this address the various sections adjourned to their respective meeting places. There were nine sections in all, each controlled by some one or other engineering society. Section IX. was in the hands of the Institution of Electrical Engineers, and was under the chairmanship of Mr. W. E. Langdon. To this section the bulk of the electrical Papers were contributed, but stray Papers of electrical interest were to be found in almost all the sections. Mr. Langdon opened the section with a short presidential address, the principal theme of which was the backwardness of British electrical engineering as compared with the United States and the Continent. A reprint of this address has appeared in our columns, and as, naturally, it was not debated upon we may pass on to the first Paper, which was read by Mr. W. B. Sayers. This Paper, which was entitled "Glasgow Exhibition: Some of the Chief Objects of Interest to Electrical Engineers," was prepared at the request of the sectional committee. The Paper served as a guide to the subsequent visit of members of the section to the electrical exhibits in the exhibition. Commencing with the exhibits in the grounds, Mr. Sayers stated that the conductors for the arc lights are of aluminium. Passing to the British Schuckert Company's exhibit, he referred to the transforming plant, for 500 volts continuous to 10,000 volts three-phase, by means of rotatory and static transformers. The three 10,000 volts circuits are interrupted by a Schuckert high-tension switch, when about 5 amperes is flowing in each circuit, 5 amperes representing about 100kw. Each switch unit consists of two terminals, each in the form of a wire frame, mounted so as to be in the same vertical plane. At the lower side the frames are about 3in. apart, but the rising wires diverge from each other at an increasing rate. The circuit is opened by a switch blade at the bottom of the frames, and the arc which is established is carried upwards between the diverging wires by the air-current and so stretched out until it breaks. Mr. Sayers also described the pumping plant and electric locomotives exhibited by this firm. Dealing next with the British Westinghouse Company's exhibits, Mr. Sayers mentioned the electric tramcar fitted with the Newall track brake. In this brake the magnets in pulling towards the rails also pull the shoe brake on to the wheel, thus increasing the adhesion at the same time that the brake is applied. The brake is operated by the car motors run as generators. Particulars were then given of the exhibits in the Machinery Hall, descriptions of which are appearing in our serial articles on the Glasgow Exhibition. Upon the conclusion of this Paper, which was not discussed, the section adjourned to the exhibition and was conducted in parties, by numerous guides, to the chief exhibits of electrical interest.

Meanwhile, in the Railways section, presided over by Sir Benjamin Baker, Prof. C. A. Carus-Wilson read an interesting Paper on "The Economy of Electricity as a Motive Power on Railways at present Driven by Steam." The substance of this Paper was given by Prof. Carus-Wilson in his remarks during the discussion on Mr. Connett's Paper at the Institution of Mechanical Engineers. Its main purpose is to show that electric traction is better adapted to branch line than to main line traffic, an opinion in which few electrical engineers will concur. In the discussion, Mr. H. Ritchie, superintendent of the Taff Vale Railway, criticised the Paper. He first observed that the figures omitted to take into consideration transhipment of goods from the main to the branch line. He moreover considered that Prof. Carus-Wilson's unit, the day-mile, was not a fair comparison, and suggested the train-mile as being more suitable. Sir Douglas Fox believed that main railway traction was the problem of the near future. He looked for "a really light accumulator" as the solution of the problem, and he stated that the adoption of electric traction by railways would only be possible if it could be made to work in with existing steam traffic.

Two Papers of electrical interest were also read in Section III., controlled by the Institution of Mechanical Engineers, under the chairmanship of Mr. W. H. Maw. The first of these was a joint Paper on "Trials of Steam Turbines for Driving Dynamos," by the Hon. C. A. Parsons and G. Gerald Stoney. The Paper gives tabular data of a number of tests of steam turbo-dynamos ranging from 24kw. to 1,000kw., this last being the engine set built for the Elberfeld Corporation.

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Particulars of this last test appeared recently in *The Electrician* (Vol. XLVI., p. 425). The Paper states that in larger sizes of 1,500kw., with 200lb. steam pressure and 150° of superheat, a consumption not exceeding 28½lb. per kilowatt-hour non-condensing has been guaranteed. In the discussion Prof. Schroter, of Frankfort, stated that the economy of steam turbines was found not to diminish after long-continued use. With 50° of superheat 8 per cent., and with 100°, as much as 12 per cent. of economy was obtained. Replying, Mr. Stoney said there was no difficulty in working with even 350° of superheat. The second Paper in the mechanical section was on

"Rating and Testing of Electrical Machinery,"

by Mr. Gisbert Kapp. An abstract of the Paper is given below.

With the growing application of electricity, the commerce with electrical apparatus forms an important part of the general commerce of every civilised country. Such commerce should be put upon a safe basis by clearly defining the properties of the articles bought and sold. Electrical plant also enters into international commerce, and the question of how it shall be rated and tested appears to be a fit subject for an international engineering congress. The rating of electrical machinery must always be influenced by the condition of its use. Thus a tramway motor, rated by the builder at so many horse power, will develop that power when in service only occasionally. The time during which this maximum power is required is short if compared with the total running time. Under these conditions the motor will not overheat. If, however, the same motor were used for driving a workshop, and had to give out the rated power continuously, it would break down from overheating. The same type of motor must, therefore, be rated differently in the two cases. The question of efficiency is frequently a source of trouble between buyer and seller, especially in direct coupler generators. The combined efficiency can easily be measured, but not the efficiency of each part separately. According to the method employed, the separate efficiencies found may vary greatly; hence, to protect buyer and seller alike, it is desirable that there should be recognised methods for testing efficiency. These methods should be simple and inexpensive, and cause little disturbance to the regular working of the plant. The German Association of Electrical Engineers has last year appointed a committee to investigate the question of rating and testing electrical apparatus, and has this year at the annual meeting provisionally adopted the report presented by the committee. The final adoption has been postponed until the value of the Association "Standards for Rating and Testing Electrical Machinery" has been found out by practical use. These standards are given in an appendix to the Paper.* By issuing them the Association does not desire to interfere in any way between buyer and seller if the two parties agree in detail upon the properties which the articles bought and sold shall have. The standards are only intended to apply to that extent which is not covered by special conditions of the contract. The standards refer to electric generators, motors, connectors, and transformers, but not to switches, fans, and other subsidiary apparatus. As regards the rating, three working conditions are to be distinguished, namely, intermittent use, short time use, and continuous use. The working conditions must be stated on the name plate. The temperature rise is prescribed, and also the extent to which apparatus must be capable of being overloaded. A definite insulation resistance is not required, but a test for dielectric strength by application of high pressure. For testing efficiency eight methods are given, and the maker of the apparatus is at liberty to select any of these as the method under which the efficiency he guarantees shall be tested. The method selected must be stated in the tender.

## WEDNESDAY, SEPTEMBER 4TH.

The proceedings of the Electrical Section opened on the second day with probably the most important electrical Paper read during the Congress. Certainly it is one that excited the highest degree of interest, and the historical natural philosophy theatre was overcrowed with members anxious to hear it. We refer to the Paper by Herr O. Lasche, of Berlin, on

"High-Speed Railways,"

of which the following is an abstract:

The car described in the Paper is now finished, and, so far as trials and tests in the factory can give an indication of its behaviour under working conditions, has answered all expectations. It was tested at a peripheral speed of the wheels of about 56 metres per second, corresponding to a car speed of 200km. to 210km. per hour, and has been shown to the technical experts of the Studiengellschaft für Elektrische Schnellbahnen prior to its transference to the experimental line.

1. *Experimental Line.*—The Studiengesellschaft was formed for the purpose of studying the technical and economical requirements of electric driving on long-distance railways. The maximum limit of speed for the trials determined upon was 200km. per hour. After careful consideration it was decided to use an existing military line from Berlin to Zossen, placed by the German Military Department at the disposal of the Association, as the construction of a special experimental line would have involved a serious loss of time and much extra expense. The line selected is specially suitable, as it can be used for tests of the relative merits of different types of permanent way, track beds, rail profiles and rail joints. The present Paper relates exclusively to the construction and testing of the car, and to investigations and experiments in connection therewith. The running tests on the line will shortly commence, and will, it is hoped, form the basis for future practice in two completely different senses.

(*a*) *Attainment of a Speed of 80km. to 100km. per hour.*—In the first instance, it is necessary to ascertain what speed is attainable without necessitating alterations in the existing line. Then the extent of the diminution in the wear and tear of the track must be determined when electric cars are used, as compared with that caused by steam locomotives running at the same speed. In many cases it is probable that the electrical working of a line with single motor cars will enable existing bridges and tracks to meet the requirements of rapidly increasing traffic, whereas the use of heavier steam locomotives or longer trains would necessitate alterations. The attainment of these speeds would, in itself, be regarded as satisfactory, for distances would be covered in a reasonable time, and the public would have a more frequent train service, with shorter trains, instead of being provided with a few long trains in the day. The absence of smoke is a point in favour of electric trains. The construction of motor cars presents no difficulty, and no special alterations, either of the track or signalling arrangement, or of the ordinary working conditions, are required for an electrical service. It is not, however, necessary that electric traction should be more economical than steam traction; it will in many cases be sufficient to ensure its adoption to prove that the public will find it more agreeable, and that the general arrangements meet the requirements of the age.

(*b*) *Attainment of a Speed of 200km. per hour.*—The experiments will be continued in the direction of determining the best working conditions for running at high speeds, the limits of which can only be ascertained by trial. For such high speeds as are here contemplated, the present systems of signalling might have to be altered, and the crossings and switches abandoned. It will be absolutely necessary to establish all high speed service on a separate track, with special lines in either direction, exclusively for this service. Lines for local and goods traffic must be built separately. The investigations to be made relate to the motor cars, the construction of the track, and the necessity for ensuring safety.

2. *The Construction of the Motor Car.*—The motors are attached to the car itself, and no separate locomotive is used. Each car will accommodate about 50 passengers. The motors have in all a normal output of 1,000 H.P., and a maximum output of 3,000 H.P. The tests will show whether so much power is really necessary, and will indicate the consumption of power at different speeds, and under the influence of head or side winds.

For the working of long distance railways, the three-phase alternate current system could alone be considered. The generation and transmission of three-phase currents at from 40,000 to 50,000 volts pressure present no difficulty, but on the experimental line the pressure will be only 12,000 volts, the current being supplied from the central generating station of the Berlin electricity works, which is situated at a distance of 12½km. from the commencement of the line. The length of the line is 24km. At present, transformers are placed on the car itself to transform the current down from 12,000 to 400 volts; but it is still undecided whether, in practice, it may not be better to use motors of medium voltage, say of 3,000 volts, taking the current at this pressure from the line, to which it is supplied through transformers placed in transformer houses at definite intervals along the track. In this case the transformers would reduce the pressure from 50,000 to 3,000 volts. It is well known that static transformers require no attendance as compared with rotatory transformers.

The car is provided with a driver's platform at either end, from which the control is effected. All parts carrying current are placed in a special apparatus compartment, which is separated from the rest of the car by a double sheet-iron partition, so that passengers and attendants cannot come into contact with current at dangerous pressures. The total length of the car is about 22 metres, and in cross-section it conforms to the standard structure of the German State Railway carriages. The car body is carried by two bogies, each with three axles, of which the centre is only a running axle, whilst each of the others carries a 250 H.P. motor, capable of developing a maximum of 750 H.P. The diameter of the car wheels is 1,250mm., and the speed about 960 revs. per min.

3. *Investigation with reference to the Construction of the Motor Car.*—The problem before the designer was the creation of something altogether new—namely, the construction of an experimental motor car, without reference to any existing type either of low-speed electric locomotive or of street railway cars. The sole aim in the investigation was the construction of a motor car to run long distances at the highest possible speed.

The weight of the electrical equipment was, in the first instance, not less than 50 tons for the required output of 3,000 H.P., but, by modifying the construction of the starting apparatus, motors and transformers, the weight was reduced to 30 tons; but of this weight a large proportion was due to the transformers, which may possibly be dispensed with altogether hereafter.

The mechanical connection between the motors and the axles of the wheels was a matter of the greatest importance, the use of intermediate gearing being out of the question on account of the wear and tear to which it would be subjected. Although from the first the object was to obtain an elastic coupling, various designs and devices were tried, in some of which the motor was rigidly attached to the axle, whilst in other springs were introduced. The designing of a spring attachment for use at about 1,000 revs. per min., and with an output of 750 H.P. per motor, was a difficult task. The problem was solved by connecting the motor to the wheel by an elastic coupling, and providing an elastic suspension for the motor, the springs being arranged so as to have increasing rigidity as the load increases. The motors are accordingly mounted on a hollow shaft, of

* A translation of them appeared in *The Electrician* of June 21st, p. 339, and a report of the discussion of them in *The Electrician* of July 5th, p. 401.

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which the surface speed in the bearings is nearly 15 metres per second. Experiments and observations have been made as to the friction both at this speed, and at others up to 25 and 30 metres per second, and under very great bearing pressures.

Starting resistances for motors of 250 H.P. to 750 H.P. have already been used in practice, but the problem of arranging them in a confined space, for use in continuous-current regulation in connection with a current of 4 × 750 H.P., has never before been contemplated. The relative advantages of liquid and metal resistances were considered in detail. The use of the former at first seemed out of the question, whilst the latter involved the employment of a large number of contacts, brushes, connecting cables, and resistance material, making them too heavy and cumbersome. Four motors, each with three armature circuits, give a total of 12 phases, in each of which was inserted a resistance divided into 12 steps; but, in spite of this sub-division, the regulation was found to be too jerky to be satisfactory. Ultimately a liquid starting device, that could be equally well used for large winding engines, was designed. The resistance material was a solution of soda, but the apparatus had nothing in common with the ordinary liquid starting resistance. Taking into account the fact that a speed of 200km. per hour was contemplated, it was arranged to provide, in addition to the Westinghouse air-brake, an electrical brake, which could be used either in connection with, or independently of, the source of current. The brake was so designed that it could be applied either gently or powerfully at will.

Other investigations were made besides those above referred to, and from the results obtained in the preliminary trials, there is every reason to hope that the motor car will meet all requirements, and enable the Association to deal with the questions relating to the running of the car on the track.

In opening the discussion Sir William Preece said that the electrical world of both hemispheres was indebted to Herr Rathenau, of the Allgemeine Elektricitäts Gesellschaft, for allowing Herr Lasche to read his Paper and to give with such candour the facts connected with the high-speed railway car which they had built. He contrasted the ways of Germany with those of England. The German Emperor he said took direct personal interest in the undertaking, and a large amount of money had been expended upon its development. In England, on the other hand, large amounts of money had been expended in opposing electric traction, as, for instance, in connection with the Liverpool-Manchester high-speed railway. Now that the promoters of that line had got their bill, they were looking for "a German Emperor" to provide them with money to build the line. He expressed decided preference for the three-phase system of traction and the use of high-pressures on the line. Finally, he hoped that the discussion would deal with the Paper on broad principles and not in any captious spirit, criticising petty details. Herr Rathenau, the next speaker, acknowledged the kind remarks which had been made by Sir William Preece, and suggested that in high-speed railway traction electrical engineers had a new problem for the successful solution of which it would be necessary for all to work together, sinking petty differences and national jealousies. If the introduction of electric light had occupied engineers for some 20 years, the introduction of electric traction on our railways would occupy them until the end of the century. Dr. Silvanus P. Thompson, continuing the discussion, regarded this as an epoch-making Paper. Sir William Preece had spoken of spending money in opposing progress, but he (Dr. Thompson) said there was another way of mis-spending money, viz., on wrong experiments. He regarded Sir William Preece's experimental line on the "Underground" railway as a wrong experiment, for it proved nothing that electrical engineers did not know already. In fact, it did nothing more than convince a board of directors. What should have been done was to experiment with high-pressure three-phase currents on this line. Everything in modern developments pointed to the abolition of the commutator. Mr. Alexander Siemens said that one broad criticism of the Paper might be that the engine thus far had only been run on rollers, or, as he put it, "moved stationary." It would be a very different matter to run such a locomotive on actual rails, especially on existing lines, and he thought that for a speed of 200 miles an hour existing permanent ways would be found useless. Herr Kolben criticised the regulation of the motors by means of resistances, and suggested that grades of speed could be obtained by varying the number of active poles and the arrangement of the windings. Mr. Gisbert Kapp said that 18 months ago he rode on the 10,000 volt experimental car at Berlin built by Messrs. Siemens and Halske. In this car everything was earthed and, therefore, perfectly safe. We were accustomed in high-pressure work to the announcement that the apparatus was dangerous and should not be touched. This was a wrong principle; things ought to be so arranged that a notice board could be put up, "You may touch everything. It is all perfectly safe!" That practically was the way this Berlin car had been built.

By the time this discussion was concluded it was noon, and only one hour remained for the reading and discussion of the remaining three Papers. The first of these was on

"The Protection of Trolley Wires,"

by Prof. A. Jamieson.

This Paper was treated under the following headings, together with eight figures showing different kinds of trolley wire guards. Specimens and tests of the Glasgow tramway trolley, guard, span, and tension wires, together with their various mechanical and electrical fittings, Post Office aerial lines and underground cables, as well as the National Telephone Co.'s bare bronze wires and their overhead multiple wire cables, were shown and remarked upon by the author:—1. Recent accidents, and the necessity of keeping trolley wires free from contact with other overhead conductors. 2. Methods which have been adopted and proposed for protection against contacts with trolley wires. 3. Board of Trade and Post Office regulations. 4. Contacts between, and the breaking of, guard, span and trolley wires. 5. Freeing, earthing, and other safety devices. 6. Aerial telephone and telegraph cables *versus* underground wires or cables. Under the last heading the author stated that there were now in Glasgow three authorities dealing with telephone wires, viz.:—1. The Government Postal Engineering Department, who aimed at placing all their principal city wires underground which at present cross tramway routes. 2. The National Telephone Co., who had hitherto been prevented from opening the streets, and had until recently used bare, thin, bronze aerial wires, but who were now supplanting these (along the main routes which cross tramway lines) by multiple wire cables, each containing about 100 fine insulated wires. They employ two of these wires for each telephone circuit, upon the "closed circuit principle," in order to prevent inductive and earth interferences. These insulated cables were much safer than the bare wires. The Glasgow Corporation, who, having full authority over their streets, had taken the precaution to place all their main telephone cables in underground cast-iron pipes. He said: "There cannot be the slightest doubt that the only sure and safe plan is to place all non-tramway conductors, of whatever kind, underground. If this were done then there would be no necessity for guard wires, thereby leaving the trolley wires free from extraneous contacts, and minimising the aforementioned dangers."

Owing to the extremely limited time only two speakers took part in the discussion on this Paper. Mr. M. B. Field thought it unfair that tramways should be saddled with the responsibility of dangers from overhead wires. What was necessary was that telegraph and telephone wires should be placed underground. With regard to guard wires, he had found that when these were insulated practically no trouble arose, but since they had been earthed the experience of Glasgow tramways engineers was that they gave rise to considerable trouble. With a few words from M. Gerard, the discussion was brought to a close, and as only a quarter of an hour remained for the next two Papers, these were read in abstract and were not discussed. We hope to publish an account of these Papers in a future issue.

Meanwhile, in the Railways Section Mr. I. A. Timmis read his Paper on

"Modern Practice in Railway Signalling."

The following is an abstract of Mr. Timmis' Paper:

The changes which steam effected when it came into use as an aid to more rapid movement of people and material on land and water, created an ever-increasing desire and want for more perfect and faster means for effecting that movement. And now that another force of nature—electricity—has come to the aid of steam, the growth of railways has developed enormously, and the desire and necessity for intercommunication in all countries has not only increased, but must go on increasing; as a consequence the engineers of railways are obliged to fit new signalling systems in order to deal with the larger stations, greater number of main lines and sidings and larger cabins, the increase in number of trains and higher speeds. It has become necessary to place the points and danger signals at a greater distance from the cabins. The result of these altered conditions is that some other power is required to take the place of manual. Three new forces have been tried—hydraulic, pneumatic and electric.

*Hydraulic.*—The experience gained from signal work operated by this force proves that it cannot compete with the pneumatic and electric systems, and so it is not advisable to take up time in describing it.

*Pneumatic.*—There are two systems that use air as an operating force:—

1. *The Westinghouse High-pressure.*—In the first installations that were fitted in the United States the signals and point were operated by the air conveyed through a main supply pipe and its branches to a cylinder on each signal post and at each pair of points, and the air was admitted to the cylinders by hydraulic power, which was put into action at the signal cabin by the signalman moving a small lever. The hydraulic pressure



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acted on a valve, which admitted the air into the cylinder and moved a piston. But a later development introduced an electric current as the controlling agent. The levers in the cabin are interlocked; when a signal lever is pulled over an electric current is sent to an electromagnet on the signal post, which compresses a spring, closes the exhaust port, and opens the high-pressure, air-admission valve. The piston in the cylinder then lowers the signal. When the electric current is interrupted the spring closes the valve, opens the exhaust, pushes back the armature, and the counter-weight puts the signal to danger." When a point lever is moved in either direction the operation of the points, in each direction, is practically as described for the signals. Thus there is a magnet controlling each end of the point cylinder wfth one slide valve. But there is a third magnet to lock the slide valve, and in addition it breaks and changes the electric circuit and sends an indication current back to the signal cabin when the points are over and locked, and this current operates an electromagnet in the cabin, which enables the signalman to lower the necessary signals.

2. *The Low-pressure Pneumatic.*—This system is altogether on different lines from the high-pressure. The operating is effected by air at 15lb. pressure, and the controlling by air at half that pressure. To operate points the lever is pulled over half way, and is then stopped. The controlling current goes to the points and admits the higher pressure air into a cylinder, when the points are moved and locked, and a return indication is sent to the cabin, which releases the lever and completes its throw. The movement of the points and the locking bar and locking bolt are effected by a plate or flat bar with grooves and studs in it. There are four pipes to work each signal—main supply, two controllers and one return—and there are five pipes to a pair of points.

Both the above systems can be fitted to work with a track circuit but this involves the use of electricity and adds considerably to complication of detail.

*Electric.*—In the United States a system is fitted by the Union Switch and Signal Co., where the power is supplied from primary batteries, and each signal is lowered to "line clear" by a small motor geared 1,000 to 1. An electromagnet then holds the signal, and the motor is cut out. When the circuit is broken the signal goes to "danger" automatically. Another system, fitted by the Taylor Company, uses secondary batteries, and the signals are operated practically in the same way as just described. Points are also worked by motors geared 20 to 1 to the driving wheel. The first quarter revolutions of the wheel unlocks the points, and the last quarter locks them and closes the return indication current to the cabin, and reverses the circuit for a reverse movement. Interlocking is effected in the cabins in the lever frame.

In this country the first practical system fitted was on the Liverpool Overhead Railway. This is an automatic system, and of course only works the signals. A full description is in the *Engineering* of February 10, 1893. As a train leaves a station it puts the starting signal to danger by means of a striking bar fitted to the rear vehicle operating a breaking contact; and when the train is a suitable distance ahead of the signal the same bar operates a making contact which closes a circuit. This circuit is completed by the signal just passed being at "danger," and then the signals in the rear block are lowered automatically to "line clear." The train goes on to the "home signal" at the next station, and puts it to "danger." There is thus always at least one signal at "danger" in the rear of a train, and no vehicle can be left on the line if the signals are lowered in a block. An electromagnet of the "long pull" type operates each signal with some 250 watts, and the volume of current is automatically reduced to one-tenth as the signal is lowered. The points are electrically interlocked with the signals on both lines at the cross-over roads, and in addition they are mechanically locked. After the author had fitted the signal work on the Liverpool Overhead Railway, he fitted a small but complete installation, not automatic, on the Western Railway of France, by which the signals and points are all worked by electromagnets, and the points are all locked and repeated. The Western Railway of France have adopted that system. Since then he fitted another automatic system on the small circular railway, 2 miles in length, in the Paris Exhibition of 1900, practically on the same lines as that on the Liverpool Overhead Railway, but the signal arms and magnets, and resistance and contacts, are all small and light, and encased so as to avoid the action of wind and weather.

We now come to the important non-automatic installation—the "Crewe system"—at Crewe, where some 1,200 levers are being fitted, and nearly one-half are finished or well in hand. The signals are fitted in principle similarly to those on the Liverpool Overhead Railway, except that there is a counter-weight, as shown in the drawings. Each pair of trailing points are operated by a pair of magnets, but the facing points are operated and locked by an electric motor designed and made at Crewe, which, by the aid of worm gearing, completes the work. The first part of the travel of the gearing unlocks by half the throw of one rod; then the other rod moves the points over by a complete throw; and then the other rod, by the completion of its throw, locks the points again, and sends a return indication circuit to the cabin, which enables the signalman to complete the movement of his lever, and at the same time the selector rod at the points determines what signals can be lowered. Unless the points are locked no signals can be lowered. The 300-lever cabin now being fitted will have only about 150 cables of ⅞in. diameter, from the cabin, each cable holding several leads. But if the low-pressure pneumatic system were to be fitted to do the same work, it would require 1,200 tubes from the cabin. This is a condition which is of very serious moment, and is an important factor in favour of electricity.

The final system to be considered is also entirely electrical, and embraces a track circuit. It is necessary to describe it, because there can be no question that in the near future all lines of railway heavily charged with passengers and goods, mixed traffic, including fast expresses, must have a track circuit fitted; and there is also no doubt that the initial difficulties which were met with in the earlier attempts have been sufficiently overcome to render it a certainty. In this system, as in other systems, the levers in the cabin are, of course, mechanically interlocked. The signals are worked with the same magnets and gearing, only more powerful than on the Liverpool Overhead Railway. The points are operated and locked by a pair of electromagnets with a 7in. throw, and the final travel of the magnets is softened in its force by an air cushion. At the same time, a return current is sent to the cabin lever, which completes the throw of his lever, and advises him that the points are locked. When the signal is lowered the circuit is completed in the lever frame, and the lever is held in the forward position by a small electromagnet, and when the current is broken the lever goes automatically to the back position. Thus the signalman knows what is done. This arrangement enables a track circuit to be fitted economically. This circuit has a small battery in each block operating a small magnet, which, when energised, completes the main circuit. It should be stated here that, if electric leads for such low potentials as not over 200 volts are properly fitted, it is absolutely impossible for any circuit to go wrong. There is no force of nature so constant, so easily taken from place to place, or so instant in its action.

Among the speakers in the discussion on this Paper were Sir Douglas Fox and Mr. Webb, of Crewe. Both these engineers spoke in the highest praise of Mr. Timmis's electrical system of signalling. Sir Douglas Fox, referring to its use on the Liverpool Overhead Railway, said that the result after nine years' use had been most satisfactory at all the 12 stations where it had been introduced, and there had been a saving of the employment of no less than 12 signalmen throughout that time. Mr. Webb, referring to the electrical signalling system of the London and North-Western Railway, said that over some 50 miles of sidings there would soon be not a single point rod visible on the ground, the entire work being done underground by means of electric conductors. They were now constructing a signal-box for 800 levers, worked electrically, for the purpose of controlling the north section of Crewe station.

Simultaneously an important Paper was read in the mechanical section by Messrs. James Crighton and W. G. Riddell on

## "Power Required to Drive Marine Engine Works and for Electric Lighting,"

an abstract of which follows:

It is not the intention of the writers to attempt to describe a model engine works or driving plant, but rather to enumerate, and show the result of, a few improvements which have been adopted by the firm with which they are connected. About three years ago it was decided to rearrange the works in a thorough manner, and to fit up a new power installation. The works had gradually grown during upwards of 30 years, and most of the buildings were in excellent condition, and in no need of reconstruction. The problem to be solved, then, was how to lay down an economical driving plant, which would conform to the existing conditions, and which would not lead to an unnecessary sacrifice. At that time the motive power of the works consisted of one marine type boiler working at 80lb. pressure, and supplying steam to three vertical compound engines for driving the machinery, and one vertical compound engine for lighting purposes. The points in favour of so many units were:—(1) The saving in steam when running one or two machines at night, which might be driven by one of the small engines; and (2) the fact that, in the event of a breakdown of one engine, the other part of the works were not affected. It was, however, decided to put in one engine capable of driving and lighting the entire works, and, to meet the difficulty of late work, by driving those machines which experience showed were most likely to be needed at night with motors which could be connected with current from the Glasgow Corporation. The engine was made to a simple design and of such strength as to make the fear of a breakdown very remote. It is capable, as at present constructed, of developing 260 I.H.P., but this may be increased to 600 I.H.P. A cylindrical marine boiler, design to work under either forced or natural draught, was selected as the most suitable type, and has proved itself both economical and reliable. It has a working pressure of 200lb. per square inch, and evaporates about 9lb. of water per pound of coal.

The position of the power station was fixed, to a certain extent, by circumstances. The works are situated in a busy part of the city of Glasgow, where ground is costly, and economy of floor space essential. There is no direct communication with any railway, so that all material has to be carted to and from the works. Close proximity to the street was, therefore, an important factor in settling the position of the boiler. The position chosen was between the engine and boiler departments, and as the difference in the floor level of these departments is about 6ft., the boiler was placed on the lower level, and the coal tipped over into a bunker in front of it. The ashes were returned by a hydraulic hoist to a receiver on the higher level, under which a cart might be filled automatically. The engine was placed as near the boiler as possible, with the crank shaft parallel to two of the main lines of shop shafting. Two dynamos were laid down for lighting and driving purposes, and these and the two lines of shafting were connected to the main engine shaft with belts, and all so arranged as to be easily disconnected. Motors were laid down to drive all outlying shafting.

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Before instituting a comparison between the old and new systems of driving the works, it may be well to enumerate briefly various units which made up the old installation. These were:—1. A marine type boiler, working at a pressure of 80lb. per square inch. The feed water for the boiler was heated to 205°F., as in the new boiler. 2. Three compound non-condensing engines, indicating collectively, say, 151 I.H.P., for driving purposes. 3. One compound non-condensing engine, for lighting purposes, of, say, 65 I.H.P. The boiler evaporated about 6·75lb. of water per pound of coal, and the engines used 43·8lb. of water per I.H.P. per hour. This gave an average coal consumption of 6·4lb. of coal per I.H.P. per hour.

In calculating the cost of a horse-power for a year, the coal used for raising steam for smithy hammers and blower engines has not been taken into account, but the steam for electric lighting has been charged in each case, as it was almost impossible to obtain accurate figures without doing so. It will be seen that the power for electric lighting is much greater in the new than in the old system, and it may be contended that the greater efficiency of a horse-power in the new system of driving is partly due to the better lit workshops; but this is a refinement into which the scope of this Paper does not admit of investigation.

It now remains to be shown by how much the new system is better than the old, or, in other words, at how much smaller cost it produces work. Since the power in an engine works is expended in removing material from rough castings and forgings, a figure may be found by which different systems may be compared, the system by which the greatest weight of material is removed at the smallest cost being the most efficient. In order to make the grounds of comparison similar the cuttings produced by machines whose scrap is not in proportion to the power expended—such as shearing machines and saws—are not taken into account; but the weight of all turnings, borings, &c., for a fixed period is divided by the cost of a horse-power for the same period, and a money value for the power per ton removed can thus be obtained. From the tables accompanying this Paper it will be seen that the cost of removing 1 ton under the old system of driving was £5·21, and under the new system £2·48, showing a saving by the new system of 52 per cent. Notwithstanding this great saving, it is abundantly clear that the cost may be much further reduced. It is hoped that this Paper may help to provide a basis on which to calculate the relative efficiency of the driving plant in similar works.

*(To be continued.)*

## PROF. A. W. RÜCKER'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.*

The first thought in the minds of all of us to-night is that since we met last year the great Queen, in whose reign nearly all the meetings of the British Association have been held, has passed to her rest. To sovereigns most honours and dignities come as of right; but for some of them is reserved the supreme honour of an old age softened by the love and benedictions of millions, of a path to the grave, not only magnificent, but watered by the tears both of their nearest and dearest, and of those who, at the most, have only seen them from afar. This honour Queen Victoria won. All the world knows by what great abilities, by what patient labour, by what infinite tact and kindliness, the late Queen gained both the respect of the rulers of nations and the affection of her own subjects. Her reign, glorious in many respects, was remarkable, outside these islands, for the growth of the empire; within and without them, for the drawing nearer of the Crown and the people in mutual trust; while, during her lifetime, the developments of science and of scientific industry have altered the habits and the thoughts of the whole civilised world. The representatives of science have already expressed in more formal ways their sorrow at the death of Queen Victoria, and the loyalty and confident hope for the future with which they welcome the accession of King Edward. But none the less, I feel sure that at this, the first meeting of the British Association held in his reign, I am only expressing the universal opinion of all our members when I say that no group of the King's subjects trusts more implicitly than we do in the ability, skill, and judgment which His Majesty has already shown in the exercise of the powers and duties of his august office; that none sympathise more deeply with the sorrows which two great nations have shared with their sovereigns; and that none cry with more fervour, "Long live the King!"

But this meeting of the British Association is not only remarkable as being the first in a new reign. It is also the first in a new century. It is held in Glasgow at a time when your International Exhibition has in a special sense attracted the attention of the world to your city, and when the recent celebration of the ninth jubilee of your university has shown how deeply the prosperity of the present is rooted in the past. What wonder, then, if I take the chair to which you have called me with some misgivings? Born and bred in the South, I am to preside over a meeting held in the largest city of Scotland. As your chosen mouthpiece I am to speak to you of science when we stand at the parting of the centuries, and when the achievements of the past and present, and the promise of the future, demand an interpreter with gifts of knowledge and divination to which I cannot pretend. Lastly, I am the President of the British Association as a disciple in the home of the master, as a physicist in a city which a physicist has made for ever famous. Whatever the future may have in store for Glasgow, whether your enterprise is still to add wharf to wharf, factory to factory, and street to street, or whether some unforeseen "tide in the affairs of men" is to sweep energy and success elsewhere, 53 years in the history of your city will never be forgotten while civilisation lasts.

More than half a century ago a mere lad was the first to compel the British Association to listen to the teaching of Joule, and to accept the law of the conservation of energy. Now, alike in the most difficult mathematics and in the conception of the most ingenious apparatus, in the daring of his speculations and in the soundness of his engineering, William Thomson, Lord Kelvin, is regarded as a leader by the science and industry of the whole world. It is the less necessary to dwell at length upon all that he has done, for Lord Kelvin has not been without honour in his own country. Many of us who meet here to-night met last in Glasgow when the university and city had invited representatives of all nations to celebrate the jubilee of his professorship. For those two or three days learning was surrounded with a pomp seldom to be seen outside a palace. The strange middle-age costumes of all the chief universities of the world were jostling here, the outward signs that those who were themselves distinguished in the study of Nature had gathered to do honour to one of the most distinguished of them all. Lord Kelvin's achievements were then described in addresses in every tongue, and, therefore, I will only remind you that we, assembled here to-night, owe him a heavy debt of gratitude; for the fact that the British Association enters on the twentieth century conscious of a work to do and of the vigour to do it is largely due to his constant presence at its meetings and to the support he has so ungrudgingly given. We have learned to know not only the work of our great leader, but the man himself; and I count myself happy because in his life-long home, under the walls of the university he served so well, and at a meeting of the Association which his genius has so often illuminated, I am allowed, as your president, to assure him in your name of the admiration, respect, nay, of the affection, in which we all hold him.

I have already mentioned a number of circumstances which make our meeting this year noteworthy; to these I must add that for the first time we have a section for education, and the importance of this new departure, due largely to the energy of Prof. Armstrong, is emphasised by the fact that the chair of that section will be occupied by the vice-president of the Committee of Council on Education—Sir John Gorst. I will not attempt to forecast the proceedings of the new section. Education is passing through a transitional stage. The recent debates in Parliament; the great gifts of Mr. Carnegie; the discussion as to university organisation in the North of England; the reconstitution of the University of London; the increasing importance attached to the application of knowledge both to the investigation of nature and to the purposes of industry, are all evidence of the growing conviction that without advance in education we cannot retain our position among the nations of the world. If the British Association can provide a platform on which these matters may be discussed in a scientific but practical spirit, free from the misrepresentations of the hustings and the exaggerations of the partisan, it will contribute in no slight measure to the national welfare. But amid the old and new activities of our meeting the undertone of sadness, which is never absent from such gatherings, will be painfully apparent to many of us at Glasgow. The life-work of Prof. Tait has ended amid the gloom of the war-cloud. A bullet, fired thousands of miles away, struck him to the heart, so that in their deaths the father and the brave son, whom he loved so well, were not long divided. Within the last year, too, America has lost Rowland; Viriamu Jones, who did yeoman's service for education and for science, has succumbed to a long and painful illness; and one who last year at Bradford seconded the proposal that I should be your President at Glasgow, and who would unquestionably have occupied this chair before long had he been spared to do so, has unexpectedly been called away. A few months ago we had no reason to doubt that George Francis FitzGerald had many years of health and work before him. He had gained in a remarkable way not only the admiration of the scientific world, but the affection of his friends, and we shall miss sadly one whom we all cared for, and who, we hoped, might yet add largely to the achievements which had made him famous.

### *The Science of the Nineteenth Century.*

Turning from these sad thoughts to the retrospect of the century which has so lately ended, I have found it to be impossible to free myself from the influence of the moment and to avoid, even if it were desirable to avoid, the inclination to look backward from the standpoint of to-day. Two years ago Sir Michael Foster dealt with the work of the century as a whole. Last year Sir William Turner discussed in greater detail the growth of a single branch of science. A third and humbler task remains—viz., to fix our attention on some of the hypotheses and assumptions on which the fabric of modern theoretical science has been built, and to inquire whether the foundations have been so "well and truly" laid that they may be trusted to sustain the mighty superstructure which is being raised upon

* Delivered at Glasgow on Wednesday.



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them. The moment is opportune. The three chief conceptions which for many years have dominated physical as distinct from biological science have been the theories of the existence of atoms, of the mechanical nature of heat, and of the existence of the ether. Dalton's atomic theory was first given to the world by a Glasgow professor—Thomas Thomson—in the year 1807, Dalton having communicated it to him in 1804. Rumford's and Davy's experiments on the nature of heat were published in 1798 and 1799 respectively; and the celebrated Bakerian lecture, in which Thomas Young established the undulatory theory by explaining the interference of light, appeared in the "Philosophical Transactions" in 1801. The keynotes of the physical science of the nineteenth century were thus struck, as the century began, by four of our fellow-countrymen, one of whom—Sir Benjamin Thompson, Count Rumford—preferred exile from the land of his birth to the loss of his birthright as a British citizen.

*Doubts as to Scientific Theories.*

It is well known that of late doubts have arisen as to whether the atomic theory, with which the mechanical theory of heat is closely bound up, and the theory of the existence of an ether have not served their purpose, and whether the time has not come to reconsider them. The facts that Prof. Poincaré, addressing a congress of physicists in Paris, and Prof. Poynting, addressing the Physical Section of the Association, have recently discussed the true meaning of our scientific methods of interpretation; that Dr. James Ward has lately delivered an attack of great power on many positions which eminent scientific men have occupied; and that the approaching end of the nineteenth century led Prof. Haeckel to define in a more popular manner his own very definite views as to the solution of the "Riddle of the Universe," are perhaps a sufficient justification of an attempt to lay before you the difficulties which surround some of these questions. To keep the discussion within reasonable limits, I shall illustrate the principles under review by means of the atomic theory, with comparatively little reference to the ether, and we may also at first confine our attention to inanimate objects.

*The Construction of a Model of Nature.*

A natural philosopher, to use the old phrase, even if only possessed of the most superficial knowledge would attempt to bring some order into the results of his observation of Nature by grouping together statements with regard to phenomena which are obviously related. The aim of modern science goes far beyond this. It not only shows that many phenomena are related which at first sight have little or nothing in common, but, in so doing, also attempts to explain the relationship. Without spending time on a discussion of the meaning of the word "explanation," it is sufficient to say that our efforts to establish relationships between phenomena often take the form of attempting to prove that, if a limited number of assumptions are granted as to the constitution of matter, or as to the existence of quasi-material entities, such as caloric, electricity and the ether, a wide range of observed facts falls into order as a necessary consequence of the assumptions. The question at issue is whether the hypothesis which are at the base of the scientific theories now most generally accepted are to be regarded as accurate descriptions of the constitution of the universe around us or merely as convenient fictions. Convenient fictions be it observed, for even if they are fictions they are not useless. From the practical point of view it is a matter of secondary importance whether our theories and assumptions are correct, if only they guide us to results which are in accord with facts. The whole fabric of scientific theory may be regarded merely as a gigantic "aid to memory" as a means for producing apparent order out of disorder by codifying the observed facts and laws in accordance with an artificial system, and thus arranging our knowledge under a comparatively small number of heads. The simplification introduced by a scheme which, however imperfect it may be, enables us to argue from a few first principles, makes theories of practical use. By means of them we can foresee the results of combinations of causes which would otherwise elude us. We can predict future events, and can even attempt to argue back from the present to the unknown past.

But it is possible that these advantages might be attained by means of axioms, assumptions and theories based on very false ideas. A person who thought that a river was really a streak of blue paint might learn as much about its direction from a map as one who knew it as it is. It is thus conceivable that we might be able, not indeed to construct, but to imagine, something more than a mere map or diagram, something which might even be called a working model of inanimate objects, which was nevertheless very unlike the realities of Nature. Of course, the agreement between the action of the model and the behaviour of the things it was designed to represent would probably be imperfect, unless the one were a facsimile of the other; but it is conceivable that the correlation of natural phenomena could be imitated, with a large measure of success, by means of an imaginary machine, which shared with a map or diagram the characteristic that it was in many ways unlike the things it represented, but might be compared to a model in that behaviour of the things represented could be predicted from that of the corresponding parts of the machine. We might even go a step further. If the laws of the working of the model could be expressed by abstractions, as, for example, by mathematical formulæ, then, when the formulæ were obtained, the model might be discarded, as probably unlike that which it was made to imitate, as a mere aid in the construction of equations, to be thrown aside when the perfect structure of mathematical symbols was erected. If this course were adopted we should have given up the attempt to know more of the nature of the objects which surround us than can be gained by direct observation, but might nevertheless have learned how these objects would behave under given circumstances. We should have abandoned the hope of a physical explanation of the properties of inanimate Nature, but should have secured a mathematical description of her operations. There is no doubt that this is the easiest path to follow. Criticism is avoided if we admit from the first that we cannot go below the surface; cannot know anything about the constitution of material bodies; but must be content with formulating a description of their behaviour by means of laws of Nature expressed by equations.

But if this is to be the end of the study of Nature it is evident that the construction of the model is not an essential part of the process. The model is used merely as an aid to thinking, and if the relations of phenomena can be investigated without it so much the better. The highest form of theory—it may be said the widest kind of generalisation—is that which has given up the attempt to form clear mental pictures of the constitution of matter, which expresses the facts and the laws by language and symbols which lead to results that are true, whatever be our view as to the real nature of the objects with which we deal. From this point of view the atomic theory becomes not so much false as unnecessary; it may be regarded as an attempt to give an unnatural precision to ideas which are and must be vague. Thus, when Rumford found that the mere friction of metals produced heat in unlimited quantity, and argued that heat was therefore a mode of motion, he formed a clear mental picture of what he believed to be occurring. But his experiments may be quoted as proving only that energy can be supplied to a body in indefinite quantity, and when supplied by doing work against friction it appears in the form of heat. By using this phraseology we exchange a vivid conception of moving atoms for a colourless statement as to heat energy, the real nature of which we do not attempt to define; and methods which thus evade the problem of the nature of the things which the symbols in our equations represent have been prosecuted with striking success, at all events within the range of a limited class of phenomena. A great school of chemists, building upon the thermodynamics of Willard Gibbs and the intuition of Van t'Hoff, have shown with wonderful skill that, if a sufficient number of the data of experiment are assumed, it is possible, by the aid of thermodynamics, to trace the form of the relations between many physical and chemical phenomena without the help of the atomic theory.

But this method deals only with matter as our coarse senses know it; it does not pretend to penetrate beneath the surface. It is, therefore, with the greatest respect for its authors, and with a full recognition of the enormous power of the weapons employed, that I venture to assert that the exposition of such a system of tactics cannot be regarded as the last word of science in the struggle for the truth. Whether we grapple with them, or whether we shirk them; however much or however little we can accomplish without answering them, the questions still force themselves upon us: Is matter what it seems to be? Is interplanetary space full or empty? Can we argue back from the direct impressions of our senses to things which we cannot directly perceive; from the phenomena displayed by matter to the constitution of matter itself? It is these questions which we are discussing to-night, and we may, therefore, as far as the present address is concerned, put aside, once for all, methods of scientific exposition in which an attempt to form a mental picture of the constitution of matter is practically abandoned, and devote ourselves to the inquiries whether the effort to form such a picture is legitimate, and whether we have any reason to believe that the sketch which science has already drawn is to some extent a copy, and not a mere diagram, of the truth.

*Successive Steps in the Analysis of Matter.*

In dealing, then, with the question of the constitution of matter and the possibility of representing it accurately, we may grant at once that the ultimate nature of things is, and must remain, unknown; but it does not follow that immediately below the complexities of the superficial phenomena which affect our senses there may not be a simpler machinery of the existence of which we can obtain evidence, indirect indeed, but conclusive. The fact that the apparent unity which we call the atmosphere can be resolved into a number of different gases is admitted, though the ultimate nature of oxygen, nitrogen, argon, carbonic acid and water vapour is as unintelligible as that of air as a whole, so that the analysis of air may be said to have substituted many incomprehensibles for one. Nobody, however, looks at the question from this point of view. It is recognised that an investigation into the proximate constitution of things

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may be useful and successful, even if their ultimate nature is beyond our ken.

Nor need the analysis stop at the first step. Water vapour and carbonic acid, themselves constituents of the atmosphere, are in turn resolved into their element of hydrogen, oxygen and carbon, which, without a formal discussion of the criteria of reality, we may safely say are as real as air itself. Now, at what point must this analysis stop if we are to avoid crossing the boundary between fact and fiction? Is there any fundamental difference between resolving air into a mixture of gases and resolving an elementary gas into a mixture of atoms and ether? There are those who cry "halt!" at the point at which we divide a gas into molecules, and their first objection seems to be that molecules and atoms cannot be directly perceived, cannot be seen or handled, and are mere conceptions, which have their uses, but cannot be regarded as realities.

It is easiest to reply to this objection by an illustration. The rings of Saturn appear to be continuous masses separated by circular rifts. This is the phenomenon which is observed through a telescope. By no known means can we ever approach or handle the rings; yet everybody who understands the evidence now believes that they are not what they appear to be, but consist of minute moonlets, closely packed indeed, but separate the one from the other. In the first place Maxwell proved mathematically that if a Saturnian ring were a continuous solid or fluid mass it would be unstable and would necessarily break into fragments. In the next place, if it were possible for the ring to revolve like a solid body, the inmost parts would move slowest, while a satellite moves faster the nearer it is to a planet. Now spectroscopic observation, based on the beautiful method of Sir W. Huggins, shows not only that the inner portions of the ring move the more rapidly, but that the actual velocities of the outer and inner edges are in close accord with the theoretical velocities of satellites at like distances from the planet. This and a hundred similar cases prove that it is possible to obtain convincing evidence of the constitution of bodies between whose separate parts we cannot directly distinguish, and I take it that a physicist who who believes in the reality of atoms thinks that he has as good reason for dividing an apparently continuous gas into molecules as he has for dividing the apparently continuous Saturnian rings into satellites. If he is wrong, it is not the fact that molecules and satellites alike cannot be handled and cannot be seen as individuals that constitutes the difference between the two cases.

It may, however, be urged that atoms and the ether are alleged to have properties different from those of matter in bulk, of which alone our senses take direct cognisance, and that therefore it is impossible to prove their existence by evidence of the same cogency as that which may prove the existence of a newly-discovered variety of matter or of a portion of matter too small or too distant to be seen. This point is so important that it requires full discussion, but in dealing with it, it is necessary to distinguish carefully between the validity of the arguments which support the earlier and more fundamental propositions of the theory and the evidence brought forward to justify mere speculative applications of its doctrines which might be abandoned without discarding the theory itself. The proof of the theory must be carried out step by step.

The first step is concerned wholly with some of the most general properties of matter, and consists in the proof that those properties are either absolutely unintelligible, or that, in the case of matter of all kinds, we are subject to an illusion similar to that the results of which we admit in the case of Saturn's rings, clouds, smoke and a number of similar instances. The believer in the atomic theory asserts that matter exists in a particular state; that it consists of parts which are separate and distinct the one from the other, and as such are capable of independent movements. Up to this point no question arises as to whether the separate parts are, like grains of sand, mere fragments of matter; or whether, though they are the bricks of which matter is built, they have, as individuals, properties different from those of masses of matter large enough to be directly perceived. If they are mere fragments of ordinary matter, they cannot be used as aids in explaining those qualities of matter which they themselves share. We cannot explain things by the things themselves. If it be true that the properties of matter are the product of an underlying machinery, that machinery cannot itself have the properties which it produces, and must, to that extent at all events, differ from matter in bulk as it is directly presented to the senses. If, however, we can succeed in showing that if the separate parts have a limited number of properties (different, it may be, from those of matter in bulk), the many and complicated properties of matter can, to a considerable extent, be explained as consequences of the constitution of these separate parts, we shall have succeeded in establishing, with regard to quantitative properties, a simplification similar to that which the chemist has established with regard to varieties of matter. The many will have been reduced to the few. The proofs of the physical reality of the entities discovered by means of the two analyses must necessarily be different. The chemist can actually produce the elementary constituents into which he has resolved a compound mass. No physicist or chemist can produce a single atom separated from all its fellows, and show that it possesses the elementary qualities he assigns to it. The cogency of the evidence for any suggested constitution of atoms must vary with the number of facts which the hypothesis that they possess that constitution explains. Let us take, then, two steps in their proper order, and inquire, first, whether there is valid ground for believing that all matter is made up of discrete parts; and, secondly, whether we can have any knowledge of the constitution or properties which those parts possess.

*The Coarse-grainedness of Matter.*

Matter in bulk appears to be continuous. Such substances as water or air appear to the ordinary observer to be perfectly uniform in all their properties and qualities, in all their parts. The hasty conclusion that these bodies are really uniform is, nevertheless, unthinkable. In the first place the phenomena of diffusion afford conclusive proof that matter when apparently quiescent is, in fact, in a state of internal commotion. I need not recapitulate the familiar evidence to prove that gases and many liquids when placed in communication interpenetrate or diffuse into each other; or that air, in contact with a surface of water, gradually becomes laden with water vapour, while the atmospheric gases in turn mingle with the water. Such phenomena are not exhibited by liquids and gases alone, nor by solids at high temperatures only. Sir W. Roberts Austen has placed pieces of gold and lead in contact at a temperature of 18°C. After four years the gold had travelled into the lead to such an extent that not only were the two metals united, but, on analysis, appreciable quantities of the gold were detected even at a distance of more than 5mm. from the common surface, while within a distance of ¾mm. from the surface gold had penetrated into the lead to the extent of 1oz. 6dwt. per ton, an amount which could have been profitably extracted.

Whether it is or is not possible to devise any other intelligible account of the cause of such phenomena, it is certain that a simple and adequate explanation is found in the hypothesis that matter consists of discrete parts in a state of motion, which can penetrate into the spaces between the corresponding parts of surrounding bodies. The hypothesis thus framed is also the only one which affords a rational explanation of other simple and well-known facts. If matter is regarded as a continuous medium the phenomena of expansion are unintelligible. There is, apparently, no limit to the expansion of matter, or, to fix our attention on one kind of matter, let us say to the expansion of a gas; but it is inconceivable that a continuous material which fills or is present in every part of a given space could also be present in every part of a space a million times as great. Such a statement might be made of a mathematical abstraction; it cannot be true of any real substance or thing. If, however, matter consists of discrete particles, separated from each other either by empty space or by something different from themselves, we can at once understand that expansion and contraction may be nothing more than the mutual separation or approach of these particles. Again, no clear mental picture can be formed of the phenomena of heat unless we suppose that heat is a mode of motion. In the words of Rumford, it is "extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in [his] experiment [on friction] except it be motion."* And if heat be motion, there can be no doubt that it is the fundamental particles of matter which are moving. For the motion is not visible, is not motion of the body as a whole, while diffusion, which is a movement of matter, goes on more quickly as the temperature rises, thereby proving that the internal motions have become more rapid, which is exactly the result which would follow if these were the movements which constitute sensible heat.

Combining, then, the phenomena of diffusion, expansion, and heat, it is not too much to say that no hypotheses which make them intelligible have ever been framed other than those which are at the basis of the atomic theory. Many other considerations also point to the same conclusion. Many years ago Lord Kelvin gave independent arguments, based on the properties of gases, on the constitution of the surfaces of liquids, and on the electric properties of metals, all of which indicate that matter is, to use his own phrase, coarse-grained—that it is not identical in constitution throughout, but that adjacent minute parts are distinguishable from each other by being either of different natures or in different states. And here it is necessary to insist that all these fundamental proofs are independent of the nature of the particles or granules into which matter must be divided. The particles, for instance, need not be different in kind from the medium which surrounds and separates them. It would suffice if they were what may be called singular parts of the medium itself, differing from the rest only in some peculiar state of internal motion or of distortion, or by being in some other way earmarked as distinct individuals. The view that the constitution of matter is atomic may and does receive support from theories in which definite assumptions are made as to the constitution of the atoms; but when, as is often the case, these assumptions introduce new and more recondite difficulties, it must be remembered that the fundamental

* *Phil. Trans.*, 1,798, p. 99.

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hypothesis—that matter consists of discrete parts, capable of independent motions—is forced upon us by facts and arguments which are altogether independent of what the nature and properties of these separate parts may be. As a matter of history the two theories, which are not by any means mutually exclusive, that atoms are particles which can be treated as distinct in kind from the medium which surrounds them, and that they are parts of that medium existing in a special state, have both played a large part in the theoretical development of the atomic hypothesis. The atoms of Waterston, Clausius and Maxwell were particles. The vortex-atoms of Lord Kelvin, and the strain-atoms (if I may call them so) suggested by Mr. Larmor, are states of a primary medium which constitutes a physical connection between them, and through which their mutual actions arise and are transmitted.

(*To be concluded.*)

## TRAMWAY LINE CONSTRUCTION.

Mr. A. L. C. Fell, general manager of the Sheffield tramways, who has recently been to Germany to make the reception tests of a 1,000kw. generator built for the British Thomson-Houston Co. at the works of the Union Elektricitäts Gesellschaft, has made use of the opportunity to inspect some of the tramway lines in that country. He gives some interesting notes in his report to the Sheffield Tramways committee, and we extract the following remarks with regard to the track and overhead construction :—

*Track Work.*—Director H. Giron, of Cologne (where electric tramways are now being constructed), sent out an inquiry to a large number of managers of German tramways and light railways, to ascertain which was the best method of construction to adopt. The following summarised replies appear to be the most important :—

1. On roads having a concrete foundation it is best to interpose some durable but elastic material between the rails and the concrete, special care being taken to adopt means to absorb the "hammering" at the joints.
2. Great care should be taken to drain the rail foundations, especially at the rail joints.

It would be advisable to adopt these suggestions on one of the new sections in Sheffield, as the running of the cars is becoming very noisy at the rail joints on several of the routes.

*Rails.*—In Hamburg combined fish and sole plates are used, and are strongly recommended, as not only is the joint thoroughly sound, but a much better contact is made across the joint. At curves on the various parts of the track the grooves are all very much widened out to avoid breaking the flanges of the wheels. Before this was done a great deal of trouble was experienced. In addition, the groove in the outer rail is nearly filled up, so that the outer car wheels take their bearing on the flanges only. This means that the outer wheels, for the time being, have larger peripheries, and will travel over more ground than the inner wheels in the same time, thus doing away with the grinding or marking time of the inner wheels which otherwise takes place. It also prevents the rails round the curves being so quickly worn away. I thought that the flanges of the wheels would be damaged, but was informed that this was not the case. I think it would be advantageous to try this method round the curves on, say, one route in Sheffield.

*Bonding.*—In the majority of cases the same type of bond is used as in Sheffield. Various other types have been tested. With electrically welded rail joints the experience has been very bad in Hamburg and in Berlin. In the former place about one joint in every 10 broke, in the latter about one in eight, shortly after being put into operation. With the cast welded joint, however, the experience has been much better, as only about 3 per cent. of the joints are faulty.

*Overhead Construction.*—The trolley lines in nearly all cases are mounted on flexible suspensions, and in the majority of cases span wire construction is adopted. Flexible suspensions are supposed to make the trolley wire less liable to break, but, although I believe this has something to do with it, I think that the following are the most important considerations, viz. :—

1. The type of the ear used for suspending the trolley wire.
2. The amount of sag left in the span.
3. Overheating of the wire when soldering.

The last point is the most important one. Experience shows that trolley wires generally break either at section insulators or at splicing ears. This is partly due to the sharp bend which has to be put in the wire when terminating it, and partly to the overheating of the wire. The mass of metal in the splicing ear and section insulator is very great in proportion to the mass of the trolley wire at the joint, a great heat has therefore] to be applied to get the former to a soldering temperature. This means that the trolley wire lying in the ear becomes very much overheated and loses its skin hardness, and in time elongates and breaks. The best method to adopt, therefore, is to use long thin ears, so that the mass of the ear at any point is not much greater than the mass of the adjacent wire. It is also necessary to make the ear as springy as possible in itself, so that it bends with the wire when the trolley wheel presses against it. If, in addition to these arrangements, a flexible suspension is added, in my opinion the best results will be obtained. In the cities visited I found that, wherever short stiff ears were used, great trouble was experienced with broken wires. This is the case in Berlin; whereas in Hamburg, where long ears are used, very few wires break. At Brussels very little trouble has been experienced with the centre running trolleys, but a great many wires have broken where the side trolley system has been in operation. I have had some trolley wire in use at Brussels tested, and find that the tensile breaking and torsion breaking tests give the same results as with the copper trolley wire now in use in Sheffield.

*Conduit System.*—In Brussels I had the opportunity of thoroughly inspecting the conduit system in operation. The first cost of the conduit system installed at Brussels was about three times as great as the trolley system. The cost of upkeep is about the same. It appears to be fairly simple and runs satisfactorily. The plough or contact maker runs in an opened out groove in one of the rails. Both the positive and return conductors are placed in the same trench on insulators. One of the chief difficulties experienced is the switching over arrangement at the points; it is necessary to have a man at each set of points to switch over. The greatest disadvantage of the system is the question of drainage. Brussels is fortunately situated in this respect, as there are no steep undulating gradients such as on the Sheffield routes, and the sewerage system is very perfect. Even although this is the case, trouble is experienced in winter by snow and salt flooding out the conduits and short-circuiting the mains and thus stopping the traffic.

*Cars.*—The cars in all the cities visited are all of the single-deck type. The most novel feature with regard to car construction was seen at Brussels, where the panels of the cars are made of compressed paper. This is light, strong and pliable, and damaged parts are easily repaired. In Hamburg nearly all the cars are fitted with track-cleaning apparatus. This can be worked by the driver where necessary. The cleaner only takes a little dirt out of the lines, but the principal idea is that it is better only to take out what is absolutely necessary, as otherwise the whole cleaning of the street would be done by the tramway company, as the road sweepers fill up the grooves in the rails almost as fast as they are cleaned out.

*Wheels.*—Steel-tyred wheels are rapidly being adopted in the cities visited, in preference to the chilled iron, which has given a great deal of trouble through broken flanges, &c., notwithstanding that the grooves in the rails are considerably wider than those allowed by the Board of Trade in this country. In Hamburg and Brussels it has been found that the life of steel-tyred wheels is from three to four times that of chilled iron wheels. The tyres of the wheels in these cities are the same thickness as those which are now being used in Sheffield. Wheels with wrought-iron centres are used in a great many cities.

*Life guards.*—In accordance with your instructions, I went carefully into this question, and inspected a large number of experimental life-guards, which have been, and are being, tested. The general opinion seemed to be that persons are more liable to be killed by a so-called life-guard than by a simple V-shaped "cow-catcher," or pilot board, fixed in front of the wheels to act as a guard. The protection is placed not only in front but also at the sides of the truck frame, so as to make it practically impossible for anything to get under it. To get the best results, the guards are mounted either on the axle boxes or on that part of the truck frame on which there is no oscillation due to the truck springs. The guard can thus be kept very close to the ground. In Hamburg I was informed that over 100 different types of life-guard had been tried, but it is considered that the type above mentioned is the best in every respect. I would suggest that a car be fitted with a guard of this description.

The Tramways committee has adopted the following recommendations :—

That on roads having a concrete foundation some durable but elastic material be interposed between the rails and the concrete, so as to absorb the hammering at the joints; also that the rail foundations, at the rail joints, be drained.

That the grooves in the rails be widened at the curves, to avoid breaking the flanges of the car wheels, and that on one section the groove in the outer rail of the curves be filled up and tested as suggested.

That the rails on the mile of track be fitted with combined fish and sole plates mentioned in the report.

That the foregoing recommendations be tried on one of the routes in Sheffield as an experiment.

That a netting be placed under the telegraph wires at Fitzalan-square, in order to prevent the wires falling on to the road in case of a breakage.

That a life guard of the V shape be fitted to one of the cars in Sheffield.

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# CORRESPONDENCE.

## EDISON'S ALKALINE STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This discussion seems to display a tendency to stretch out, also, I think, to get a little wide of the mark. The original point in dispute, as will be remembered, was whether the iron in the negative electrode in Edison's battery could, with the graphite which is interspersed among it, form a couple in caustic alkali.

Mr. Wade's rejoinder to my letter consists of two parts—a statement of theory and a statement of fact. In the former he admits that the electrolysis takes place in the dissociated alkali itself, and that the decomposition of the water is only an "ultimate" result. This is misleading, and would appear to be giving the whole case away. The electrolysis of water is never anything else but an ultimate, that is to say a secondary result. Pure water is unelectrolysable, and is in fact a high-class insulator. Mr. Swinton has recently employed it to replace oil in high-tension induction coils. There being only two kinds of electric conductivity—metallic and electrolytic—it is only in proportion as water contains electrolysable substances that it can let current through it, and be electrolysed. To take 1·5 as the voltage required to electrolyse water is merely, therefore, a convention, and really means that that is the voltage required to electrolyse water containing sulphuric acid. It is always the electrolyte that is split up and the water that is decomposed by the product so produced, unless in cases where those products not reacting with water are themselves deposited. The voltage required for electrolysis, therefore, depends on the electrolyte in solution and not on the water, otherwise the voltage required to electrolyse solutions would be the same no matter what salts or bodies are present. Will Mr. Wade assert that it is?

As regards the statement of fact, Mr. Wade has evidently neglected to prevent the occurrence of oxygen polarisation on his annode (which will, of course, occur with an iron annode in caustic alkali), and so has got too high a result. In adddition, caustic potash requires a slightly higher voltage than the caustic soda to which I referred.

To revert: As stated above the real point is whether the iron of the negative plate can decompose the electrolyte. The behaviour of zinc and copper in dilute sulphuric acid would seem to throw further light on the point. In dilute sulphuric acid zinc and copper only give a P.D. of 0·8 volt. The P.D. required to decompose the dilute sulphuric acid electrolytically is, as we are agreed, 1·5 volts. A zinc plate with which grains of copper are intermixed will, however, decompose the dilute acid freely, and yet the P.D. of the couple is only 0·8 volts. Local action might, therefore, quite well take place in Edison's negative, even if it were true that the P.D. of the couple graphite-iron were equal to the P.D. required to split up the solution present.—Yours, &c.,

R. N. LUCAS.

# LEGAL INTELLIGENCE.

## Liverpool Corporation v. M'Cullough.

In the Chancery of Lancashire on Tuesday, this adjourned case came before Mr. Registrar F. Willis Taylor. Plaintiffs sought to restrain Mr. M'Cullough, formerly assistant tramways manager, from publishing letters, or any part of letters, which they alleged had been wrongfully taken out of the Corporationpress letter-book, and ordering him to give up certain originals of letters which it was alleged he had still in his possession.

Mr. MANSFIELD for the Corporation, said defendant was assistant manager of the tramways, and had charge of the Lambeth-road works department. Some dispute arose in August last with regard to his conduct in the managament, and on Aug. 22 he discussed matters with the sub-committee, who decided that he should attend on the following day at 2.30 p.m., at the Corporation offices, and give any explanation he could. He did not, however, attend that meeting. A resolution was then passed that defendant's services be dispensed with from that day, and that three months' salary should be paid to him in lieu of notice. Having received this notice defendant took out of the office a letter-book and a lot of correspondence on Aug. 23. On Aug. 25 he handed the letter-book to Mr. F. W. Rowland, member of a firm of contractors executing work for the Corporation in connection with the tramways. Mr. Rowland had copies made of a number of letters. The return of the letter-book was demanded by the town clerk. They had since received the letter-book, but 41 pages and nine half-pages were missing out of the letter-book. Defendant pleaded that he required copies of certain letters to justify his conduct before the committee when it met, as he had asked that certain allegations made against him should be considered. If that had been defendant's object, there was no reason why he should mutilate the letter-book, or tear half-pages out and retain them, or tear off the numbers from other pages so that they could not be traced through the index. The Corporation further demanded that certain letters be delivered up, and that defendant be restrained from giving any information in respect of them. There were from 80 to 100 original letters missing from the office of which defendant had charge.

Mr. ROTCH, for defendant, said his client had not got the letter-book, and that he had given up to the Corporation all the documents belonging to them which he had had in his possession. It was never defendant's intention to make any improper use of letters or documents. He only wanted the copies in order to be able to justify his conduct to the committee. He admitted that technically the book was wrongfully taken away, but his client was certainly entitled to keep the copies he had made, but not to make any improper use of them. There was no evidence of any intention on the part of defendant to publish or distribute any of these copies. Defendant would undertake not to make any use of the copies until the trial of the action, except for his defence before the committee, which he hoped would investigate the matter.

Mr. MANSFIELD asked that three specific missing letters, which defendant said he had mislaid, should be given up. There was (the Corporation believed) some ulterior motive on the part of the defendant running through all the business. He (counsel) asked for an injunction, requiring defendant to deliver up all original letters, or other original documents belonging to the Corporation and wrongfully taken away by defendant or his agents from their custody, also the parts of the letter-book, also the copies of the letters he had had made, and that defendant be restrained until the trial of the Chancery action from making any use of any information that he had obtained from the perusal of the books and documents of the Corporation.

Mr. ROTCH said the documents were mainly reports by the general manager, and were absolutely necessary to defendant for his defence. There was no evidence against the defendant, except a suspicion in the minds of some of the officials.

Eventually an order was made for the defendant to deliver up forthwith all original documents and letters and any pages or parts of pages of the letter-book he had in his possession. As to the copies of letters, the question to be tried in the action was whether these copies belonged to defendant or not. But defendant could not make any use of them. He had, however, handed these letters to an outside party, a contractor to the Corporation, and technically that was publishing the documents, and for that he must be restrained. He could not, however, be restrained from reading them before the committee, but must be restrained from parting with the copies or distributing them, or publishing any of the letters or documents or in any way making use of the information they contained. The costs of the application would be made costs in the action.

## Nalder Bros. and Thompson (Ltd.) v. J. Bakewell & Co.

In the City of London Court, on Tuesday, plaintiffs sought to recover 12s. 6d., balance of an account for goods supplied. Plaintiffs received an order for electrical instruments, but no time was fixed for delivery. On the point of completion defendants intimated that if the goods were not in Sheffield next day they would not accept delivery. In order to get the goods to Sheffield in time plaintiffs had to dispatch them by passenger train at an increased rate, over which the present dispute arose. Defendants urged that the order was to be completed within three weeks. Had the instruments been supplied in that time it would not have been necessary to send the goods by passenger train.

The ASSISTANT REGISTRAR said the objection had not been raised by defendants in their correspondence with plaintiffs, and therefore judgment would be for plaintiffs for the amount claimed and costs.

## Alleged Failure to supply Electricity.

At Manchester City Police Court, on Wednesday, the Electricity committee of Manchester Corporation were charged before the stipendiary (Mr. F. J. Headlam), at the instance of Mr. S. Howard, Oldham-street, with failing to comply with his demand to be supplied with electric current for illumination. The summons alleged that the Corporation had on Aug. 12, and every subsequent day, failed to maintain through the distributing main in Oldham-street a supply of electricity of sufficient voltage for the use of all consumers entitled to be supplied through the mains; that the complainant applied on Aug. 9 for a supply of electricity to his premises in Oldham-street; and that he had been deprived of such supply, suffering, in consequence, serious loss and damage to his trade.

Mr. ROE-RYCROFT, for the complainant, said Mr. Howard took the premises in Oldham-street on June 24 from a person named Murray, to whom electric current was supplied until two days before Mr. Howard took possession, Murray having stayed on for a short time. Mr. Howard purchased the electrical fittings from Murray, and applied to the Corporation for a supply of current. It appeared, however, that without his knowledge or consent the Corporation had removed the meter. In complainant's windows were showcases fitted with electric lamps, and if electric supply was not kept up he would be involved in great expense in putting in gas fixtures. He (counsel) submitted that under the Act of Parliament and under the Corporation's Provisional Order, 1890, Mr. Howard was entitled to a supply. Mr. Howard had written to the Corporation electrical department for form of application, but no answer was received.

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Mr. Howard wrote again on Aug. 12 stating that the meter had been removed, and that he desired to be supplied with current. To that letter a reply was sent by the chief engineer that the communication had been sent to the secretary. Two further letters were sent and two telephone messages, but no reply came. The matter was placed with Mr. Howard's solicitors, who notified the Corporation that they would be held liable for failure to supply, and later that legal proceedings would be taken. The reply to this was that no meeting of the Electricity committee would be held until Aug. 28. On Aug. 29 complainant received a letter stating that the committee could not connect the premises until they were able to state definitely what current could be supplied from the Bloom-street generating station. The committee were then written to, but seemed to be husbanding their resources for the electric tramcars. He (Mr. Roe-Rycroft) submitted that the Corporation were under an obligation to supply current on application. They were liable to a penalty, under one section of the act, of £5 per day for every day on which they failed to maintain supply, and another section stated that "Whenever the undertakers make default in supplying energy to any owner or occupier of premises to whom they may be or are required to supply energy under this order they shall be liable to a penalty not exceeding 40s. in respect of every such default for each day on which such fault occurs." In conclusion, he asked for the infliction of a severe penalty.

Mr. HEADLAM said that any money penalty inflicted by that Court would go back again to the Corporation.

Mr. ROE-RYCROFT: That is not so. This is a case where the Court has discretion to pay the penalties to the complainant.

Mr. HOWARD, supporting his counsel's opening, said other shops were provided with electric light, including those immediately adjoining his premises on both sides.

In cross-examination Mr. HOWARD admitted that in his letter of Aug. 9 he merely asked for a form of application.

Mr. BELL (for the Corporation), on this, took objection to the summons. The Corporation were summoned for failing to supply on an application of Aug. 9, and the summons must fail.

Mr. HEADLAM: By not sending the form of application you may put everybody off.

After examining the act and the letter of Aug. 9, Mr. HEADLAM said he was afraid Mr. Bell's objection was fatal to the action.

Mr. ROE-RYCROFT: I shall ask your worship to amend it and make it the 12th, when there was clearly a request to supply. There is an admission by the Corporation that they cannot perform their obligations, and on that point they are liable to a penalty of £5 per day.

Mr. BELL: But the Board of Trade has approved the order of 1890 sanctioning conditions of supply. We say complainant is not a person entitled to be supplied with electrical energy, and I ask the stipendiary to dismiss the summons on that ground.

The magistrate agreed that the summons was generally bad, and dismissed the action, but without costs.

### Workmen's Compensation.

At Edmonton (Middlesex) County Court, on Monday, an application was made by the Edison and Swan Company in respect of an arbitration under the Workmen's Compensation Act, in which they were respondents. A lad in their employ met with an accident whilst following his work, resulting in the loss of a finger. Judge Tindal Atkinson made an award under the Workmen's Compensation Act (by consent) for the company to pay the lad 3s. 5d. per week. On behalf of the company it was now stated that an arrangement had been come to with the boy's father to pay a lump sum of £10. Nothing had yet been paid under the award.

His HONOUR said that £6 was now due, so that for another £4 the father was prepared to surrender the 3s. 5d. per week. The agreement was outside the purview of the Court altogether, and he could not, therefore, entertain the application for a stay of execution now made. If the father accepted the £10 and subsequently attempted to enforce the award the company could apply to him.

### Trades Union Cases.

In the Chancery of Lancashire, Liverpool, on Tuesday, before Mr. F. Willis Taylor, the action brought by Banister Bros., Blackburn, against the president, secretary and members of the Blackburn District Weavers', Winders' and Warpers' Association for an injunction to restrain them from picketing during the strike at the plaintiffs' mills, was again adjourned for a week.

Seven members of the Limerick branch of the Amalgamated Society of Carpenters and Joiners were arrested at Limerick on Tuesday, charged with conspiracy against Mr. M. Gough, builder, who refused the society's demand for higher wages. Defendants were remanded, on bail, to next sessions. The solicitors for Mr. Gough have served notice on the secretary of the Carpenters' Society that legal proceedings will be taken against the society in the High Court for damages.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"The Indicator Handbook." By C. N. Pickworth. Part II. (Manchester: Emmott & Co.) 3s.

"Annual Report of the Board of Regents of the Smithsonian Institution for the Year ended June 30, 1899." (Washington: United States Government Printing Office.)

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

A demonstrator in electrical engineering is required at Heriot Watt College, Edinburgh. Applications to the principal by Sept. 21. See advertisement.

There are vacancies for a shift engineer and an improver at the Dundee electric lighting and traction station. Applications to the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, by Sept. 16. See advertisement.

Messrs. S. Z. de Ferranti (Ltd.), Hollinwood, near Manchester, require a good electrical draughtsman with knowledge and experience of station switch gear. See advertisement.

A clerk-in-charge is required for the telegraph department of the Government of the Gold Coast. Applications to Crown Agents for the Colonies, Downing-street, London, S.W., by Sept. 16.

Telegraph linesmen are required by the Government of Northern Nigeria. Some particulars of the appointment are set out in an advertisement, and applications must be sent in to the Crown Agents for the Colonies, Downing-street, London, S.W., by Sept. 21. Messrs. Preece and Cardew, 13, Queen Anne's-gate, London, S.W., will answer inquiries.

A lecturer in electrical engineering is required for a London technical institute preparing for City Guilds examinations. Applications to Mr. W. Keller, 70, Springbank-road, Hither Green, London, S.E., by Sept. 28. See advertisement.

Wigan Corporation require a charge engineer. Salary £104. Applications to borough electrical engineer (Mr. H. Collings Bishop), Bradford-place, Wigan, by Sept. 18. See advertisement.

Lurgan Technical Instruction committee require a headmaster and organiser for their new technical school. Salary £250. Applications by 19th inst.

Edinburgh Corporation require a superintendent of mains. Applications to Mr. F. A. Newington, 5, Dewar-place, by 21st inst.

Mr. J. Newlands, controller of the telegraph office, Edinburgh, has been appointed a traffic manager (jointly with Mr. T. Mason) for telegraph business, in succession to Mr. Trenam promoted. Mr. Newlands is well known throughout the service from his earnest work in connection with the Post Office Benevolent Society. The vacancy at Edinburgh has, we understand, been filled by Mr. Plackett from Leeds.

Mr. A. R. Bell, assistant engineer at Swansea, has been appointed resident electrical engineer to the Uxbridge Electric Lighting Co.

Mr. R. H. Rinder, superintendent of construction to the Birkenhead Corporation electric tramway department, has been appointed to a similar position by the South Lancashire Electric Traction and Power Co.

**Ashton-under-Lyne.**—Application has been made for sanction to borrow £30,000 additional for electricity supply.

**Bendigo (Victoria).**—The ceremony of laying the foundation-stone of the Bendigo electricity works of the Electric Supply Co. o. Victoria (Ltd.) was recently performed by the mayor (Councillor S. Ryan). The initial cost of the scheme is estimated at about £120,000 Current will be supplied in the city of Bendigo and in the new borough of Eaglehawk.

**Bradford.**—On Tuesday the Corporation resolved to increase the salary of the city electrical engineer (Mr. R. A. Chattock) by £100 per annum as from July 1 last, and a further £100 from July 1 next.

Tenders have been accepted for the electric lighting and tramways departments. The electrical equipment of Manchester-road, Leeds-road, Wakefield-road, Sunbridge-road and Manningham-lane tramway routes was authorised, and £27,012 was voted for feeder cables, &c.

The revenue of the tramways for the year ended March 31 shows that the number of car miles run was 714,150. The total receipts were £33,123, or 11·131 per car mile. The annual expenditure, including £5,955 for interest and sinking fund and £8,451 for depreciation, was £32,585, and the net profit £537. 12s. 5d.

The Idle and Thackley electric tramway routes were opened for traffic on Tuesday.

**Carrara (Italy).**—A concession has been granted for a term of 52 years to the Societa Tramvia e Luce Electrica di Carrara for the construction, equipment and working of an electric tramway between this town and Carrara di Marina, and for the lighting of the town by electricity. The company have the right to supply current for private lighting and power. The town is the centre of the famous marble industry, and has a population of about 30,000. The tramway route to be first constructed is 3 miles in length.

**Customs Duties.**—The Spanish tariff classification on covered copper wires imported into Spain has recently been modified. Copper wire covered with cotton, silk or other textile fibres, with or without indiarubber or other insulating materials, is now dutiable

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(under No. 81 of the tariff) at the rate of £2. 10s. 10d. per cwt. (1p. 25c. per kilogramme). Copper wire for electric light and power conductors, covered with various insulating materials, is dutiable (under No. 305 of the tariff) at 7s. 6d. per cwt. (18p. 50c. per 100kg.). This modification suppresses the second paragraph of No. 305 of the tariff. Complete trucks, imported in detached pieces, and bogies, consisting of frames with wheels for cars on electric tramways, are dutiable (under No. 298 of the tariff) at 6s. 11d. per cwt. (17p. per 100kg.) as "machine motors of any kind." This revokes former tariffs Nos. 61 and 311.

**Dudley.**—The Corporation have authorised the laying of cables for public and private lighting in several additional streets, and have consented to the proposal of the British Electric Traction Co. for constructing a short length of double track tramway.

**East Grinstead.**—Messrs. Medhurst and Lloyd recently prepared a report for the Council recommending the erection of electricity works at an estimated cost of £12,844, but the Electric Light committee were indisposed to adopt the report, and the Council last week, by 5 to 4, approved a motion for a special meeting, Mr. Medhurst to be invited to attend, for a fee of 10 guineas, to explain his scheme.

**Electric Traction in Yorkshire.**—At Dewsbury on Wednesday representatives of local authorities in the heavy woollen district assembled in order to meet representatives of the British Electric Traction Co. who are promoting a scheme for the construction of a system of electric tramways in the district of a total length of about 26 miles, at an estimated capital expenditure of about £300,000. The following places were represented:—Ravensthorpe, Cleckheaton, Birkenshaw, Heckmondwike, Liversedge, Clifton, Gomersal and Thornhill. The chair was occupied by Ald. Kilburn, Dewsbury, and the following officials of the company were present: Mr. C. W. G. Little (chief executive electrical engineer), Mr. Prescott, Mr. E. A. Paris (resident engineer), Mr. E. A. Hopwood (district secretary), Mr. H. L. Barber (secretary to the undertaking). The consulting engineer (Mr. S. Sellon) explained the proposals of the company, and dealt with the objections, especially as to the narrowness of the roads. The Board of Trade had shown a decided preference for double lines, and if he had not offered a double line the Board would have insisted on it. They proposed to use granite setts throughout the whole district, but they were prepared to meet the local authorities with reference to local stone on certain gradients. He must press the necessity for a double line, which experience had taught them was essential. If Dewsbury Council could suggest any plan which, at a reasonable cost, would remove the obstacles of which they complained, the company were ready to discuss it. Votes of thanks terminated the proceedings. Each local authority will call a special meeting to further discuss the matter. Batley Corporation, being opposed to the scheme, was not represented.

**Electic Tramways in Surrey.**—The London United Tramways (Ltd.) are preparing a comprehensive scheme for the extension of their system of electric tramways in the county of Surrey, the districts scheduled including Leatherhead, Esher, Thames Ditton, Wimbledon, Mitcham, Barnes, Croydon, Cheam, Sutton, Carshalton, Ashtead, &c.

**Electrical Development in Russia.**—The official opening of the first section of the electric tramways in Riga took place recently.

Electric tramways are in regular operation in the town of Libau and are well patronised.

At the town of Pernau there was opened last year an extensive range of wood-pulp mills, the erection and equipment of which have cost about £700,000. The mills have been furnished with very complete electric power and lighting plants.

**Electrical Illuminations for the Czar's Visit to France.**—We are informed by Electric Lighting Boards (Ltd.) that their Paris representatives are providing electric illumination devices on a large scale on the occasion of the visit of the Czar of Russia to Dunkirk and Compiègne. The approaches to the castle at Compiègne are to be illuminated by E.L.B. devices requiring 7,000 lamps.

**Hawick (N.B.).**—The Urban Electric Supply Co. have commenced the erection of electricity station buildings in Commercial-road.

**Japan.**—In a note in our last issue, p. 767, we commented upon the non-success of British tenderers in the supply of cables for telephonic purposes to Japan, and the fact that this trade was almost exclusively in the hands of American and German manufacturers. We have received the following from the St. Helens Cable Co.:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have noted your remarks re dry core cable for Japan. It may be of interest to know that my firm has repeatedly secured orders for dry core cables for the Japanese Government, and are sending out a considerable quantity just now. The Japanese authorities have, however, adopted a different type of dry core cable than that used largely in this country, the paper insulation being lapped on instead of being put on longitudinally. The electrical results are not as satisfactory as obtained by the English method of covering each wire, inasmuch as the electrostatic capacity is comparatively higher than on our English cables with a similar conductor. The only advantage that might be claimed is greater mechanical strength of each individual insulated conductor, which might be of advantage in connecting up station ends of cables. The following are some tests made on a cable made to Japanese specification:—

*Conductor, 20 S.W.G. No. of Conductors, 53.*

| —— | Capacity. mf. per mile. | Dielectric Resis. Megohms per mile | Average in layer per mile. |
|---|---|---|---|
| Outside layer ... | 0·0923 | 13,209 | 0·0942 mf. 12,088 megs. |
| | 0·0949 | 11,634 | |
| | 0·0949 | 11,634 | |
| | 0·0949 | 11,634 | |
| First layer ... .. | 0·0902 | 11,080 | 0·0890 mf. 11,080 megs. |
| | 0·0886 | 11,080 | |
| | 0·0836 | 11,080 | |
| Centre ..... | 0·1009 | 11,079 | 0·1009 mf. 11,079 megs. |
| | 0·1009 | 11,079 | |
| | 0·1009 | 11,079 | |
| | 0·1009 | 11,079 | |

Average of all wires { Capacity 0·0947 microfarads per mile. Dielectric resistance 11,399 megohms per mile.

HEYLDIA.

**Kearsley.**—The Council have arranged with Farnworth for the supply of electricity for public and private lighting, the Kearsley Council retaining the right to take over the mains at six months' notice. The Council have authorised the borrowing of £22,000 for additional generating plant.

**Leamington.**—The Council have rejected a proposal to put down independent generating plant for lighting the town hall and public buildings.

**Light Railways.**—The Glamorgan County Council are applying for authority to construct five lines of light (electric) railway at an estimated cost of £615,804.

The Canterbury-Herne Bay light railway scheme has been revised, and application has been made to the Light Railway Commissioners for an order.

The British Electric Traction Co. have again applied for an order to authorise the construction of light electric railways in the Crewe district. The Town Council, who were unsuccessful in their application for an order last year, have decided to oppose. It will be remembered that about a couple of years ago the British Electric Traction Co. secured an order for Crewe, but, owing to the onerous conditions imposed by the Council, the company allowed the order to lapse. The revised scheme comprises the construction of six lengths of line through the main streets of the town.

**Liverpool.**—At the meeting of the Corporation on Wednesday, the chairman of the Tramways committee (Ald. Petrie) made a lengthy statement as to the dismissal of Mr. M'Cullough, late assistant manager of the tramways.

He said Mr. M'Cullough came from Toronto about 12 months ago and was appointed head of the works in Lambert-road, where repairs of the electrical equipment were effected. He also had control of the overhead equipment generally, and the Council, recognising his ability, increased his salary of £360, at which he was engaged, to £550, rising to £600. At the meeting of the committee on July 12, the town clerk submitted two letters from contractors wishing to withdraw from contracts, which had been entered into and confirmed by the Council. A sub-committee was appointed to investigate these matters, and held a meeting on July 25, and had before them some of the contractors, who explained their reasons for wishing to withdraw from their contracts. The sub-committee found that Mr. M'Cullough had patented certain electrical appliances, particularly a trolley-head and a cross-over. These patents he had disposed of, or had entered into an agreement with firms in Liverpool who had been doing work for the Corporation, and were upon the list of Corporation contractors. It was the duty of Mr. M'Cullough at Lambert-road works to inspect and pass all materials taken into the works before payment would be made for them. He (Ald. Petrie) was deputed by his colleagues to see Mr. M'Cullough, and talk the matter over, and in an interview he pointed out to Mr. M'Cullough the serious position in which he had placed himself by entering into an agreement with a contracting firm. The agreement was practically a partnership. Mr. M'Cullough expressed regret at having entered into the agreement, and said he had not recognised that he was doing any harm. He expressed willingness to cancel the agreement with the firm referred to. Upon his return from Norway he went into the matter carefully and fully, and thoroughly agreed with what his colleagues had done during his absence. Mr. M'Cullough had certainly lost his confidence as an official, and he believed also lost the confidence of the committee generally. Ald. Petrie then replied to certain criticisms by Mr. Utley and others of the policy adopted by the Committee in regard to certain plant. He said Mr. M'Cullough had been asked to report upon different sorts of wheels used in tramway work, and to make a proper test, but up to the present time there had been no report received from him. The "Griffin" chilled wheels alluded to in the charges had been found to chip very largely wherever there were looplines. The Council would recollect that the overhead trolley system was designed and carried out by the late Dr. John Hopkinson when the Dingle line was laid. Dr. Hopkinson was the first man in the kingdom in connection with electric traction, and was particularly careful that everything connected with the system should be durable and strong. The committee had spared no expense in getting the best material, and Messrs. R. W. Blackwell & Co. had carried out the contract, not only to the full satisfaction of the city

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engineer, but to the inspectors of the Board of Trade. He did not take Mr. Utley's criticisms very seriously, as he had a complete answer. Regarding the cars, they were very fortunate to have them, as the design was the most popular of any in the country, and had been copied by other tramway undertakers. They had a standard car built of the best material and efficient in every way. As to their lamps, Mr. M'Cullough found himself in March last running short of lamps, and made a requisition to the general manager. Lamps could not be got from the contractors at the time, and Mr M'Cullough said he had tested a lamp called the "Premier" lamp, and found that it ran 400 hours. He recommended the purchase of 10,000 to 15,000 at 6d., the price quoted by the contractors, against the usual price of 8½d., the firm guaranteeing that they would run 600 hours. Personally he did not know that any of the lamps were in use at all till he received a communication from Mr. M'Cullough. He found that 10,000 lamps had been used, and he believed they had given every satisfaction. They were ordered entirely on the recommendation of Mr. M'Cullough. It had been said that Mr. M'Cullough had saved £1,800 on grease, but the total amount expended on grease in any one year was only £750. Regarding brake blocks, in respect to the life of the wheels, Ald. Petrie said these blocks were of the American pattern, chilled iron, and it was found that the life of the wheels had been materially reduced, the life of the block being extended at the expense of the wheels. As to maintenance, he believed that by the end of the year the Liverpool tramways maintenance account would compare favourably with that of any other similar undertaking in the country. They were doing all possible to keep maintenance as low as possible, consistent with efficiency and service. In Liverpool, for the seven months ended July 31, the gross profits were £87,622, against £117,000 in Glasgow for 12 months. Liverpool's interest on sinking fund was £28,584, so that there was a balance of £26,448. It was only three years ago they commenced electric traction, and they now had cars running all over the city and carrying two millions of people per week, with a small percentage of accidents or delay.

Ald. SMITH also made a lengthy statement, similar in purport to that of Ald. Petrie.

The TOWN CLERK announced that he had received a letter from Mr. M'Cullough's solicitors, reiterating his wish to have an opportunity of meeting the charges made against him. It was said that Mr. M'Cullough had no wish to re-enter the Corporation's service, but could not rest under the serious imputation that he had forfeited the confidence of the committee without having the charges made against him thoroughly and impartially investigated.

Mr. UTLEY moved that a special committee, consisting of the whole Council, be appointed to consider the circumstances of the dismissal of Mr. M'Cullough. He took exception to many of the statements made by Ald. Petrie.

Mr. TAGGART seconded the amendment, and said if there was nothing to conceal he saw no reason why the committee should object to the proposed inquiry. They wished to know whether Mr. M'Cullough had really an interest in a certain firm, and they might reasonably expect a specific statement as to whether any of the members of the Tramways committee were themselves interested in the Corporation contracts. He especially asked for a definite statement from Ald. Petrie as to whether he was interested or not in the supply of the "Premier" electric lamps which had been mentioned. Had he any shares in the company who made these lamps? He hoped the committee would agree to the inquiry in their own interests.

Ald. F. SMITH said the committee had no time to waste on inquiries. They had a big undertaking to manage which required all their time and energy. In regard to the engineering details of the tramways they were constantly making experiments as to the relative value of different materials. He might add that the committee was mostly composed of successful business men.

Ald. Dr. COMMINS said Mr. M'Cullough had been dismissed at a moment's notice and under circumstances that would render his abilities, if he possessed any, useless for the rest of his life, or at any rate until his character was cleared of the imputations which had been made upon it.

Sir W. B. FORWOOD said the Corporation had never before been asked to appoint a committee to hear an appeal by a servant who had been dismissed by a committee. Electrical experts were too few in number for the committee to wish to dismiss an able servant.

Mr. MILES said: With regard to the purchase of 10,000 lamps from the Premier Company at 6d. each, he asked if an arrangement could not have been come to between the Corporation and a company to supply such lamps at a nominal figure?

Ald. PETRIE, replying on the question of the supply of lamps, said he was not aware that any lamps had been bought by the committee from the Premier Lamp Company. Unfortunately for himself he some years ago, and before his connection with the tramways committee, had invested a small sum of money in a company which had not proved successful. He had nothing to do with the management of the company. It appeared that in March a report was submitted by Mr. M'Cullough that their stock of lamps was very low and unless, at least, 1,000 lamps could be delivered almost at once some of the cars would have to run with less than their proper number of lamps. Mr. M'Cullough reported that the only available immediate supply was through the Premier Company, and after enquiry as to the character of these lamps an order was placed for 2,000. Later they received an offer to supply these lamps for lots of 10,000 at 6d. each, and Mr. M'Cullough reported that the test of the lamps had been satisfactory and recommended an order for from 10,000 to 15,000 lamps be given, and an order was placed for 10,000 lamps. The Premier Company had given a guarantee of 600 hours' life for their lamps, and the best average that the committee had previously secured was 565 hours at an average price of 8½d. per lamp.

Mr. E. L. LLOYD said the committee were compelled to dismiss Mr. M'Cullough, and everything that had happened since went to confirm the wisdom of the committee's action.

The amendment was lost by 64 to 16 votes.

**Municipal Telephony.**—A conference of authorities within the Burnley area will be held shortly to consider a proposal to establish a municipal telephone service.

A committee of seven was appointed by Sheffield Corporation on Wednesday to report upon the question of establishing a municipal telephone service.

**Nelson.**—An inquiry into the Council's application for borrowing £25,000 additional for extensions to the electricity works will be held on 18th inst.

Application has been made to the Board of Trade for sanction to a loan of £8,700 for reconstructing and electrically equipping the borough tramways.

The revenue of the electricity department for 1900-01 was £1,932. 12s 5d., against £1,828. 0s. 4d. in the previous year. The expenditure was £1,860. 12s. 5d., against £1,538. 12s. The estimated profit was £117 and the actual £70. Further borrowing powers for £14,450 were sanctioned during the year. The amount expended on capital account was £1,882. 3s. 5d., making the total £13,498. 19s. 1d.

**New Brompton.**—The Council have applied for sanction to a loan of £27,000 for purchasing so much of the undertaking of the Chatham, Rochester and District Electric Lighting Co. as lies within the New Brompton area.

**Novel Fire Alarm.**—Commander Wells, chief of the Metropolitan Fire Brigade, recently had presented to him, as a souvenir of the South African conflict, a 4·7 shell. This has been converted into an electric fire alarm signal at the brigade's headquarters.

**Plymouth.**—On Monday the Electricity and Street Lighting committee submitted estimates of the first year's working of the electricity department. The estimated expenditure for the year was £3,815 and the actual £5,641. The estimated revenue was £6,327 and the actual £6,834, leaving a net deficit of £1,310. Mr. RADFORD (chairman of the committee) in moving approval of the estimates, said the total units generated were 543,250, and the units sold 432,532. The high price of coal greatly affected the financial results, and among other causes was the fact that only £150 had been allowed for rates and taxes, and that figure had been exceeded by £382. Their great difficulty was the mistake made in calculating the cost of the electricity works buildings, which was nearly £1,300 more than was estimated, and consequently there were heavier charges for interest and sinking fund. The demand for electricity far exceeded what they anticipated, and before they had been working three months they had to refuse a number of consumers and to incur fresh capital expenditure in extensions. They were now again in almost the same position. They had provided considerable additions to their plant, and could now supply current to another 6,000 8 c.p. lamps. But at the rate new orders were coming in they would soon be working at their full capacity, and would be able to meet expenses. In the new extension they could put in a large amount of additional machinery without any greatly increased expenditure. He (Mr. Radford) never expected that the undertaking would pay in the first three years, but supported it as necessary for public lighting and tramways, and with the knowledge and belief that it would ultimately be of very great benefit to the town. Mr. PAGE considered the position a serious and alarming one. It seemed as if the early history of the trams was to be repeated in the electricity undertaking. The committee should see whether economies could not be effected, or whether the charges for electric current were just. If they charged 3½d. per unit for public lighting they would receive £1,500 a year for the arc lights. But last year they received only £1,100, out of which £300 was paid for repairs, so that the revenue from the current supplied to the arc lamps was only £750, or about half what they ought to receive. He protested against supplying electricity for public lighting at a loss. They were told the average cost of current was 4¾d. per unit. Yet they were supplying public arc lamps at 1¾d. per unit. He moved: "That the minute be referred back in order that the Council may be informed as to the estimated number of units of electricity which will be generated and sold during the year ending March 31, 1902, and the cost of generation for tramways, private lighting and public lighting, respectively for the past and current years." The report was eventually adopted, Mr. Radford undertaking to supply the information asked for by Mr. Page.

**Poland.**—The Russian Government has taken over the telephone exchange of Warsaw, and has granted a Swedish company a lease to work it. A new exchange is to be established and all existing overhead wires to be placed underground.

**Presentation.**—The term of office of Mr. W. J. Hope-Johnstone, electrical engineer to the Bedford Corporation, expired on 9th inst., and on the preceding Saturday, Mr. Hope-Johnstone was presented by the chief assistant (Mr. Barkham), on behalf of the staff and employés, with a travelling dressing case and an illuminated address.

**Prestwich.**—The Council are urging the Manchester Corporation to complete their arrangements for leasing and working the local tramways.

**Sevenoaks.**—The Electrical Power Storage Co. possess a provisional order for this district, but as some difficulty has been experi-

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enced in acquiring a suitable site for a generating station, application is to be made to the Board of Trade for an extension of time.

**South Africa.**—The Johannesburg Town Council are losing no time, as they are establishing a system of electric tramways. The *British and South African Expert Gazette* announces that tenders for plant and electrical equipment will shortly be invited.

The Dundee Electric Lighting and Power Co. (Ltd.), hrs been formed to acquire the concession recently granted by the Dundee Town Council to Messrs. Swete and Lyster for the erection of electricity works.

**Southampton.**—The borough electrical engineer (Mr. F. H. Chaplin) having resigned, the Electricity committee recommend that a successor be advertised for at £500 per annum.

The Local Government Board have deferred for the present the further consideration of the Council's application to borrow £4,000 for electricity extensions. Sanction has been given, however, to borrow £600 for a cable to supply the Ordnance Survey Office with current for power in view of urgency of the work.

**Southport**—The Council are applying for a provisional order to construct a loop line of tramway on the Scarisbrick-road route.

The accounts of the electricity department were submitted and approved on Tuesday. There was a gross profit of £7,292, against £6,384 the previous year. The net profits, owing to the increased cost of fuel, had fallen to about £700, so that, £1,500 having been promised towards reduction of rates, there was a deficit of about £800. Since the inauguration of the undertaking £10,677 has been repaid out of sinking fund. The capital expenditure is £133,036, an addition of £32,899 during the year, £10,063 being for tramway plant.

**Swansea.**—Up to date, the applications for electric current number 143, and 117 have been connected to the mains. The electrical engineer (Mr. Cawthra) urges the Electric Lighting committee to take into immediate consideration the question of extending the generating plant for the 1902 season.

Last week the committee received a communication from the consulting engineers (Messrs. Kincaid, Waller and Manville) relative to the objections of Mr. Cawthra to the acceptance of the tender of a foreign firm for new plant at £1,470, and conditionally recommending the acceptance of the British Westinghouse Co. (£1,880) or that of the British Schuckert Co. (£1,894). There were several tenders between the original tender and the two now recommended, but the engineers could not advise the committee to accept any of them because they were not aware of any work the tenderers had done in England. Mr. Cawthra is to communicate his views to Mr. Manville on the machinery which the British Schuckert Co. have already supplied to the Corporation, and, pending Mr. Manville's reply, further action in the matter has been postponed.

**Telephony in Spain.**—A concession has been granted to the Conde de Rodas for the establishing and working an inter-urban telephone service between Madrid and Santander via Valladolid, Leon and Palencia. A company is to be formed to take over the concession.

**Tube Railway for the Shields.**—The proposal to construct an electric tube railway to connect the North and South Shields is taking shape, and appears likely to receive public support of a sufficiently liberal character to justify its being energetically proceded with. Last year, it will be remembered, a Parliamentary Committee considered a Bill for the construction of an aerial bridge across the river Tyne. This measure was rejected on the ground of probable interference with the navigation of the river.

**Water Power in Germany.**—The Munich authorities are said to be considering a scheme to utilise the waters of the river Isar in the generation of electric current.

**Western Union Telegraph Co.**—What is described as a "brief, unofficial sketch" of the growth of this company during the 50 years of its existence has been prepared by the secretary, and a copy has reached us. The New York and Mississippi Valley Printing Telegraph Co., the predecessor of the Western Union Company, was registered at Albany, U.S.A., on April 8, 1851. Some of the illustrations in the brochure are of historic interest, and include an illustration of House's original printing telegraph and a photographed specimen of printing by Buckingham's new machine telegraph. The history is written in true transatlantic style, and claims for priority in invention of land-line telegraph apparatus for American inventors are stoutly asserted.

**Wolverhampton.**—The Council are applying for sanction to a loan of £1,000 for wiring premises on the easy payment system. If the Council's application is refused we understand the profits of the electricity department will be applied to the purpose.

**Workhouse Lighting.**—St. Helens Guardians have appointed an Electric Lighting committee to collect information on electric lighting, with authority to consult an expert.

Fulham (London) Guardians decided yesterday to increase the boiler power at the workhouse and to provide electricity generating plant, &c., for the electric lighting of the workhouse, infirmary and board offices at a total cost not exceeding £11,111.

**Cricket.**—A match was played on the West London ground last week between the head office staff of the Eastern Telegraph Co. and the officers and crew of the c.s. "Amber," resulting in an easy win for the head office staff. For the victors Mr. L. S. Wells secured a useful hundred, and double figures were also made by Messrs. Woodcook, H. J. Burke, Adye, and J. G. Macmillan. For the losing team Mr. R. G. Cross made 42, and Messrs. T. and G. Heale both made double figures. The total scoring was :—For the staff, 225 ; for the ship, 116.

The members of the electricity departments of the Blackpool and Southport Corporations engaged in their fifth annual cricket match a few days ago when Southport proved victorious by 27 runs—Southport 90, Blackpool 63.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Hull* Electric Lighting committee require two high-speed three-crank compound steam engines of 800 I.H.P. each, and four steel Lancashire boilers. An advertisement contains additional particulars. Forms of tender, &c., from the city treasurer, Mr. T. G. Milner. Tenders to chairman, Town Hall, Hull, by noon Sept. 26. Further information can be obtained from the city electrical engineer (Mr. A. S. Barnard), Sculcoates-lane, Hull.

*Newport* (Mon.) Corporation invite tenders for the supply and erection of winches for outside coal handling, piping, switchboard, cables, cable-ways, overhead construction, complete electric motor car and repair shop equipment. An advertisement contains further particulars. Specifications, &c., of the consulting engineer (Mr. H. F. Parshall), 8, Prince's-street, Bank, London, E.C. Tenders to the town clerk (Mr. Albert A. Newman) by 5 p.m. Oct. 21.

*Poplar* (London) Libraries committee invite tenders for the installation of electric light in four public libraries. An advertisement contains some particulars. Specifications of the electrical engineer (Mr. Alfred Blackman), Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders to town clerk (Mr. Leonard Potts) by 10 a.m. Oct. 1.

*Huddersfield* Corporation invite tenders for the supply and erection of a 600kw. alternating electricity plant at the electricity works, St. Andrew's-road. Specifications, &c., of the borough electrical engineer at the works, and tenders to the town clerk, Mr. F. C. Lloyd, Town Hall, Huddersfield, by Sept. 30. An advertisement gives additional particulars.

*Leeds* Lighting committee invite tenders for a main switchboard. An advertisement contains further particulars. Specifications from the manager (Mr. Harold Dickinson), 1, Whitehall-road, Leeds, and tenders to the town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Oct. 8.

*Reading* Corporation invite tenders for the construction of new tramways and the reconstruction of existing tramways, including the electrical bonding of the rails, provision and laying of conduits and drawing-in boxes for the underground work, &c. Tenders to Chairman Tramways Committee) by noon 28th inst.

*Willesden* Guardians invite tenders for economisers, dry-back marine boilers, piping, pumps, heaters, &c.; steam dynamos, boosters, accumulators, switchboards, &c. ; wiring for about 1,000 lights on the conduit system ; cranes, motors, electric fans, &c. Applications to Mr. J. Hutton Haylor, 329, High-road, Kilburn, N.W.

*Bournemouth* Town Council invite tenders for steel-grooved girder rails, &c., conduit, permanent way construction and rail bonding, ploughs and carrying attachments to cars, and wood-block, tar, macadam and granite sett paving. Tenders to town clerk by noon Sept. 17.

*Blackpool* Corporation invite tenders for 30 arc lamps, switches, &c., suitable for rectified current ; also for 40 arc lamp canopies. Particulars from the electrical engineer.

*Blackpool* Cleansing committee invite tenders for the erection of six additional cells to the refuse destructor, new boiler, &c. Tenders by 28th inst.

*Blackpool* Tramways committee require tenders for 550 tons of rolled steel girder rails, 27 tons of fish plates, 10 tons of bolts, nuts and washers, 21 tons of crucible cast steel points and crossings, &c. Tenders by 21st inst.

*East Ham* District Council invite tenders for construction of permanent way of tramway extensions. Tenders to chairman Works committee by noon 17th inst.

*Sheffield* Corporation require boilers, economisers, motors, fans, iron chimneys, brickwork or iron flues, &c. Tenders to Mr. S. E. Fedden, Commercial-street, Sheffield, by 30th inst.

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*London County Council* require tenders for electric lifts, pumps, fans, &c., for the electrical equipment of the Greenwich footway tunnel and its approaches. Tenders by Oct. 8.

*London County Council* also invite tenders for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

*Maidenhead* Corporation require three 60kw. steam dynamos, two Lancashire boilers with fittings, economiser with dampers, &c. Tenders to town clerk by noon 23rd inst.

*Salford* Corporation invite tenders for the lighting of the new Strawberry-road generating station. Tenders to town clerk by noon 20th inst.

*Poplar* (London) Electricity committee require multiple core lead-covered feeder and network cables and accessories for mains extensions. Tenders to town clerk by Sept. 18.

*Ashton-under-Lyne* Corporation invite tenders for a surface condenser of about 1,000 sq. ft., with pumps. Tenders by noon Sept. 18.

*Ross Electric Light and Power Co.* invite tenders for generating plant. Tenders to Bank Offices, Ross, by noon Oct. 21.

*Kirkcaldy* Corporation require arc lamp posts, wall brackets and switch-boxes. Tenders to the town clerk by Sept. 16.

*Whitehaven* Water and Lighting committee invite tenders for six months' supply of incandescent lamps. Tenders by Sept. 16.

*Glasgow* Corporation invite tenders for the supply and laying of cables. Tenders to town clerk by 5 p.m. Sept. 25.

Tenders are required for wiring the *Bury* (Lancs.) New Market Hall and shops. Tenders to town clerk by Sept. 14.

*Rochdale* Electricity committee require tenders for feeder and distributor cables. Tenders by noon Oct. 2.

*Willesden* District Council invite tenders for the erection of electricity generating station and sub-station. Tenders by Sept. 24.

*Bray* (Ireland) District Council require tenders for electrical supplies. Tenders by Oct. 3.

Tenders are invited until 24th inst. by *French* Post and Telegraph authorities for 145km. of submarine cable core, 25 tons of 8mm. diameter iron wire, 35 tons 2½mm. ditto, 45 tons 5mm. ditto, and 100 tons 7mm. ditto. Tenders to 103, Rue de Grenelle, Paris.

*Prussian* State Railway authorities, Coblentz, invite tenders until Sept. 20 for six electrically-operated luggage lifts.

## TENDERS RECEIVED AND ACCEPTED.

Bradford Corporation have accepted the tender of Witting Bros. for 100 electric car bodies and 100 electrical equipments at £44,250, and that of Hurst, Nelson & Co. for 100 trollies at £1,450.

The following tenders have also been accepted :—

Keighley Electrical Engineering Co. for 15 4½ H.P. electric motors at £28 each.

Phœnix Dynamo Manufacturing Co., 24 7 H.P. motors at £56, 15 10 H.P. motors at £67. 10s., and a 20 H.P. motor at £154 each.

Lancashire Dynamo and Motor Co., a 15 H.P. motor, £96.

Holdsworth & Sons, three feed tanks, £276.

British Insulated Wire Co., 2 miles of insulated cable, £2,920. The tender of the B.I.W. Co. has also been accepted for the supply of cable and other materials required for the tramways in Manchester-road, Leeds-road, Sunbridge-road, Wakefield-road and Manningham-lane at £27,012. A third contract has also been secured by the same company in connection with the scheme for doubling the distributing mains in Thornton-road, between Listerhills-road and Ashfield Mills, the amount of the contract being £13,474.

The following tenders have been received for the Norfolk County Asylum, Thorpe, near Norwich :—

*Electrical Plant.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Laurence, Scott, & Co. (*accepted*) | £2,456 | 6 | 0 | J. H. Holmes & Co. | £2,638 | 0 | 0 |
| E. Scott and Mountain | 2,858 | 0 | 0 | Alliance Electric Co. | 2,612 | 9 | 8 |
| Royce Limited | 2,762 | 10 | 0 | Siemens Bros. & Co. | 2,595 | 10 | 6 |
| Crompton & Co. | 2,657 | 0 | 0 | Reavell & Co. | 2,500 | 0 | 0 |

*Wiring and Fittings.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mann & Co. (*accepted*) | £3,484 | 11 | 7 | Hall and Hackblock | £4,081 | 9 | 7 |
| Hemingway and Pritt | 6,654 | 1 | 2 | W. J. Furse & Co. | 3,964 | 6 | 6 |
| Crampton & Co. | 4,750 | 0 | 0 | S. H. Heywood | 3,749 | 2 | 10 |
| Alliance Electric Co. | 4,224 | 14 | 9 | | | | |

The following tenders have been accepted by the Nelson Town Council for the supply of electricity generating plant, &c. :—

Dorman and Smith, switchboard and main cutouts ; Greenwood and Batley, balancer and booster ; Edward Wood & Co., iron and steel work ; Walter Macfarlane & Co., iron staircase to switchboard platform ; Improved Electric Glow Lamp Co., incandescent lamps ; Ferranti Limited, meters.

Nelson Town Council have also accepted tenders amounting to £3,274. 6s. for building work in connection with extensions to the electricity generating station.

Five tenders were received by the liquidator of the Isle of Man Tramways and Electric Power Co. (Ltd.) for the purchase of the undertaking. The Douglas Town Council offered £40,000 for the Douglas Bay horse and the Upper Douglas cable sections. These sections are subject to royalties to the Council of 15 and 5 per cent. respectively on the gross earnings. For the electric sections from Douglas to Laxey, Laxey to Ramsey, and Laxey to Snaefell summit, Mr. Harold Vickers offered £188,850. The British Electric Traction Company offered £225,000 for the whole concern, while a Manchester firm offered £210,000. The tenders will be considered by the liquidator (Mr. W. H. Walker) next week.

We are informed that the National Electric Wiring Co. have obtained an order, through their Liverpool branch, from Messrs. Vickers, Sons and Maxim for the electric lighting of Vickerstown, Barrow-in-Furness. At present nearly 500 houses are built and others are to be started shortly.

Dudley Corporation have accepted the tender of Ferranti Limited for a steam engine at £3,145, and that of the Electric Construction Co. for a dynamo at £1,969.

The tender of Messrs. Crompton & Co. has been accepted for arc and incandescent lighting, and supplying and laying mains at the Albert Edward and Northumbrian Docks, Tyneside, at £6,128.

Glasgow Corporation have accepted the tender of Messrs. Macartney, McElroy, & Co. for the overhead work for tramway extensions at £32,511.

St. Annes-on-the-Sea District Council have accepted the tender of Messrs. Dick, Kerr & Co. for a steam dynamo.

## BUSINESS NOTICES.

Messrs. C. M. Stead and F. Scott, trading as Stead and Scott, electrical engineers, 3, Wade-street, Leeds, have dissolved partnership. Debts by Mr. Scott, who continues.

Messrs. H. F. Clough and A. Turner, trading as the Virginia Electric Co., 10A, Virginia-street, Southport, have dissolved partnership. Debts by Mr. Clough.

Mr. G. Braulik has ceased to hold the agency for arc lamps manufactured by Messrs. Koerting and Mathiesen, of Leutzch, near Leipzig.

Mr. W. H. Palmer (late of Palmer and Watson) has started business at 42, Castle-street East, London, W., as electrical engineer and contractor, under the style of Palmer & Co, and has engaged Mr. J. F. Davie, late of the "M.D." Engineering Co. and Moody Bros. as manager. Trade catalogues are invited.

## LIQUIDATION.

Claims against the Yorkshire Motor Car Manufacturing Co. (Ltd.) must be sent by 28th inst. to Mr. J. W. Brown, Tenterfield, Northowram, near Halifax.

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**For Sale**—The Cleveland Trust (Ltd.), Royal Exchange, Middlesbrough, have for sale a quantity of bare copper cable, some wooden poles, and over-head service mains, &c. See advertisement.

The electric plant and business of the Macroom electricity works are for sale as a going concern. Particulars from Messrs. J. W. Ainsworth & Co., 74, Blakey-moor, Blackburn, Lancs. See advertisement.

Particulars are given in an advertisement of some electrical plant which Messrs. Williams, Cornforth & Co., Kidsgrove, Stoke-on-Trent, have for sale.

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during August was £42,096, against £42,107 in the preceding month and £148,317 in August last year. The total for the eight months ended Aug. 31 was £637,169, against £697,592 for the corresponding period last year.

**Exports to South Africa.**—A valuable statement relating to the exports to South Africa from Great Britain is published by the *British and South African Export Gazette*, from which it appears that plant and material for electric lighting was sent in 1900 to the value of £75,588, compared with £102,597 in 1899, a decrease of over £24,000. The value of telegraph apparatus and wire imported from Great Britain in 1900 amounted to £51,413, against £431,703 in 1899, a falling off of no less than £380,290. Under the heading of machinery, apparatus, instruments and materials, large exports are made from this country ; but these are included in larger groups, and are, therefore, unascertainable separately.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 4 to 10, with the ports of destination :—

*Africa*—Alexandria, £29 ; Beira, £103 (telegraph material); Cape Town, £728 (including £695 telegraph instruments) ; Chinde, £607 (including £511 telegraph cable) ; Durban, £1,575 ; East London, £231 (telegraph material). *Argentina*—Buenos Ayres, £1,468 (including £849 telegraph material) ; Rosario, £45. *Australasia*—Sydney, £111 ; Wellington, £88. *British Guiana*—Demerara, £35. *Canada*—Toronto, £210. *China*—Shanghai, £17. *Ceylon*—Colombo, £105. *Denmark*—Copenhagen, £56 (telegraph wire). *Germany*—Bremerhaven, £180 (telegraph instruments) ; Hamburg, £200 (telegraph material). *Holland*—Amsterdam, £150 ; Flushing, £30 ; Rotterdam, £52 (telegraph material). *Hong Kong*, £21. *India*—Bombay, £174 ; Calcutta, £792 (including £438 telegraph wire) ; Karachi, £665 (telegraph material). *Italy*—Genoa, £82. *Japan*—Tokio,

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£136. *Norway*—Christiania, £247 (including £70 telegraph wire). *Portugal*—Lisbon, £61. *Straits Settlements*—Singapore, £22. *Sweden*—Stockholm, £99 (telegraph wire). Total £8,319, against £12,523 in the corresponding week last year (Sept. 5 to 11).

**Tramway Telephones at Glasgow.**—A complete system of telephones is in course of erection by the Glasgow Corporation for their electric tramways, entirely distinct from the public telephone service. By means of these independent lines it will be possible to establish communication between any tramway official from the street pillars, section boxes, sub-stations, depôts, the power station, head office and residences. The "traction" telephone is a comparatively recent development, but all the same there is now no important tramway service in the kingdom without an installation. Glasgow, however, has, we understand, the most complete service of any yet erected. The telephone systems now being put in comprise three in all, and these are as follows:—

Telephone Plug Box.

Telephone Street Post used at Glasgow.

(1) A 100-line switchboard at head office, with lines to the Pinkston power station, 5 sub-stations, 14 depôts, and all the official residences of the staff, numbering about 35 stations. The board is of the General Electric Co.'s standard double line pattern. A 100-line carbon lighting and heavy current arrester and distribution board is provided in connection with the switchboard. The instruments are throughout of the G.E.C. K 69 pattern with magnets. There are about 40 telephone street posts of the G.E.C. standard pattern K 1,000, as shown in the accompanying illustration. These posts contain a Hunningscone-Deckert microphone double-pole Bell receiver, magneto call apparatus, similar to the K 69 instruments, and two dry cells. The posts are fitted with lock-up door, a key being carried by each official and tramcar conductor.

(2) A 12-line switchboard at Pinkston power station, of similar type to that at head office, with lines to the five sub-stations and chief official residences. The instruments on this system are also of the K 69 type.

(3) Every section pillar, of which there are 142, is fitted with a G.E.C. patent "traction" telephone plug box, as shown above, and these all radiate to the nearest sub-station, where they call up the special terminal telephone. The telephone in the sub-station rings directly the four-pronged plug of the collapsible telephone is inserted, and continues to ring until the receiver is lifted off the hook, when speaking can take place.

Every precaution has been taken to ensure rapid communication, to ensure prompt attention and repairs in case of accident or breakdown. In the event of such an occurrence the conductor or inspector unlocks the nearest street telephone post and reports the matter to head office, whence instructions are sent to Pinkston or to the nearest depôt or sub-station, as may be necessary. The foreman of the emergency gang of workmen thus put in action is provided with a pocket telephone which he uses from the nearest section pillar to maintain communication with headquarters.

**The Nernst Lamp.**—On Wednesday evening (Sept. 4) Lord Kelvin switched on the Nernst lamp installation at the stand of the Electrical Co., London, at the Glasgow Exhibition. There were present on the occasion, besides Lord Kelvin, Lady Kelvin, Dr. J. T. Bottomley, LL.D., and Mrs. Bottomley, Sir William Preece, Geheimrat E. Rathenau, Mr. Oscar von Miller, Mr. J. Stottner (general manager of the company), and others. This is the first installation of these lamps in Scotland, and we are informed that they will be used every evening till the close of the exhibition. Mr. Buhler (representative of the company at the exhibition) will give information respecting these lamps at the stand.

**B.T.H. Plant.**—Pamphlet No. 109, issued by the British Thomson-Houston Co., has something to say regarding alternating-current generators.

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

May 18, 1901.

10,345. J. LIGHTFOOT and C. MONKMAN. London. Improved method of and means for forming joints on or connecting electric wires.
10,357. SIEMENS BROS. & Co. (LTD.) and F. JACOB. London. An improvement in electric conductors.
10,377. SARAH DIXON & SON (LTD.). Leeds. Main controlling electric switch.
10,459. V. G. APPLE. London. Improvements in storage batteries.*

May 21. 1901.

10,480. A. H. HICKLEY. Liverpool. Improvements relating to telephonic systems.
10,482. A. L GOVAN. Glasgow. A cell for electrolysis.
10,505. T. A. EDISON. London. Improvements in storage batteries.*
10,506. THE EDISON ORE-MILLING SYNDICATE (LTD.). London. Improvements in magnetic separating apparatus (T. A. Edison, United States).*
10,559. G. S. MEYER. London. A new or improved telephone receiver-holder. (Date applied for under Patents, &c., Act, 1883, sec. 103, Dec. 8, 1900, being date of application in United States).

May 22, 1901.

10,562. S. HUTCHINS. Manchester. Improvements in dynamos and electric motors.
10,569. W. W. MCLAUCHLAN. Manchester. Improvements in means or apparatus for preventing contact of telephone and telegraph wires with the trolley wires of electric tramway installations.
10,571. G. H. WOODS. Manchester. Improvements in junction boxes for electric wire and like installations.
10,587. G. SPERRYN and W. H. WOOD. Birmingham. Improvements in electrical lamp holders.
10,609. P. J. WILLIAMS. London. Electro-magnetic electric railway track switch and means for controlling and operating same.
10,623. A. H. NICHOLSON and THE NEW PHONOPORE TELEPHONE CO. (LTD.). London. An improvement in telephone apparatus.*

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

10,348. VAN DER PLOEG. Electromagnetic motor.
11,907. BOLTOW. Block or mounting for electrical, gas and like fittings.
11,937. STAFSING and EGNÉR. Telephone systems.
11,965. BARR, STROUD and BECKER. Electric receivers and electric clocks.
12,331. SCHELLBACH. Blocks for electric and like conduits.
12,737. OPPENHEIMER. (Actiengesellschaft, Mix and Genest.) Holders for electric incandescent lamps.
12,893. ROSATI. Underground wires and accessories for transmitting electric energy.
13,962. JENSEN. (Yurgae Signalphone Manufacturing Co.) Electric signal registering systems for telephone systems.
14,558. BLOCHMANN. Transmission and receiving of telegraphic signals.
15,748. PARTRIDGE. Electric switches, fuses, and other apparatus in which destructive electric arcs are liable to be formed.
16,644. DE FERRANTI. Electricity meters.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ASTAR CO. (LTD.)**—Reg. Aug. 27, capital £2,000 in £1 shares, to acquire the London businesses of the German-American Electric Co. and Kroning & Co., and to carry on the business of importers, exporters and dealers in electrical apparatus, &c. The subscribers are Paul Stern, electrical engineer, F. Flower, manager, L. Lehmann, merchant, J. B. Gomes, manager, H. Wagstaff, J. P. Lant, and E. F. H. Kroning, merchant. The first managing directors are P. Stern and E. F. H. Kroning.

**BRITISH ARC CARBONS MANUFACTURING CO. (LTD.)**—Reg. Sept. 2, capital £6,000 in £1 shares, to manufacture carbons, carbon rods and candles for electric arc lights, filaments for incandescent lamps, carbon plates, batteries, cells, accumulators and other articles for electrical purposes. The first directors are C. Tomlinson and J. Bailey.

**BUENOS AYRES ELECTRIC TRAMWAYS (1901), LTD.**—Reg. Aug. 24, capital £250,000 in £5 shares, to construct in the Argentine Republic, or elsewhere in South America, railways, tramways, light railways, cars, engines, rolling stock, electrical and other plant and machinery, rails, sleepers, and all requisites and equipments therefor, and to carry on the business of carriers of passengers and goods, producers and suppliers of electricity for all purposes, electricians, mechanical engineers, &c.

**ELECTRIC AND ORDNANCE ACCESSORIES CO. (LTD.)**—Reg. Aug. 29, capital £50,000 in £1 shares, to carry on business as manufacturers of and dealers in omnibuses, motor cars and other vehicles, electricians, engineers, machinists, &c.

**LANCASHIRE AND GRAND TRUNK ELECTRIC TRAMWAYS (LTD.)**—Reg. Aug. 27, capital £100 in £1 shares, to carry on business as con-

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structors of light railways, producers and suppliers of electricity for all purposes, &c.

**MILLENIUM MOTOR CAR SYNDICATE AND AGENCY (LTD.)**—Reg. Aug. 28, capital £1,500 in £1 shares, to acquire inventions relating to electric ignition for explosion engines, and to carry on the business of manufacturers of and dealers in engines, motor cars, carriages and engines of all kinds, &c.

**MOTOR HAULAGE CO. (LTD.)**—Reg. Sept. 4, capital £15,000 in £5 shares, to carry on in the United Kingdom the businesses of engineers, makers of motors, motor lorries and cycles, trucks and self-propelled vehicles of all kinds, electrical and mechanical engineers, electricians, &c. The subscribers are H. P. Brown, W. H. Taylor, consulting engineer, R. Palmer, H. Hutchinson, engineer, J. Freeman, F. E. Baron, consulting engineer, and J. S. Critchley, mechanical engineer.

**NEW IMPERIAL ELECTRIC LAMP (LTD.)**—Reg. Sept. 4, capital £3,000 in £1 shares, to carry on the business of manufacturers and importers of and dealers in electric and other lamps and apparatus, manufacturers of and dealers in dynamos, engines, motor cars, carriages, cycles, engines and apparatus, electrical and mechanical engineers, &c.

**PIONEER GAS, ELECTRIC LIGHT AND POWER CO. OF SOUTH AFRICA (LTD.)**—Reg. Sept. 4, capital £2,000 in £1 shares, to acquire and deal with any rights, concessions or contracts for generating and supplying electricity, gas or other agent for lighting, power, &c., in the Cape of Good Hope, Orange River Colony, the Transvaal and elsewhere in South Africa, and to carry on business as electricians, electrical and general engineers, suppliers of electricity, manufacturers of electrical apparatus, &c. The subscribers are J. A. Kelman, C. S. Kelman, J. A. Kelman, jun., engineer, E. Kelman, D. E. Kelman, R. W. Blackburn, and G. C. Eedes.

**WILSON HARTNELL & CO. (LTD.)**—Reg. Sept. 5, capital £20,000 in £1 shares, to acquire the business now carried on by Wilson Hartnell at Leeds, and to carry on the business of engineers, boiler makers, metal workers, makers of dynamos and electrical plant, builders of locomotives and rolling stock, &c. The subscribers are—W. Hartnell, engineer, H. W. Heston, engineer, C. Todd, Mrs. G. M. T. Hartnell, M. Lee, W. S. Harrison and R. L. Alkin, engineer. Minimum cash subscription £3,000. The first directors are Wilson Hartnell and such others as may be elected by the subscribers.

**WREXHAM AND DISTRICT ELECTRIC TRAMWAYS (LTD.)**—Reg. Aug. 26, capital £50,000 in £5 shares, to carry on business as carriers of passengers and goods, electrical and mechanical engineers and contractors, manufacturers of and dealers in railway and tramway electrical apparatus, generators of electricity, &c. Registered office, Donington House, Norfolk-street, London, W.C.

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**EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)**—The annual return to Aug. 16 gives the capital as £1,000,000 in 150,000 "A" and 50,000 "B" shares of £5 each, of which 117,400 "A" and 23,564 "B" have been taken up. 10s. per share has been called up on 89,261 "A" and £44,630. 10s. has been received. £456,667. 10s. considered as paid, being £203,515 on 17,139 "A" and 23,564 "B" considered as fully paid, and £253,152. 10s. on 89,261 shares credited with £2. 10s. paid and 10,000 credited with £3 paid. Mortgages and charges £444,023.

**ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)**—On Aug. 1 the capital was £200,000 in 20,000 ordinary, 100 founders' and 19,900 preference shares of £5 each, all of which have been taken up. £1 per share has been called up and paid on the ordinary and £5 per share on the founders' and preference shares. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 27d. per oz. (Sept. 12). Consols (2¾ per cent.) 93 1/16—94 1/16 for money, 94—94⅛ for account; 2½ per cent. 94½—95 (Sept. 12). Consols Pay Day, Oct. 2; Stocks and Shares Continuation Days, Sept. 25 and Oct. 9; Ticket Days, Sept. 26 and Oct. 10; Pay Day, Sept. 27; Mining Share Carry-over Days, Sept. 24 and Oct. 8.

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**BUENOS AYRES GRAND NATIONAL TRAMWAYS CO. (LTD.)**—At the meeting on Tuesday, the chairman (Mr. N. G. Burch) said that "electrification" had been very much in evidence in Buenos Ayres during the past year or two. The Anglo-Argentine Company had been electrifying their line, as had also the Capitale, and, what was of more importance to their company, the Belgrano Company, which traversed for some distance a route of great value to the Grand National Company. The competition in the Palermo circuit alone last year had involved the company in an expenditure of £3,000. They therefore desired to test electric traction, which had been in the minds of all tramway investors and workers the last few years, and which had led to results which were favourable to that system. An object in acquiring the Nueva line and having a pooling arrangement with that line, under which 4½ miles of track were to be converted to electric traction, was to have a practical and useful guide and test as to what electric traction could do and to what extent they could adopt the system with advantage throughout their own system. If the gentlemen who had acquired the Nueva line had taken it into their heads to electrify it without their company's co-operation the Grand National Company's horse-drawn system would have been disastrously affected by the competition.

**DAVIS AND TIMMINS (LTD.)**—The dividend on the 6 per cent. preference shares is declared for the six months to June 30.

**ELMORE'S.**—Those who are unfortunately interested in the Elmore companies will find little satisfaction in the "clean up" now proceeding in the columns of the *Financial Times*, as to the degree of responsibility which attaches to the directors of Elmore's Trust (Ltd.) and the Messrs. Elmore respectively for the failure of the so-called "Rapid" process of electro-deposition of copper.

**HAMPSTEAD ELECTRIC SUPPLY CO. (LTD)**—There would appear to be still undisposed of a considerable number of preference and ordinary shares in this company. A circular offering a number of these shares for purchase is being liberally distributed, but investors in electrical securities will be best advised to leave both classes of shares in the hands of present holders.

**MIDDLESBROUGH (U.S A.) TOWN AND LANDS CO. (LTD.)**—The directors' report states though the revenue for the year ended Dec. 31 has not been sufficient to meet expenses, the loss is less than in former years, amounting to $11,387. Owing to the cessation of operations of the electric light company at the Virginia Co.'s plant, the progress of that subsidiary enterprise had not been so satisfactory during the year, but the business had been carried on without loss. An entirely new process, involving a new departure in the metallurgical treatment of zinciferous ores, was brought to the board's notice some months ago. Preliminary tests had been made under unfavourable conditions. The patentees of the process were of opinion that, with a perfected plant it would prove simple in operation and capable of giving a high percentage of recovery of zinc, while rendering the residues tractable to ordinary smelting methods for the recovery of the copper, silver and gold contents, and steps were being taken to prove that. With reference to the Phœnix process, the working costs were governed principally by the cost of the electrical power and chlorine necessary for the process. The proprietors of the process having secured a contract for the supply of electrical power and chlorine at a low cost, determined to move their works to Runcorn, and the removal of the plant to the new site was now in progress. The directors had, therefore, been unable to secure a complete test of the process on a working scale upon their own ores, but they were advised that the results under the new and more favourable conditions would prove successful.

**ROCKHAMPTON (QUEENSLAND) GAS AND COKE CO. (LTD.)**—New cables have been purchased in England, and improvements made at the generating station, in order to bring the supply of current up to date. A dividend at the rate of 6½ per cent. per annum has been declared.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange Committee has ordered the further issue of 6,390 7 per cent. £2 fully-paid cumulative preference shares (Nos. 25,001 to 31,390) of the *Electric Construction Co. (Ltd.)* to be quoted in the official list. Application has also been made for a special settling day in and to grant a quotation to the further issue of 31,000 £3 fully paid shares (Nos. 54,001 to 85,000) of *Crompton & Co. (Ltd.)*

**TELEGRAPH MANUFACTURING CO. (LTD.)**—The transfer books of the preference shares will be closed from 16th to 30th inst. inclusive, for the payment of the dividend due Oct. 1.

**WESTERN UNION TELEGRAPH CO.**—The accounts for the quarter ending Sept. 30 (partly estimated) show net earnings $1,850,000, increase $144,000; balance available for dividends $1,611,000, increase $144,000; surplus after payment of dividends $394,000, increase $144,000. The usual quarterly dividend of 1¼ per cent. has been declared.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways. | Sept. 7 | 4,827 | + 192 | 9 | 43,348 | + 2,316 |
| *Blackburn Corporation.. | ,, 6 | 589 | + 102 | 36 | 17,828 | + 1,736 |
| Blackpool Corporation... | ,, 5 | 1,942 | + 539 | †23 | 27,532 | + 6,944 |
| Blackpool and Fleetwood | ,, 7 | 1,733 | + 338 | 10 | 14,712 | + 192 |
| Bolton Corporation ..... | ,, 8 | 1,464 | + 54 | 23 | 35,511 | + 3,533 |
| Bradford Corporation... | ,, 8 | 1,191 | + 511 | 23 | 25,208 | +13,487 |
| Brisbane Trams ..... | July 24 | 1,819 | + 324 | ... | ... | ... |
| *Bristol Trams & Carriage | Sept. 6 | 3,904 | + 275 | 9 | 37,441 | + 5,032 |
| *Buenos Ayres & Belgrano | Aug. 11 | 2,572 | + 182 | 6 | 15,552 | + 2,766 |
| Calcutta Trams. Co. ... | Sept. 7 | R18,932 | -R1,972 | 10 | R103,507 | + R7,895 |
| Carlisle Trams. Co. ..... | ,, 7 | 194 | + 3 | 10 | 2,170 | + 131 |
| Central London Railway | ,, 7 | 5,532 | + 885 | 10 | 56,559 | ... |
| City & South London Ry. | ,, 8 | 1,834 | + 347 | 10 | 18,394 | + 3,372 |
| Cork Elec. Trams ..... | ,, 5 | 527 | - 21 | 35 | 16,760 | + 2,017 |
| Dover Corporation ..... | ,, 7 | 290 | - 2 | 23 | 5,869 | + 322 |
| Dublin & Lucan Rly. ... | ,, 8 | 131 | + 1 | 10 | 1,472 | + 263 |
| Dublin United ..... | ,, 6 | 4,205 | + 108 | ‡10 | 40,212 | + 1,659 |
| Dublin Southern Dist.... | ,, 6 | 1,116 | - 18 | ‡10 | 11,795 | |
| *Dundee Corporation ... | ,, 4 | 754 | + 244 | 10 | 7,158 | + 2,431 |
| *Glasgow Corporation ... | ,, 7 | 13,436 | +3,771 | 13 | 158,270 | +37,065 |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ..... | ,, 7 | 1,664 | + 378 | 10 | 17,441 | + 4,116 |
| Liverpool Corporation... | Aug. 31 | 9,457 | + 678 | 35 | 310,844 | +41,559 |
| *Liverpool Overhead Rly. | Sept. 8 | 1,605 | - 187 | 10 | 17,359 | - 128 |
| *Manchester Corporation | ,, 7 | 2,221 | ... | §13 | 25,769 | + 51 |
| Perth (W.A.) Elec. Trams | ,, 6 | 800 | + 394 | ‡10 | 8,823 | + 5,132 |
| Portsmouth Corporation | ,, 7 | 1,141 | - 85 | ... | ... | ... |
| *Sheffield Corporation ... | ,, 8 | 3,661 | +1,020 | 10 | 37,903 | +11,982 |
| Southampton Corporat'n | ,, 5 | 1,063 | + 270 | 10 | 10,114 | + 3,215 |
| Southend Corporation | Aug. 31 | 366 | ... | 7 | 2,483 | ... |
| | Sept. 7 | 364 | ... | | | |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 4. | | Price Wednesday, Sept. 11. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Sept. 11. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅞ | ⅞ | ⅞ | ⅞ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 95 | 100 | 97 | 102 | ... | ... | 99½ | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ | 10½ | 9½ | 10½ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 102 | 105 | 4 6 4 | ... | 103 | 102½ |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. | 7¾ | 8¼ | 7¾ | 8¼ | 4 6 2 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¼ | 8¾ | 8¼ | 8¾ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅞ | 8 | 7⅞ | 8 | 2 3 9 | ... | ... | ... |
| 50,000 | 5 | 4 0 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 5 0 | February and August | 9½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 3 18 3 | ,, ,, | ... | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 103 | 105 | 103 | 105 | ... | ... | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5½ | 6 | 5⅝ | 6 | 4 11 8 | March | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 107 | 110 | 108 | 111 | 4 1 8 | June and December | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8½ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11¼ | 12½ | 11½ | 12½ | 4 16 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 120 | 125 | 121 | 123 | 3 19 9 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | 4 8 0 | ... | ... | ... |
| 40,000 | 10 | s/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8 | 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 13 4 | March and September | 12⅝ | 12½ |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 6¼ | 6¾ | 6¼ | 6¾ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | 7⅞ | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6¾ | 7 | 6¾ | 7 | 4 2 7 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 98,767 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13 | 14 | 4 5 9 | April and October | 13¼ | 13⅛ |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 111 | 114 | 111 | 114 | 3 19 4 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 98 | 101 | 3 9 8 | ... | 99 | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15 | 16 | 4 7 6 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5¾ | 6¾ | 5¾ | 6¾ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 800,000 | 1 | 1/0 | Rand Electric | 7/16 | 9/16 | 7/16 | 9/16 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 60 | 70 | 60 | 70 | ... | January and July | ... | ... |
| £107,800 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 9 1 | April and October | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15 1/16 | 15⅛ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2¼ | 2 | 2¼ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2 | 3 | 2 | 3 | ... | ... | 5⅛ | 2⅛ |
| 109,518 | 5 | 5 0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | ... | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4¼ | 4⅛ | 4⅜ | 4 11 5 | April and October | 4 1/16 | 4 1/16 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 124 | 129 | 12[illegible] | 129 | 4 13 6 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary | 8 | 9 | 8 | 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 95 | 100 | 95 | 100 | 5 0 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 12 9 | ... | ... | ... |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | 4⅞ | 4 1/16 |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 102 | 104 | 103 | 105 | 4 6 7 | ... | 104¼ | ... |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary | 21½ | 22½ | 21½ | 22½ | 3 13 4 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 | 115 | 112 | 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 | 6½ | 6 | 6¼ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9½ | 9¾ | 9½ | 9¾ | 5 2 7 | May and November | 9 1/16 | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 100⅝ | 102⅞ | 101⅞ | 103⅞ | 4 9 1 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 14 | 14⅜ | 14 | 14½ | 6 6 4 | ... | 14⅜ | 14¼ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11⅞ | 12¼ | 11⅞ | 12¼ | 4 18 0 | February and August | 12 1/16 | 12 |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 122 | 125 | 122 | 125 | 4 0 10 | ... | 124½ | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅜ | 1⅞ | 1⅜ | 1⅞ | ... | ... | 1 13/16 | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5¾ | 5¼ | 5¾ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5¼ | 5¾ | 5¼ | 5¾ | 2 3 6 | ... | 5 9/16 | 5½ |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 103 | 105 | 104 | 107 | 4 14 7 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prv. Certs. (all pd.) | 97 | 100 | 98 | 101 | 5 0 2 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11½ | 12½ | 11⅝ | 12⅝ | 2 8 0 | ... | ... | ... |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 105 | 107 | 105 | 107 | 4 4 8 | ... | ... | ... |
| 400,000 | 1 | 1/2⅝ | Cape Electric Tramways Shares | 1⅝ | 2⅛ | 1⅝ | 2⅛ | 2 16 6 | ... | ... | ... |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock | 102 | 105 | 102 | 105 | 3 16 2 | June and December | 104¼ | 102¼ |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 105 | 108 | 105 | 108 | 3 14 1 | ... | 107 | 106 |
| £440,100 | Stock | ... | Do. Deferred Stock | 98 | 101 | 99 | 102 | ... | ... | 101 | 100 |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/0 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ | 5¾ | 5¼ | 5¾ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 103 | 105 | 103 | 105 | 3 16 7 | ... | ... | ... |
| £815,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 52 | 54 | 52 | 54 | 2 15 7 | February and August | 53 | ... |
| 47,500 | 10 | 2/0 2/16 | Do. Ordinary (Nos. 22,501 to 70,000) | 5¼ | 5¾ | 5¼ | 5¾ | 2 3 6 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 | 134 | 129 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 123 | 127 | 123 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 | 118 | 113 | 118 | 3 8 0 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 12 | 13 | 12 | 13 | 3 16 11 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref. | 5¼ | | 5¼ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 21½ | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 111 | 113 | 3 19 8 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 7 | 7⅛ | 7 | 7⅛ | 3 16 1 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference xd | 12¾ | 13 | 13⅛ | 13 | 3 18 11 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 104 | 103 | 104 | 3 16 11 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 7 9 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 100 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 100 | 102 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 80,000 | 5 | s/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | 1 12 0 | ... | ... | ... |
| 10,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10⅛ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 106 | 109 | 106 | 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 93 | 96 | 92 | 95 | 3 2 8 | June and December | 93 | ... |

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 4. | | Price Wednesday, Sept. 11. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Sept. 11. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 9 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ | 4⅛ | 3⅜ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 | 56 | 53 | 56 | 5 11 9 | Feb., May, Aug., Nov. | 55½ | 53 |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 | 100 | 98 | 100 | 6 0 3 | ,, ,, | 99⅝ | 98⅜ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10⅜ | 11⅛ | 10½ | 11 | 2 5 6 | ,, ,, | 10 1/16 | 10 1/16 |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 17 9 | ,, ,, | 101½ | 101½ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 | 6 | 5 | 6 | 7 10 0 | February and August | 5⅝ | 5 5/16 |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 13½ | 14½ | 13½ | 14½ | 6 17 11 | ,, ,, | 14 | 13½ |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ | 104⅞ | 100⅞ | 104⅞ | 4 7 0 | January and Ju'y | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10⅜ | 11⅛ | 10½ | 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | ... | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | 100 | 103 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 143 | 148 | 143 | 148 | 4 14 7 | Jan., Apr., July, Oct. | 146 | 143 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 97 | 100 | 97 | 100 | 3 10 4 | ,, ,, | 97⅜ | 97 |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 115 | 118 | 115 | 118 | 3 8 7 | May and November | 117 | 115½ |
| 300,000 | 10 | 2/6 | Eastern Extension | 13¾ | 14½ | 14 | 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14 1/16 | 14 |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 115 | 120 | 115 | 120 | 3 6 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101⅞ | 104⅞ | 101⅞ | 104⅞ | 3 17 7 | May and November | ... | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 33 | 31 | 32 | 4 13 9 | January and July | ... | ... |
| £78,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos | 100 | 103 | 100 | 103 | 4 7 10 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [to 1,200) (red.) | 41 | 45 | 41 | 45 | 5 11 1 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent.'Debs.,1904 xd | 102 | 105 | 102 | 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 18 1 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) xd | 99 | 102 | 99 | 102 | 4 17 10 | March and September | 100¾ | 99½ |
| 30,008 | 2½ | ... | West Coast of America | ¼ | ⅜ | ¼ | ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | ... | West India and Panama | ¼ | ⅜ | ¼ | ⅜ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | ... | ,, ,, | 5 1/16 | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 | 104 | 101 | 104 | 4 16 2 | January and July | ... | ... |
| 207,630 | 10 | 3/0 | Western Telegraph (late Br zil'n Submarine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14½ | 14 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 | 105 | 102 | 105 | 4 15 10 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 7 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) | 3½ | 4 | 3½ | 4 | 6 5 0 | August | ... | ... |
| 224,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | 2/6 | 3/6 | 2/6 | 3/6 | 4 5 9 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3¾ | 4 | 3⅝ | 3⅞ | 6 9 0 | February and August | 3⅝ | 3⅜ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 | 14 | 12 | 14 | 4 5 9 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 | 14 | 12 | 14 | 4 5 9 | ,, ,, | 12 1/16 | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅝ | 4⅞ | 4⅝ | 4⅞ | 5 2 7 | ,, ,, | 4⅞ | ... |
| £2,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 | 98 | 95 | 98 | 3 11 10 | June and December | 97½ | 96½ |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 | 98 | 95 | 98 | 4 2 1 | ... | 98½ | ... |
| 171,504 | 1 | 0/8⅜ | Oriental | ⅞ | 1 | ⅞ | 1 | 6 0 0 | April and October | ⅞ | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 | 5½ | 5 | 5½ | 6 7 3 | July | 5⅝ | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | ... |
| £ 79,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 15 11 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅝ | ¾ | ⅝ | ¾ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅝ | ¾ | 9/16 | 11/16 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅝ | ¾ | ⅝ | ¾ | 8 11 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 8 | 9 | 8 | 9 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 5 4 4 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ | 5¼ | 4¾ | 5¼ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅝ | 1⅞ | 1⅝ | 1⅞ | 5 14 3 | September | 1⅝ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 | 2¼ | 2 | 2¼ | 5 6 8 | ,, | 2 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 102 | 105 | 102 | 105 | 4 5 9 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 | 102 | 99 | 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 | 18 | 15 | 16 | 4 13 9 | ,, ,, | 15 | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¾ | 6¼ | 5¾ | 6¼ | 4 0 0 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 110 | 114 | 110 | 114 | 3 19 6 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 | 95 | 92 | 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 5 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅛ | 3¾ | 3⅛ | 3¾ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.) | 100 | 105 | 100 | 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ¼ | ½ | ¼ | ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ | 2½ | 1½ | 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb.Stock(red.) | 80 | 85 | 80 | 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts.(all pd) | 85 | 90 | 85 | 90 | 5 13 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5¾ | 6¼ | 5¾ | 6¼ | 5 12 0 | Half-yearly | ... | ... |
| 20,000 | 5 | 1/6¼ | Do. 6% Cumulative Preference | 5½ | 6 | 5½ | 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 4 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. | 1½ | 2 | 1½ | 2 | 6 0 0 | January and July | ... | ... |
| 31,300 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 2¾ | 2½ | 2¾ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 | 102 | 98 | 102 | 3 18 5 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9¾ | 10½ | 9¼ | 10¼ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary | 16½ | 17½ | 16½ | 17½ | 6 1 5 | February and August | 17 | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ | 6 | 5⅛ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb.Stock(red.) | 110 | 114 | 110 | 114 | 3 19 0 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21½ | 22½ | 4 8 11 | ,, ,, | 22½ | 21 1/16 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 33 | 42 | 38 | 42 | 5 0 0 | March and July | 40 | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 | 106 | 104 | 106 | 3 15 10 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10⅛ | 11⅛ | 10½ | 11⅛ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ | 6½ | 5⅜ | 6½ | 4 0 0 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 | 11 | 10 | 11 | 5 9 0 | April and October | 10½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ | 7 | 6½ | 7 | 4 5 9 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 | 6 | 5 | 6 | 5 0 0 | ... | ... | ... |
| 180,327 | 10 | 4/6 | Globe Telegraph and Trust | 10½ | 11 | 10⅜ | 11 | 4 15 5 | Jan., Apr., July, Oct. | 10⅞ | ... |
| 190,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14¾ | 15½ | 15 | 15½ | 3 17 5 | ,, ,, | 15 1/16 | 14⅞ |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 127 | 132 | 127 | 132 | 4 11 8 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,218. [No. 22. Vol. XLVII.] FRIDAY, SEPTEMBER 20, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 1 Opf.


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## NOTES.

ONE of the few English electrical engineers who availed themelves of the invitation of the American Institute to attend its congress and visit some of the chief objects of electrical engineering interest on the other side of the Atlantic, endeavours in the notes we publish in another column to dispel the glamour which has long surrounded American electrical engineering practice. He is of opinion that, after due allowance has been made for the difference of conditions in the two countries, Great Britain is not really behind America, that the best work here is equal to the best work there, while a certain amount of indulgence is shown to slip-shod work in the United States which would certainly not be extended to it in this country. As he says, Great Britain, on account of her free trade, is in the position of being able to choose the best each country produces; and it is the natural tendency of British engineering to use the best, even though it be the most costly. But the matter must be looked upon from another point of view also. Some of our finest examples of electrical engineering, and some of our finest plant, are either obtained from the United States or the Continent, or else are built up largely on American or Continental lines. Our engineers have in the past done much to remove the reproach that we are a nation of shopkeepers; but there is still a danger of a large proportion of our electrical engineers degenerating into a species of merchants who merely import and erect foreign-made plant. Now that this danger is being more widely recognised, the necessary energy to avert it should not be wanting.

THE Kensington and Notting Hill Companies' joint electricity supply works, a description of which we conclude in another column, are of interest for several reasons. The Kensington Company and the Notting Hill Company are the pioneers in carrying out a joint electricity supply scheme within the metropolitan area; so that, naturally, on its success will probably depend the gradual unification of other supply stations. This unification must be a question of exceedingly slow growth owing to the enormous diversity of systems that are now being used in London, but that it will gradually take place seems a very likely contingency. We do not suppose that there will ever be one huge station to supply the whole of the metropolitan area, but the development will probably take place with regard to the interconnection of the generating stations and sub-stations. For instance, we understand that the new joint supply station of the St. James' and the Westminster Companies is being equipped more or less on similar lines to those of the joint works above referred to, and we shall certainly look forward to an arrangement between these four companies whereby electrical energy may be supplied from one to the other in case of emergency. It may be remembered that the inter-connecting trunk main already existing between the networks of the London Electric Supply Corporation and the Metropolitan Electric Supply Co. has, at least once, proved of incalculable benefit to the latter company.

SIMPLICITY is the keynote of the Kensington and Notting Hill system, and is obtained in a large measure by the use of asynchronous motor-generators; and that efficiency has not been ignored is evident from the employment of boilers working at 200lb. pressure with triple-expansion engines. Owing to the fast-speed engines, the generating sets are exceedingly compact, especially when compared with the usual Continental polyphase practice which has in several instances been introduced into this country. The use of fast-speed sets of large size, inductor alternators, and asynchronous motor-generators, have all been criticised at one time or another; but now we have practical and working examples, and, with the help of the Board of Trade returns, we shall have a means of arriving at the probable efficiency. We trust that the working cost will not prove excessive, and we wish the joint companies commercial success in their venture.



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As announced in our last issue, the Metropolitan and Metropolitan District railways have not been able to come to terms with regard to the electrical equipment of their lines, and the Board of Trade is therefore called upon to arbitrate. Many reports are current as to what is to be done next, but we have every reason to believe that each company will prepare a statement of its case under the advice of their technical advisers (Mr. H. F. Parshall for the Metropolitan District Company, and Mr. T. Parker for the Metropolitan Company). These statements will be submitted to a committee appointed by the Board of Trade, and the Hon. A. Lyttelton, K.C., has been mentioned as the probable chairman. We also learn from a usually well-informed quarter that the Metropolitan District Company has decided to place its contract for the electrical equipment with the British Westinghouse Co., subject, of course, to the result of the arbitration.

City and Guilds Technical College, Finsbury.—The new session begins on Monday, September 30th. Some particulars are given in an advertisement on another page.

South Western Polytechnic, London.—The new session of the South Western Polytechnic, commences for evening classes on September 23rd and day classes September 30th.

City of London College.—The Michaelmas term of the City of London College commences on September 30th. Some further particulars of the classes are set out elsewhere.

Interruption in the West London Tramways.—The electric tramway service from Shepherd's Bush to Southall was interrupted on Tuesday night at Ealing Broadway, owing to an earth on a feeder. The necessary repair was executed and the service resumed after the lapse of about two hours.

| Cable Interruptions. | Date of Interruption |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cadiz—Teneriffe | Aug. 6, 1901 |
| Bolama—Bissao | Aug. 16, 1901 |
| Trinidad—Demerara | Aug. 27, 1901 |
| Curaçoa—Cora | Sept. 11, 1901 |
| Bolama | Sept. 12, 1901 |
| Malta—Tangiers | Sept. 13, 1901 |

The Nernst Lamp.—Presumably we may expect that the Nernst lamp will shortly be on the market in this country, for we learn that the Prism Globe Co. has obtained an order from the Shipley Corporation for a number of two-light swan-neck bracket fittings for public lighting, each pair to carry two 40-watt Nernst lamps. The Shipley Corporation has in progress a three-wire 460-volt continuous-current station, Mr. R. C. Quin being the consulting engineer.

Cape-Australia Cable.—The cs. "Scotia," which left Aden on Sept. 8 for Cocos Island with the Cocos-Perth (W.A.) section of the Cape-Australia cable, arrived at Colombo (Ceylon) to coal on Wednesday, and left yesterday for Cocos. The cs. "Anglia," which arrived at Mauritius on Sept. 8, proceeded at once to lay the Mauritius-Rodrigues section, and has buoyed the shore end at Rodrigues. It is anticipated that the new triplicate line to Perth (W.A.) will be completed and opened for traffic by the end of October. The laying of the Perth-Adelaide section will probably be completed early in 1902.

Electric Supply in Newcastle.—In our issue of June 14 we referred to Mr. Mordey's report to the Corporation of Newcastle-upon-Tyne, pointing out the dilemma in which the Corporation might find itself placed 20 years hence on account of the multiplicity of systems of electric supply in its district. On the strength of that report the Council decided to oppose the extensions of the Newcastle-upon-Tyne Electric Supply Co., but we learn that the Board of Trade has, in spite of the representations made to it by the Corporation, now notified its approval of the entire transmission and distribution scheme originally proposed by the company.

Errata.—In our analysis of the Dublin United Tramways Co.'s accounts on page 753 of our issue for September 6th, we were in error in stating that Mr. J. W. Towle is the tramway manager. This gentleman is the electrical superintendent, and Mr. C. W. Gordon is manager to the company.

With reference to the letter on page 805 of our last issue from Mr. R. N. Lucas, on the subject of Edison's alkaline storage battery, the important word "not" was unfortunately omitted from the last sentence. This should read:—"Local action might, therefore, quite well take place in Edison's negative, even if it were true that the P.D. of the couple graphite-iron were *not* equal to the P.D. required to split up the solution present."

The Walthamstow Electricity Supply Works.—The electricity works of the Walthamstow Urban District Council, which will be opened to-day, have several points of interest. The station is a Dowson gas one, and Westinghouse three-crank gas engines with three vertical cylinders are employed, running at 168 revs. per min. and directly connected to multipolar continuous-current dynamos. The works lie in the centre of the supply area and feed the network at four points, the feeders being in each case about $\frac{3}{4}$ mile long. There is already a large demand for current, there having been, up to date, about 150 applications for it, corresponding to about 10,000 8 c.p. lamps, and including four public buildings. The streets are to be lighted with 63 arc lamps, arranged nine in series across the outers of the 2 × 230 distribution network. The present equipment of the station includes two gas generators, three gas-driven dynamos, and a 600 ampere-hour battery. Extensions have already been decided upon. We reserve a detailed description of the plant for a future issue.

The Late President McKinley.—In connection with the assassination of the President of the United States the officers and members of the Eastern and Associated Telegraph Companies' staff in London telegraphed to Mr. George G. Ward, vice-president of the Commercial Cable Co., New York, expressing to him and the officers and staff of his company their sincere sorrow at the death of President McKinley, whose career of honour and usefulness to his country had been severed so suddenly by the ruthless hand of the assassin. They desired to offer their meed of praise for the work the President lived to accomplish, and deep sympathy with the American people for the great loss they had sustained. To this message Mr. Ward replied, on behalf of the officers and staff of the Commercial Cable Co., thanking the officers and members of the telegraph companies' staff in London for the kindly sympathies conveyed in their telegram. He adds: "It is indeed a sad blow, yet one which tends to increase the love and respect of a people for its guiding spirits."

International Association for Testing Materials.—The Congress of the International Association for Testing Materials was held at Budapest on September 9th to 14th, under the presidency of Prof. L. von Tetmajer, and was largely attended by engineers from all parts of the world. The delegates present included 4 from England, 41 from Austria, 3 from Belgium, 9 from Denmark, 2 from the United States, 36 from France, 152 from Hungary, 70 from Germany, 8 from Norway, 12 from Italy, 26 from Russia, 1 from Roumania, 3 from Spain, 1 from Servia, 10 from Switzerland, and 5 from Sweden. After an inaugural presidential address and address of welcome from the Hungarian authorities, a representative of each country was elected an honorary president of the Congress, Mr. Bennett H. Brough being chosen for England, and Prof. H. M. Howe for the United States. The other English and American members present were:—Sir William H. Bailey (Manchester), Mr. Bertram Blount (London), Dr. C. J. Renshaw (Ashton-on-Mersey), and Dr. R. Moldenke (New York). There were no Papers of direct electrical interest.

Opening of the Worthing Corporation Electricity Works.—The inauguration of electricity supply at Worthing takes place to-morrow, when the Marquis of Abergavenny will switch on the current. The system is a three-wire continuous one, with 230 volts at consumers' terminals. The power station equipment consists of two marine boilers, each having an evaporative capacity of 9,000lb. of water per hour, and two high-speed enclosed engines, driving multipolar dynamos with an aggregate capacity of 288kw. A 600 ampere-hour battery

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is installed, having a maximum discharge rate of 150 amperes. Callender's vulcanised bitumen mains have been laid in Albion Clay Co.'s ducts, and the streets will be lighted with 110 arc lamps. Already extensions have been sanctioned by the Corporation, who received their provisional order in 1895, and to whom Messrs. Burstall and Monkhouse have been acting as consulting engineers. The question of an electric tramway system supplied from the lighting station has been receiving much attention, but nothing definite has yet been arranged. The lighting tariff is 6d. for lighting and 3d. for power, with discounts. Mr. A. Porter is the resident electrical engineer.

**Westminster Abbey Lightning Conductors.**—The lightning conductor system of Westminster Abbey has been entirely renewed under the direction of Mr. Killingworth Hedges. Seven-strand copper cables $\frac{3}{8}$in. diameter are carried horizontally along the apex of the roof of the nave and transepts, and continued over the Henry VII. chapel. Cables are also led from these conductors to smaller ones on the towers, lantern, and higher parts of the building, and thence to earth, the conductors being strained by special holdfasts, which hold them 6in. from the structure. About thirty 4in. aigrettes are fixed along the horizontal conductors some 80ft. apart, each of these aigrettes being made of four pieces of solid copper joined to the conductor by means of joint-boxes filled with solder, a method which is employed for all the joints on the system. In order to keep the earth connections moist, a pipe is led in each case to the nearest rain-water spout in such a way that the rain water will be diverted sufficiently to keep the carbon round the earth plate or tube moist. A solid copper wire $\frac{1}{4}$in. diameter protects each of the pinnacles of the building, and these wires are attached to a common conductor laid horizontally on the lowest roof and connected with the lead roofing.

**Memorial to James Bowman Lindsay.**—Last Saturday an obelisk in memory of James Bowman Lindsay was unveiled by Sir William Preece, who delivered an oration in which he referred in glowing terms to the magnificent, though hitherto almost unrecognised work of this most modest of pioneers. The obelisk was erected, from funds raised by public subscription, over Lindsay's grave at the Western Cemetery, Dundee. The front panel bears the inscription:—

"In memory of James Bowman Lindsay. Born at Carmyllie, September 8, 1799; died at Dundee, June 29, 1862, aged 63 years. Erected by public subscription, June 29, 1901."

On the south the following inscription:—

"A pioneer in electrical science; foretold the application of electricity as an illuminant, a motive power to replace steam and substitute for coal in heating. He devised an electrical telegraph, 1832; suggested welding by electricity, produced a continuous electric light, 1835; proposed a submarine transatlantic telegraph, 1843; and accomplished wireless telegraphy through water, 1853. As a philologist his attainments were extraordinary. In 1828 he began the compilation of a dictionary in 50 languages, uncompleted when he died. An accomplished scientist, a profound student, an earnest Christian."

On the north panel are inscribed quotations from Lindsay's writings:—

"The Electric Light.—The light is intensely bright, and lights may be increased without limit. Wheels may be turned by electricity, and small weights raised over pulleys. Houses and towns will in a short time be lighted by electricity instead of gas, and heated by it instead of coal, and machinery will be worked by it instead of steam.—April 11, 1834."

"Brilliant illumination will be obtained by a light incapable of combustion, and on its introduction to spinning mills conflagrations will be unheard of. . . . It will blaze with undiminished lustre amidst tempests of wind and rain, and, being capable of surpassing all lights in splendour, it will be used for lighthouses and telegraphs. The present generation may yet have it burning in their houses and enlightening their streets.—October 28, 1835. "J. B. LINDSAY."

**Obituary.**—It is with deep regret that we announce the death of Mr. Walter T. Goolden, which occurred last Monday at Cookham. Mr. Goolden, it will be remembered, was a partner in the firm of Edmunds and Goolden, which was among the pioneers of heavy electrical engineering industry in England. He maintained his connection with the firm when it was converted into Goolden and Trotter, and later to W. T. Goolden & Co., and he became a director of Messrs. Easton, Anderson and Goolden, managing the businesses of this company and of the Electrical Coal-Cutting Contract Corporation in the North of England and Midland Counties. He was also managing director of the Typewriting Telegraph Corporation. Mr. Goolden was born in 1848. He was educated at Magdalen College, Oxford; was a science scholar of Merton College in 1867, and took a First-Class degree in Natural Science in 1871. Mr. Goolden examined at one time for the Civil Service Commission, was assistant-examiner in Natural Philosophy to the University of London from 1888 to 1887, and to the Science and Art Department, South Kensington, from 1871 to 1894.

We have also to record the death of Mr. H. D. Norman, electrical engineer to the municipality of East London, South Africa, which occurred suddenly on July 30th. Mr. Norman had been in East London only a few months, and previously to accepting the position of municipal electrical engineer there he had been engaged in the electrical department of the Durban Municipal Council, and before that had occupied a similar position in the electrical department at Johannesburg. He was only 28 years of age, and was a native of Brighton, Sussex.

**The New Bradford Electricity Works.**—The foundation stones of the new generating station at Bradford were laid last Friday. The new works are situated in Valley-road and face the Midland Station, on a piece of ground adjacent to the second generating station that was erected by the Corporation. The front will be built in ornamental stonework, and will constitute one side of the engine room. The engine room will run parallel to the roadway, and behind this will be the boiler house. At the north end of the building will be an economiser house, feed water storage tanks, and ash bunkers. Beyond this will be the chimney. The buildings are so designed that they may be duplicated by building another engine house at the back of the boiler house, the boiler house itself being so arranged that the boiler horse-power installed can be doubled to deal with the engines in this second engine room. The interior of the engine room will be built with glaze bricks of an ornamental design. The portion that is being built at present will be capable of accommodating three engines having a total of 6,000 H.P. Two of these, ordered from Messrs. Cole, Marchent and Morley, are practically finished. The electric generators, each having a capacity of 1,000kw., have been built by the British Westinghouse Electric and Manufacturing Co., and have been delivered. Surface condensing plant will be installed, and operated in connection with the cooling tower that is now being erected over the reservior. An electrically-driven 30-ton overhead crane will be fixed in the engine room for the purpose of erecting or repairing any parts of the plant. The engine room, when completed, will be capable of containing 5 units, having a total capacity of 10,000 H.P., and the second engine room, at the back of the boiler house, will be of the same capacity, making the total output of this station when finally completed equal to 20,000 H.P. The boiler house is arranged to accommodate two batteries of boilers, and it is proposed to adopt the water-tube type of boiler, fitted with mechanical stokers and superheaters. It is proposed to instal six boilers, having a total capacity of 4,800 H.P. The gases from these will pass into a main flue, which will conduct them through an economiser and into the chimney. The chimney will be built of brick and circular in form, having an internal diameter of 13ft. It will be 200ft. high, and capable of dealing with the furnace gases required by 10,000 H.P. A large coal store has been arranged over the centre part of the boiler house, capable of containing 2,000 tons of coal, and it is proposed to put in a complete elevating and conveying apparatus to deal with the coal and ashes. The buildings were commenced early in the year, and should have been very shortly ready to receive the plant. Owing, however, to the building strike which has been in operation during the summer, the work has been very much delayed, and it will be impossible now to instal the plant and get into working order before the summer of next year. In order, however, to deal with the increased demand for electricity, arrangements have been made to instal two engines of 300 H.P. each in an extension of the present engine house. The whole of the work is being carried out to the specification and under the supervision of Mr. R. A. Chattock, electrical engineer to the Corporation.

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# THE KENSINGTON AND NOTTING HILL COMPANIES' JOINT ELECTRICITY SUPPLY WORKS.

(*Concluded from page 781.*)

**Miscellaneous.**—A workshop which adjoins one side of the engine house is provided with various sized lathes, a drilling machine, a screwing machine and other tools for carrying out repairs. Railway lines are brought into the workshop, and a 10-ton overhead traveller is provided for unloading goods. In an outbuilding a blacksmith's shop is provided, with the usual forge and tools. Above the workshop are the offices, consisting of clerks', engineers' and drawing offices, board room, stores, accumulator room, lavatories and bath room.

and City Railways into Hunt-street, and then away to the two companies' districts. Ten out of 12 cables have been drawn in, and before use they were tested up to 10,000 volts for half-an-hour to earth and half-an-hour between each of the cores.

**Motor-Generators.**—The motor-generators used both by the Kensington and Notting Hill Companies are of the Oerlikon asynchronous type, their general appearance being clearly shown in Figs. 21 and 22. The motors have wound rotors,

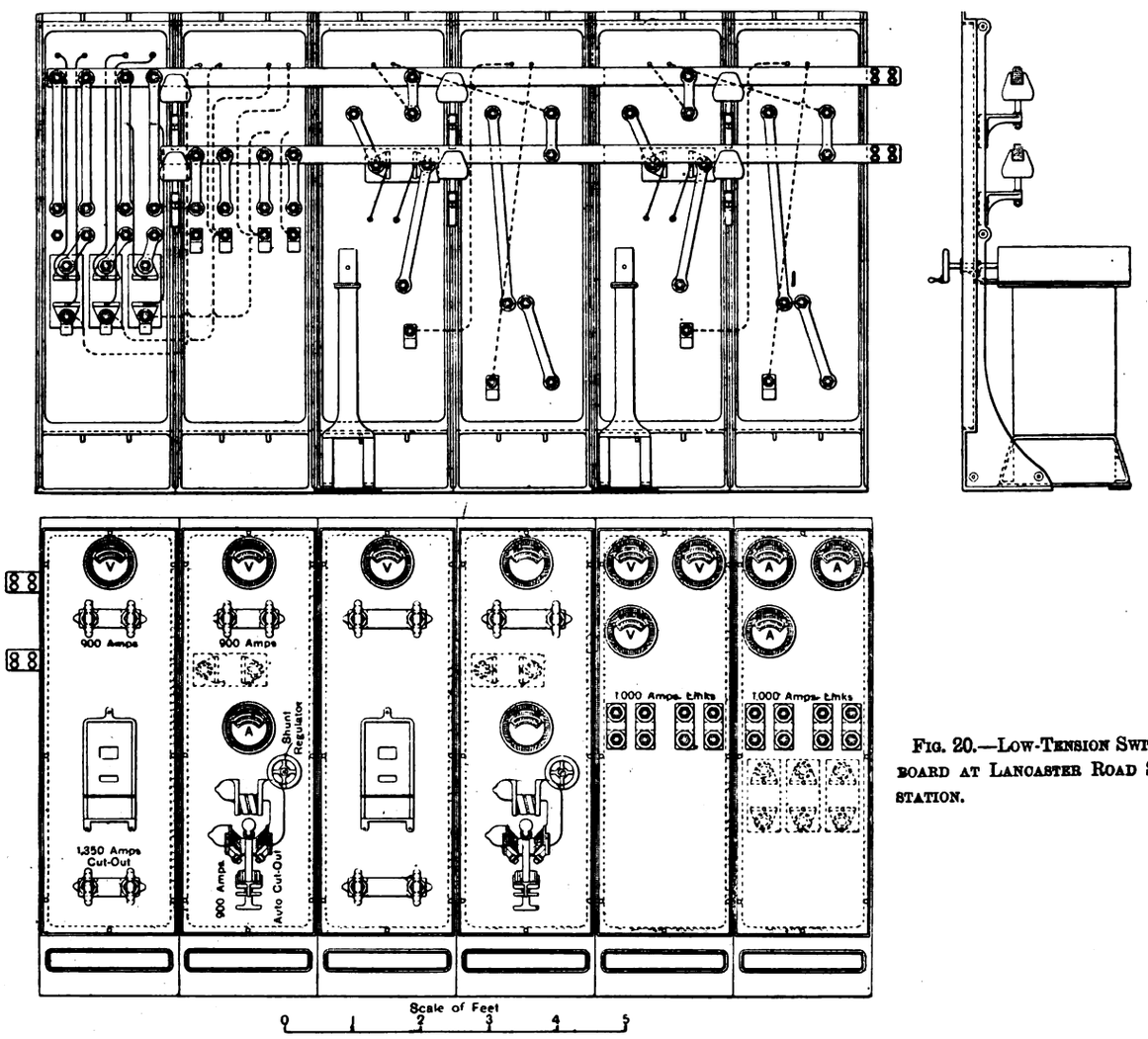


FIG. 20.—LOW-TENSION SWITCHBOARD AT LANCASTER ROAD SUBSTATION.

A complete set of apparatus has been provided for testing coal and for boiler trials. It consists of a 2in. Schonheyder's high-pressure water meter, weighbridge for the coal, dasymeter for measuring the $CO_2$ draught gauge, and pyrometer.

A 20-ton electrically-driven traveller is provided for the engine-room. The insulation of the alternators and mains is tested by means of a 80kw. transformer, either 7,800 or 10,000 volts being employed.

**Main Feeders.**—The feeders from the generating station to the sub-stations are all in duplicate; they are of the British Insulated Wire Co.'s clover leaf pattern, taped and drawn into Doulton casings, each conductor being 0·15 sq. in. in area. Under the switchboards the cables are laid beneath the floor of a cable subway constructed the whole length of the engine-house; the mains then pass into the conduits, which are surrounded with 6in. of concrete; they are carried under and across the lines of the West London and the Hammersmith

which are provided with slip rings for connecting to the starting resistance. These resistances are placed between motor and generator at the Kensington sub-stations and near the switchboards by the Notting Hill Company (*see* Fig. 22). When the motor has reached full speed and the rotor resistance is cut out, the brushes can be removed from the slip rings by means of a lever, shown to the right of the motor in Fig. 22. The clearance between the rotor and stator is about 1·5mm. and liners are used to correct for wear of the bearings. The generators are of the multipolar type with cast-steel yokes, and the field magnets can be excited directly from the brushes or from the 'bus bars. Copper gauze brushes are used with one leading carbon brush to each set. The large dynamos have barrel-wound armatures, whilst for the smaller sets evolute end connections are used.

**The Kensington and Knightsbridge Company's Sub-stations.**—The Kensington Company have obtained the lease of a

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series of vaults at the back of the Albert Hall, which should provide room for plant for many years to come. The present equipment consists of one 100kw., two 180kw. and three 200kw. machines. The smallest-sized unit runs at 420 revs. and the larger ones at 380 revs.

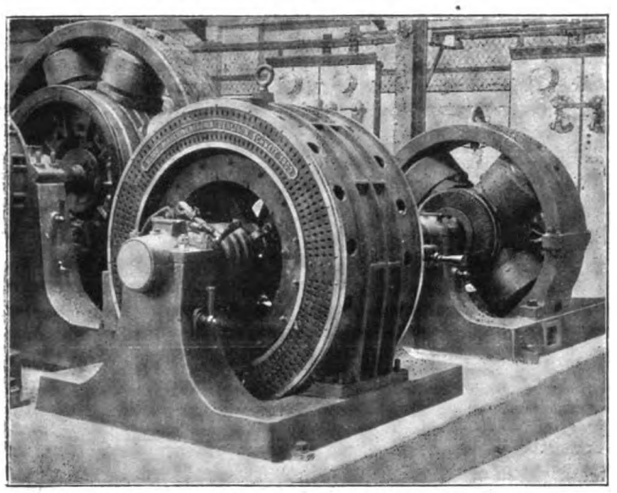

FIG. 21.—GENERAL VIEW OF THE HIGH STREET SUB STATION.

Four cables from the generating stations enter the sub-station, and are divided into separate cables in B.I.W. joint boxes. Fuses as shown in Fig. 19 in our last issue are in circuit with each cable. The high-pressure switchboard is similar in design to that at Wood-lane, and caged in the same way, but there is an additional precaution, the fuses being separated by slate slabs. The 'bus bars consist of copper tubes which form a ring main, and they can be disconnected at three places. The three cables to each motor have a lay of about one turn in 10ft. All the high-pressure switchboards at this station as well as at the generating station were supplied by Messrs. O. Berend & Co., who also supplied the low-tension board at Wood-lane. The switches were manufactured by Messrs. Voigt and Haeffner.

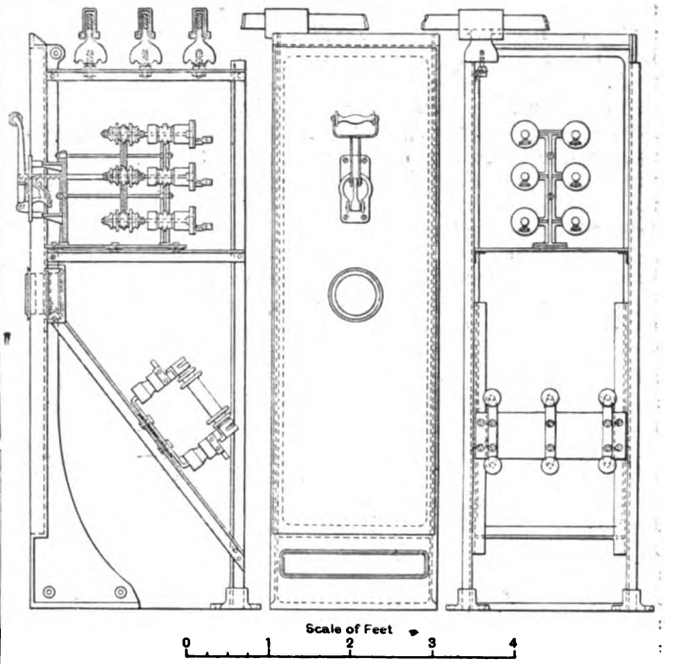


FIG. 23.—A HIGH-TENSION PANEL AS USED AT THE NOTTING HILL COMPANY'S SUB-STATIONS.

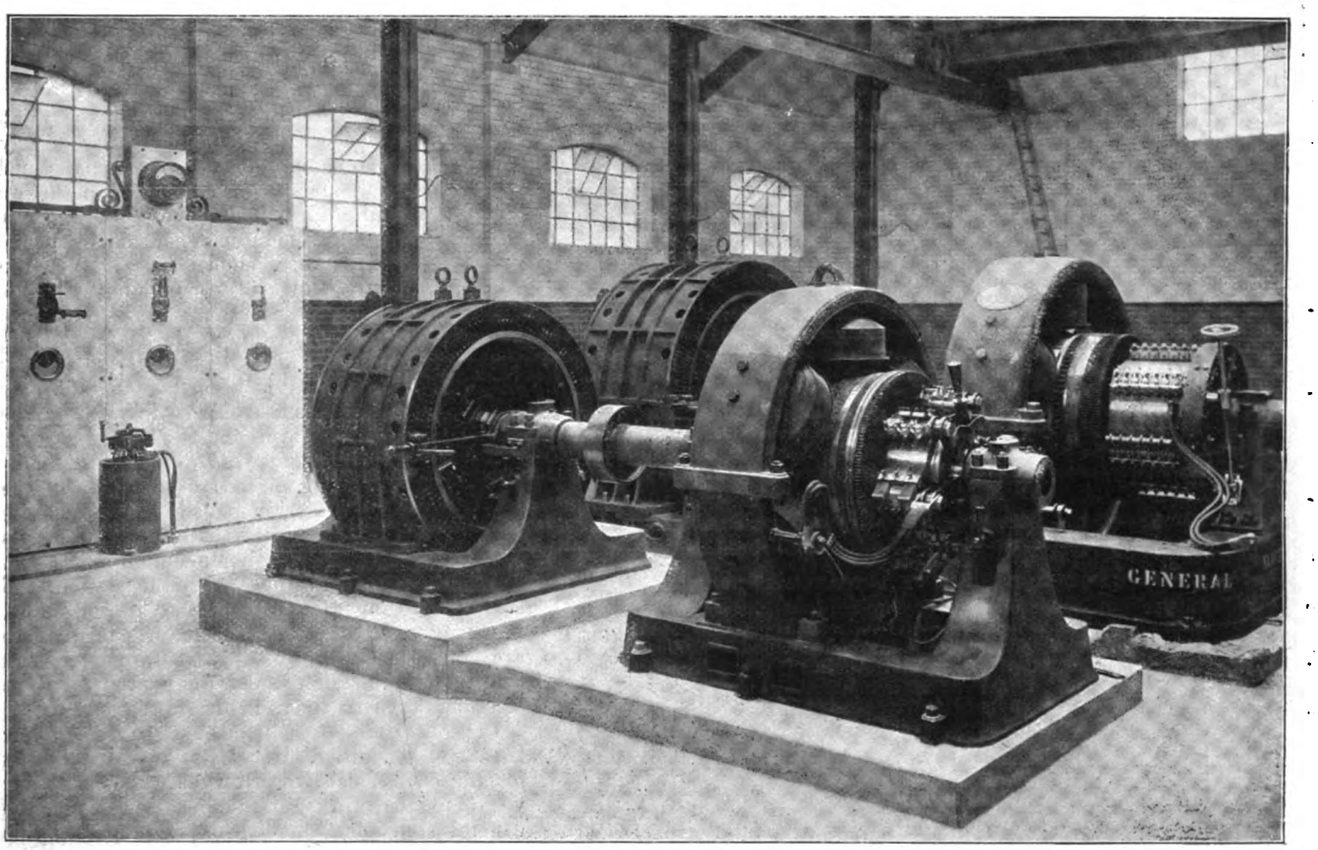


FIG. 22.—GENERAL VIEW OF LANCASTER ROAD SUB-STATION.

The low-tension board was constructed by Messrs. Moy. There are six generator panels and four feeder panels. The fuses are of copper shunted with a small tin fuse in a fibre tube. The instruments are of the Eversheld moving-coil type.

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Motor-generators are also being installed at the Kensington Court station.

**The Notting Hill Company's Sub-stations.**—The Notting Hill Company have made their first sub-station on the same premises as their generating station in High-street, Notting Hill Gate, but they have now nearly completed a second in Lancaster-road. A portion of the first sub-station is shown in Fig. 21, and Fig. 22 gives a general view of the Lancaster-road station. In the Notting Hill sub-station two 60kw., two 180kw. and one 300kw. motor generators have been installed, and there is room for one further 300kw. set, whilst in the Lancaster-road sub-station one 100kw. and one 180kw. sets are being erected, the last-named having the generator of the Byng-Hawkins type, which was made in England; the others the General Electric Co. obtained from Switzerland. The principal difference between the Notting Hill station and the Kensington station is in the switchboards. In the sub-station now working the panels are opposite the machines. The high-tension panels are separated by white glazed brick walls, the whole working apparatus being practically enclosed in a separate room with a locked door. The low-tension panels are placed in front with a clear footway between, and the backs are quite open. This arrangement is clearly depicted in Fig. 25. The high-tension boards are of the standard Oerlikon pattern for this class of work, and have been supplied by the General Electric Co. The arrangements can be easily traced from Figs. 23, 24 and 25. The switches have a total double break of about 12in.; this takes place inside a porcelain tube and there is practically no arc. The fuses are of the pop-gun order with a break of about 8in.; the actual fuse is made of silver, as this metal is found to be the most reliable, a given size of wire breaking nearly always with the same current; they are inclined so that the fuse and plug are shot in a direction where they will not cause damage. The rotor of the 300kw. motor generator is started by means of a water resistance, shown in Fig. 24, the starting current being about 700 amperes. A tell-tale, giving the position of the resistance plates is fixed on the wall above the regulating handle. The rotor resistances of all the smaller machines are of the type shown in Fig. 22. As will be seen from this last-named illustration the arrangement of the switchboards at Lancaster-road sub-station is somewhat different, the high-tension panels being placed on one side of the room and the low-tension panels on the opposite side. The arrangement of the low-tension panels is shown in Fig. 20. Each sub-station is in direct communication with the Wood-lane station, the signalling being carried out either by telephone, telescriptor, or bell. In the main station there are two separate sets of apparatus, one for each company's sub-stations, and these are placed in chambers between the switchboard sections.

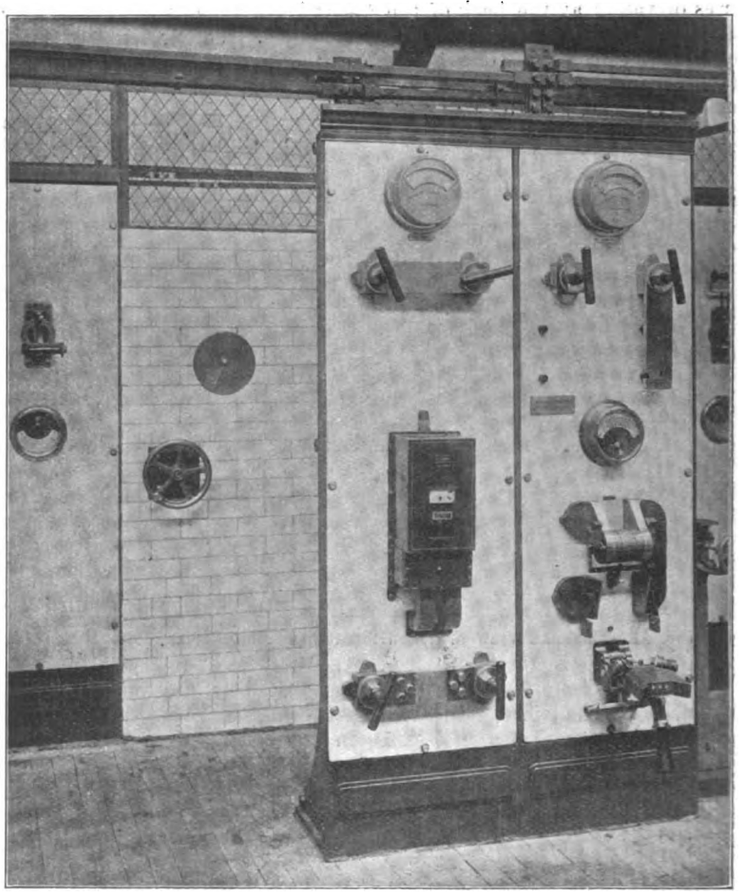

Fig. 25.—Front View of Switchboards at High Street Sub-Station.

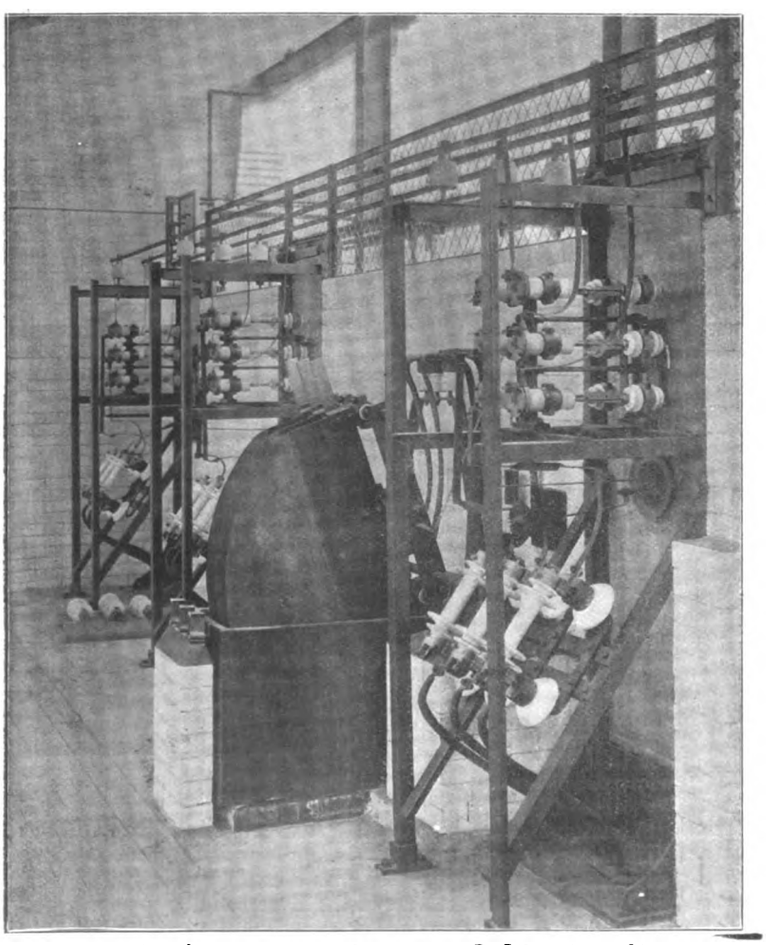

Fig. 24.—Back View of High-Tension Switchboards at High Street Sub-station.

In conclusion, we should like to record our thanks to Mr. Miller, Mr. Schultz and Mr. Bennett for the courtesy shown us on the occasion of our visits to the works and sub-stations, and the general assistance afforded us in preparing this article. We are also indebted to many of the contractors for information.

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**Opening of the Electric Tramways at Portsmouth.**—In consequence of the death of President M'Kinley, the inauguration of the electric tramways has been postponed until Tuesday, 24th inst.

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## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 785.*)

### MESSRS. SCHUCKERT'S WORKS.

The firm of Schuckert & Co. dates back to 1878, when Johann Sigmund Schuckert started a small workshop in Nuremberg, in which he repaired sewing machines, and made some classes of measuring instruments. He soon devoted his attention to electricity, and in 1874 built an experimental hand-driven dynamo, which was quickly followed by machines for electro-plating and subsequently for electric lighting. The demand for these machines becoming regular, he moved in 1878 to a larger workshop, in which he employed 12 workmen and three apprentices. Around this the enormous works of the Schuckert company gradually grew, and the firm is still one of the largest manufacturing works in Germany. Schuckert himself retired from business on account of ill-health in 1892 and died in 1895. It was due to his energy that the works developed as they have done, but he was a "continuous-current" man, and since his retirement a great change has come over the works, new shops for large alternating-current dynamos having been erected, so that the firm now occupies a position among the leading manufacturers of both continuous and alternating-current machinery. Fig. 59 is interesting as showing the gradual extension of the works to their present dimensions, each shop in the diagram being marked with a date to enable this to be traced.

The old 1878 buildings have been rebuilt, and converted into workmen's rooms, comprising stores, canteens, baths, schoolroom, &c. The newer works are divided into three parts. In the first of these, facing the Landgraben-strasse, the main offices are situated, and behind them is a large open yard, which is used as a store for castings. The large machine shops behind this, built in 1890 and 1895, consist of a double shop over 300ft. long, in which the large continuous-current machines are built. On one side of this are the machine tools and on the other the erecting shop, in which is also provision for testing the finished machines. A gallery is devoted to the lighter work. In the building next to this, bearing the date 1891, small continuous-current machines up to 50 H.P. are manufactured, and the fittings for larger machines up to 300 H.P. At the eastern end of this building the armatures of large machines are wound, and beyond this winding shop is the power house, supplying current for lighting and driving the works. In the shops on the western side, field-magnet

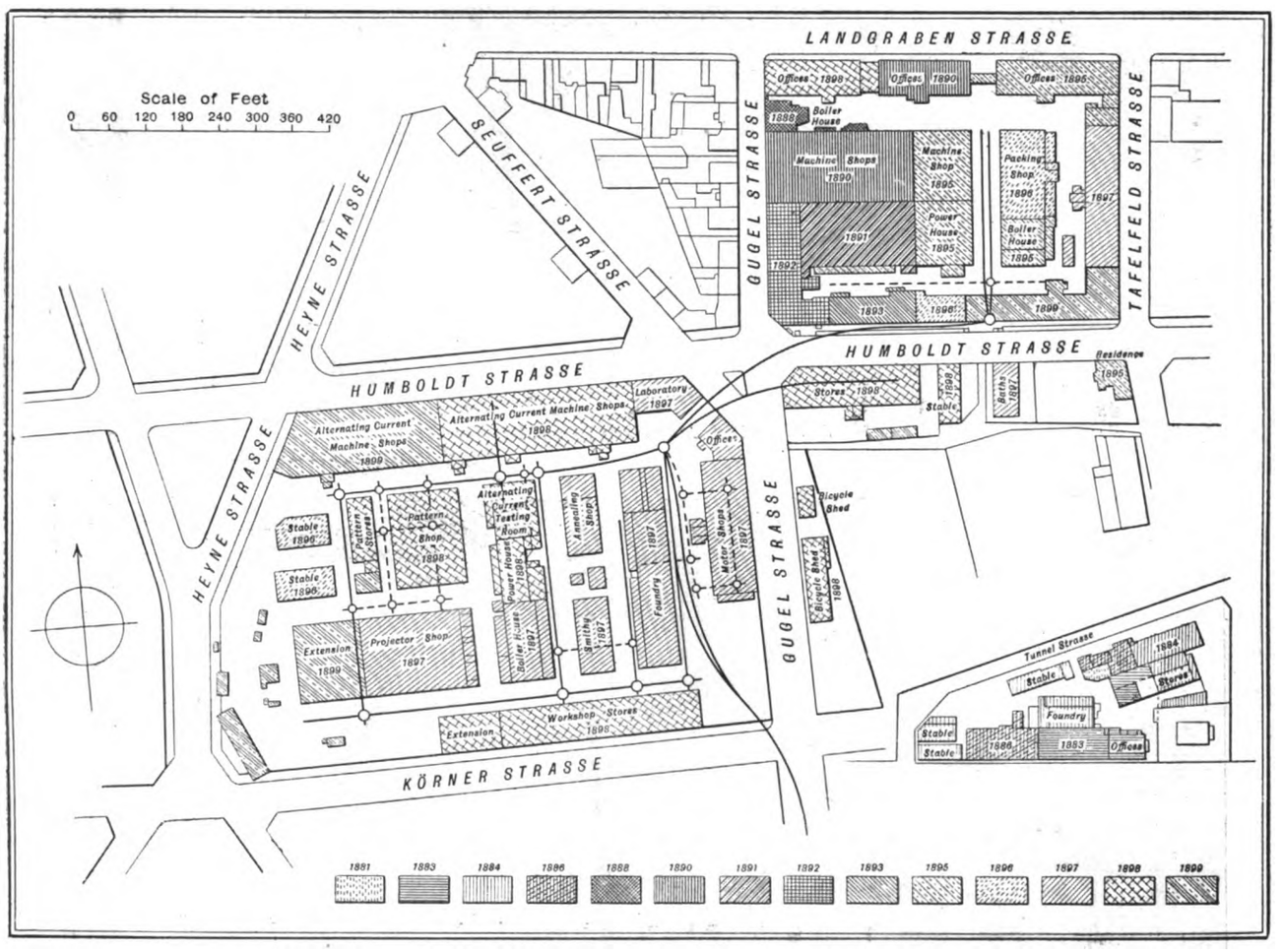


FIG. 59.—PLAN OF THE SCHUCKERT WORKS, SHOWING DATES OF EXTENSIONS.

coils are wound, and on upper floors the armature-winding of smaller machines and the winding of transformer coils and the cotton-covering of armature bars is carried on. The remaining shops of this portion of the works have mostly several floors, and, where not otherwise marked in the figure, lighter work, such as the manufacture of arc lamps, switches and various accessories, is largely carried on there.

The newer or south-west part of the works is bounded on the north by the fine new shop for alternating-current machinery, and on two of the other sides by buildings with several storeys. The purposes to which the various shops here are put are marked in Fig. 59, and this figure also shows the rails which are laid between the various shops and departments of the works.

The greatest interest was shown in the fine new shop for alternating-current machinery shown in Fig. 60. The construction of the roof renders it extremely light, and it is seen

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that windows are also provided for the side bays and galleries. The central portion of the shop is devoted to the erection of large alternators, the two ends and one side to machine tools, and along the other long side are arranged the fitters' benches.

It was noticeable that American machine tools were chiefly used in both the new and old shops. One fine vertical lathe, with a bicycle-wheel construction, took work up to 12 metres diameter. Another was seen working on a steel

FIG. 60.—NEW ALTERNATING CURRENT SHOP.

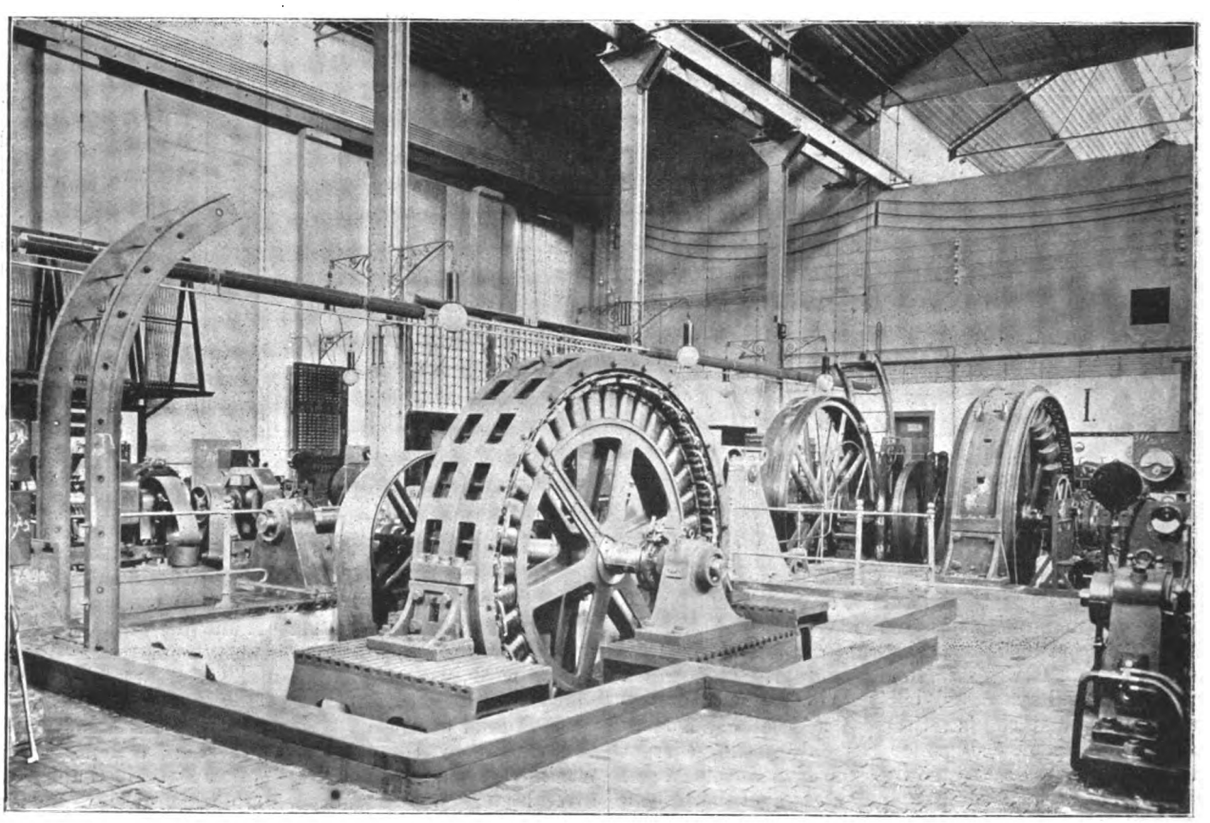

FIG. 61.—ALTERNATING CURRENT TESTING ROOM.

During the time of our visit a 3,700 H.P. 5,000 volt three-phase machine was being tested in the shop, its 9-metre diameter stator being too large to handle in the alternating-current testing room illustrated in Fig. 61.

casting, and making a deep cut at a peripheral speed of 18 metres per second with Krupp's new tool-steel, and this speed, I was informed, can be increased to 24 or 25 metres per second on cast iron. As in other shops, portable machine

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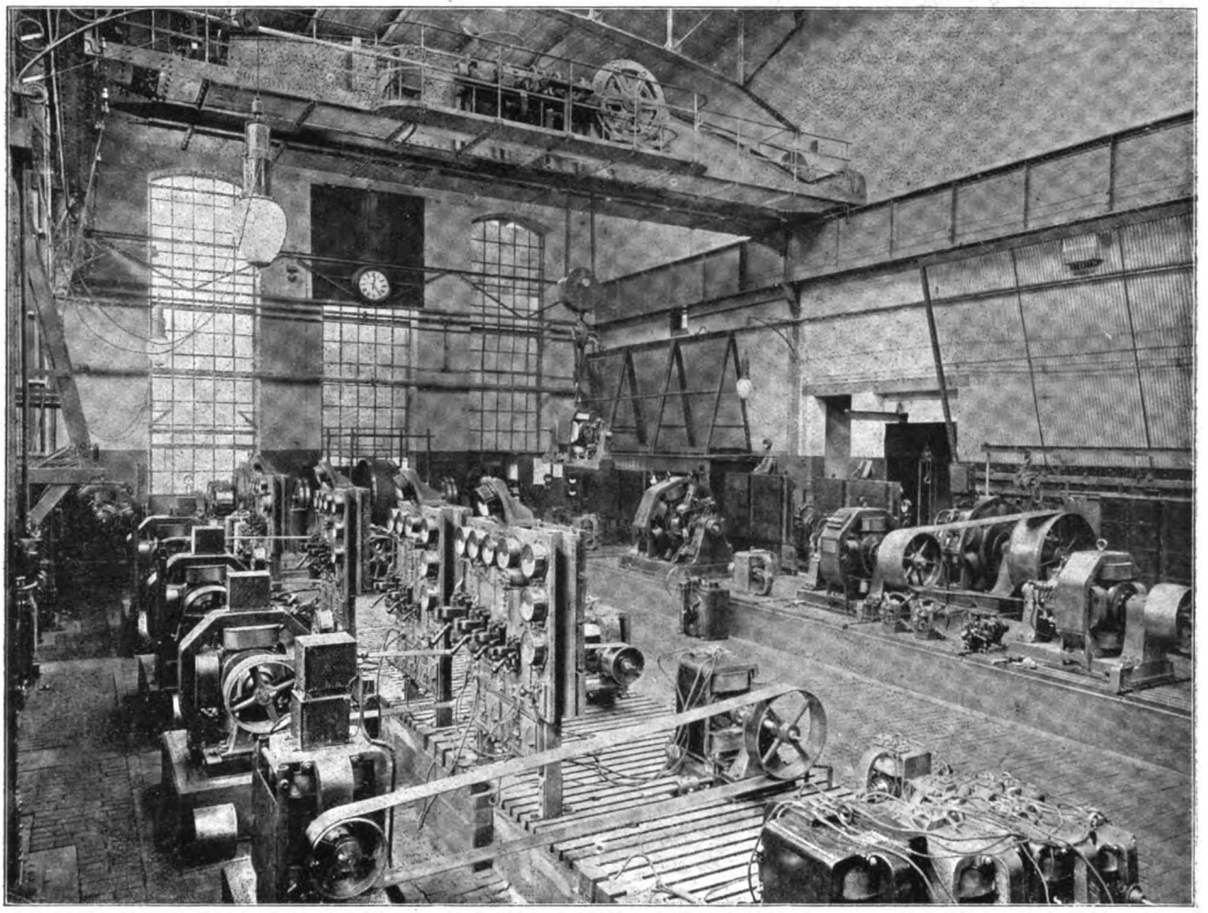

FIG. 62.—CONTINUOUS CURRENT TESTING ROOM.

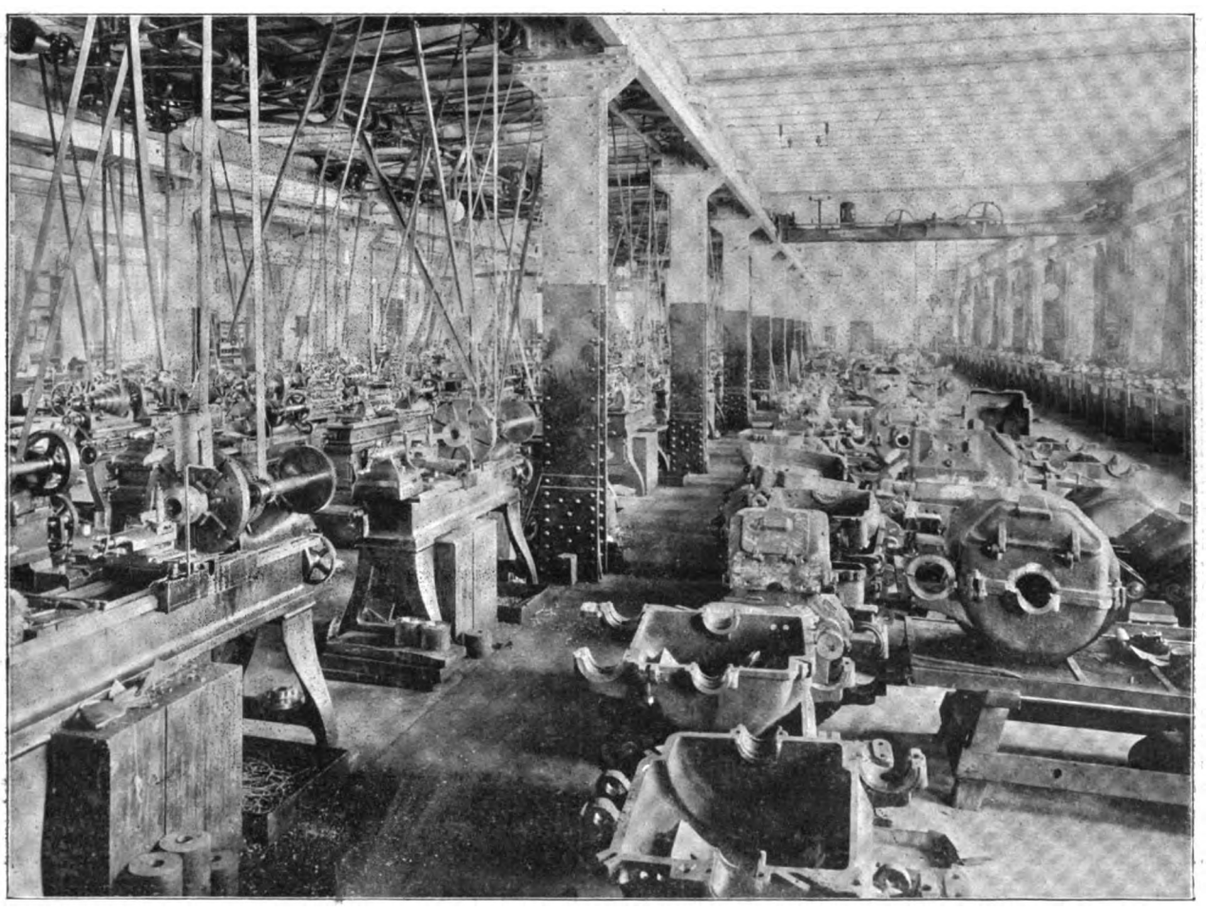

FIG. 63.—TRAMWAY MOTOR SHOP.

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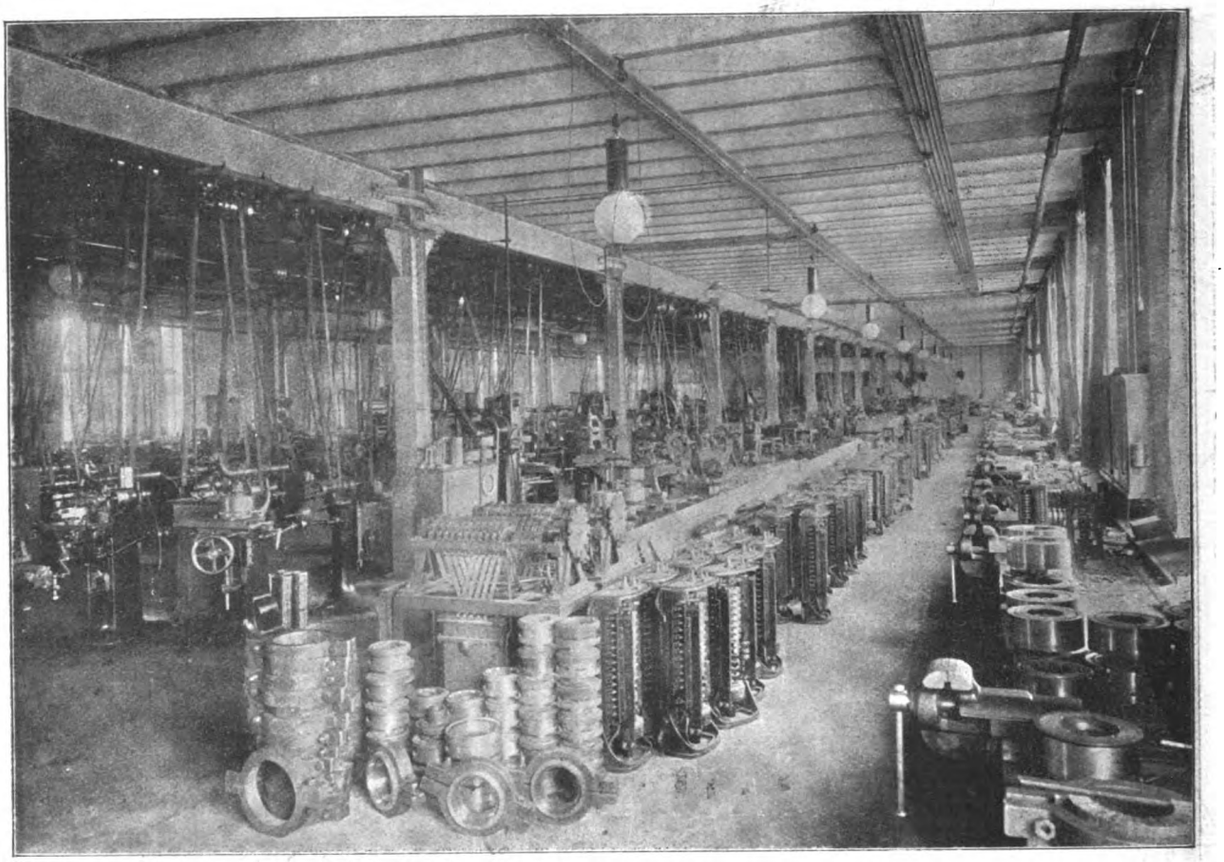

FIG. 64.—CONTROLLER SHOP.

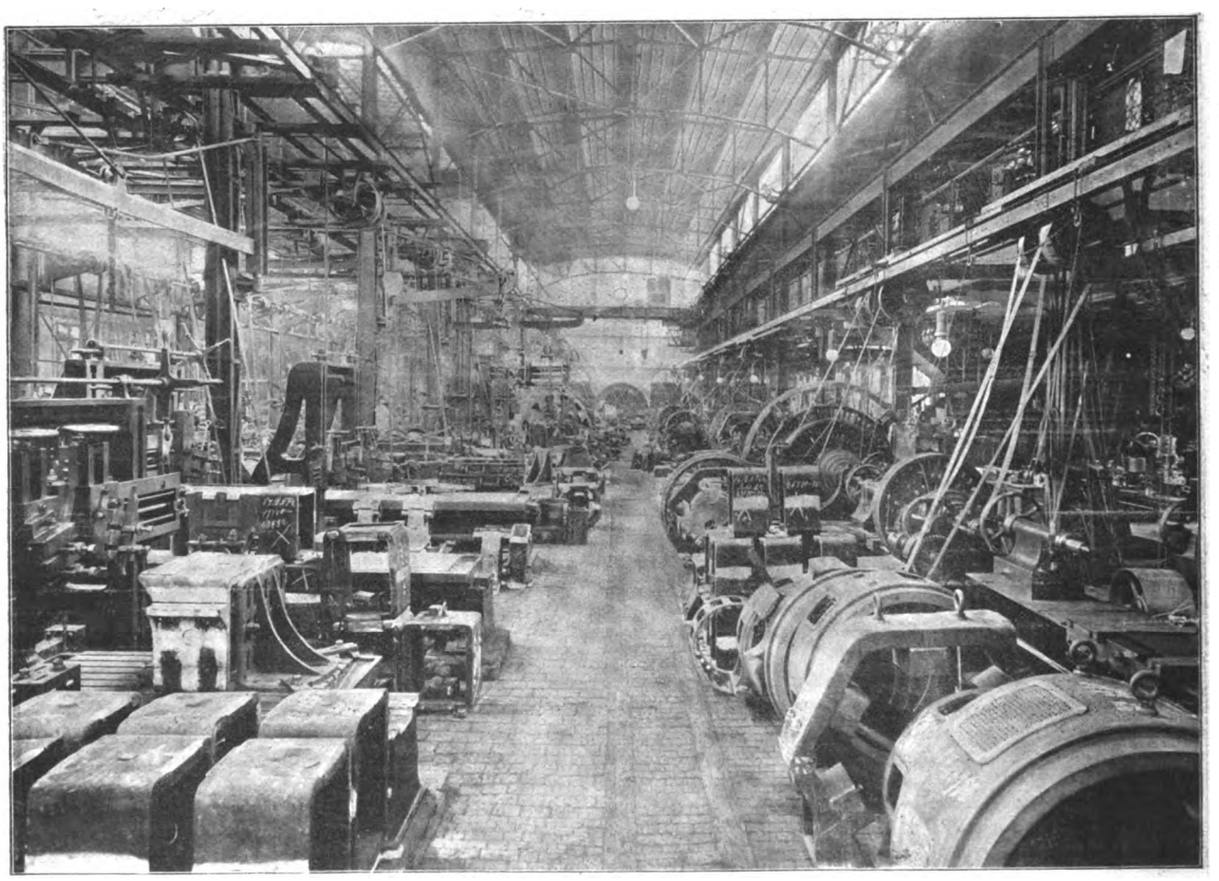

FIG. 65.—CONTINUOUS CURRENT MACHINE SHOP.

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tools were employed to a certain extent, among them chipping chisels worked with compressed air.

In the alternator construction, closed slots were employed very much. The slots were made leaving a very thin width of metal against the air-space. In the case of small machines this is usually filed away, and in larger machines left closed. One of the latest types of the Schuckert alternator is seen in the foreground in Fig. 61. The continuous-current generators seen were mostly with smooth armatures, the smaller machines and motors having slotted armatures.

Power is supplied from two power houses to the various shops, 8,500 H.P. of plant being required and a battery of 3,000 ampere-hours. Current is supplied both for lighting and power on the 2 × 220 volts three-wire system. The largest motors are of 30 H.P.

*(To be continued.)*

## THE INTERNATIONAL ENGINEERING CONGRESS AT GLASGOW.

*(Concluded from page 801.)*

There was also read in the Section on Naval Architecture and Marine Engineering, presided over by the Earl of Glasgow, a Paper of interest to electrical engineers, by Mr. Robert Robertson, B.Sc., entitled

"Notes for Discussion on Electrical Power Supply in Shipbuilding Yards and Marine Engine Works."

An abstract of this Paper is as follows:

Works of this kind, like all others, differ in size, in arrangement and in many other respects so much that each case must be taken and considered in detail by itself before any reliable conclusion can be arrived at as to the advantages in that particular instance. The conditions ruling in a shipyard are so different from those in an engine works that it will be convenient to consider the two separately, and also to take the latter part first.

*Engine Works.*—The advantages claimed for electrical driving in marine engine works may be conveniently classified under three heads, viz.:—(1) Saving in cost of power; (2) Flexibility of the system; (3) Increased output.

1. In considering this subject, the saving in cost of power is too often looked upon as the only advantage to be gained, and the advantage is treated lightly because the whole cost of power in a work of this class only bears a very small proportion to the other cost of production. It must, however, be evident that if the advantages gained under the other heads are such as to result in substantial increase of output and diminished cost of production, they are of much greater importance than the saving in cost of power. The saving to be effected in the cost of power may be considered under two heads: (1) The saving in power production; and (2) the saving in distribution. By the adoption of a central power plant with boilers and engines grouped together upon a suitable site, it is possible to use with advantage all appliances for getting cheap power, and thereby effect considerable reduction in the amount of steam used per horse-power generated. This saving is placed by several authorities, who have investigated the subject, at from 30 to 50 per cent. In order to appreciate the saving under the head of distribution, it is necessary to consider the circumstances in each case. Under the old system of driving, this loss consists of evaporation from steam pipes, losses in main shafts, belting, bevel gearings, &c.; and it is evident that these losses are practically constant at all loads, and bear a very much higher proportion to the total power when only partial load is on the plant. In the case of the electrical system the distribution by means of wires or cables takes the place of the steam pipes, main shafts, main belts, bevel gearing, leaving in most cases only short lengths of straight shafts. The losses in the wires are such that they fall off in greater proportion than the load falls off, and therefore bear a more or less constant proportion to the power being used. The saving to be effected by this means at full load will probably not exceed 5 or 10 per cent., but at all other times, when the load is other than the maximum, the saving will be much greater.

2. Under the second head of the advantages of this system of power—*i.e.*, flexibility—little need be said further than indicating the possibilities. The use of separate motors for large tools, or for small groups of tools, enables these to be placed in the most suitable positions for convenient handling of the materials, irrespective of the position or direction of line shafts, &c. The advantages to be got by the extended use of portable tools, more especially in heavy work, is very great, the time and labour of shifting and setting the tools in many instances being very much less than if the heavy castings have themselves to be shifted frequently. The flexibility of the system is also of great advantage in the extension of works.

3. It is more difficult to appreciate the advantage of increased output, and it is by no means easy to demonstrate it, but there has been, on various occasions when the subject has been discussed, considerable testimony by those who have adopted the system, that not only a very substantial increase of output is obtained, but also at a very considerable reduction of cost for labour. Among other causes for this improvement we have already seen the advantage of being able to place tools in the most convenient situations, and the possible large use of portable and semi-portable tools, several of which may be at work on the same piece of machinery simultaneously. The absence of a considerable amount of belting and shafting also admits of more extended and free use of overhead cranes, and such cranes are more speedily operated themselves by electric power. A further advantage is obtained from the fact that individual machines can more easily be driven at their most economical speed by electric driving.

*Shipyards.*—It is evident that all the advantages claimed in the case of engine works are greatly enhanced when the workings of shipyards is considered. The same principles may be applied as in the other case, and it is unnecessary to consider them more in detail; but the advantages to be obtained by the flexibility of the system reach their maximum in a shipyard as compared with any other industry. The tools themselves are, as a rule, of a heavy class, which can most conveniently and economically be driven by independent motors, and may thus be disposed in such positions as to reduce to a minimum the handling of the raw material. With the increasing size of ships, and corresponding increase of weights of the component parts, this is of the greatest importance. Further advantages may be obtained in a shipyard by the facility with which electricity may be applied to all forms of gantries, cranes, or other lifting appliances used in the erection of ships. Portable tools may be applied on board the ships during construction, and temporary workshops with semi-portable tools fitted up on board.

*Equipment.*—Here, also, it is only possible to deal with general principles. Broadly speaking, there are two systems which may be adopted—viz., the continuous-current system, and the multiphase alternating current system. As regards the actual driving, either system is suitable for the shipbuilding industry, and each system has advantages peculiarly its own. The outstanding advantage in favour of the continuous current is the fact that motors of this class can more easily be adapted to run at varying speeds. On the other hand, there are several advantages with multiphase current for work of this class. The starting arrangements are very simple, especially with small motors; the moving parts are of strong mechanical construction, and less liable to damage by overloading; and there are no brushes and commutators requiring attention. There is very little between the systems as regards cost and efficiency.

The question as to whether single motors on each machine tool or group driving by means of short shafts should be adopted is of the greatest importance as regards economy in working. In the class of works under consideration there is, as a rule, not much difficulty in arriving at a decision. Unless in the case of special portable tools, it is not economical to employ motors of less than 5 H.P. Below this size the cost of motors per horse power increases very rapidly and their efficiency decreases very rapidly, and, in addition, where machines are worked intermittently and at varying powers, it is possible by suitable grouping to arrange a motor of, say, 10 or 20 H.P. upon a shaft to drive machines which, if supplied by separate motors, would require an aggregate of more than double that power. Single motors may be employed in the shipyard to greater advantage, but the tools in this case are of such a class that in very few cases will smaller motors than 5 H.P. be required. It is impossible to consider the question of cost of installation in a general way, as it will vary in every case according to circumstances. In conclusion, it may be confidently asserted that in the case of starting new engine shops and shipyards, it is undoubtedly the best policy to adopt electrical power, and that in most cases it will pay to make the change in existing works.

In the brief discussion on this Paper Mr. Napier, of Glasgow, and Mr. de Russett spoke on the advantages of electric power and on the importance of a supply of cheap electric power for such purposes.

We may mention that in the Iron and Steel Section, presided over by Mr. William Whitwell, Mr. Arthur Wingham read a Paper on "Internal Strains in Iron and their Bearing upon Fracture." Space does not allow of our abstracting this Paper, but we refer to it in case our readers may be interested in the subject. In the Gas Section Dr. Leybold, of Hamburg, read a Paper on "Electrolysis of Gas Pipes, &c."

### THURSDAY, SEPEMBER 5TH.

In the electrical section three Papers were down for reading. The first of these was by Mr. M. B. Field on "The Relative Advantages of the Three, Two, and Single-Phase Systems for Feeding Low-Tension Networks." The tabular and illustrated matter in this Paper does not well admit of being abstracted, and we hope to reprint the Paper in full. Briefly, however, we may say that the Paper advocates the use of three-phase currents for feeding low-tension networks in all cases except purely for electric lighting. With mixed systems—*i.e.*, those for both lighting and power, Mr. Field inclines towards the use of a three-phase network with the motors on all three circuits, the lamps being placed on only one circuit. In this system regulation can be effected by controlling the pressure on the lamp section alone, the motors tending to equilibriate the system as a whole.

The discussion opened by Mr. Gisbert Kapp and Mr. Eborall stating that they would send in their remarks in writing to the secretary. Herr Kolben was the first speaker. He regarded

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the Paper as being perfectly correct in its relations to practice, and commented on the fulness of the data, especially as regards cables. He considered three-phase working to be the final goal towards which all electrical engineering was rapidly tending. It is difficult to reconcile with this his opinion that the three-phase system is not adapted to the Metropolitan Underground Railway, but it is probable that he looks for the development of a suitable three-phase motor in the future. He stated that with the three-phase system regulation losses on this line would be very large, owing to the frequent stops and starts; the three-phase system, in fact, was, in his opinion, only adapted to lines on which trains ran at a steady speed over a considerable distance. Referring to mixed systems, he said that 30 per cent. difference of load between the several phases made very little difference as regards regulation, a fact which stood in favour of this method of working. Prof. Carhart, continuing the discussion, stated that three-phase working was becoming very general in the United States, and that no large new plants were being erected on the single-phase or two-phase systems. As regards frequency, a low figure was not found objectionable, even 25 pulsations producing, he said, no bad result in the electric lighting. Open arcs were everywhere disappearing in the United States, they were being replaced by enclosed arcs worked in parallel. Mr. W. B. Esson explained that the three-phase system with a neutral conductor does for alternating currents exactly what Hopkinson's three-wire system did for continuous currents. It might be thought that the three-wire, single-phase system would, therefore, be equally as good, but in practice no advantage would thereby be obtained, while, on the other hand, many advantages arising from the difference of phases would be lost. He predicted that there would be no more large single-phase stations built in the United Kingdom. Dr. Silvanus P. Thompson objected to Mr. Esson's wish that our ideas as regards the three-phase system should become crystallised. He considered there was room for several systems, even for the two-phase system. For instance, in changing over from single phase to polyphase working it was often advantageous to use the two-phase system, building up the circuits on the single-phase first and then transferring to the two-phase when all the circuit arrangements were completed. As regards single phase working, he reminded the audience that Mr. Ferranti was still the apostle of single-phase working, and had never, even in face of all the modern developments of large three-phase plants, changed his opinion that we shall all in the end have to get back to single-phase machinery for every branch of electrical engineering.

The next two Papers dealt practically with the same subject of dynamo design, and were discussed conjointly. The first of these, by Mr. H. M. Hobart, was on—

### "Modern Commutating Dynamo Machinery, with Special Reference to the Commutation Limits."

**Abstract:**

In the design of the continuous-current dynamo, in spite of the lapse of many years since the introduction of such machinery, there is not that progress observable which has characterised electrical engineering in general. There is certainly still very great opportunity for improvement, and much may be done without any radical innovations merely by making more general use of the technical knowledge of the subject at present at our disposal. One persistent error has been the, perhaps, natural assumption that the kilowatts output should be given predominating consideration in laying down the lines of the design, and that the required voltage and amperage are of altogether minor importance. This has led to the frequent use of very inappropriate designs, particularly with relation to the commutator, the armature winding and the number of poles and general construction of the magnetic circuit. Machines of different voltages, but for the same kilowatts output, have, however, one set of features in common—namely, all those features relating to the amount of mechanical power to be transformed into electrical, or vice versa; in other words, the *mechanical* design in general. The Paper goes on to describe a group of machines designed with due regard not only to these features of mechanical similarity, but also to the points where the designs should diverge in order to suitably comply with the requirements of the different voltage and current ratings. In these machines, which are described in considerable detail, the base, stands, bearings, and shaft are the same for all voltages, but while in the low-voltage design the electromagnetic part of the machine is extremely narrow and the commutator wide, the high-voltage machine has precisely the opposite characteristics. Since, however, the diameter of commutator, armature, field bore and magnetic yoke are the same for all voltages, it is quite practicable to use to a great extent the same drawings and patterns for all voltages, the patterns being extended or not according as castings for machines of the one or the other voltage are required. It is shown how naturally all this works out, and the opinion is put forth that by the use of these principles the best results for a given outlay may be obtained. For the group of machines described, which range from 80kw. at 580 revs. per min. to 150kw. at 425 revs. per min., the cost for "net effective material" was quite uniformly 16·3s. per kilowatt for all voltages. The guarantee to which they were designed is given as follows:—25 per cent. overload for one half-hour without harmful sparking or heating. Thermometrically measured temperature increase of warmest part not to exceed 50°C. above surrounding atmosphere during continuous operation at rated load. No harmful sparking or heating with momentary overloads of 50 per cent. Fixed brush position for all these conditions. Insulation of entire machine, from copper circuits to iron, to withstand for one minute at 20°C. the application of the following R.M.S. voltages:—

| Rated voltage. | Test voltage. |
|---|---|
| 115 | 2,500 |
| 230 | 3,000 |
| 550 | 3,500 |

Incidentally the assertion is made that low reactance voltage greatly outweighs in importance low armature strength so far as relates to excellence in commutation, and high commutator peripheral speeds are advocated on account of the very great improvement in commutating constants thereby rendered practicable. Careful attention to all these different considerations still permits of a fair degree of interchangeability and uniformity in the designs for different voltages of the same kilowatts output.

The Paper treats in considerable detail of the author's* method of estimating the reactance voltage. The following principles underlie this method:—Experiments on various arrangments of armature slots of a wide range of shapes and sizes, with variously proportioned coils arranged in many ways with respect to these slots, have shown that the number of C.G.S. lines of magnetic flux set up per ampere-turn of these coils may, as an average, be taken at

4·0 lines per centimetre of "embedded" length.
0·8 „ „ "free" „

The tests made showed a very much smaller range of variation in these values for different proportions than has generally been considered to be the case; hence, while in abnormal cases modified values should be taken, one may, nevertheless, in the great majority of designs, make an amply sufficient approximation to the reactance voltage by the use of these average values. In the course of the description of this method, the following rather interesting conclusion is pointed out:—

The inductance of a coil laid upon the surface of the armature—*i.e.*, on the lines formerly so frequently employed, and sometimes, nowadays, termed "smooth core" construction—is, with customary proportions, rarely much less than one-third, and often one-half or more as great as in the case of the same coil laid in slots.

This conclusion follows from the experimental result that with ordinary open slots, with parallel sides, of the proportions generally found in modern continuous-current generators, the inductance per centimetre of "embedded" length is generally only some four to six times greater than the inductance per centimetre of "free" length, and with the dimensions of face conductors and end connections nowadays generally used, the inductance of the "free" length is a very considerable percentage, say 25 to 40 per cent. of the total inductance of coil.

After illustrating these methods and principles by data of a number of designs of machines of all sizes, the Paper takes up the consideration of the case of large high-speed commutating machines, and it is stated that, by the employment of high armature reaction (as expressed in armature ampere turns per pole-piece), and high commutator peripheral speeds, even 600 volt machines of large capacity may be designed with excellent commutating properties for high speeds.

The Paper closes with mention of the large number of ratings required to meet all the present commercial requirements for a line of small motors, and expresses the opinion that it is false economy not to admit at the outset the magnitude of the undertaking of manufacturing such a complete line.

The companion Paper, of which we give an abstract below, was read by Mr. H. A Mavor, on—

### "Design of Continuous-Current Dynamos."

The present methods of designing dynamos and recording results do not readily lend themselves to comparison of machines of different outputs. It would, therefore, be of advantage if a suitable unit of comparison could be devised, and it is suggested that a consideration of the continuous-current dynamo, leaving out of account all the non-essential elements of design and construction, and concentrating attention upon the vital portion of the machine which alone is concerned in the direct generation of energy, would lead to a suitable basis of comparison. It is, therefore,

* This method of estimating the reactance voltage is based upon substantially the same principles as the method published two years ago by Mr. H. F. Parshall and the present writer. The novelty in the method, as then described by them, consisted chiefly in starting from the basis of representative values for the inductance, as expressed in terms of the lines set up per ampere turn per unit of length of laminations, and it led to substantially the same results as one obtains by the method in its present form. As now set forth, it allocates the components of the inductance in the "free" and "embedded" lengths respectively, giving guiding values for estimating these components, and supporting them by fairly thorough tests and by experience gained in applying the method to a great variety of machines, so that now, it is believed, the method may be employed still more effectively.

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proposed to consider as a whole the region occupied by the armature conductors in the magnetic field. This region may be named the "active belt" of the armature. It is bounded by the peripheral surface of the armature, the surface of the core at the bottom of the slots and the ends of the core. An examination of the machine in the terms of the energy generated in this "active belt" leads to the interesting result that machines of very widely varying size, output and speed, give a remarkably constant value in watts generated per cubic centimetre at unit velocity in unit field. This constant may be expressed in symbols thus :—

$$K = W/\pi dls \times \pi dn \times F. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The value of the constant K must be a compromise between economy in first cost and efficiency of radiation of lost watts. The maximum value gives zero electrical efficiency; the maximum possible output of the machine is at half this value.

A reduction of value of the constant leads to increased quantity of material, increased cost of construction, and increased electrical efficiency. A consideration of the dynamo from this point of view suggests increase in the depth of the "active belt," reduction in the watts generated per cubic centimetre, and reduction in the depth of the core so as to minimise hysteresis and eddy current losses in the core, with consequent increase in diameter and multiplication of the number of poles. A comparison between the results obtained by different designers of the proper value of this constant should be of immediate interest. It will be noted that this consideration includes the radiation of all lost energy from the surface of the armature, the value being the total watts generated by the machine.

The total E.M.F. of the machine in volts is given by

$$E = 2\pi dlFGmn/p \times 10^8. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The reactance voltage of any machine considered on the lines of Messrs Parshall and Hobart's book on "Electric Generators" may be ascertained by a very simple calculation. Assuming a sine wave form for the fluctuations in the current under commutation, the value of the reactance voltage is given by the formula

$$r = \frac{2\pi \frac{G}{b} nflbm^2C}{p \times 10^8}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and from 2 and 3

$$r = EC fm/dF. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The value of the field $f$ due to the current under commutation is probably not so constant as indicated in the work above referred to, but any desired correction may be made on this factor by introducing the relation between the depth and width of the slot or any elements which the designer may consider it necessary to introduce. The value of F, the average field, per unit surface of the core being practically constant, the reactance voltage of any machine can be ascertained practically by inspection. This formula (4) indicates that the reactance voltage is not subject to much modification for any given output.

The average E.M.F. generated in $m$ turns of the winding

$$e = 2mlF\pi dn/10^8. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

In lap-wound armatures $e$ equals difference of potential between adjacent sections of the commutator.

In wave-wound armatures the difference of potential between adjacent sections of the commutator equals

$$e \times \text{Poles}/2.$$

From these formulæ are derived

$$\frac{GmC}{p} = \frac{K \times \pi ds \times 10^8}{2} = \text{Ampere turns in the armature.} \quad \text{(From 1 and 2).} \quad (6)$$

$$\frac{e}{r} = \frac{dF \times p}{f \times GmC}. \quad \text{(From 3 and 5).} \quad . \quad . \quad (7)$$

$$\frac{e}{r} = \frac{2F}{K\pi fs10^8}. \quad \text{(From 1, 4 and 5).} \quad . \quad (8)$$

$$\frac{e}{r} = \frac{2\pi F^2}{60f10^8} \times \frac{d^2R}{W}. \quad \text{(From 1 and 8).} \quad . \quad . \quad (9)$$

Curves are plotted of 7, 8 and 9, showing the relation of ampere turns on armature, slot depth and armature dimensions, to the reactance voltage and E.M.F. between commutator segments.

Turning now to the consideration of cost, it is found that in the case of many groups of machines there is no regular ratio between the cost and the output. There ought to be such a regular relation, and the following method is suggested for obtaining this result :—Plotting watts per revolution as abscisse and costs as ordinates, the position of each machine is marked, and the points representing cost and output for each carcase of a given diameter with varying length are joined by a straight line which is produced to the origin. The point where this line cuts the zero ordinate gives the limit of cost to which this carcase approaches as the core length is reduced to zero, and may be called the base cost of any given carcase; the slope of the line drawn through the costs of the machine at different lengths show the cost per inch length of "active belt" on that carcase. Increase in diameter increases the base cost and reduces the slope of the line passing through the costs of the actual machines, so that, starting from the smallest diameter and passing to the largest, will give a succession of straight lines, each touching its next lower neighbour at one point, and producing a curve made up of segments of the lines representing each machine, each segment showing the economical range of length for the machine which it represents.

*Symbols used in this Paper.*—A = Length of air space. $b$ = The maximum number of sections of commutator covered by the brush. C = Total armature current in amperes. $d$ = Diameter of core measured to the middle of the active belt in centimetres. $e$ = Average E.M.F. generated in $m$ turns of the winding in volts. E = Total E.M.F. generated by armature in volts. $f$ = Induction field in C.G.S. lines per centimetre length of slot, due to one complete turn. F = Average flux taken over the whole surface of the armature, in C.G.S. lines per centimetre. G = Number of sections in the commutator. K = Ergs per second generated per cubic centimetre of active belt at unit velocity in unit field $\times 10^7$, called energy factor. $l$ = Net length of armatare core in centimetres. $m$ = Armature turns per commutator section. $n$ = Revolutions of armature per second. P = Number of poles in magnets. $p$ = Number of paths through armature. $r$ = Reactance voltage. $s$ = Depth of slot in centimetres. R = $60n$ = revolutions per minute. W = EC = Total watts generated by active belt.

Opening the joint discussion, Mr. H. A. Mavor expressed the opinion that Mr. Hobart's Paper required the introduction of his (Mr. Mavor's) "energy factor," in order to make it complete and practical. He thought that no one could design a good dynamo merely from the information in Mr. Hobart's Paper. The chief detail requiring improvement in modern dynamos was the commutator. Mr. Kapp, the next speaker, said that continuous current might be old fashioned, but it was not obsolete. There still remained a great deal of useful work that might be done by means of continuous currents. With regard to the question of deep versus flat slots, he said we must judge every case on its own merits. For certain purposes deep slots were preferable to shallow slots. As regards the power of a dynamo in terms of its size, he had been in the habit of using the following formula

$$P = c\left(\frac{D}{100}\right)^2 \frac{LU}{100};$$

where

P = power in kilowatts,
$c$ = a coefficient varying from 0·6 to 2·6 according to the design of the machine,
D = the diameter of the armature in metres,
L = length of armature in metres, and
U = revolutions per minute.

Dr. Silvanus P. Thompson, discussing the term "energy factor," invented by Mr. Mavor, explained that it really was the number of amperes per square centimetre of what Mr. Mavor defines as the "active belt." With regard to Mr. Kapp's formula, he reminded the audience that Mr. Steinmetz had devised an even simpler formula for the same purpose, viz.,

$$P = \frac{d \times l}{s};$$

where

$d$ = diameter of armature in inches,
$l$ = length of armature in inches, and
$s$ = a constant varying from 2 to 4 according to the design of the machine.

With regard to Mr. Hobart's Paper, Dr. Thompson observed that we require more information in order to assimilate what Mr. Hobart has already given. Several quantities had been omitted which were necessary in order to test Mr. Hobart's theory. An essential feature of this theory was what Mr. Hobart, in conjunction with Mr. H. F. Parshall, had termed the "reactance voltage." Dr. Thompson thought that this quantity was not really the crucial quantity to be considered in connection with satisfactory commutation. No one had experimentally investigated what goes on in the moment of commutation. The current had to change from a positive to an equal negative value, and it could not possibly do this instantaneously. We were completely ignorant of the curve representing the changes going on while the reversal occured. Mr. Hobart had assumed that the connecting curve was a sine curve smoothly joining the two steady currents before and after commutation. Dr. Thompson denied that this took place. In his opinion the real determining factor in commutation was the width and resistance of the brush in contact with the commutator strip. Mr. W. A. Chamen spoke of the possibility of running dynamos of large power at high speeds, and described briefly the 2,400 H.P. Willans engine at Port Dundas. With regard to commutating large dynamos, he considered that the difficulties were mechanical and not electrical. Mr. W. B. Sayers made a few remarks on standardisation of plant. He also quaintly observed that in commutation the current "does not know where it has to get to"; in other words, although the current starts from a definite value there is nothing to guide it definitely to an exact reversed value.

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Col. R. E. Crompton said that, from experiments he had carried out, he could support Mr. Mavor's theory as a practical theory. He agreed with Mr. Chamen that the difficulties of commutating large dynamos were principally mechanical, but he said that the use of the wheel press had greatly removed many of these difficulties.

In bringing the proceedings of the Electrical Section of the Congress to a close Mr. Langdon proposed the following two resolutions, which were carried by acclamation :—

1. "That the cordial thanks of the members of Section IX. of the International Engineering Congress be given to Dr. Caird and the committee of the Congress, and to Mr. Cormack, the general secretary, for the admirable arrangements made by them for the comfort and convenience of the members."

2. "That the best thanks of the Institution of Electrical Engineers be given to the University of Glasgow and to Prof. Gray for their kind permission to use the rooms of the natural philosophy theatre of the University for the present Extraordinary General Meeting of the Institution."

Only one Paper of direct electrical interest was read in any of the other sections on Thursday—viz., Mr. James More's Paper, in the Municipal Section, on

"Recent Tramway Practice."

The following is an abstract of this Paper:

In dealing with this subject, one has some difficulty in deciding what the term "recent" may mean. It may mean recent as compared with practice 20 years ago, which period covers many different systems of traction; or it may mean recent as compared with five years ago, which practically means electric traction, with a small amount of cable traction. Electric traction in this country can hardly be considered of much practical value any longer back than five years, but it has greatly developed and matured in that time. The writer will, therefore, confine himself to a review of this method of traction, with a brief observation on the few cable lines in this country. Regarding the permanent way, however, it is worth considering over a longer period, as it applies to all methods of traction in principle, only differing in degree as to stability under the different methods.

*Rails.*—During the last 20 years there has been a considerable change in the section, chemical composition, and physical qualities of these. Until about 1885 there were many built-up systems used. Some of these were fairly successful with the light cars used for horse traction, but failed completely when steam locomotives were used. About 1880 light sections of girder rails were used to some extent, about 58lb. to the yard.

*Girder Rail.*—In 1883 the girder rail was generally adopted, to the exclusion of most others, and the weight was increased to from 80lb. to 100lb. per yard. The fishplates, however, were, as a rule, much too light. The usual standard lengths of rails at that time were 24ft. At the present time 45ft. may be called the standard, although some have been rolled 60ft. long. The sections have also much improved.

*Steel.*—Ten years ago the common percentage of carbon was 0·35. At the present time the steel used for tramway rails contains from 0·55 to 0·65 per cent. of carbon.

*Fishplates.*—There has been great improvement in fishplates and in joints generally. There are also numerous different designs of soleplates, &c., all meant to minimise the pounding at the rail joint when the cars pass over.

*Points and Crossings.*—There has not been any important improvement in these excepting that at the present time the cast steel is somewhat harder by the addition of manganese. This was first adopted by Mr. R. A. Hadfield, M.Inst.C.E., of Sheffield. Chilled iron points and crossings are becoming rarer every day for tramway purposes, but the writer thinks this is only due to the makers not making their patterns to suit the heavy electric cars.

*Electric Traction.*—As regards the electric traction of the present day, the writer thinks it is unnecessary to discuss any other than the overhead system, as this is the only system that has shown good financial results. The conduit system may become a financial success, but it is doubtful. The heavy initial cost is almost prohibitive, being more than that of the cable system. At the present day we may take it that the 500 volts continuous current is the standard. Recently, however, there has been high potential alternating current tried on the Continent, with alternating motors on the cars. It cannot be said, however, that this has yet proved to be a success.

*Power House.*—In the modern power house there are several kinds of different boilers adopted, some of the tubular marine type, and others of the water-tube type, such as the Stirling and Babcock and Wilcox boilers. These latter are specially useful where space is restricted, and where a lighting circuit is used in the same station as the traction circuit. There are, however, numerous engineers who will, if it is at all possible adopt the old-fashioned Lancashire boiler with Galloway tubes. The writer is among that number. Of course, it is advisable in all installations to use an economiser, so as to raise the temperature of the feed water. These or exhaust steam heaters are generally adopted now, and effect a very substantial economy. The type and speed of the engine vary to a great extent, but the practice is almost invariable to have direct-driven generators—that is, to have the generators fixed on the crank shaft of the engine.

*Feeders.*—The feeder insulation adopted is generally paper or bituminous insulation. Sometimes they are laid in ducts or conduits, and threaded after the conduits are completed. In other cases they are laid in iron troughs and run in with solid bitumen. Both methods have their advantages, which, however, are dependent on various circumstances.

*Trolley Wires.*—The trolley wires are usually divided by section insulators into half-mile sections, any half-mile of which can, therefore, be cut out at the section boxes, which are placed in pillars on the footpath or underground pits.

*Wiring.*—As to the wiring, there are several methods of doing this. Where the road is very wide there is no doubt the central pole with short arms is the correct thing. There are cases, however, where roads are too narrow for this, and two wide for the side-pole system. In this case, sometimes there are span wires fixed by rosettes to buildings on each side of the street, and in others there are poles put up with a span wire between. Then there is the side-trolley system, where in no case the trolley wire is over the centre of the track. This is advisable where it is practicable, as there is less danger of accident to the trolley pole.

*Poles.*—The poles are made of steel tubing, tapered in some cases, and in other cases made to three different diameters shruk one on another. The latter are somewhat cheaper, but there is no doubt that the tapered pole has a better appearance.

*Cars.*—As to the cars, there is no doubt that the bogie car with the maximum traction truck is easier on itself and on the road, and more suitable for fast running. The four-wheeled car, however, is more generally used, as it has been found that the smaller cars with a fast service pay better than large cars with a slow service.

*Motors.*—It is usual only to have two motors either on a bogie or a four-wheeled car, but in many cases, where the district is hilly and the bogie type is adopted, it is advisable to have a motor on each axle—that is, four motors in all.

In the working of tramways, the modern, up-to-date manager fully realises that an essential factor to good financial results is to get the highest mileage per day out of his cars, of course with due time being allowed for dropping and picking up passengers. There are towns in this country where, in the writer's opinion, pick-up passengers are sacrificed for the sake of high mileage, and numerous accidents are caused which might be avoided. To facilitate this high mileage, it is becoming customary to fix stopping places at different parts of the route, and there is no doubt that this has tended towards the increasing of the mileage of the cars, but in the writer's opinion it is at the expense of the receipts in so far as pick-up passengers are concerned, especially where ½d. fares are charged for short distances.

The discussion was principally occupied with questions of track rail and road-bed construction. Several speakers advocated the centre groove rail, and Mr. Brodie, the city engineer of Liverpool, stated that although he was in favour of this type of rail he had recommended the adoption of the side tread rail at Liverpool in order to conform to current practice. Some remarks were made by one or two speakers on the advantages of bituminous grouting over concrete for wood-paved track.

Among other Papers read in other sections on Thursday we may mention Mr. Greenwood's Paper on "The Metric System," which advocated the abolition of the British system of weights and measures in engineering. In the same section Mr. J. H. Wicksteed read a useful Paper descriptive of the "100-ton Universal Testing Machine with Variable Accumulator at the James Watt Laboratories, Glasgow University."

## A COMPARISON OF AMERICAN AND BRITISH METHODS.

(BY OUR OWN CORRESPONDENT.)

The Congress of the American Institute of Electrical Engineers, held in New York last month, was highly successful. The Institute had invited electrical engineers from all countries to attend, and it is a matter for regret that, owing to the prearranged visit to Germany and the Glasgow Congress, official delegates were not sent by this country, as the friendly feeling existing between the two countries' engineers would, no doubt, have been materially increased. While France sent an official deputation, there were only seven Englishmen present; and, as there were not many visitors from other European countries either, the meeting was hardly as international as it might have been. The hospitality and kindness of the American Institute to its guests, however, was beyond all praise, the greatest possible courtesy being shown in the arrangements both on the trips of inspection and on the more social gatherings.

The trip included a visit to the principal existing supply stations in New York and the two new power houses in course

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of erection, to the Crocker-Wheeler works at Ampere, the New York Telephone Co.'s exchange at 18th Street and Irving-place, to the General Electric Works at Schenectady, the power stations at the Niagara Falls and their distributing stations, and the Electrical Exhibition at the Pan-American Exhibition, making a most interesting and also instructive tour.

The following notes on American electrical engineering practice, as seen from an English point of view, have suggested themselves to the writer. When comparing the state of electrical engineering in England and the United States, it is necessary to look at the causes of difference in the practice of the two countries. Probably the most important is the difference in the governmental regulations. In America, engineers have been given a practically free hand, and an indiscriminate advance has taken place, although without doubt a great deal of slipshod work has been done. As this has not been allowed in England the advance, though slower, is perhaps in some cases on firmer lines. Secondly, the relation between labour and fuel, which has necessitated extreme attention being paid to labour-saving machinery in the States, has in this country rather caused the absolute efficiency of the plant to be the first consideration. Again, England has a free trade, and thereby the advantage of being able to buy all that is best abroad, while the heavy import duties of foreign countries have prohibited the purchase of our best ideas by our competitors.

Great outcry is often made that English methods and advance have been hampered by the governmental methods of our country, but the question whether such guiding is good on the whole, or in part, is certainly not without supporting arguments. While, on the one hand, it is due to this influence that there are not in England to-day schemes of such magnitude as there are to be seen in the United States already at work or in course of construction, it is also true that but for the fatherly interest displayed by our legislature, the schemes in England would not have reached the state of finish and safety that they can to-day boast of.

Making more special comparison between the New York and London electricity supply stations, there are many noteworthy divergences of method. Coal in New York can be obtained at the wharves small, but very clean and free from dust, at from 4s. to 6s. per ton, whereas labour has to be paid for at nearly double the rate current in London, the result being that the absolute efficiency of the power obtained from the coal is not such an important question as making the whole station automatic. The higher speed engines in use in our modern practice are not to be seen, and though as high a steam pressure as 200lb. to the square inch is in use, compound engines only are adopted, making the machinery appear very large for the power generated, while saving the greater complexity. The beautiful systems of control and labour-saving schemes are perhaps the greatest advance to be seen in the United States: the arrangement of pneumatic and motor control for switches, so that the whole huge system of high-tension machinery can be regulated by one man without moving is an object lesson in labour economy. Even the governors of the engines themselves are controlled by a motor actuated from the switchboard in large plants, where the saving of work for the engine driver soon pays for the extra installation. It may be open to question, on the other hand, how far it is wise to make such a station controlled by a staff so small in comparison to the plant, as the failure of one man can then bring with it most serious consequences, and the breaking of one link in the mechanism may entirely upset the satisfactory working of the whole station. Of course, the problem of coal handling has been dealt with very fully in England, yet the most efficient classes of coal, when freight has been paid to London, do not favour a state of affairs where the fuel is absolutely not touched except by machinery, so that the difference in practice in the two countries is really only one of divergent conditions rather than engineering skill. In connection with the fuel question, it is of interest that the combined generating station and refuse destructor does not yet appear to have been tried, although the question of the disposal of refuse is no less a difficulty than on our side of the Atlantic. No doubt this is due to the extra cost of labour necessitated by the greater amount of handling of this class of fuel.

The problem of continuous *versus* alternating supply seems no nearer solution than last year when such diverse opinions were expressed at Paris. If there is a tendency at all in America it is perhaps to transmit power universally with three-phase current, stepping down with stationary transformers and the converting to continuous current with rotatories. The present English practice in the matter of lamp voltage has not been followed at all, the standard lamp pressure being about 110. This appears rather curious as, of course, it necessitates a multiplication of sub-stations; and no apparent reason is given other than the human dislike of change. It is somewhat curious to find conservatism on such a subject in the United States. Perhaps it would be scarcely fair to criticise the methods used in distribution, as they are due no doubt to the vastly rapid strides in demand, yet we have something to be thankful for in that the paternal Government would not tolerate such curious arrangements as a host of telephone wires, high-tension feeders, a couple of transformers and tramway trolley wires all supported on the top of one wooden pole. One may also see wires which carry high-tension current, lying indiscriminately on the cross bars, having dropped off their insulators. It is scarcely wonderful with this and kindred conditions, that the supply of electricity is none too certain, and that, for example, twice in one week the supply was stopped from the Niagara power station, once for so long as two hours (and that, by utter contrariness, on "Electrical Day"), due to line faults. A better state of affairs is, of course, found in New York City, although even there the Board of Trade would not always be quite happy.

Reviewing the whole situation, it is open to doubt whether, on the whole, English engineers need consider themselves behind their American confrères. Where the American gains in unrestricted advance the Englishman possibly has an advantage in thoroughness of work, which may eventually give him the lead; and, as has already been pointed out, whereas most other countries rigidly refuse any machinery but their own, in our modern plant may be seen the best from all nations. The British manufacturer has thus the opportunity of selecting all that is good in foreign machines, and adding all the knowledge gained in these islands, so that we should be able to turn out a class of machinery which can be excelled by none.

The laws governing the direction of advance are the same, and no less observable, in the factory than the power house. The often-quoted advance in labour-saving machines is clearly due to the high wages, as in some cases the capital cost would more than balance the saving of labour at the scale paid in England. The movable tools enabling four or five shaping and drilling machines to work on one casting at the same time are, perhaps, in more general use than elsewhere, although, of course, the method is employed to some extent in England, and more on the Continent. The forming machines for the armature windings are also rather superior to anything that was in England till quite recently—possibly even they are still ahead. A feature of great interest at the General Electric Co.'s Works at Schenectady was the motor-driven 10,000 volt oil switch, giving a remarkably quick and accurate break.

Traction, in practice, is scarcely in such a superior state as one would have expected. In New York, for example, although there is a great deal of slotted conduit line, it is curious to note that virtually the same system is at work as that laid down at Blackpool some 15 years ago, and which only failed owing to the extraordinary conditions of tide and sand. The control, of course, is up to date, but the track is nearly identical. Whether it is a case of good intentions being the paving stones of New York with the highway authorities, or only another example of the extraordinary mixture of up-to-dateness with primeval simplicity it would be hard to decide, but certainly the road surrounding the track, and often the track itself, in the heart of New York City is in such a marvellous state of disrepair that it is a source of constant wonderment that the accident wards are ever with a vacant bed. In fact, although our tramway equipments are largely based on American prac-

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tice, it would be difficult to find a better system of tramwork in the States than can be shown in many English towns. A great deal of inter-urban tramway work has been done, especially in Western America; but the progressive spirit has in many cases outstepped caution, and, though the power is supplied by water, often the schemes have proved by no means financially sound, and would not have appealed to the British investor.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Electro-chemical Microscopy.*—R. Kohn suggests a new method of research, specially applicable to plant physiology. It consists in producing gold deposits under the microscope by means of the electrolysis of a thin superficial layer of gold chloride. He proves that all vegetable cells show P.D.s which regularly appear in the course of the cellular activity. All plants are pervaded by a connected system of electric conductors whose conductivity is many times higher than the conductivity of their insulating surroundings. These conductors are identical with Schimper's *Leitscheiden*. It is not clear whether they should be classed as metallic or as electrolytic conductors, but the greatest probability speaks for the latter. The solution of starch at the top cells and its deposition in an insoluble form at the root is equivalent to an electrolytic transmission, a kind of telegraphic transmission of carbo-hydrates. The chief conductor lies to the right and left of the mid-rib of the leaf, and is two cells deep.

[R. Kohn, Pamphlet, Mercy, Prag, 1901.]

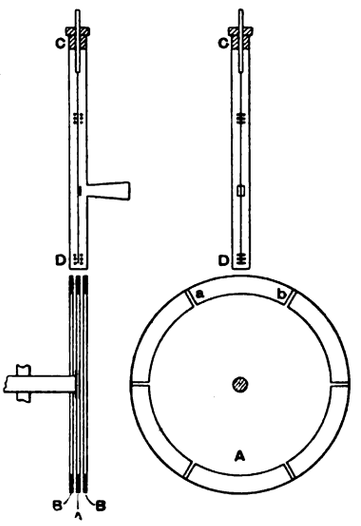
*Vibrations of Incandescent Lamp Filaments.*—The filament of an incandescent lamp is thrown into rapid vibrations in the cold state by the slightest disturbance. If it is held to the ear, a metallic note is heard, which appears to consist of several notes not harmonically related. When the lamp is burning the oscillations rapidly die away. This is not due to a loss of elasticity, since the pitch of the note heard remains the same; but there is probably a magnetic damping effect. The incandescent filament may be kept in a state of vibration by the simple device of bringing a magnet into its neighbourhood, provided that either the lamp or the magnet are fed by an alternating current. The vibrations are not like those of Baun's cathode beam, strictly in unison with the current curve, but are practically sinusoidal. If two incandescent filaments are so arranged that their vibrations are normal to each other, the point of intersection, which appears black, describes Lissajou's figures. If the two lamps are in parallel, the figure is a straight line. The vibration of the filament may, by a suitable arrangement of diaphragms, be used for producing intermittent illumination and for determining the periodicity of an alternating current by illuminating a rotating sector.

[R. Kempff-Hartmann, *Physikal. Zeitschr.*, August 24, 1901.]

*Selenium Experiments.*—J. W. Giltay describes some instructive experiments for demonstrating and studying the photo-electric properties of selenium. In the first of these a selenium cell of Shelford Bidwell's pattern is mounted in a drum resembling a fluoroscope, and the intermittent illumination produces a tone of corresponding pitch in a telephone put in circuit with the selenium cell. In another experiment the lid is removed from an ordinary Siemens telephone, and a monometric box substituted for it. The telephone is joined with a small induction coil and a microphone in the usual manner. On speaking into the microphone, the monometric flame, which is an acetylene flame, is thrown into corresponding vibrations which, acting upon the selenium cell, produce changes of resistance, and these are re-converted into sound by a telephone inserted in a circuit containing the selenium cell. The third experiment is even more interesting. The selenium cell is enclosed in a box with three small incandescent lamps connected in series, and inserted in the secondary circuit of an induction coil. The primary circuit contains a carbon microphone. On speaking into the latter the lamps, which are fed by 16 accumulators, exhibit variations of luminosity corresponding with the sound vibrations, and these are re-translated into sound by the selenium cell.

[J. W. Giltay, *Physikal. Zeitschr.*, August 24, 1901.]

*Rowland's Convection Experiment.*—In view of Crémieu's denial of the existence of magnetic effect of electric convection, A. Eichenwald has repeated the experiment of Rowland, who first furnished some evidence of a positive nature. Between two vertical zinc plates B, B a light disc of micanite A rotates on a horizontal axis. It is 25cm. in diameter, and is covered along both edges with strips of tinfoil *ab*. The strips of tinfoil form a condenser with the zinc plates, and may be charged by means of sliding contacts. At the upper edge of the plate a vertical tube CD of electrolytic copper is mounted, containing a very light astatic pair of needles suspended by a quartz fibre. Every precaution is taken to protect the needles from magnetic influences. Rotation of the uncharged disc produces a deflection which is independent of the direction of rotation. When the disc is charged, another and a larger




deflection is superadded, corresponding in direction and amount to that which would be produced by an electric current conveying the same quantity of electricity. The author therefore regards Crémieu's negative result as due to disturbing influences.

[A. Eichenwald, *Physikal. Zeitschr.*, September 7, 1901.]

## ON THE CHANGE OF CONDUCTIVITY OF METALLIC PARTICLES UNDER CYCLIC ELECTROMOTIVE VARIATION.*

BY PROF. JAGADIS CHUNDER BOSE, M.A., D.SC.

### *Introduction.*

A mass of conducting particles has its conductivity changed when subjected to rapid electric vibration, as, for instance, when acted on by electric waves. In my previous Papers,† I have adduced reasons leading to the conclusion that electric radiation produces molecular changes, and that conductivity variation is the expression of such change. We know that the physical properties of a given substance depend on its molecular condition. We should, therefore, expect any molecular change to be attended with changes in the physical properties of the substance, electric conductivity being one of these. The wide difference in electric conductivity of the same substance under different molecular conditions is seen in the case of carbon, in its two allotropic forms of graphite and diamond. That radiation is effective in producing allotropic changes is seen in the conversion of the yellow into the red variety of phosphorus under the action of light.

That the variation of conductivity produced by electric radiation is due to some atomic or molecular action is seen from the fact that it is dependent on the chemical nature and the molecular condition

* Paper read before Section A of the British Association.

† "On Electric Touch and the Molecular Changes produced by Electric Radiation." *Proc.* Roy. Soc., February 8, 1900. "On the Similarities of Effect produced by Electric Stimulus on Inorganic and Living Substances." *The Electrician*, September, 1900.

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of the substance. Thus, under electric radiation, the positive class of substances, *e.g.*, Fe, Mg, &c., exhibit an increase of conductivity, whereas the negative class of substances, *e.g.*, K, Br, I, &c., exhibit a diminution. The effect of molecular conditions in determining the sign of response to electric radiation (*i.e.*, increase or diminution of conductivity) is shown by the two molecular varieties of silver, the response being positive in one and negative in the other. (See "On Electric Touch," *ibid.*).

We see, then, that conductivity variation is the expression of some molecular change. In many cases (potassium, Ag', brominated lead, &c.) we find that the variation persists only during the action of radiation. On the cessation of this stress the substance at once shows elastic self-recovery. It would thus appear that the conductivity variation is a molecular strain effect produced by radiation. This view is further supported by the fact that in working with self-recovering receivers of various types, both positive and negative, I have not only found that for each intensity of radiation there is a corresponding conductivity variation, but also when the substance is subjected to the continued action of radiation, that the conductivity distortion attains a maximum value, and then remains constant, balanced by a force of restitution. As was said before, however, when the radiation is stopped, the substance *at once* recovers its original conductivity. With an increase of intensity of radiation, the corresponding conductivity variation also increases, and vice versa. I have, in a Paper "On the Continuity of Effect of Light and Electric Radiation on Matter" (*Proc.* Roy. Soc.), given an account of one such self-recovering receiver, of negative type, made of silver particles, where the conductivity variation is almost exactly proportional to the intensity of radiation. Self-recovery in general is merely a question of time; with certain substances it takes place immediately, with others, after a longer or shorter interval; again, in a larger number of cases, after a comparatively long period. This view of conductivity variation as the expression of some molecular change, will receive independent support from the experiments in a self-recovering receiver to be described later.

In the case of substances which exhibit quick and perfect self-recovery, the quasi-elasticity seems to be considerable, and there is recovery even when they are subjected to moderately strong electric stress. But with other substances this limit is easily exceeded, and there is then produced a more or less permanent molecular, and attendant conductivity, distortion. Even with such substances self-recovery is sometimes exhibited when the intensity of radiation is feeble. These conductivity changes take place not only with excessively rapid Hertzian oscillations, but also with much slower electromotive variations. Thus an electromotive variation, whether quick or slow, seems to be the effective cause of the conductivity change. With non-recovering substances there is produced an irreversible molecular change, attended by more or less permanent variation of conductivity. These molecular strain effects, of which the conductivity variation is the outward expression, can be removed by molecular vibration, by mechanical taps, or by the application of gentle heat.

In the above case it is seen that after a rapid cyclic variation of E.M.F. the substance is different from its primitive condition; in other words, at the end of the process there is an irreversible molecular change seen in a conductivity *hysteresis*. If this view be correct, then we can study its molecular changes step by step, by observing the conductivity variations undergone by the substance as it is carried through a complete cycle of electromotive variation. The rapidity of this process must be just sufficiently slow to allow the successive changes to be noted. The suddenness of electric variation no doubt exerts an influence on the amount of change; but this is a question of degree only.

The investigation thus resolves itself into the determination of the variation of conductivity of the sensitive particles, as the mass is subjected (1) to a continuously increasing E.M.F. from zero to a maximum, and then (2) to a continuously diminishing E.M.F. from the maximum back to zero. The required information may be obtained by the interpretation of the characteristic curve, in which the abscissæ represent the impressed E.M.F., and the ordinates give the corresponding values of the current. A continuously increasing E.M.F. may be made to act on the sensitive substance, by the movement of a slider over a potentiometer wire, say, to the right. The scale readings of the potentiometer give the values of the E.M.F. The readings of the galvanometer in circuit give the corresponding values of the current; movement of the slider to the left produces a continuous diminution of E.M.F. The characteristic curve can thus be obtained from the observed values of E.M.F. and the corresponding currents.

This is a bare outline of the principle of the investigation described in this Paper. In practice various experimental modifications have to be introduced in order to overcome numerous difficulties.

Before entering upon the subject of experimental arrangements, I may repeat what I pointed out in February, 1900,* that with regard to their sensitiveness to electric radiation, there are three types of substances, positive, negative and neutral, differentiated "by the characteristic curves of variation of current with E.M.F." The positive exhibit an increase of conductivity; the negative show a diminution of conductivity; and the neutral do not exhibit any conductivity change. The first two of these classes again fall into the subdivisions, of substances which exhibit self-recovery and those which do not. The characteristic curves of the three classes of substances thus belong to three distinct types, so that it is possible to determine the class to which the sensitive substance belongs by its characteristic curve.

These curves also throw much light on the obscure subject of the action of radiation on various sensitive substances. In the present Paper I shall deal with the first class of substances, *i.e.*, those which show a diminution of resistance, and amongst these I shall take typical instances of non-recovering and self-recovering substances, and describe the peculiarities of their cyclic characteristic curves.

*Experimental Arrangements.*

The electric circuit consists of (1) the sensitive substance, (2) a delicate dead-beat D'Arsonval galvanometer, and (3) a potentiometer arrangement for a gradual and continuous increase or diminution of E.M.F.

1. *The Sensitive Substance.*—Experiments were made with both single and multiple contacts. In the former case two rods of the substance were made to press against each other by means of a fine micrometer screw, or by means of springs. Sometimes the contact ends of both the rods were rounded; in other cases a pointed end pressed against the second rounded piece. The pressure of contact has to be adjusted very carefully.

In the case of multiple contacts, a small quantity of metallic filings was put in a glass tube, and the fragments compressed between two electrodes, the pressure being regulated by a micrometer screw, which should be perfectly easy-running. The pressure was adjusted till a feeble initial current flowed through the circuit. The micrometer screw, together with the tube of filings, were appropriately fixed on a heavy base. This rested in turn on a steady pedestal, with one or two sets of pneumatic tyres interposed. Experiments were carried out with the sensitive substance in air, or immersed in kerosine.

2. *The Galvanometer* was appropriately shunted so as to give a deflection of one division of scale for a definite small fraction of an ampere. In some experiments, for example, one division of the scale was equal to $10^{-6}$ ampere. The calculation of resistance of the sensitive substance is very much facilitated if the scale values of the galvanometer and the potentiometer are suitably adjusted beforehand. The resistance of the shunted galvanometer and the potentiometer was practically negligible in comparison with the resistance of the sensitive substance, a resistance which usually varied from about 1,000 to 50,000 ohms.

3. *The Potentiometer* consisted of a thin nickeline wire of uniform section, 20in. in length. Each inch of the scale was further subdivided into tenths. A storage cell with an interposed resistance was applied to the terminals of the potentiometer, and the resistance adjusted till the terminal E.M.F. attained a suitable value. This was found by the help of an auxiliary voltmeter applied to the terminals of the potentiometer.

The E.M.F. acting on the main circuit was derived from the potentiometer; one end of the circuit was connected with one terminal of the potentiometer and the other connected with a slider, the movement of which to the right or to the left increased or diminished the impressed E.M.F. The sliding contact was made by means of a bent flat metallic spring which uniformly pressed against the potentiometer wire. Care was taken to maintain a uniformly good electrical contact. Any sudden introduction of the E.M.F. was avoided with special care, as, owing to the self-induction of the circuit, an unknown induced E.M.F. would then act on the sensitive substance. For this reason the slide-contact was never broken. Starting from zero of the scale (E.M.F. = 0) the slider was moved at a uniform rate to the right, thus continuously increasing the E.M.F. without any sudden variation. Movement of the slider to the left produced a continuous diminution of E.M.F. The voltaic cell was never cut off from action till the slider returned to zero.

*Method of Observation.*

One observer moved the slider at a uniform rate and called out the successive potentiometer readings; the corresponding deflections of the galvanometer were read off by a second observer, and a third took down in parallel columns the applied E.M.F. and the corresponding galvanometer readings. From these data the characteristic curves could be subsequently obtained.

These curves proved so deeply suggestive, and appeared to throw so much light on many obscure phenomena, that I repeated them frequently for the last two years in order to be convinced of their accuracy. The above method of work was, however, very tedious. It took a long time and the co-operation of three persons to complete one experiment, and the curves could only be obtained from a series of observations which were not absolutely continuous. I have, therefore, been trying for a long time to devise a recording apparatus by which a continuous curve could be *directly* obtained in some very much simplified manner.

* See "Electric Touch," *Proc.* Roy Soc., Vol. LXVI., p. 457.



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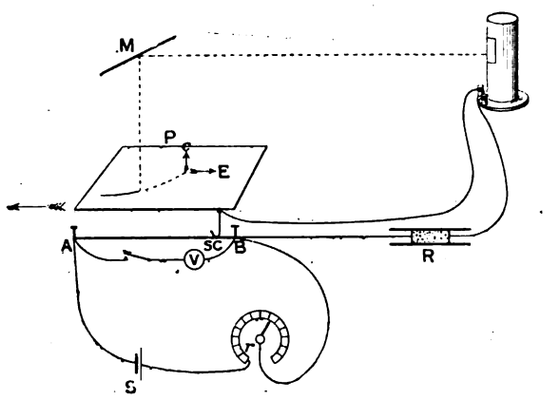
*The Conductivity Curvograph.*

If a platform be fixed to the slider of the potentiometer, then the movement of the platform in one direction would continuously increase the E.M.F. acting on the circuit containing the sensitive substance. (See Fig. 1.) If the galvanometer spot of light is thrown down on the platform by a mirror, suitably inclined, and if the movement of the spot of light, due to variation of current, take place at right angles to the motion of platform, then a continuous curve would be traced on the platform, of which the abscissæ would represent the E.M.F. and the ordinates the currents. This curve could be fixed if we laid a sheet of photographic paper on the platform, or we might obtain it by the simpler expedient of following the track of the galvanometer spot with a pencil.




P, Moving Platform. AB, Potentiometer. R, Sensitive Receiver. r, Rheostat. V, Voltmeter. SC, Sliding Contact. S, Secondary Cell. M, Mirror.

FIG. 1.—Diagrammatic Representation of Conductivity Curvograph.

I used squared paper for recording the curves. It is divided in inches, and these further sub-divided into tenths. The potentiometer wire is 20in. long, and the length of the platform is the same. As the platform moves through its own length past a fixed index, the sliding contact moves through the whole length of the potentiometer. If the applied E.M.F. at the terminals A and B be, for example, 1 volt, each inch of paper along the platform would then represent $\frac{1}{20}$th of a volt or 0·05 volt, the smaller sub-division representing 0·005 volt. This or any other suitable terminal value of E.M.F. may be obtained with the help of the storage cell S, a rheostat *r* and an auxiliary voltmeter V, applied to the terminals A and B.

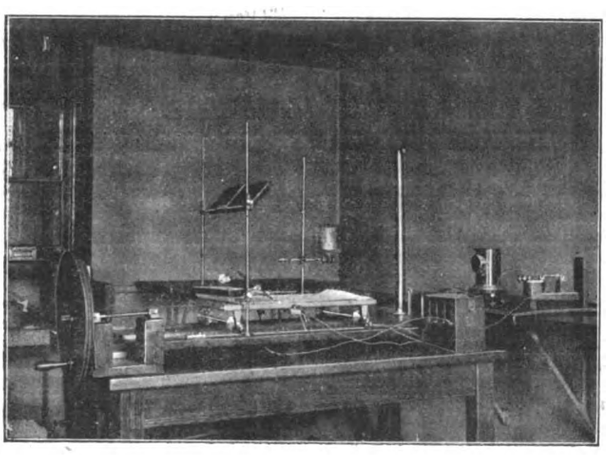


FIG. 2.—Conductivity Curvograph.

The galvanometer, as was said before, is also adjusted by means of a shunt, so that a deflection of one division is a convenient small fraction of an ampere. The absolute values of the E.M.F. and current being known, it will be seen that the resistance of the sensitive substance at any point of the curve can easily be determined.

In the completed apparatus of which the photograph is shown in Fig. 2, the platform is mounted on small wheels and moves on rails with perfect smoothness. A wire connected with one end of the platform is carried round a large winding wheel and a second wire connected with the other end of the platform carries a counterpoise, the weight of which is nearly sufficient to overcome the friction of the carriage and of the winding wheel. When the wheel is turned at a uniform rate in one direction, the platform carrying the paper also moves at a uniform rate, at the same time producing a continuous increase of E.M.F. acting on the circuit. When the wheel is turned in the opposite direction, the counterpoise reverses the motion, and the impressed E.M.F. undergoes a continuous diminution. In this way we can produce either an increase, or a decrease, or a rapid cyclic variation of E.M.F. I shall first describe in detail the rising part of the curve thus obtained, and then deal with its peculiarities when carried through a complete cycle.

*(To be continued.)*

## ELECTRICITY WORKS ACCOUNTS.

### Hull Municipal Electric Supply Works.

The last year's accounts of this undertaking are on the whole most satisfactory. In our comments last year on the preceding year's results, we had to note a substantial increase in the aggregate costs. It is satisfactory to find this year that, notwithstanding the much heavier coal bill, the total costs have been reduced and brought back to a figure sensibly lower than that of 1899-1900. To a great extent this improvement is only what might fairly have been expected in view of the larger output and the better load factor. The output last year at 1,807,075 units sold was 39 per cent. above that of 1899-1900, and the load factor had risen from 7·64 to 9·1 per cent. It is in consideration of this low load factor and the high coal prices which prevailed that we characterise the costs at 2·52d. per unit as being satisfactory.

The management and property charges and the two generating items of oil, waste, &c., and repairs and maintenance show particularly good figures. We are glad to see a reduction in the total receipts per unit—there was certainly room for it.

During the year the lamp connections rose from the equivalent of 79,376 to 106,831 8 c.p. lamps—an advance of nearly 35 per cent.

### South Shields Municipal Electric Supply Works.

In improving upon the already excellent cost figures of 1899-1900, even but slightly, the management of this undertaking has made quite a striking achievement. We learn from Mr. Jos. H. Jeckell (who was borough electrical engineer until a few months ago, and is now at Coventry) that during the whole of the year 15s. per ton was paid for the coal ordinarily obtained for 7s. It is highly creditable that the fuel item should still remain under 0·7d. per unit, and the generating works and total costs well under the 1899 averages of municipal stations. The management and property charges, as well as the several works costs share in contributing economical figures.

Mr. Jeckell draws our attention to the lower allocation to the sinking fund last year as compared with the preceding years, and he explains that on investigation it was found the sinking fund was being contributed to on an unsatisfactory system, and that £440 had already been paid in excess of requirements. If this were so it would naturally have the effect of showing a smaller surplus in each year at South Shields, although the working profits were higher compared with other places. Mr. Jeckell cites many undertakings in support of this opinion, including Belfast, where, with an average capital in 1899 of £117,335, the gross profit was £5,936, representing 5·06 per cent. The redemption charge was £976 or 0·83 per cent., and interest £2,837 or 2·42 per cent., leaving a surplus of £2,123, while, with a higher percentage working profit, South Shields paid interest and sinking fund charges amounting to 5·85 per cent. on the mean capital, incurring a deficit for the year of £73. Other towns cited come between the cases of South Shields and Belfast as extremes in illustrating this difference in dealing with the capital charges. The basis for determining the redemption charge at Shields has now been altered by the committee.

Owing to the greatly increased price of coal the price of current was increased from 7d. and 2d. to 7d. and 3d. for the quarter ended at March 31st last.

During the year the lamp connections advanced by 34·7 per cent. and the load factor rose from 11·46 to 12·24 per cent., with an increase in the output of nearly 51 per cent.

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| | HULL. | SOUTH SHIELDS. |
|---|---|---|
| *Undertaking Worked by* | Kingston-upon-Hull Corporation. | South Shields Corporation. |
| *Date of Commencement of Supply* | January 16, 1893. | September, 1896. |
| *System of Supply* | 3-wire cont., with batteries and rotaries in sub-stations. | Alt.-current transf. sub-stations with 2-wire distribution. |
| *Chief Engineer* | A. S. Barnard. | J. H. Cawthra. |

| YEAR ENDED | MAR. 31, 1900. | MAR. 31, 1901. | MAR. 31, 1900. | MAR. 31, 1901. |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 1,210,490 | 1,962,657 | 634,464 | 944,629 |
| „ **SOLD (TOTAL)** | 940,192 | 1,307,075 | 501,839 | 755,826 |
| „ sold to consumers | 940,192 | 1,307,075 | 394,039 | 573,094 |
| „ sold for public lighting, &c. | nil | nil | 107,800 | 182,732 |
| „ used on works | 160,605 | 427,341[e] | 16,417 | 22,650 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 15·6 | 13·8 | 14·6 | 15·1 |
| Maximum supply demanded | 1,405 kilowatts | 1,639 kilowatts | 500 kilowatts | 705 kilowatts |
| Number of public lamps | nil | nil | 68 arc, 256 glow[a] | 84 arc, 107 glow[f] |
| Number of consumers | 1,326 | 1,541 | 476 | 680 |
| Connections to mains in 8-c.p. lamps | 79,376 | 106,831 | 26,004 | 35,025 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 60,300 | 95,000 | 34,400 | 50,000 |
| **CAPACITY OF PLANT IN KILOWATTS** | 1,928 | 3,037 | 1,100 | 1,600 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £128,490 / £66·7 | £170,415 / £56·1 | £99,037 / £90·1 | £150,837 / £94·2 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 128,490 / 66·7 | 170,415 / 56·1 | 99,037 / 90·1 | 150,837 / 94·2 |
| **RECEIVED (TOTAL)** | 130,302[a] / 67·6 | 162,509[f] / 53·5 | 74,102 / 67·4 | 111,721[h] / 69·8 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 128,490 / 66·7 | 159,774 / 52·6 | 74,102 / 67·4 | 110,782 / 69·2 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | nil / — | 10,641 / 3·50 | 25,873 / 23·5 | 40,055 / 25·0 |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | — / — | 10,641 / 3·50 | 25,873 / 23·5 | 40,055 / 25·0 |
| **REPAID (TOTAL)** | 11,546 / 5·99 | 11,546 / 3·80 | 447 / 0·406 | 3,138 / 1·96 |
| **RESERVE OR SINKING FUND** | — / — | 4,204 / 1·38 | 4,680 / 4·25 | 4,148 / 2·59 |
| **DEPRECIATION FUND** | 10,093 / 5·24 | 11,324 / 3·73 | — / — | — / — |
| **EXPENDED (TOTAL)** | 133,802 / 69·4 | 169,980 / 55·9 | 88,687 / 80·6 | 128,489 / 80·3 |
| Lands and buildings | 13,526 / 7·02 | 15,727 / 5·18 | 12,218 / 11·1 | 13,741 / 8·59 |
| Plant | 63,302 / 32·8 | 78,020 / 25·7 | 44,169 / 40·2 | 58,666 / 36·7 |
| Mains | 55,825 / 29·0 | 75,083 / 24·7 | 30,798 / 28·0 | 54,572 / 34·1 |
| Miscellaneous | 1,150 / — | 1,150 / 0·379 | 1,502 / 1·37 | 1,509 / 0·943 |
| **BALANCE OF CAPITAL ACCOUNT** | −3,500[b] / −1·82 | −7,471[b] / −2·46 | −14,584[b] / −13·3 | −16,768[b] / −10·5 |
| **REVENUE—** | Total. / Per unit sold. | Total. / Per unit sold. | Total. / Per unit sold. | Total. / Per unit sold. |
| **TOTAL** | £19,291 / 4·927d. | £24,577 / 4·515d. | £7,973 / 3·813d. | £11,922 / 3·786d. |
| Revenue from supply | 18,390 / 4·698d. | 23,713 / 4·355d. | 6,312 / 3·020d. | 9,739 / 3·093d. |
| „ meters, &c. | 617 / 0·158d. | 769 / 0·141d. | 203 / 0·097d. | 280 / 0·089d. |
| „ public lighting | — / — | — / — | 1,454 / 0·696d. | 1,903 / 0·604d. |
| „ sale of lamps, &c. | — / — | — / — | — / — | — / — |
| „ miscellaneous sources | 283 / 0·072d. | 94 / 0 017d. | 4 / 0·002d. | — / — |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £10,632 / 2·715d. | £13,736 / 2 523d. | £3,952 / 1·890d. | £5,911 / 1·877d. |
| **WORKS COSTS** | 7,893 / 2·015d. | 10,798 / 1·983d. | 2,661 / 1·273d. | 4,387 / 1·394d. |
| *Generation of electricity* | *6,746 / 1·722d.* | *9,898 / 1·800d.* | *2,207 / 1·058d.* | *3,733 / 1·186d.* |
| Fuel (including cartage, &c.) | 3,398 / 0·868d. | 6,080 / 1·116d. | 923 / 0·442d. | 2,108 / 0·670d. |
| Oil, waste, water, stores | 416 / 0·106d. | 546 / 0·100d. | 229 / 0·110d. | 259 / 0 082d. |
| Wages at station | 1,999 / 0·511d. | 2,500 / 0·459d. | 794 / 0·380d. | 1,005 / 0·319d. |
| Repairs and maintenance at station | 933 / 0·238d. | 682 / 0·125d. | 261 / 0·125d. | 360 / 0·114d. |
| *Distribution of electricity* | *1,147 / 0·293d.* | *990 / 0·182d.* | *47 / 0·022d.* | *122 / 0·039d.* |
| Wages, &c. | 456 / 0·116d. | 598 / 0·110d. | 47 / 0·022d. | 122 / 0·039d. |
| Repairs, renewals of mains, &c. | 691 / 0·176d. | 392 / 0 072d. | | |
| *Public lighting* | — / — | — / — | *408 / 0·195d.* | *533 / 0·169d.* |
| Attendance | — / — | — / — | 401 / 0·195d. | 513 / 0·163d. |
| Renewals | — / — | — / — | 7 / 0·003d. | 20 / 0·006d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 2,739 / 0·700d. | 2,938 / 0·540d. | 1,292 / 0·618d. | 1,524 / 0·484d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *1,116 / 0·285d.* | *1,220 / 0·224d.* | *288 / 0·138d.* | *249 / 0·079d.* |
| *Management* | *1,623 / 0·415d.* | *1,718 / 0·316d.* | *1,004 / 0·480d.* | *1,275 / 0·405d.* |
| Salaries | 1,155 / 0·295d. | 1,294 / 0·238d. | 702 / 0·336d. | 781 / 0·248d. |
| Stationery, &c. | 126 / 0·032d. | 147 / 0·027d. | 59 / 0·028d. | 85 / 0·027d. |
| Establishment charges | 175 / 0·045d. | 152 / 0·028d. | 122 / 0·058d. | 183 / 0 058d. |
| Law charges, &c. | 167[c] / 0·043d. | 125 / 0·023d. | 121[c] / 0·058d. | 226[i] / 0·072d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £8,659 / 7·57% | £10,841 / 7·14% | £4,020 / 5·46% | £6,011 / 5·54% |
| Sum carried to Depreciation Fund | 1,924 / 1·68% | 1,231 / 0·810% | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 3,506 / 3·06% | 4,780 / 3·15% | 2,176 / 2·96% | 2,067 / 1·90% |
| Net interest on loans (incl. Debenture charges) | 3,230 / 2·82% | 4,830 / 3·18% | 2,129 / 2·89% | 3,185 / 2·93% |
| **BALANCE FROM LAST ACCOUNT** | — / — | — / — | 284 / 0 386% | 461[j] / 0·424% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — / — | — / — | —[d] / — | 1,679[k] / 1·55% |
| *Deficit* | — / — | — / — | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 55·1% | 55·9% | 49·6% | 49·6% |
| Expenditure per kilowatt capacity | £5. 10s. 3d. | £4. 10s. 5d. | £3. 11s. 10d. | £3. 13s. 11d. |
| **REVENUE PER KILOWATT CAPACITY** | £10. 0s. 0d. | £8. 1s. 11d. | £7. 4s. 11d. | £7. 9s. 0d. |
| Expenditure per 8-c.p. lamp capacity | 3s. 6¼d. | 2s. 10¾d. | 2s. 3½d. | 2s. 4½d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 6s. 4¾d. | 5s. 2¼d. | 4s. 7½d. | 4s. 9½d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 4s. 10¼d. | 4s. 7½d. | 6s. 1½d. | 6s. 9¾d. |
| Price charged for lighting, per unit | 5d. | 5d. or 5½d. (1 hr.) to 2½d. | 7d. to 2d.[e] | 7d. to 3d. |
| Price charged for power, per unit | 2½d. | 2½d. | 2d. [per 16 c.p. glow | 2d. [ann.[g] |
| Price charged for public lighting | — | — | £22. 10s. per arc, £2. 12s. | £22. 10s. per arc per |

**HULL.**—REMARKS—*a* Inclusive of £1,812 instalments written off meters and £74,905 temporary loan. *b* Over-expended. *c* £160 to insurance. *d* Consumers wired for not less than six kilowatts have option of maximum demand system at 5½d. per unit for first hour and 2½d. after. *e* Circulating pumps, &c., are all electrically driven. *f* Inclusive of £2,735 from revenue written off meters and £106,189 temporary loan.

**SOUTH SHIELDS.**—REMARKS—*a* 16 c.p. glow lamps average. *b* Over-expended. *c* £29 to law and £92 insurance. *d* There was a credit balance of £211, being the amount received on account of delay in delivery of plant. *e* On Wright system (1-hour scale). *f* The glow lamps are from 16 c.p. to 32 c.p. *g* The glow lamps are charged at: Each post with two 16 c.p. lamps, 1s. per week; with two 25 c.p. lamps, 1s. 6d. per week; and for each post with two 32 c.p. lamps, 2s. per week. *h* £939 premiums on 3 per cent. stock. *i* Law £141, insurance £85. *j* Inclusive of £250 compensation received. *k* Includes £459 "Transfers from Provision Account."

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# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny

Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* The Editor.

*All letters for insertion in* "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

Subscription Rates.—The Rates for Subscriptions to "The Electrician" are as under:—

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| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
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## THE BRITISH ASSOCIATION AT GLASGOW.

The conspicuous success of the British Association meeting at Glasgow has fully realised the expectations formed of it some time ago. It is true that the attendance has been considerably below what was anticipated, and, indeed, does not compare favourably with the attendance of recent years in the larger cities of the United Kingdom. This, however, is not to be explained as being due to any defection of regular members and associates, but merely that the local contingent on this occasion was considerably smaller than usual. During the summer there has been a long and almost uninterrupted series of scientific and other congresses in Glasgow; and it was scarcely to be expected that the citizens, thus sated with scientific conventions, would attend in any large numbers the meetings of the British Association held so late in the year. Indeed, we fear that, financially speaking, the British Association has made a mistake in selecting Glasgow as its meeting place this year. This circumstance, however, has not in the least detracted from the utility of the proceedings of the various sections. Remembering that the British Association for the Advancement of Science came into existence before the Victorian Era, and having regard to the rapid strides and developments of science during that period, it is somewhat surprising that the initial aims and objects of the Association remain ostensibly unaltered even to the present day. Notwithstanding the friendly and healthy competition of other multifarious scientific bodies, this Association is still capable of justifying its existence to the scientific world; its utility, whether to those who attend its meetings, or to the still wider circle of those who from outside keenly watch the progress of science, is a proved fact. We express this opinion with all the greater pleasure because there have not been wanting, during the past few years, occasions when we have feared that the British Association was, to use a popular expression, "played out" for all purposes but that of an amateur scientific picnic. From our own observation this year, in regard to electrical and allied Papers, and from the opinion of others competent to judge in regard to the other sections, we are able to record a distinct improvement in the quality of the Papers read and in the value of the discussions. So far as concerns Section A, able chairmanship has generally

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limited each speaker to a reasonable length of time, with the result that much more work has been accomplished during each sitting. On the other hand, the absence of several prominent speakers who usually attend was to be regretted, the most conspicuous of all being that of the late Prof. G. F. FitzGerald, whose absence has created a blank that not the ablest of his confrères can fill. Notable also was the absence of Dr. Oliver Lodge and of Prof. J. J. Thomson, not to mention numerous other less well-known professors. With regard to the Engineering Section, the absence of electrical Papers is probably accounted for by the Engineering Conference held in the same building during the previous week.

The conversion of the title of Section G from "Mechanical Science" to "Engineering," and the creation of an entirely new Section L for "Educational Science," indicate a decided change in the scope of the Association, although perhaps not at present in its ultimate aims. So long as the individual sections were each strictly confined to a definite branch of science, strictly so called, the scope of the Association was unmistakable. Only when a new branch of science sprang into existence, or when an old branch became too cumbersome to retain its unity and called for sub division, could any new section be created. Indeed, not many years ago this was held to be sufficient ground for refusing to create a section devoted to Medicine, it being logically maintained that Medicine is not a science in itself, but merely an application of several sciences. Precisely the same argument is applicable to Engineering. "Mechanical science" is an exact and definite thing; but "Engineering" is but a congeries of arts for directing and using the knowledge acquired through almost every branch of science. If, therefore, Section G is to cover the entire range of Engineering, there no longer exists any valid objection to the creation of a section for Medicine, another for Surgery, another for Photography, and so on. This consummation is devoutly *not* to be wished, and we had preferred that Section G should retain its original title. These considerations lead us to criticise the newly-created Section L, which is devoted to the so-called "Educational Science." Is there such a thing as educational science? There may be, indeed there should be, a good deal of science in the methods of education, using the word "science" not in the sense in which the British Association originally used it, but in the wider sense of *technique*, in which it is used in connection with many other accomplishments, not to forget even boxing and pugilism. We scarcely credit that it is in this wider sense that Prof. H. E. Armstrong and his associates wished to select it as the title for their new section. The only point of contact between Section L and the electrical profession during the past meetings has been the somewhat acrimonious discussion inaugurated by Prof. John Perry on the teaching of mathematics. Judging by this and other indications, the education section promises to be far less scientific than political, a tendency which, if it is allowed to develop, will not redound to the credit of the British Association. As regards the discussion on mathematical teaching, we will not enter at length upon such debatable ground. It appears to us, however, that the point of disagreement between those who advocated a thorough mathematical training and those who, with Prof. Perry, thought that an abridged and practical curriculum in mathematics should suffice, resemble a wrangle as to the relative merits of a knowledge of photography and a knowledge of how to use a "Kodak." Prof. Perry practically tells his pupils that they press the button and his equations do the rest, whereas the strict mathematician is able to do the whole process from beginning to end, and to understand thoroughly what he is doing. There is also great force in Major MacMahon's criticism of Prof. Perry's method—viz., that it assumes that all boys are to be trained as if they were going to be engineers. We ourselves insisted on this criticism in a leading article some time ago when we discussed the question.

## THE BRITISH ASSOCIATION AT GLASGOW.

As announced in our last issue, the proceedings of the British Association at its Glasgow meeting last week were inaugurated by the delivery of the presidential address by Prof. A. W. Rücker. This profoundly interesting address was reprinted in part and commented on in our last issue, and is concluded this week. We will, therefore, proceed at once to describe the electrical features of the various sectional meetings.

*Thursday, September 12th.*

The proceedings in each section commenced with the delivery of the various presidential addresses. In Section A (Physics) Major P. A. MacMahon, F.R.S., selected as his subject a purely mathematical discussion of a somewhat recondite nature. In Section B (Chemistry) Prof. P. Frankland, F.R.S., discoursed on "The Position of British Chemistry at the dawn of the Twentieth Century." The only other presidential address of interest to electrical students was that in section G (Engineering), by Col. R. E. Crompton, who divided his address into three parts:—(1) Modern development of passenger and goods traffic as affecting carriage on railways, tramways, and ordinary roads; (2) Standardisation and interchangeability, and (3) the National Physical Laboratory. We reprint this address in another part of our issue this week.

In Section A no less than nine Papers were down for discussion. These related principally to general physics and were not of a directly electrical character, but in many cases the discussions bore on the electrical aspects of the questions involved. The first Paper to be read was "On Elastic Fatigue as Shown by Metals and Woods," by Prof. A. Gray, F.R.S., J. S. Dunlop, and A. Wood. Prof. Gray announced that the researches had originated in the following manner: Experiments on the properties of wood in regard to elasticity and fatigue had been carried out some time since in Lord Kelvin's laboratory. After the interval of rest over a Sunday, it was found that the wood experimented on showed evidence of marked recovery of its original elasticity. Prof. Gray's Paper, in which he has been assisted by two of his students, whose names are coupled with his own, deals with a continuation of this inquiry as to the nature of this recovery. Incidentally we may mention that Prof. Gray believes that this investigation throws light on the reason why certain musical instruments when played upon by bad players become useless. The bad playing develops what are called false notes, and the instrument seems to acquire the vicious habit of always emitting these notes when they have been elicited a few times. Cornets, for example, have this objectionable property; it is also well known that after violins have been played upon by expert players for some time their tone improves in richness and quality. Investigating the rate of subsidence of the oscillations produced in timber when released from torsional or transverse stress, Prof. Gray found that the rate increases as the oscillations diminish. A rod of pine 1 sq. cm. in section and 2ft. or 3ft. in length, when thrown into transverse vibration, was found to have its modulus of elasticity rapidly diminished as the oscillations continued; but after an interval of rest of about the same duration as that of agitation, it was found that the initial elasticity was completely recovered. Continuing the agitation, the modulus now fell more rapidly than before, and to a still lower value, and a subsequent period of repose produced but little, if any, recovery. With maple rods of the same size and treated in a similar manner, it was found that the first application of the transverse vibration led to a slight but undeniable *increase* of the modulus; but successive periods of agitation and repose produced results similar in general respect to those with pine. During a brief discussion on this Paper, Lord Kelvin remarked

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that the cause of the improvement of violins with age was a problem still unsolved by physical science, though he thought that Prof. Gray's researches might tend towards its solution.

Prof. G. Quincke, of Heidelberg, next read a Paper descriptive of his researches "On the Clearing of Turbid Solutions and the Influence of Light on the Motion of the Suspended Particles." Briefly summarising this Paper, we may say that its author observed that small quantities of electrolyte dissolved in a turbid solution promote rapid coagulation and precipitation of the suspended solid matter, while on the other hand colloidal and other dielectric substances defer precipitation. It is found that the acceleration of this deposition is proportional to the valency of the electrolyte. He suggests that the influence of light on the coagulation might be due to its heating effect. In the discussion, the question was raised as to whether colloidal solutions were equivalent to turbid solutions in which the suspended particles were so small as to be invisible; and this aspect of colloidial solution, as opposed to real solution, was supported by Prof. Quincke. Prof. Gray now read a Paper dealing with the second part of the researches described in his first Paper—viz., "On the Relation between Temperature and Internal Viscosities of Solids." The solids experimented on were pure and commercial copper, brass, iron, steel, and German silver. Either in the form of a wire or of a long spiral spring, the metal was suspended vertically inside a double tube which formed a water or oil bath around it for the purpose of altering its temperature. A number of curves were exhibited in conjunction with the Paper, and these showed that the rate of subsidence of torsional vibrations in the case of the wires, and of longitudinal vibrations in the springs, increased with the rise in temperature—*i.e.*, that at a higher temperature the viscosity was diminished, and a longer time occupied in oscillation before quite coming to rest.

The next Paper, by Prof. W. Ramsay, F.R.S., dealt with a subject closely allied to Prof. Quincke's Paper — viz., "Hydrostatic Pressure" when the fluid contains solid matter in suspension. Prof. Ramsay illustrated the point of his Paper as follows:—If a bucket is filled with bullets, and then filled up with water, we have a crude analogue of the fluid referred to. A hydrometer placed in this bucket would, of course, not give the mean density of the water and the bullets, but merely that of the water. Imagine the bullets to be made smaller and smaller until they were like a fine mud suspended in the water; at what size of bullet would the hydrometer exactly indicate the mean density of the turbid fluid? So far as concerns invisible particles, whose presence is indicated only by the polarisation of light, and not by the microscope, Prof. Ramsay finds that the buoyancy of the fluid corresponds with its true mean density; but there appears to be some doubt as regards fluids with visible particles in suspension. Prof. Ramsay suggested that the use of the lactometer for gauging the amount of cream in milk was fallacious; it certainly must be so if the cream exerts no buoying effect on the instrument. Dr. Larmor, however, was rather sceptical about this. Lord Kelvin said an interesting point connected with this inquiry was the effect of quicksands in relation to the submergence of solids that would ordinarily float in water.

Mr. E. H. Griffiths, F.R.S., now read his Paper on "The Freezing Points of Certain Dilute Solutions." Probably the most interesting point was that made by Dr. Larmor in the discussion—viz., that, inasmuch as Mr. Griffiths had found that the distance apart at which the electrolytic ions of the dissolved substance commence to exert an influence on one another was about 15 molecules of the water, it followed that the degree of molecular concentration was analogous to the point at which Boyle's law ceased to hold for gases. At this point Dr. R. T. Glazebrook, F.R.S., gave some account of "The Buildings of the National Physical Laboratory," illustrating his remarks by lantern slides.

Electrical Papers were scarce in other sections, but in Section G (Engineering) Mr. D. H. Morton gave an account of "The Mechanical Exhibits in the Glasgow Exhibition," and in Section I (Physiology) Sir John Burdon Sanderson read a Paper "On the Use of the Telephone for Investigating the Rhythmic Phenomena in Muscle."

*Friday, September 13th.*

Some excitement was created on Thursday by the announcement in the *Journal* that a discussion would take place on Friday in Section A on Dr. V. Crémieu's criticisms on the electromagnetic theory in relation to the magnetic effect of a moving electric charge. A large number of members attended therefore on Friday in expectation of an exciting debate. The proceedings commenced at 10:30 a.m. with the report of the committee on electrical standards, followed by a Paper by Mr. S. Skinner in the nature of an appendix to the report. Mr. Skinner's Paper was entitled "Note on a Comparison of the Deposits in Silver Voltameters with Different Solvents." In 1892 Schuster and Crossley discovered that about $\frac{1}{1000}$th more silver is deposited in a voltameter when in vacuum than when in air. Mr. Skinner experimenting with two voltameters, one containing the usual aqueous solution of silver nitrate and the other a solution of this salt in piridin, found that the electrochemical equivalent of silver as obtained from the aqueous solution differed from the piridin solution about the same amount as the difference obtained between the air and vacuum. In effect the true electrochemical equivalent of silver has to be raised from 0·1118 to 0·1119. In the discussion Mr. Griffiths said he had long favoured the higher value, and he further regarded piridin as a better solvent on account of the less risk of removing any of the deposit by subsequent washing, the deposit being harder and more consistent. Prof. Threlfall doubted whether there exists any definite electrochemical equivalent of silver. The value, he said, depends on the purity of the solution and the temperature of the voltameter. He advocated the use of fused salts in preference to solutions. Prof. Schuster pointed out that the voltameter is intended to give not an absolutely accurate standard but a sufficiently close approximation to the values obtained by absolute measurements. Lord Kelvin advocated the use of copper in place of silver, employing Prof. Thomas Gray's method and formula, with a current density corresponding to 50 sq. cm. per ampere. Mr. Erskine Murray spoke of having used zinc with satisfactory results; and Prof. Quincke said that in Germany the copper voltameter was extensively used, and found to be satisfactory.

Prof. A. Schuster now read his Paper "On the Conduction of Electricity through Mercury Vapour." The author first spoke of the extreme difficulty in obtaining perfectly pure mercury vapour, free from oxygen or other gas. He then described the apparatus with which he had sought to obtain the highest possible purity. Using the voltage of about 1,000 cells between the surfaces of mercury over which the vapour was formed, he found that the discharge commenced at about 100°C., and as the purity increased the temperature at which discharge took place rose to 130° or 160°. Even at atmospheric pressure, with the vapour at this temperature, a strong discharge was obtainable from 1,000 cells, and in every case the much-debated dark space was clearly in evidence. The sparks appeared to spring from the line of contact between the mercury surface and the glass. In the discussion Lord Kelvin described this as "a very upsetting Paper"—for, if Prof. Schuster's results were correct, the conclusion was forced upon physicists that the mean free path of the mercury molecules might be as much as 2cm. or 3cm. in length, even at atmospheric pressure, within the dark space. Prof. Schuster, however, preferred to believe that the mean free path had nothing whatever to do with the existence of the dark space.

Dr. Crémieu now read his Paper, "Sur les Effets Magnetique de la Convection Electrique," or, rather, he discoursed upon the substance of his Paper. Our readers are well aware that Dr. Crémieu, in attempting to obtain an electromagnetic effect from a moving electrostatic charge, by a new method originated by himself, obtained an absolutely negative result. Further experiment led him to believe that this negative result was the proper one, or, in other words, that no electromagnetic effect really occurs. This, of course, is in direct conflict with Prof. Rowland's results, as, indeed, with those of all who have experimented with apparatus beyond criticism. Space does not admit of our describing Dr. Crémieu's experiments in detail in this article; we hope to

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do so in an early issue. We may say, however, that the essence of Dr. Crémieu's method consists in suddenly charging a rapidly-moving surface spinning inside a coil placed in a galvanometer circuit. It was expected that the sudden convection current thus established would induce a current in the coil, but no such induction took place. The first speaker in the debate, Dr. H. A. Wilson, adopted the line of criticism that the negative result was due to the screening effect of the charge induced in the stationary metallic parts of the apparatus. He conceived that as the charge moved round with the rotating part of the apparatus it drew round with it an equal and opposite charge in the metal shrouding of the apparatus, this producing a neutralising convection current. Dr. Larmor described Dr. Crémieu's experiments as "good experiments well carried out," and he did not admit the validity of Dr. Wilson's criticisms. Dr. Larmor, however, confessed that if Dr. Crémieu's conclusions are correct we shall have to revolutionise completely our ideas of the relationship of electricity to matter, and the convenient electron will have to be abandoned. Lord Kelvin said that what is needed is that the very fundamental experiment be repeated as carefully as modern appliances will admit—viz., that a charge should be rotated in proximity with one needle of an astatic pair, the apparatus being reduced to its simplest possible elements in order to eliminate criticism as to the disturbing influence of unnecessary parts. He then went on to announce, as his profound conviction, that electricity in motion must produce electromagnetic effect.

Mr. G. M. Minchin, F.R.S., read his Paper "On Photo-Electric Cells," describing the manner in which these selenium cells are made and the mode in which they may be used for measuring the radiant energy of the stars. He gave, as an example, that the light from Vega focussed by a 2ft. telescope on one of these cells produced an E.M.F. of $\frac{1}{4}$ volt, or was equivalent to a naked candle at a distance of 2ft. from the cell. Mr. B. Hopkinson read a short Paper "On the Necessity for Postulating an Ether." The necessity for Mr. Hopkinson's Paper is certainly more problematical than any doubt as to the necessity for postulating an ether at this late period in the history of physical science. Mr. Hopkinson's Paper was not discussed. The concluding Paper for the day was that by Prof. J. Chunder Bose, on "The Change of Conductivity of Metallic Particles under Cyclic Variations of E.M.F." We reprint a portion of this Paper in another part of our issue this week. It is regrettable that owing to the lateness of the hour this important communication was not discussed.

*Saturday, September 14th.*

On Saturday all the sections took a whole holiday, with the exception of the hard-working Section A, which contemplated a programme of 11 Papers, and the new Section L (Education), which united with a portion of Section A in a discussion on the teaching of mathematics, opened by Prof. J. Perry. This joint discussion, together with the numerous excursions arranged and the fine weather, combined to reduce the attendance at the physical department of Section A to a very low figure. Moreover, this small audience showed considerable disinclination to discuss the Papers, with the result that Paper after Paper was read without comment. The proceedings commenced with the reading of the report of the Committee on Radiation in a Magnetic Field. Mr. Griffiths then read a communication from Messrs. C. Bedford and C. F. Green on "A Method of Determining Specific Heats of Metals at Low Temperatures." The method is a modification of the usual method of mixtures, and was described by Prof. Callendar as promising to be a very useful method. After Dr. M. W. Travers had read a valuable communication by himself and Mr. G. Senter on the "Comparison of Constant Volume and Constant Pressure Scales for Hydrogen between 0°C. and −190°C.," Prof. H. L. Callendar gave a "Note on the Variation of the Specific Heat of Water." Prof. Callendar uses an electrical calorimeter consisting of a platinum wire through which a measured current of electricity is passed, the wire being placed in a calorimeter surrounded by a vacuum jacket. Equating the electrical energy to the measured heat acquired by the calorimeter plus the heat radiated, the specific heat of the heat-absorbing substance is determined. The Paper is accompanied by a table giving an immense number of useful constants. Dr. H. A. Wilson's Paper on "The Laws of Electrolysis of Alkali Salt Vapours" gives the result of a valuable and interesting piece of research, leading to the conclusion that Faraday's laws of the electrolysis of liquids are applicable to the vapours of alkaline salts. Experimenting with a large number of salts, and injecting the aqueous solutions of the salts into a blast of air between two electrodes, it was found that the product of the electrochemical equivalent of the ions into the maximum current which could be passed, at any voltage whatever, through the vapour was always a constant equal to $2{\cdot}76 \times 10^{-2}$. It is regrettable that this highly valuable and suggestive Paper raised no discussion. A preliminary note was communicated by Mr. F. G. Cottrell on "The Theory of the Lippmann Electrometer and Related Phenomena." The author described his Paper as being preliminary to a series of investigations on the phenomena associated with the use of different electrolytes in this instrument.

Meanwhile, in Section L, Prof. John Perry read a Paper stating his well-known views on the teaching of mathematics. An exciting discussion ensued. Prof. Forsyth inclined to regard Prof. Perry's position as extravagant, and he advocated the teaching of pure mathematics independently of its physical and other scientific applications. The restricted aspect of Prof. Perry's position was also commented upon, it being pointed out that all boys were not intended to become engineers. Several eminent teachers, however, sided with the author, while some of the speakers threw blame for present defects in the teaching of mathematics upon the Civil Service Commission and other educational authorities.

*Monday, September 16th.*

It is usual in Section G (Engineering) to devote Monday to electrical Papers. This year, however, no electrical Papers were forthcoming, with the exception of Mr. Killingworth Hedges' Paper on "The Protection of Public Buildings from Lightning," which is hardly a matter of electrical engineering. The only other Paper of electrical interest was that by Prof. E. Wilson on "The Commercial Importance of Aluminium." Mr. Hedges, in his Paper, sketched the various means which had been adopted in the past to safeguard buildings from lightning. He then described modern practice in this direction, and announced that data now being collected by the Lightning Research Committee would ultimately lead to definite practical results. In the discussion, Prof. F. G. Baily commented on the lack of any scientific system or set of rules for the guidance of builders and architects. In reply, Mr. Hedges said that he preferred not to lay down any definite rules until the best practice had been thoroughly indicated. Prof. Wilson's Paper practically reviewed the progress of the aluminium industry during the past 10 years, and described some of the applications and uses of this metal. The Paper, however, contained no new information of importance, neither did it elicit anything novel in the brief discussion.

In Section A several Papers on general physics were read and discussed. These, however, were not of direct electrical interest. There was some discussion on the proposal by Dr. C. E. Guillaume to adopt the megadyne per square centimetre as the scientific unit of pressure, the general opinion being adverse to this unit. Dr. J. T. Bottomley, F.R.S., read a useful Paper on the "Radiation of Heat and Light from Polished and Dull Surfaces." He finds that the ratio of the radiation from polished and blackened platinum strips is approximately as 1 to 7 between temperatures of from dull to white heat. The remaining Papers were chiefly of meteorological interest.

*Tuesday, September 17th.*

No Papers of electrical interest were read in any of the sections on Tuesday. The Papers in Section A were on gravitational and optical subjects.

*Wednesday, September 18th.*

Several of the sections, including Section G, did not sit on Wednesday. Section A had a programme of 11 Papers. The proceedings commenced by the reading of the report of the

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Committee on the Determination of Magnetic Force on Board Ship. Bearing on this subject, Capt. E. W. Creak, F.R.S., and Dr. R. T. Glazebrook, F.R.S., read Papers in connection with the magnetic records to be taken by the "Discovery" during her forthcoming Antartic expedition. Capt. Creak exhibited and described the instruments for the determination of the magnetic constants in those latitudes. The observatory on board the "Discovery" is so constructed that there is no iron within 30ft. radius of the instruments, even the rigging within this radius being of rope. In the discussion Dr. Glazebrook pointed out that it was impossible to adopt absolute methods of measurement on a shipboard observatory. All that could be done would be to take observations relative to the absolute determinations at some convenient coast station in the neighbourhood, the constant of the instrument being previously ascertained at that station. The instruments prior to being sent on board the "Discovery" had been compared with the standard magnetic instruments at Kew. They had been found to agree with the Kew instruments within 5min. or 6min. Dr. Schuster observed that the instruments were not provided with verniers, and he approved of this omission. He also inquired as to the "secular changes" which might arise through the variation in the number of tins in the provision store, which he believed was near the observatory; but Capt. Creak assured him there was no likelihood of error on this account. Dr. Glazebrook's Paper described the recording instruments which had been built on the Kew model for recording the declination and the horizontal and vertical forces. These instruments make a continuous photographic record of the measured quantities.

Prof. G. Quincke read a Paper on "The Interference and Polarisation of Electric Waves," describing some ingenious pieces of apparatus for producing plane polarised Hertzian radiation of definite wave length, and for causing two waves, one displaced a quarter-wave length behind the other, to interfere. An ordinary oscillator is placed at the mouth of a metal tube leading into a square metal box from which two branch tubes curve round to a similar box containing the coherer. This apparatus gives always waves of the same wave length, whatever may be the nature of the oscillator and whatever the fluid or other substance filling the tubes. Prof. Quincke found that the ratio of the velocities of the waves in the tubes to the waves outside was as four to three in the apparatus which he used. In another form of the apparatus the radiation from the oscillator is passed through a straight tube to the coherer, but midway along this tube there is a T-piece consisting of a vertical tube which may be either closed or open. By adjusting the length of this T-piece the reflected wave from the bottom of it may be made exactly to interfere with the wave passing straight through. These pieces of apparatus, in fact, closely resemble the accoustical apparatus for producing similar phenomena with sound. In the discussion Dr. Larmor suggested that the wave-length was determined by the tubular apparatus, and not by the actual oscillator, the tubes picking out the particular oscillation corresponding to their own natural period of oscillation. Prof. Quincke agreed with this explanation of the phenomena. A Paper by Mr. G. Barlow described "The Effects of Magnetisation on the Electrical Conductivity of Iron and Nickel." A number of curves accompanied the Paper and showed that the effect is very marked, being greater than can be accounted for by change of length and diameter of the magnetised wire. The increase in the electrical resistance is found to vary approximately as the square of the magnetic induction, there being a second term varying as the fourth power, and a third term varying as the sixth power of the induction. Prof. A. Gray, F.R.S., now read two Papers on "The Influence of a Magnetic Field on the Viscosity of Magnetisable Liquids and Solids." The liquids used were ferrous sulphate and ferric chloride. An almost concentrated solution was passed through a considerable length of capillary tube arranged in a stack between two magnet poles, the tube being turned either so as to allow the magnetic lines to pass along the tube or else across it at right angles. With ferrous sulphate a diminution in the viscosity amounting to about $\frac{3}{4}$ per cent. was observable when the flow of fluid was along the lines of a rather weak magnetic field. With ferric chloride much more marked diminution was observable in the same conditions. When the stack of capillary tube was turned so as to be at right angles to the magnetic lines, no change in the viscosity was observable. The experiments on solids were made by observing the variation in the torsional damping of a loaded vertical wire when longitudinally magnetised. Soft iron wire exhibited marked reduction in its viscosity as the magnetic induction was increased. Precisely the opposite result was obtained with nickel, the viscosity rapidly increasing as the induction increased in strength.

Prof. F. G. Baily briefly described an interesting invention of his own for the measurement of the permeability of iron and steel and other high permeability samples. The apparatus depends on the measurement of the ratio of B to H in the sample. A complete magnetic circuit is formed by two lengths of the sample joined by short iron blocks at the ends. Magnetising coils are placed round the sample. In one of the blocks is a narrow gap perpendicular to the direction of the lines of force. Above this is pivoted a pair of astatic magnets. The lower magnet is influenced by the difference of magnetic potential between the two sides of the gap, the force being proportional to B. Round the upper magnet is placed a small coil in series with the main magnetising coils, which acts on the magnet with a force proportional to H. Using the principle of the sine galvanometer, the coil is rotated until the two forces are balanced, the position of the magnet system being along the line of the gap. Then $\mu = B/H = f(\theta)$. The coil is shaped to give an almost uniform scale through some 80deg. of arc, and the permeability is read directly on the scale. The scale is calibrated for a standard size of specimen, and the value for any other size is obtained by multiplying by the ratio. A wide range is obtained by using only a part of the magnetising coils when the permeability is high. The magnetising force is read on a separate instrument, such as a suitable amperemeter. Regulating resistances, a reversing switch for demagnetising, and a switch for altering the range are added.

## LIST OF THE ELECTRICAL PAPERS READ AT THE BRITISH ASSOCIATION MEETING AT GLASGOW.

The following is a complete list of electrical Papers read and reports presented at the Glasgow Meeting of the British Association, September 11 to September 19, 1901:—

*Section A.—Mathematical and Physical Science.*

Presidential Address, by Major P. A. McMahon, F.R.S.

"On Elastic Fatigue, as shown by Metals and Woods," by Prof. A. Gray, F.R.S., J. S. Dunlop, and A. Wood.

"On the Clearing of Turbid Solutions and the Influence of Light on the Motion of the Suspended Particles," by Prof. G. Quincke.

"On the Relation between Temperature and Internal Viscosities of Solids," by Prof. A. Gray, F.R.S.

"Hydrostatic Pressure," by Prof. W. Ramsay, F.R.S., and G. Senter.

"The Freezing Points of Certain Dilute Solutions," by E. H. Griffiths, F.R.S.

"The Buildings of the National Physical Laboratory," by Dr. R. T. Glazebrook, F.R.S.

"Note on a Comparison of the Deposits in Silver Voltameters with Different Solvents," by S. Skinner.

"On the Conduction of Electricity through Mercury Vapour," by Prof. A. Schuster, F.R.S.

"Sur les Effets Magnétique de la Convection Electrique," by Dr. V. Crémieu.

"On Photo-Electric Cells," by Prof. G. M. Minchin, F.R.S.

"On the Necessity for Postulating an Ether," by B. Hopkinson.

"On the Change of Conductivity of Metallic Particles under Cyclic Variations of Electromotive Force," by Prof. J. Chunder Bose.

"A Method of Determining Specific Heats of Metals at Low Temperatures," by C. Bedford and C. F. Green.

"A New Gauge for Small Pressures," by Prof. E. W. Morley and C. F. Brush.

"The Transmission of Heat through Water Vapour," by Prof. E. W. Morley and C. F. Brush.

"Comparison between Constant Volume and Constant Pressure Scales for Hydrogen between 0°C. and −190°C." by Dr. W. M. Travers and G. Senter.

"Note on the Variation of the Specific Heat of Water," by Prof. H. L. Callendar, F.R.S.

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"The Laws of Electrolysis of Alkali Salt Vapours," by Dr. H. A. Wilson.
"Preliminary Note on the Theory of the Lippmann Electrometer and Related Phenomena," by F. G. Cottrell.
"Effect of Non-Electrolytes on the Lippmann Electrometer Curve," by J. A. Craw.
"Determination of the Surface Tension of Mercury by the Method of Ripples," by J. A. Craw.
"The Potential Differences of Allotropic Silver," by J. A. Craw.
Report of the Committee on Electrical Standards.
Report of the Committee on Radiation in a Magnetic Field.
Joint Discussion with Section L on the Teaching of Mathematics, opened by Prof. J. Perry, F.R.S.
Report of the Committee on Underground Temperature.
"The Application of Fourier's Series in Mathematical Physics," by Dr. H. S. Carslaw.
Discussion on the Proposed New Unit of Pressure, opened by a Paper by Dr. C. E. Guillaume.
"The Michelson-Morley Effect," by Dr. W. M. Hicks, F.R.S.
"The Law of Radiation," by Dr. J. Larmor, F.R.S.
"Radiation of Heat and Light from Polished and Dull Surfaces," by Dr. J. T. Bottomley, F.R.S.
Report of the Committee on the Determination of Magnetic Force on Board Ship.
"On New Instruments for Magnetic Work on Board Ship," by Capt. E. W. Creak, F.R.S.
"A Determination by a Thermal Method of the Variation in the Critical Velocity of Water with Temperature," by Dr. H. T. Barnes and E. G. Coker.
"The Interference and Polarisation of Electric Waves," by Prof. G. Quincke.
"On the Effects of Magnetisation on the Electrical Conductivity of Iron and Nickel," by G. Barlow.
"The Influence of a Magnetic Field on the Viscosity of Magnetisable Liquids," by Prof. A. Gray, F.R.S.
"The Influence of a Magnetic Field on the Viscosity of Magnetisable Solids," by Prof. A. Gray, F.R.S.
"Stress and Magnetisation of Nickel and Cobalt," by J. W. Peck and R. A. Houstoun.
"A New Form of Permeameter," by Prof. F. G. Baily.
"Note on the Coherer," by Prof. J. Blyth.
"On a New Electromagnet and an Echelon Spectroscope for Magneto-optic Observations," by Prof. A. Gray, F.R.S., and Dr. W. Stewart.

*Section B.—Chemistry.*

"The Position of British Chemistry at the Dawn of the Twentieth Century," by Prof. Percy Frankland, F.R.S. (Presidential address).
"The Electrolytic Conductivity of Halogen Acid Solutions," by Dr. J. Gibson.

*Section G.—Engineering.*

Presidential Address by Col. R. E. Crompton.
"A Recording Manometer for High-pressure Explosives," by J. E. Petavel.
"Mechanical Exhibits in the Glasgow Exhibition," by D. H. Morton.
Report of the Committee on Resistance of Road Vehicles to Traction.
"A Leaf Arrester for Intercepting Leaves in the Intake of a Water Supply," by Earl Rosse.
"The Protection of Public Buildings from Lightning," by Killingworth Hedges.
"The Commercial Importance of Aluminium," by Prof. E. Wilson.

*Section L.—Physiology.*

"On the Use of the Telephone for Investigating the Rhythmic Phenomena in Muscle," by Sir John Burdon Sanderson.

## PROF. A. W. RUCKER'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.*

*(Concluded from page 804.)*

*Properties of the Basis of Matter.*

It is easy to show that, whichever alternative be adopted, we are dealing with something, whether we consider it under the guise of separate particles or of differentiated portions of the medium, which has properties different from those of matter in bulk. For if the basis of matter had the same constitution as matter, the irregular heat movements could hardly be maintained either against the viscosity of the medium or the frittering away of energy of motion which would occur during the collisions between the particles. Thus, even in the case in which a hot body is prevented from losing heat to surrounding objects, its sensible heat should spontaneously decay by a process of self-cooling. No such phenomenon is known, and though on this, as on all other points, the limits of our knowledge are fixed by the uncertainty of experiment, we are compelled to admit that, to all appearance, the fundamental medium, if it exists, is unlike a material medium, in that it is non-viscous; and that the particles, if they exist, are so constituted that energy is not frittered away when they collide. In either case, we are dealing with something different from matter itself in the sense that, though it is the basis of matter, it is not identical in all its properties with matter.

* Delivered at Glasgow on September 11, 1901.

The idea therefore that entities exist possessing properties different from those of matter in bulk is not introduced at the end of a long and recondite investigation to explain facts with which none but experts are acquainted. It is forced upon us at the very threshold of our study of Nature. Either the properties of matter in bulk cannot be referred to any simpler structure, or that simpler structure must have properties different from those of matter in bulk as we directly knew it—properties which can only be inferred from the results which they produce. No *a priori* argument against the possibility of our discovering the existence of quasi-material substances, which are nevertheless different from matter, can prove the negative proposition that such substances cannot exist. It is not a self-evident truth that no substance other than ordinary matter can have an existence as real as that of matter itself. It is not axiomatic that matter cannot be composed of parts whose properties are different from those of the whole. To assert that even if such substances and such parts exist no evidence however cogent could convince us of their existence is to beg the whole question at issue; to decide the case before it has been heard. We must therefore adhere to the standpoint adopted by most scientific men, viz., that the question of the existence of ultra-physical entities, such as atoms and the ether, is to be settled by the evidence, and must not be ruled out as inadmissible on *a priori* grounds.

On the other hand, it is impossible to deny that, if the mere entry on the search for the concealed causes of physical phenomena is not a trespass on ground we have no right to explore, it is at all events the beginning of a dangerous journey. The wraiths of phlogiston, caloric, luminiferous corpuscles, and a crowd of other phantoms haunt the investigator, and as the grim host vanishes into nothingness he cannot but wonder if his own conceptions of atoms and of the ether—

> "shall dissolve,
> And, like this insubstantial pageant faded,
> Leave not a wrack behind."

But though science, like Bunyan's hero, has sometimes had to pass through the "Valley of Humiliation," the spectres which meet it there are not really dangerous if they are boldly faced. The facts that mistakes have been made, that theories have been propounded, and for a time accepted, which later investigations have disproved, do not necessarily discredit the method adopted. In scientific theories, as in the world around us, there is a survival of the fittest, and Dr. James Ward's unsympathetic account of the blunders of those whose work, after all, has shed glory on the nineteenth century, might, *mutatis mutandis*, stand for a description of the history of the advance of civilisation. "The story of the progress so far," he tells us, "is briefly this: Divergence between theory and fact one part of the way, the wreckage of abandoned fictions for the rest, with an unattainable goal of phenomenal nihilism and ultra-physical mechanism beyond."* "The path of progress," says Prof. Karl Pearson, "is strewn with the wreck of nations. Traces are everywhere to be seen of the hecatombs of inferior races, and of victims who found not the narrow way to the greater perfection. Yet these dead peoples are, in very truth, the stepping-stones on which mankind has arisen to the higher intellectual and deeper emotional life of to-day."† It is only necessary to add that the progress of society is directed towards an unattainable goal of universal contentment to make the parallel complete. And so, in the one case as in the other, we may leave "the dead to bury their dead." The question before us is not whether we, too, may not be trusting to false ideas, erroneous experiments, evanescent theories. No doubt we are; but, without making an insolent claim to be better than our fathers, we may fairly contend that, amid much that is uncertain and temporary, some of the fundamental conceptions, some of the root-ideas of science, are so grounded on reason and fact that we cannot but regard them as an aspect of the very truth.

Enough has, perhaps, now been said on this point for my immediate purpose. The argument as to the constitution of matter could be developed further in the manner I have hitherto adopted—viz., by series of propositions, the proof of each of which is based upon a few crucial phenomena. In particular, if matter is divided into moving granules or particles, the phenomenon of cohesion proves that there must be mutual actions between them analogous to those which take place between large masses of matter, and which we ascribe to force, thereby indicating the regular, unvarying operation of active machinery which we have not yet the means of adequately understanding. For the moment, I do not wish to extend the line of reasoning that has been followed. My main object is to show that the notion of the existence of ultra-physical entities and the leading outlines of the atomic theory are forced upon us at the beginning of our study of nature, not only by *a priori* considerations, but in the attempt to comprehend the results of even the simplest observation. These outlines cannot be effaced by the difficulties which undoubtedly arise in filling up the picture. The cogency of the proof that matter is cross-grained is in no way affected by the fact that we may have grave doubts as to the nature of the granules. Nay, it is of the first

* James Ward "Naturalism and Agnosticism," Vol. I., p. 153.
† Karl Pearson, "National Life from the Standpoint of Science," p. 62.



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importance to recognise that, though the fundamental assumptions of the atomic theory receive overwhelming support from a number of more detailed arguments, they are themselves almost of the nature of axioms, in that the simplest phenomena are unintelligible if they are abandoned.

*The Range of the Atomic Theory.*

It would be most unfair, however, to the atomic theory to represent it as depending on one line of reasoning only, or to treat its evidence as bounded by the very general propositions I have discussed. It is true that as the range of the theory is extended the fundamental conception that matter is granular must be expanded and filled in by supplementary hypotheses as to the constitution of the granules. It may also be admitted that no complete or wholly satisfactory description of that constitution can as yet be given; that perfection has not yet been attained here or in any other branch of science; but the number of facts which can be accounted for by the theory is very large compared with the number of additional hypotheses which are introduced; and the cumulative weight of the additional evidence obtained by the study of details is such as to add greatly to the strength of the conviction that, in its leading outlines, the theory is true. It was originally suggested by the facts of chemistry, and though, as we have seen, a school of chemists now thrusts it into the background, it is none the less true, in the words of Dr. Thorpe, that "every great advance in chemical knowledge during the last 90 years finds its interpretation in [Dalton's] theory."* The principal mechanical and thermal properties of gases have been explained, and in large part discovered, by the aid of the atomic theory; and, though there are outstanding difficulties, they are, for the most part, related to the nature of the atoms and molecules, and do not affect the question as to whether they exist. The fact that different kinds of light all travel at the same speed in interplanetary space, while they move at different rates in matter, is explained if matter is coarse-grained. But to attempt to sum up all this evidence would be to recite a text-book on physics. It must suffice to say that it is enormous in extent and varied in character, and that the atomic theory imparts a unity to all the physical sciences which has been attained in no other way.

I must, however, give a couple of instances of the wonderful success which has been achieved in the explanation of physical phenomena by the theory we are considering, and I select them because they are in harmony with the line of argument I have been pursuing. When a piece of iron is magnetised its behaviour is different acccording as the magnetic force applied to it is weak, moderate, or strong. When a certain limit is passed the iron behaves as a non-magnetic substance to all further additions of magnetic force. With strong forces it does and with weak forces it does not remain magnetised when the force ceases to act. Prof. Ewing has imitated all the minute details of these complicated properties by an arrangement of small isolated compass needles to represent the molecules. It may fairly be said that, as far as this particular set of phenomena is concerned, a most instructive working model, based on the molecular theory, has not only been imagined, but constructed.

The next illustration is no less striking. We may liken a crowd of molecules to a fog; but while the fog is admitted by everybody to be made up of separate globules of water, the critics of scientific method are sometimes apt to regard the molecules as mere fictions of the imagination. If, however, we could throw the molecules of a highly rarefied gas into such a state that vapour condensed on them, so that each became the centre of a water-drop, till the host of invisible molecules was, as it were, magnified by accretion into a visible mist, surely no stronger proof of their reality could be desired. Yet there is every reason to believe that something very like this has been accomplished by Mr. C. T. R. Wilson and Professor J. J. Thomson. It is known that it is comparatively difficult to produce a fog in damp air if the mixture consists of air and water-vapour alone. The presence of particles of very fine dust facilitates the process. It is evident that the vapour condenses on the dust particles and that a nucleus of some kind is necessary on which each drop may form. But electrified particles also act as nuclei; for if a highly charged body from which electricity is escaping be placed near a steam jet, the steam condenses; and a cloud is also formed in dust-free air more easily than would otherwise be the case if electricity is discharged into it. Again, according to accepted theory, when a current of electricity flows through a gas some of the atoms are divided into parts which carry positive and negative charges as they move in opposite directions, and unless this breaking up occurs a gas does not conduct electricity. But a gas can be made a conductor merely by allowing the Röntgen rays or the radiation given off by uranium to fall upon it. A careful study of the facts shows that it is probable that some of the atoms have been broken up by the radiation, and that their oppositely electrified parts are scattered among their unaltered fellows. Such a gas is said to be ionised.

Thus by these two distinct lines of argument we come to the conclusions:—First, that the presence of electrified particles promotes the formation of mist; and second, that in an ionised gas such electrified particles are provided by the breaking up of atoms. The two conclusions will mutually support each other if it can be shown that a mist is easily formed in ionised air. This was tested by Mr. Wilson, who showed that in such air mist is formed as though nuclei were present, and thus in the cloud we have visible evidence of the presence of the divided atoms. If, then, we cannot handle the individual molecules, we have at least some reason to believe that a method is known of seizing individuals, or parts of individuals, which are in a special state, and of wrapping other matter round them till each one is the centre of a discrete particle of a visible fog. I have purposely chosen this illustration, because the explanation is based on a theory—that of ionisation—which is at present subjected to hostile criticism. It assumes that an electrical current is nothing more than the movement of charges of electricity. But magnets placed near to an electric current tend to set themselves at right angles to its direction; a fact on which the construction of telegraphic instruments is based. Hence, if the theory be true, a similar effect ought to be produced by a moving charge of electricity. The experiment was tried many years ago in the laboratory of Helmholtz by Rowland, who caused a charged disc to spin rapidly near a magnet. The result was in accord with the theory; the magnet moved as though acted upon by an electric current. Of late, however, M. Crémieu has investigated the matter afresh, and has obtained results which, according to his interpretation, were inconsistent with that of Rowland. M. Crémieu's results are already the subject of controversy,* and are, I believe, likely to be discussed in the Section of Physics. This is not the occasion to enter upon a critical discussion of the question at issue, and I refer to it only to point out that though, if M. Crémieu's result were upheld, our views as to electricity would have to be modified, the foundations of the atomic theory would not be shaken.

It is, however, from the theory of ions that the most far-reaching speculations of science have recently received unexpected support. The dream that matter of all kinds will some day be proved to be fundamentally the same has survived many shocks. The opinion is consistent with the great generalisation that the properties of elements are a periodic function of their atomic weights. Sir Norman Lockyer has long been a prominent exponent of the view that the spectra of the stars indicate the reduction of our so-called elements to simpler forms, and now Prof. J. J. Thomson believes that we can break off from an atom a part, the mass of which is not more than one-thousandth of the whole, and that these corpuscles, as he has named them, are the carriers of the negative charge in an electric current. If atoms are thus complex, not only is the *a priori* probability increased that the different structures which we call elements may all be built of similar bricks, but the discovery by Lenard that the ease with which the corpuscles penetrate different bodies depends only on the density of the obstacles, and not on their chemical constitution, is held by Prof. Thomson to be "a strong confirmation of the view that the atoms of the elementary substances are made up of simpler parts, all of which are alike."† On the present occasion, however, we are occupied rather with the foundations than with these ultimate ramifications of the atomic theory; and having shown how wide its range is, I must, to a certain extent, retrace my steps and return to the main line of my argument.

*The Properties of Atoms and Molecules.*

For if it be granted that the evidence that matter is coarse-grained and is formed of separate atoms and molecules is too strong to be resisted, it may still be contended that we can know little or nothing of the sizes and properties of the molecules. It must be admitted that, though the fundamental postulates are always the same, different aspects of the theory, which have not in all cases been successfully combined, have to be developed when it applied to different problems; but in spite of this there is little doubt that we have some fairly accurate knowledge of molecular motions and magnitudes. If a liquid is stretched into a very thin film, such as a soap bubble, we should expect indications of a change in its properties when the thickness of the film is not a very large multiple of the average distance between two neighbouring molecules. In 1890 Sohncke‡ detected evidence of such a change in films of the average thickness of 106 millionths of a millimetre ($\mu\mu$), and quite recently Rudolph Weber found it in an oil-film when the thickness was 115 $\mu\mu$.§ Taking the mean of these numbers and combining the results of different variants of the theory we may conclude that a film should become unstable and tend to rupture spontaneously somewhere between the thicknesses of 110 and 55 $\mu\mu$, and Prof. Reinold and I found by experiment that this instability is actually exhibited between the thicknesses of 96 and 45$\mu\mu$.‖ There can therefore be little doubt that the first approach to molecular magnitudes is signalled when the thickness of a film is somewhat less than

* Thorpe, "Essays on Historical Chemistry," 1894, p. 368.

* See *Phil. Mag.* July, 1901, p. 144; and "Johns Hopkins University Circulars," XX., No. 152, May-June, 1901, p. 78.

† For the most recent account of this subject see an article on "Bodies Smaller than Atoms," by Prof. J. J. Thomson, in the *Popular Science Monthly* (The Science Press), August, 1901.

‡ *Wied. Ann.*, 1890, XL., pp. 345-355.

§ *Annalen der Physik*, 1901, IV., pp. 706-721.

‖ *Phil. Trans.*, 1893, 184, pp. 505-529.

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100 $\mu\mu$, or four millionths of an inch. Thirteen years ago I had the honour of laying before the Chemical Society a *résumé* of what was then known on these subjects,* and I must refer to that lecture or to the most recent edition of O. E. Meyer's work on the kinetic theory of gases† for the evidence that various independent lines of argument enable us to estimate quantities very much less than four millionths of an inch, which is perhaps from 500 to 1,000 times greater than the magnitude which, in the present state of our knowledge we can best describe as the diameter of a molecule.

Confining our attention, however, to the larger quantities, I will give one example to show how strong is the cumulative force of the evidence as to our knowledge of the magnitudes of molecular quantities. We have every reason to believe that though the molecules in a gas frequently collide with each other, yet in the case of the more perfect gases the time occupied in collisions is small compared with that in which each molecule travels undisturbed by its fellows. The average distance travelled between two successive encounters is called the mean free path, and, for the reason just given, the question of the magnitude of this distance can be attacked without any precise knowledge of what a molecule is or of what happens during an encounter. Thus the mean free path can be determined, by the aid of the theory, either from the viscosity of the gas or from the thermal conductivity. Using figures given in the latest work on the subject.‡ and dealing with one gas only as a fair sample of the rest, the lengths of the mean free path of hydrogen as determined by these two independent methods differ only by about 3 per cent. Further, the mean of the values which I gave in the lecture already referred to differed only by about 6 per cent. from the best modern result, so that no great change has been introduced during the last 13 years.

It may, however, be argued that these concordant values are all obtained by means of the same theory, and that a common error may affect them all. In particular, some critics have of late been inclined to discredit the atomic theory by pointing out that the strong statements which have sometimes been made as to the equality, among themselves, of atoms or molecules of the same kind may not be justified, as the equality may be that of averages only, and be consistent with a considerable variation in the sizes of individuals. Allowing this argument more weight than it perhaps deserves, it is easy to show that it cannot affect seriously our knowledge of the length of the mean free path. Prof. George Darwin§ has handled the problem of a mixture of unequal spherical bodies in the particular case in which the sizes are distributed according to the law of errors, which would involve far greater inequalities than can occur among atoms. Without discussing the precise details of his problem it is sufficient to say that in the case considered by him the length of the mean free path is $\frac{7}{11}$ths of what it would be if the particles were equal. Hence, were the inequalities of atoms as great as in this extreme case, the reduction of the mean free path in hydrogen could only be from 185 to 119$\mu\mu$; but they must be far less, and therefore the error, if any, due to this cause could not approaah this amount. It is probably inappreciable. Such examples might be multiplied, but the one I have selected is perhaps sufficient to illustrate my point, viz., that considerable and fairly accurate knowledge can be obtained as to molecular quantities by the aid of theories the details of which are provisional, and are admittedly capable of improvement.

*Is the Model Unique?*

But the argument that a correct result may sometimes be obtained by reasoning on imperfect hypotheses raises the question as to whether another danger may not be imminent. To be satisfactory our model of Nature must be unique, and it must be impossible to imagine any other which agrees equally well with the facts of experiment. If a large number of hypotheses could be framed with equal claims to validity, that fact would alone raise grave doubts as to whether it were possible to distinguish between the true and the false. Thus Prof. Poincaré has shown that an infinite number of dynamical explanations can be found for any phenomenon which satisfies certain conditions. But though this consideration warns us against the too ready acceptance of explanations of isolated phenomena, it has no weight against a theory which embraces so vast a number of facts as those included by the atomic theory. It does not follow that, because a number of solutions are all formally dynamical, they are, therefore, all equally admissible. The pressure of a gas may be explained as the result of a shower of blows delivered by molecules, or by a repulsion between the various parts of a continuous medium. Both solutions are expressed in dynamical language; but one is, and the other is not, compatible with the observed phenomena of expansion. The atomic theory must hold the field until another can be found which is not inferior as an explanation of the fundamental difficulties as to the constitution of matter, and is, at the same time, not less comprehensive. On the whole, then, the question as to whether we are attempting to solve a problem which has an infinite number of solutions may be put aside until one solution has been found which is satisfactory in all its details. We are in a sufficient difficulty about that to make the rivalry of a second of the same type very improbable.

*The Phenomena of Life.*

But it may be asked—nay, it has been asked—may not the type of our theories be radically changed? If this question does not merely imply a certain distrust in our own powers of reasoning, it should be supported by some indication of the kind of change which is conceivable. Perhaps the chief objection which can be brought against physical theories is that they deal only with the inanimate side of Nature, and largely ignore the phenomena of life. It is, therefore, in this direction, if in any, that a change of type may be expected. I do not propose to enter at length upon so difficult a question, but, however we may explain or explain away the characteristics of life, the argument for the truth of the atmotic theory would only be affected if it could be shown that living matter does not possess the thermal and mechanical properties, to explain which the atomic theory has been framed. This is so notoriously not the case that there is the gravest doubt whether life can in any way interfere with the action within the organism of the laws of matter in bulk belonging to the domain of mechanics, physics and chemistry. Probably the most cautious opinion that could now be expressed on this question is that, in spite of some outstanding difficulties which have recently given rise to what is called "Neovitalism," there is no conclusive evidence that living matter can suspend or modify any of the natural laws which would affect it if it were to cease to live. It is possible that though subject to these laws the organism while living may be able to employ, or even to direct, their action within itself for its own benefit, just as it unquestionably does make use of the processes of external nature for its own purposes; but if this be so, the seat of the controlling influence is so withdrawn from view that on the one hand its very existence may be denied, while, on the other hand, Prof. Hæckel, following Vogt, has recently asserted that "matter and ether are not dead, and only moved by extrinsic force; but they are endowed with sensation and will; they experience an inclination for condensation, a dislike for strain; they strive after the one and struggle against the other."*

But neither unproved assertions of this kind nor the more refined attempts that have been made by others to bring the phenomena of life and of dead matter under a common formula touch the evidence for the atomic theory. The question as to whether matter consists of elements capable of independent motion is prior to and independent of the further questions as to what these elements are, and whether they are alive or dead. The physicist, if he keeps to his business, asserts, as the bases of the atomic theory, nothing more than that he who declines to admit that matter consists of separate moving parts must regard many of the simplest phenomena as irreconcilable and unintelligible, in spite of the fact that means of reconciling them are known to everybody, in spite of the fact that the reconciling theory gives a general correlation of an enormous number of phenomena in every branch of science, and that the outstanding difficulties are connected, not so much with the fundamental hypotheses that matter is composed of distinguishable entities which are capable of separate motions as with the much more difficult problem of what these entities are. On these grounds the physicist may believe that, though he cannot handle or see them, the atoms and molecules are as real as the ice crystals in a cirrus cloud which he cannot reach; as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which sweep past us, unentangled, in the night. If the confidence that his methods are weapons with which he can fight his way to the truth were taken from the scientific explorer, the paralysis which overcomes those who believe that they are engaged in a hopeless task would fall upon him.

Physiology has specially flourished since physiologists have believed that it is possible to master the physics and chemistry of the framework of living things, and since they have abandoned the attitude of those who placed in the foreground the doctrine of the vital force. To supporters of that doctrine the principle of life was not a hidden directing power which could, perhaps, whisper an order that the flood-gates of reservoirs of energy should now be opened and now closed, and could, at the most, work only under immutable conditions to which the living and the dead must alike submit. On the contrary, their vital force pervaded the organism in all its parts. It was an active and energetic opponent of the laws of physics and chemistry. It maintained its own existence not by obeying but by defying them; and though destined to be finally overcome in the separate campaigns of which each individual living creature is the scene, yet like some guerilla chieftain it was defeated here only to reappear there with unabated confidence and apparently undiminished force. This attitude of mind checked the advance of knowledge. Difficulty could be evaded by a verbal formula of explanation which in fact explained nothing. If the mechanical, or physical, or chemical causes of a phenomenon did not lie obviously upon the surface, the investigator was tempted to forego the toil of searching for them below; it was easier to say that the vital force was the cause of the discrepancy, and that it was hopeless to attempt to account for the action of a principle which was incomprehensible in its nature.

* *Chem. Soc. Trans.*, LIII., March, 1888, pp. 222–262.

† "Kinetic Theory of Gases," O. E. Meyer, 1899. Translated by R. E. Baynes.

‡ Meyer's "Kinetic Theory of Gases" (see above). § *Phil. Trans.*, 180.

* "Riddle of the Universe" (English translation), 1900, p. 380.



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For the physicist the danger is no less serious though it lies in a somewhat different direction. At present he is checked in his theories by the necessity of making them agree with a comparatively small number of fundamental hypotheses. If this check were removed his fancy might run riot in the wildest speculations, which would be held to be legitimate if only they led to formulæ in harmony with facts. But the very habit of regarding the end as everything, and the means by which it was attained as unimportant, would prevent the discovery of those fragments of truth which can only be uncovered by the painful process of trying to make inconsistent theories agree, and using all facts, however remote, as the tests of our central generalisation. "Science," said Helmholtz, "Science, whose very object it is to comprehend Nature, must start with the assumption that Nature is comprehensible." And again: "The first principle of the investigator of Nature is to assume that Nature is intelligible to us, since otherwise it would be foolish to attempt the investigation at all." These axioms do not assume that all the secrets of the universe will ultimately be laid bare, but that a search for them is hopeless if we undertake the quest with the conviction that it will be in vain. As applied to life they do not deny that in living matter something may be hidden which neither physics nor chemistry can explain, but they assert that the action of physical and chemical forces in living bodies can never be understood if at every difficulty and at every check in our investigations we desist from further attempts in the belief that the laws of physics and chemistry have been interfered with by an incomprehensible vital force. As applied to physics and chemistry they do not mean that all the phenomena of life and death will ultimately be included in some simple and self-sufficing mechanical theory; they do mean that we are not to sit down contented with paradoxes such as that the same thing can fill both a large space and a little one; that matter can act where it is not, and the like, if by some reasonable hypothesis, capable of being tested by experiment, we can avoid the acceptance of these absurdities. Something will have been gained if the more obvious difficulties are removed, even if we have to admit that in the background there is much that we cannot grasp.

*The Limits of Physical Theories.*

And this brings me to my last point. It is a mistake to treat physical theories in general, and the atomic theory in particular, as though they were parts of a scheme which has failed if it leaves anything unexplained, which must be carried on indefinitely on exactly the same principles, whether the ultimate results are, or are not, repugnant to common sense. Physical theories begin at the surface with phenomena which directly affect our senses. When they are used in the attempt to penetrate deeper into the secrets of Nature it is more than probable that they will meet with insuperable barriers; but this fact does not demonstrate that the fundamental assumptions are false, and the question as to whether any particular obstacle will be for ever insuperable can rarely be answered with certainty. Those who belittle the ideas which have of late governed the advance of scientific theory too often assume that there is no alternative between the opposing assertions that atoms and the ether are mere figments of the scientific imagination, or that, on the other hand, a mechanical theory of the atoms and of the ether, which is now confessedly imperfect, would, if it could be perfected, give us a full and adequate representation of the underlying realities. For my own part I believe that there is a *via media*. A man peering into a darkened room, and describing what he thinks he sees, may be right as to the general outline of the objects he discerns, wrong as to their nature and their precise forms. In his description fact and fancy may be blended, and it may be difficult to say where the one ends and the other begins; but even the fancies will not be worthless if they are based on a fragment of truth, which will prevent the explorer from walking into a looking-glass or stumbling over the furniture. He who saw "men as trees walking" had at least a perception of the fundamental fact that something was in motion around him.

And so, at the beginning of the twentieth century, we are neither forced to abandon the claim to have penetrated below the surface of Nature, nor have we, with all our searching, torn the veil of mystery from the world around us. The range of our speculations is limited both in space and time: in space, for we have no right to claim, as is sometimes done, a knowledge of the "infinite universe"; in time, for the cumulative effects of actions which might pass undetected in the short span of years of which we have knowledge, may, if continued long enough, modify our most profound generalisations. If some such theory as the vortex-atom theory were true, the faintest trace of viscosity in the primordial medium would ultimately destroy matter of every kind. It is thus a duty to state what we believe we know in the most cautious terms, but is equally a duty not to yield to mere vague doubts as to whether we can know anything. If no other conception of matter is possible than that it consists of distinct physical units—and no other conception has been formulated which does not blur what are otherwise clear and definite outlines—if it is certain, as it is, that vibrations travel through space which cannot be propagated by matter, the two foundations of physical theory are well and truly laid. It may be granted that we have not yet framed a consistent image either of the nature of the atoms or of the ether in which they exist; but I have tried to show that in spite of the tentative nature of some of our theories, in spite of many outstanding difficulties, the atomic theory unifies so many facts, simplifies so much that is complicated, that we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities.

## COL. R. E. CROMPTON'S PRESIDENTIAL ADDRESS TO SECTION G OF THE BRITISH ASSOCIATION AT GLASGOW.*

At this, the first meeting of the British Association of the new century, I wish to lay before you some of the interesting problems presented by recent developments in means of locomotion on land which demand the best thoughts, not only of our engineers, but of everyone interested in the improvement in means of travelling and in the more rapid transit of goods.

During the 70 years which have passed since the introduction of railways, in almost every country passenger and goods traffic has developed itself to such an extent that almost everyone is interested in these questions; and of late years our attention has not been confined to railways only, but, owing to the invention of the cycle and motor-car, has also been directed to travel on our roadways, which during the first 50 years of the railway era had somewhat fallen into disuse. I am not able, being limited to the length of this address, to deal with many of the interesting questions affecting our long-distance railways other than by referring to the probable early introduction of railways of a new type intended to attain a speed of 120 miles per hour and worked by electrical power. The railway race to Scotland of a few years back attracted the attention of the managers of American and Continental railways to railway speed questions, and we have seen during the last few years so great improvement in the speed of the trains and the comfort of the passengers in these countries that it appears that England has already been beaten in the matter of extreme railway speed, although it is probable that our railways still provide a larger number of rapid trains than either the American, German, or French do. But whether it be in England or in the countries I have mentioned, it appears that after all the speed limit of railways of the present system of construction is reached at about 65 or 70 miles per hour. Higher speed on level runs has undoubtedly been recorded, but it is not probable that anything greatly in excess of 70 miles per hour will be reached until our railway managers initiate an entirely new system of construction. The high-speed service that is now in contemplation, not only in England but in America and Germany, intends to attain speeds of over 100 miles per hour by providing electrical means of haulage sufficient to propel light trains consisting of one, or, at the most, a few cars; and in order to render this service successful to run these light trains at short intervals of time, so, in effecting this high speed the railways will give a service which more nearly resembles the tramway service than our present system of heavy express trains at infrequent intervals. This high-speed service of light trains at frequent intervals is well suited to electrical haulage, as it works generating machinery situated at fixed points to the best advantage, and enables the best return to be obtained from the necessarily heavy capital cost of copper in the conductors which transmit the energy along the length of the line, as it is evident that if the speed be sufficient to ensure that each section of the line only carries one running train, the costs of the conductors will be in proportion to the weight of that train.

Great advantages have already been made in adapting electrical traction to long lengths of railways. The work already done by Brown, Boveri, of Baden, in Switzerland, at first on the mountain railways and afterwards on the Burghdorf-Thun full-gauge line, the experimental work of Ganz & Co., of Buda Pesth, and of Siemens and Halske at Charlottenburg, have already shown that the power problems are nearly all of them solved, so that we may feel confident that electrical engineers will very shortly surmount any power difficulties that still remain. But this high-speed railway problem at present presents certain unknown factors which can only be satisfactorily determined by the actual testing and working the lines when carrying passengers. I refer to those which deal with the increased oscillation, vibration, and noise to be expected from the extreme speeds. These matters must be met so as to give sufficient comfort and protection to the passengers, for if passengers are rendered uncomfortable by the extreme speed the service can never become popular, and on this last question depends the most important question of all—viz., the extent to which the travelling public are likely to make use of a high-speed railway service. In attempting to forecast this matter, although we meet many business men who think it would be an undoubted advantage if the journeys between

* Delivered September 12, 1901.

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important business centres occupied half the time they do at present, in the United Kingdom there are only a few journeys of sufficient length to make saving of time of great importance, but the case is far different in America and on the Continent, where the business centres are much further apart than they are here. I, as an English engineer, foresee that this topographical question will cause our English engineers to be at a disadvantage as compared with American and Continental ones, for it appears likely that the number and mileage of high-speed railways is likely to be far greater in America and on the Continent than in the United Kingdom. Before I entirely leave the subject of very high-speed railways, a rather curious speculation presents itself to us: this is, whether the need for rapid communication between town and town may not eventually be supplied by high-speed motor cars on roads specially prepared for them. Mr. Wells in his interesting forecast in the *Fortnightly Review* seems to think that the time is not far distant when all passenger traffic will be carried on special roads on motor cars. That the advantages of carrying your family and loading up your belongings at your own door, in your own or a hired car, and transporting them without any change or handling of your baggage right up to the point where your journey ends, will be so great that even for comparative long journeys travellers will prefer it to the railway, and that our railways will eventually be relegated to carrying minerals and heavy goods. But, without going so far as Mr. Wells, it does seem probable that if only a few passengers require to travel between two business centres such as Manchester and Liverpool, and to occupy only half the time from door to door at present taken by the railway and the two terminal cab rides, it might be better to provide one of Mr. Wells's improved roads on which private owners could run their own cars, paying toll for the road, and on which a public service of cars would provide for those who did not own cars themselves.

I now propose to deal at somewhat greater length with what I think is a most important problem in locomotion—viz., that caused by the congestion of street traffic in our towns and by the undoubted difficulties which exist in carrying our workers to and from their homes in the country to their places of employment in our towns. A large proportion of the workers who during the latter half of the last century lived and worked in the country are now working in towns, although some of them still live outside in order to obtain the advantages of lower rents and of a healthier life for their families, and this last class is likely to largely increase. Those who have been responsible for the enlarging and improvements of our towns have done so much to make town life preferable to country life that the country is gradually being depopulated. The results we see in the increasing difficulties which the town authorities find in dealing with the water and sewerage questions, and in the increasing mass of vehicular street traffic, which makes some of our cities veritable pandemoniums. Luckily it seems that we are likely, through the skill and energy of our engineers, to meet these difficulties in more than one way. The cycle, which commenced as an amusement and went on as a fashionable craze, has now settled down into being the poor man's horse. The number of our working population that use the cycle for going to and from their work is already very large and is steadily increasing, and their use of the roads must be considered. Then came the motor car, developed in France to such an amazing extent, and which seems now likely to be developed to an equal extent in this country. After many years of objecting to the use of the overhead trolley system, our town authorities seem now to have determined that the only way of relieving street traffic is by an enormous development of electrical tramways, and on all sides we find the large towns rivalling one another in the extent of the tramway systems which they have either acquired or are laying down for themselves. It seems opportune now to point out that a great deal of mischief may accrue by this indiscriminate use of tramways, and for those who are considering these matters I bring forward a few facts which are worthy of notice. Of course, in new countries, or in new towns in old countries, where the roads are rough and bad, anything in the nature of a tramway using rails is an improvement on a roadway; but when we are dealing with cities which already possess well laid-out and well paved streets, on which all kinds of wheel traffic can be carried on with a minimum of rolling resistance, it seems wrong from an engineering point of view to break up the surface of these streets for the purpose of laying tramways, and for the following important reasons:—Traffic carried on a roadway by vehicles, whether horse-drawn or by cycle or motor car, differs from traffic carried on rails chiefly in that the former vehicles possess an important power—viz., that of *overtaking*, which is not possessed by the latter—that is to say, that vehicles on the plain road surface can overtake a stopping or a slower vehicle going in the same direction without interfering with other vehicles, whereas on rails the vehicles going one way must always remain in the same relation to one another, so that the speed of vehicles on rails must always be regulated by that of other vehicles going in the same direction. Street tramways, for instance, must stop to set down and take up passengers; this limits the speed average and the number of vehicles per mile of track, for if there be not sufficient intervals between the vehicles they would have to stop and start nearly simultaneously. Thus the carrying capacity of the best modern electrical tramway is limited by this want of overtaking power. I have made careful inquiry from those who have great experience in tramways, not only in this country, but in America and on the Continent, and I find that it is generally admitted that the maximum carrying capacity of an electrical tramway in one direction is 4,000 passengers per hour carried past any given point. I find that a full-gauge suburban or metropolitan railway crowded to its fullest extent cannot carry more than 12,000 passengers per hour. Now, most of us have often seen large crowds taken away from a point of attraction by omnibuses and horse-drawn vehicles, and have noticed that the crowded omnibuses almost touch one another, and yet can go at a fair rate of speed. In this case, at 8 miles per hour speed, 14,000 passengers can be carried from a given point per hour.

Up to the present a public motor-car service has not yet been installed of any magnitude to enable us to compare the carrying capacity of motor cars with that of horse-drawn omnibuses, but owing to the reduced length of motor cars compared with that of omnibuses, and on account of their greater speed and greater control, motor cars can now be built to deal with great crowds at an even higher rate per hour than that noted above. It appears certain, therefore, that although the provision of electrical railways is undoubtedly an economical means of carrying passengers, yet that these tramways cannot be laid in existing thoroughfares without considerably reducing the total road carrying capacity at times of heavy pressure of traffic, and as it appears likely that either for the daily transport of the workers to and from their homes to places of employment, or for taking great crowds out into the country for pleasure purposes, a motor-car service carried out on well-made roads will compete favourably with, and in many ways may be preferable to, tramway service.

It must be remembered that the laying of tram-rails not only blocks ordinary traffic, but in our most crowded streets it introduces dangers to all wheeled vehicles not on rails, motor cars and cyclists by the skidding of the wheels when they cross the line of rails, and these dangers are daily causing, and are still likely to cause, very serious accidents.

The increased road and street traffic and the development of new means of road locomotion have made imperative some modification of our existing system of roadway administration. Cycles, motor cars, electrical tramcars have been invented and put on roads which are maintained and worked exactly as they were 70 years ago, at the commencement of the railway era, when the population of the United Kingdom was half its present figure, and that of the large towns one-tenth of the present figure. During the 150 years previous to the railway era the ancient tracks were gradually improved into tolerably efficient roads for coach and waggon traffic, but after the introduction of railways there was a complete cessation of improvement, as for 50 years after the railways started the old roads were equal to the farmers' and local traffic which the railways left for them; but for the last 20 years the roads near to the great towns have been inadequate, and now that the cyclist and motor-carist travel over the whole of the roads of the country, the neglect of our ancient roadway system is very apparent.

Although the urban populations have so greatly increased, the old coaching roads are still the only ones that exist; no main roads parallel to the old ones or alternative to them have ever been made. Towns which are now joined by railways grew out of small rows of houses built facing the main road; in fact, in many cases the road made the town. During the early part of the railway era, when the roads were so little used from coaching falling into disuse, encroachments on the roadway took place in and near the towns, such roads being now actually narrower and less suitable for traffic than in the coaching days; so that these towns which owe their existence to these roadways now put every impediment and hindrance to their use by the travelling public. What is needed is that towns situated on our main through roads should provide alternative routes, so that through travellers could, if they desired, avoid the crowded streets of the town. One method of providing such relief roads would be by bye-laws providing that all building estates should set aside land for main roads. The building estates which are developed around our great towns never provide a road which can be used as a main line of thoroughfare, although by their very act of building additional houses they cause additional congestion to the main roads. They lay out their roads to obtain quiet for those who live on the estate, and take every possible means to prevent their estate roads from taking a share of the main thoroughfare traffic.

Parliament must take in hand an improved administration of our highways by a comprehensive scheme. Far too many ancient main lines of thoroughfare, already too narrow for the traffic which is on them, are being blocked by having tramways laid on them. These cause the development of building estates, which throw additional traffic on to these thoroughfares. Apart from the roads themselves, the complicated conditions of street and road traffic demand careful regulation. Street traffic should be carried as far as possible by lines of vehicles driven as nearly parallel to one another as possible. The

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rule of the road, as it is called, and which is embodied in an Act of Parliament, 5 and 6 of William IV., which is commonly called the Highways Act, says that every vehicle is to keep as close as possible to the left, or near side of the road, except when overtaking another vehicle going in the same direction, and then it is to keep to the off side of the overtaken vehicle as closely as possible. As a matter of fact, everybody knows that this rule is habitually neglected by drivers, who, whenever they get a chance, drive down the centre of the road, so that others who overtake them dare not do so on the wrong or near side, but must pass out far to the off side of the road, and consequently interfere with the traffic coming in the opposite direction. This neglect of the rule of the road causes a great waste of space immediately behind every vehicle, and is one of the chief causes of the limited carrying capacity of the streets in cities where the police do not attend to this important matter. It can be remedied by the existing police regulations being adhered to and insisted on by fixed-point constables, or by constables moving about on motor cars or bicycles. Slow-moving and frequently-stopping vehicles are another cause of congested traffic. A great deal might be done by arranging that during certain hours much of the slower-moving traffic is shunted into alternative routes, so as to be kept by itself. An increase in the speed of the street traffic is desirable; for the faster the vehicles travel the less the street is occupied by them. Motor cars can safely travel at 16 miles an hour, and, therefore, need only take half the time and occupy only half the street surface that an omnibus does when travelling at 8 miles per hour. Such high speeds as these, which are desirable and perfectly safe for motor cars, cannot, however, be obtained unless some regulations are made as to the use of the roadways by foot passengers. There is no rule of the road for foot passengers—they pass one another on the footpath, or vehicles in the roadway, just as they please. No driver of a vehicle in the road who sees a foot passenger stepping into the roadway can ever tell with certainty what his movements will be. It will be no hardship to foot passengers to insist on their movements being regulated.

Much has been recently said and written on the subject of motor-cars and motor-waggons. It is generally admitted that there will be considerable scope for engineering skill and capital in their improvement and construction. It is by no means an easy problem to put into the hands of the public such a complicated piece of mechanism as a self-propelled carriage which has in most cases to be managed and driven by men who have had no special mechanical training. Motor-cars to be universally successful must be made so as to reduce to a minimum the liability to break down; repairs must be limited to the replacement of worn or damaged parts by other parts, which must be supplied by the manufacturers so that they can be readily put in by the unskilled users. That this can be done is shown by the success and universal use of typewriters, sewing machines and bicycles: all of these are really complicated pieces of mechanism, but which are now in such general use and in everyone's hands. In these cases, however, the organised manufacture of machines with thoroughly interchangeable parts, or components as it is the fashion to call them, has only been developed after the type of machine had settled down, and this up to the present cannot be said of the motor-car or motor-waggon. Up to the present the development of these cars has gone on on several lines. The development in France, which so far has led the world, has been principally in the direction of the use of light motors driven by petrol spirit. Again to France we owe the flash boiler of Serpollet, which assists the use of steam engines for this purpose.

At first sight, steam, with the complications of boiler, engine, and condenser, does not appear likely to compete favourably with the simpler spirit motor, but for heavier vehicles, where steady heavy pulling power is of importance, up to the present no internal combustion motor has competed with it. The Americans, with their usual skill and power of rapidly organising a new manufacture, have already turned out a very large number of steam-driven motor cars, which are so largely in use in unskilled hands that it shows that they have already solved the problem to some extent.

The directions in which the two classes of motors require further development are, for the internal combustion motors, the satisfactory and inodorous use of the heavier oils, and in this perhaps Herr Diesel may help us with his wonderfully economical motor improvements in the clutch mechanism, for with all internal combustion engines up to the present it has been found impossible to start the motor when coupled to the driving-wheels of the car; and in the case of the steam motor the simplification of the boiler, the boiler feed mechanism, the inodorous and noiseless burning of heavy oils as fuel, improved condensers, methods of lubricating the pistons and valves so as to avoid oil passing back to the boiler with the condensed water, and the rendering of all processes of boiler feed and fuel feed mechanism completely automatic so as not to require the attention of the driver. On points common to both classes, although much has been done, further improvement is required in the methods of transmitting the power from the motor to the driving wheels. In the case of the steam cars, where this has been done by single reduction, using chain, pinion and sprockets, very efficient and noiseless transmission has already been obtained, but up to the present in most of the internal combustion engines, where more than two cylinders have to be employed, it has been found necessary to arrange the crank shaft of the motor at right angles to the axle of the driving wheels, so that, part of the transmission having to be through bevel gear, this part has, up to the present, always been noisy. In the providing of noiseless and efficient chain driving, the manufacturer of cars has gained greatly by the high degree of perfection to which these chains had already attained for bicycle work.

The recent great road races which have taken place in France and elsewhere have shown that the motor car can be driven safely at a very high speed, already reaching in some cases 70 miles an hour; but to render this capacity for high speed useful, not only must special roads be provided on which these high-speed cars can travel without danger to others and with least slip and wear and tear of tyres, but a great deal requires to be done in the improvement of the pneumatic tyres, which at present get excessively hot, and, therefore, damaged by these high-speed runs. At these high speeds the mechanical work done on the material of which the outer covers of pneumatic tyres are composed is excessively high. It can probably be reduced by increasing the diameter of the wheels, but, of course, at the cost of increased weight and, to some extent, of stability, for the side strains on the wheels of these cars when swinging round curves of sharp radius are very great.

Another direction in which mechanical invention is required for the wheels of motor cars and waggons is a shoeing or protection of hard material of easily renewable character which can be firmly and safely attached to the outside of the tyre covers to take the wear and cutting action caused by the driving strain and by the action of the breaks on sudden stops.

The late R. W. Thomson, of Edinburgh, made good progress some 30 years ago in providing steel shoeing for the solid rubber tyres he then used, and the problems of providing the same for pneumatic tyres ought to be no harder than those he then successfully encountered.

One of the topics which has been most strongly discussed during the last year has been the position which this country holds relatively to other countries as regards its commercial supremacy in engineering matters. A few years back we were undoubtedly ahead of the world in most branches of mechanical engineering, but owing to the huge development of mechanical engineering in America and Germany, we are certainly being run very hard by these countries, and everyone is looking for means to help us to regain our old position. In endeavouring to learn from America we see that, although the workmen in that country receive higher wages than they do here, and although the cost of some of the materials is higher than it is here, their manufacturers manage to deliver engines, tools, and machinery of all classes of excellent quality at a price which appears to our manufacturers to be marvellously low. When we look into the matter we find that the chief difference between the manufacturer of America and the manufacturer at home is that, whether it be steam engines, tools, agricultural machinery, or electrical machinery, the American invariably manufactures goods in large quantities to standard patterns, whereas we rarely do so here, at any rate to the same extent. Where we turn out articles by the dozen the American turns them out by the hundred. This difference in the extent to which an article is re-duplicated is caused by the Americans having realised to a far greater extent than we have the advantage of standardisation of types of machinery. They have felt this so strongly that we find in America that work is far more specialised than it is here, so that a manufacturer as a rule provides himself with a complete outfit of machinery to turn out large numbers of one article. He lavishes his expenditure on special machinery to produce every part sufficiently accurate to dimension to secure thorough interchangeability; consequently the cost of erecting or assembling the parts is far less than it is here. One reason why the American manufacturer has been able to impose on his purchasing public his own standard types, whereas we have not been able to do so, is that very rarely in America does a consulting engineer come between the manufacturer and the user, whereas here it is the fashion for the majority of purchasers of machinery to engage a consulting engineer to specify and inspect any machinery of importance. By this I do not impute any blame to our consulting engineer; he considers the requirements of his client, and insists that they are to be adhered to as closely as possible; to him the facility of the production of articles in large quantities is of no moment. In America it seems to be understood by the purchaser that it is a distinct advantage to everyone concerned, both manufacturer and purchaser, that the purchaser should to some extent give way and modify his requirements so as to conform with the standard patterns turned out by the manufacturer. Although manufacturers all hope for this simplification of patterns, yet, for the reasons I have given, it will be some time before their hope is realised. But on other matters it is quite possible for manufacturers to combine, so as to obtain some standardisation of parts which they manufacture which will reduce costs and be of advantage to everyone concerned. Many years ago Sir Joseph Whitworth impressed on the world the importance in mechancial engineering of extreme accuracy, and of securing the accurate fit and interchangeability of parts by standard gauges. But in spite

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of his idea being so widely known and taught, how seldom it has been acted upon to the extent that it should be. We pride ourselves on having all our screws made of Whitworth standard, and yet how many of the standard bolts and nuts made by different makers fit one another? I myself have sat on a committee of this Association, which was called together 20 years ago, with Sir Joseph Whitworth as a member of it, to fix on a screw gauge which would be a satisfactory continuation of the Whitworth screw gauge down to the smallest size of screw used by watchmakers.* It has taken all these years to carry out the logical outcome of Sir Joseph Whitworth's original idea, viz., the providing of standards to be deposited in care of a public authority to act as standard gauges of references. The complete interchangeability of parts which I have above referred to, and which is so desirable in modern machinery, can, of course, be obtained within the limits of one works by that works providing and maintaining its own standards to a sufficient degree of accuracy; but if the articles be such as watches or bicycles, motor cars, &c., it is very desirable that all parts liable to require replacement should be made by all manufacturers to one standard of size, and, in order that the gauges required for this purpose should all be exact copies of one another, it is necessary that they should be referable to gauges deposited either with the Board of Trade or with some body specially fitted to verify them and maintain their accuracy.

Up to the present the Board of Trade has dealt with the simple standards of weight, capacity, and length, but in other countries National Standardising Laboratories have been provided, viz., by the Germans at their Reichsanstalt at Charlottenburg, and with the happiest results; here at last, through the exertion of the Council of the Royal Society, our Government has been moved to give a grant in aid and to co-operate with the Royal Society to establish a National Physical Laboratory for this country. About ten years ago Dr. Oliver Lodge gave the outlines of a scheme of work for such an institution. Later Sir Douglas Gaulton, in his presidential address to this Association, called attention to the good work done by the Germans and the crying need that existed for such an institution in this country. The matter has since progressed. A laboratory is already in existence, and will soon be at work, at Bushey House, Teddington: it is a large residence, which was once occupied by the late Duke of Clarence and afterwards by the Duc de Nemours. It will make an admirable laboratory, as it has large and lofty rooms and a vaulted basement in which work can be carried on where it is important to secure the observer against changes of temperature.

The aims of a National Physical Laboratory have been put forward by Dr. Glazebrook in a recent lecture at the Royal Institution, in which he points out how little science has, up to the present, come to be regarded as a commercial factor in our commercial world. The position of manufacturers of all classes must be helped and improved by a well-considered series of investigations on the properties of materials, measurements of forces, and by the careful standardisation of and granting certificates to measuring apparatus of all classes. Until the question is fairly faced and studied, few manufacturers realise how helpless individual effort or individual investigations must be when compared with comprehensive and continuous investigations which can be carried on by a National Laboratory so as to deal with the whole of each subject completely and exhaustively, instead of each investigation being limited by the temporary need of each manufacturer or user.

As an example Dr. Glazebrook showed how much has been done at Jena and afterwards at the Reichsanstalt in the development of the manufacture of glass used in all classes of scientific apparatus. The German glass trade has benefited enormously from these investigations. The microscopic examination of metals, which was begun by Sorby in 1864, has been much worked at by individual investigators in this country, but its further development, which is probably of enormous importance to arts and manufactures, is clearly the duty of a National Laboratory. We owe much to the investigations of the Alloys Research committee of the Institution of Mechanical Engineers; but again this is work for the National Laboratory. As regards the measurement of physical forces, how little is accurately known of the laws governing air resistance and wind-pressures, and the means of measuring them. Who can formulate with any certainty a law for the air resistances likely to be met with at speeds in excess of 80 miles an hour, the importance of which I have already noticed?

I have already alluded to the verification, care and maintenance of ordinary standard gauges of accuracy. In this electrical age the accuracy of electric standards is of supreme importance.

These are only a few of the directions in which we can foresee that the establishment of a National Physical Laboratory will be of the greatest use and assistance to our country in enabling it to hold its own in scientific and engineering matters with its energetic rivals. The work has been commenced on a small scale, but it is to be hoped that its usefulness will become at once so evident and appreciated that it will soon be developed so as to be worthy of our country.

*A report of this committee will come before you during this meeting.

# CORRESPONDENCE.

## THE DISRUPTIVE STRENGTH OF INSULATING MATERIALS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest Dr. Baur's suggestion that the disruptive strength of a dielectric is not measured by the stress (in its ordinary significance), but that the voltage required to break it is proportional to the two-thirds power of its thickness. It has long been known that the dielectric strength of insulator, expressed in terms of the stress at which it punctures, increases when the gap is small. That this increase should follow a simple law between flat electrodes might be expected, but Dr. Baur scarcely gives enough evidence for a general formula.

The curves in Mr. Siemens's Paper (which Dr. Baur prepared) are approximate straight lines from the moment the thickness exceeds 1cm., and in some cases much earlier. The curves in my Paper for mica begin to straighten out before 1mm. is reached, and Trowbridge found a straight-line law in an elaborate experiment on very great thicknesses of air.

In Appendix II., p. 64, *Proceedings* of I.E.E., Vol. XXX., 1901, I reproduce T. Gray's tests on four different oils where a similar effect is noticeable, and generally as soon as we are dealing with high voltages, and therefore thickness sufficiently great to cause what might provisionally be called "proximity resistance" if not "skin resistance" to disappear, a law simpler than Dr. Baur's—namely, the straight-line law—appears to rule.

Dr. Baur's deductions are open to question when he deals with tests made between *curved* electrodes as in a cable and proceeds to claim that tests taken on impregnated calico between *plane* electrodes follow the same law so exactly that the curves may be superposed.

In the Paper to which Dr. Baur alludes I dealt a good deal with the effect of curvature, quoting Swinburne and others to show how the stress would be increased when the curvature was small, and giving a logarithmic formula which may be expected to deal with it. Indeed, Mr. Russell pointed out in the discussion on Mr. Siemens's Paper that unlike Mr. Siemens he had found a very great difference in sparking distances with differently shaped electrodes, so I can only conclude that the identity between the tests taken on cables and those between flat electrodes alluded to by Dr. Baur is accidental and proves little.

We must look forward to the time when Dr. Baur will publish his experiments in detail,* particularly as he has apparently been exceptionally fortunate in obtaining consistent results, whereas most of us have been baffled by the erratic nature of breakdown tests, except, perhaps, in dealing with air.

In air Dr. Baur says that he has not obtained an indication of the straight-line law, but on looking up his published data† I find that the thickness was only up to 1cm., where the straight line was not to be expected. I would refer him to Trowbridge's experiments, which are, to my mind, final and convincing, apart from the fact that the straight line apparently was Maxwell's theory‡ and coincides with Lord Kelvin's§ pronounced expectation.

Now, if Maxwell's assumption is correct the stress $= S = V/d$ is a constant of the substance, and the curve connecting V and $d$ ought to be a straight line. We see that air, empire cloth, fuller board, and four oils give good straight lines, mica a fair straight line, but none of them pass through the origin. The curve, a straight line not through the origin, is $V = A + Bd$ when A and B are the constants for different dielectrics (and, perhaps, also electrodes). If, instead of plotting

* Neither Mr. Siemens nor Dr. Baur give any idea of the size of the copper conductor of most of the cables which were tested.

† *The Electrician*, March 4, 1892, p. 463.

‡ Maxwell: "Electricity and Magnetism," 3rd edition, 1892, Art. 51, p. 54:—"The value of the electromotive intensity which can exist in a dielectric without a discharge taking place is called the electric strength of the dielectric," &c.

§ Kelvin: Paper on "Electrostatics and Magnetism," 1884, Art. 340, p. 262, 2nd edition:—"It seems most probable that at still greater distances the electrostatic force will be found to be sensibly constant, as it was certainly expected to be at all distances."

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V and $d$, we plot $V/d$ and $d$, we get $Sd = A + Bd$, that is, the curve between S and $d$ is a rectangular hyperbola, and in my Paper the curves give a very decent approximation to a hyperbola.

Writing the equation $S = (A/d) + B$, we see that when $d$ is large *compared with* A, S = B = a constant, and from the diagrams on pp. 33, 35, 37, 39, 40 of my Paper (*Journal* I.E.E., 1901, Part 150, Vol. XXX.), we may conjecture that, after a thickness of from ½cm. to 1cm., the dielectric strength curve is sensibly parallel to the axis of thickness, and not, as Dr. Baur suggests, "only when the range of striking distance is small."—Yours, &c., MERVYN O'GORMAN.

London, Sept. 16.

## CITY AND GUILDS OF LONDON INSTITUTE LISTS OF BOOKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: No one will doubt the great work done by this Institute, particularly in its technological and manual training classes. The teaching, however, is not meant to be final; indeed, the object of the system of training and instruction is rather to create a desire for information on technical matters than to satisfy it.. Every intelligent student is well aware that when he has gone through the course of training—the tuition provided at this and kindred institutions—his education is just commencing. He has been told what to do, and why he should do it, and he has now to ascertain by personal experience how to do it.

I have the programme of the Institute for the coming session, and it is full of valuable information, but there is a feature of it that is not at all satisfactory. After the syllabus of each subject taught in the Institute, a list of "Works of Reference" is given. They are described as works of reference in the programme, but I find amongst them text books, reference books, trade and technical journals and art handbooks. The lists appear to have been compiled by some one not fully acquainted with the literature of the industries dealt with, since some of the works named are certainly not now standard reference books and some are even out of print. But the errors of omission are the most serious. A student who works to acquire reference and text books to assist him in mastering the practical details of his trade should have the best and most up to date. In some industries the latest published are the best, yet I find many really useful, practical reference books not even mentioned, and in some of the lists there is no mention made of the very instructive trade journals published. A student who is enquiring as to works dealing with the industry he has chosen to follow, must not rely upon the lists given by the compilers of this programme. He will miss much useful literature if he does.—Yours, &c.,

London, Sept. 17. WM. THOMSON.

[Our correspondent evidently refers to the programme of technological examinations of the Institute, not to the programmes of the Central Technical College and the Finsbury Technical College.—ED. *E.*]

# LEGAL INTELLIGENCE.

### Legality of Picketing.

The action Banister Bros. and Moore *v.* Blackburn and District Weavers', Winders' and Warpers' Association was again before Mr. F. Willis Taylor, Deputy Vice-Chancellor of the Chancery of Lancaster, on Tuesday. It will be remembered that plaintiffs ask for an injunction to restrain respondents, both individually and on behalf of themselves and other members of the association, from "watching or besetting, or causing to be watched or beset, plaintiffs' mills at Blackburn, or the approaches thereto, or the places of residence of any employés, or any place where any employés may happen to be, or in which employés are working or preparing to work for plaintiffs, for the purpose of persuading or otherwise preventing persons from working for plaintiffs, or for any purpose except merely to obtain or communicate information." It is also sought to restrain defendants "from procuring or inducing any persons who may have entered or may enter into contracts with plaintiffs to commit a breach of such contracts, and from wrongfully and maliciously persuading or inducing such persons, or conspiring to persuade or induce such persons, to put an end to or not to enter into such contracts."

For the plaintiffs, Mr. GRANT said the injunction applied for was of a similar nature to that which had been recently granted in the now famous Taff Vale case. Lately there had been quite a number of trade union cases, and the position now was practically this: It had been decided that picketing for any purpose except communicating or obtaining information was illegal at common law, on the ground that it was a nuisance to the individual, and also under the Conspiracy and Protection of Trade Act, 1875. It was well established that to persuade a person to commit a breach of contract was illegal, and it had been decided recently that for persons to conspire to induce other persons not to enter into contracts with an employer was also illegal. These were the lines on which the present injunction was asked for. Two of the defendants were officers of the defendant association; the other three were members, and were also men who had been employed as pickets. The association had been made a party to the present application, but it would be sufficient for plaintiffs if they obtained an injunctian against the five defendants and an order that they represented the association. At the same time he asked for an injunction against the association. It had been laid down in the Taff Vale case that it was the proper method to sue the trade union. His (counsel's) object was to prove a *primâ facie* case of illegality, and to show that the plaintiffs would suffer unless the illegality were restrained.

Mr. MANSFIELD (for defendants) said the undertaking given when the matter had been previously mentioned, "that defendants would not do anything illegal until the trial of the action which was pending between the parties," appeared to him to be sufficient until the trial took place.

The DEPUTY VICE-CHANCELLOR: That is an undertaking which begs the whole question. The application now made is to determine whether certain acts which are alleged to have been done are illegal. The application is also to restrain defendants from doing certain things. If these acts are illegal, and have been committed, the injunction ought to go. If they are not illegal the injunction will not go. But a mere undertaking not to do anything illegal is practically what everyone is willing to give.

Mr. GRANT said under the previous undertaking defendants were continuing to do what they did before, on the plea that it was not illegal.

Mr. MANSFIELD said he could not give the undertaking asked for.

Mr. GRANT then proceeded with his application. He said plaintiffs were owners of three mills in Blackburn. A dispute had arisen with regard to one mill only. On June 5 notice was served upon plaintiffs by defendant Cross, who was secretary of the latter association, that the employés would cease work at the end of a week from that date, and they did so. Then, although there was no dispute at plaintiffs' other two mills, notice was served on June 19, and the employés all withdrew from work. He submitted this was done through malice against plaintiffs, and that the workpeople were withdrawn from the two other mills simply as a means of putting pressure upon plaintiffs and to compel them to assent to the terms of the employés at the first mill. After the strike the usual picketing began. Threats were used, and the usual acts of illegality committed, with the result that summonses were issued against three members of the defendant association, and they were fined by the Blackburn magistrates. Then the strikers employed a band to play in the vicinity of the mill, causing crowds to assemble. Summonses were issued against the members of the band, but they elected to be tried at quarter sessions, and the case was to be heard in October. Afterwards, the band went on playing for some time, and so the plaintiffs felt compelled to come to the Vice-Chancellor in order to try and obtain immediate relief, and to stop the acts of the defendants, who were, plaintiffs urged, trying to ruin their business in order to force them to consent to the men's terms. The defendants had intimidated employés, had persuaded them to stop work, and had even bribed them to do so. Bribery was effected in this way: The men had what they called a strike fund, which, they asserted, was quite separate from the association, and payments were made to strikers out of this fund. He (counsel) pointed out that appeals which had been made to the public to subscribe to the strike funds, as well as the balance-sheets afterwards issued, all bore the name of the association, and were signed by the president and secretary of the association. He asked, therefore, that this strike fund and the association's fund should be held to be one and the same. Plaintiffs had endeavoured to work the mill since the strike, but without success. Their workpeople had been taken away by defendant association, and by promises of sums of money were induced to cease work. Employés had had to be kept in the works at meal times because they were afraid to go out, and were terrorised by the presence of pickets, and had been, by these same pickets, turned away from the mills and prevented from going to their work. Plaintiffs were suffering very serious damage from these acts of defendants, and he asked that an interlocutory injunction to stop these acts should be granted.

Affidavits in support of counsel's statements were then read, as were affidavits on behalf of defendants denying that workpeople had been asked by the pickets to leave the mills. It was admitted that certain payments had been made to weavers who had joined the strikers, but only on the application of the weavers themselves. Nothing was done on behalf of the association save to obtain or communicate information. It was denied that there was any connection between the strike funds and the association, or that any operatives had been prevented from going to breakfast or dinner owing to the conduct of any members of the association, and it was urged that it was a common occurrence in Blackburn for operatives to take their meals in the mill. With regard to the strike fund, an appeal had been made to the public for support, and the money so received was distributed weekly by a strike committee. With regard to the pickets, it was considered essential to have a number of men near the mill in order to see who was working there, and to ensure that no member of the association should draw money from the funds while he was employed by plaintiffs. If any strangers applied for work the pickets simply informed them that a strike was in existence. The main object of the pickets was to give information to the association, and they did not interfere with any persons employed at the mill or endeavour to induce them to cease work.

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The DEPUTY VICE-CHANCELLOR counselled that the matter should be left over. He was of opinion that the matter ought not to be dealt with in vacation unless a very strong case was made out. The Vice-Chancellor ought himself to hear the case, and perhaps cross-examine the witnesses. But unless the strongest case was made out on behalf of plaintiffs no order ought to be made in vacation.

Mr. GRANT: In the Taff Vale case an order was made in vacation.

Eventually the application was adjourned for a week, to enable certain affidavits to be produced.

### East v. Westminster Electric Supply Corporation.

At Brompton (London) County Court, on Monday, before Judge Stonor and a jury, Mr. W. East, newsagent, Mills-buildings, Knightsbridge, brought an action against the Westminster Electric Supply Corporation for damages in respect of personal injuries alleged to be due to negligence for which defendants were responsible.

PLAINTIFF said on 1st May he was being driven in a van along Knightsbridge. When opposite the Alexandra Hotel he saw some men hoisting a long pole by the side of an electric light standard. As the van was about to pass the pole the top end, which had been pulled up about 8ft. from the ground, dropped, falling upon his (plaintiff's) right shoulder and arm, and he had not since been able to properly use his arm, and he estimated his loss at 15s. a week to the present time. It was not true that he agreed to accept 30s. in settlement. He was not prevented from attending to his business, but had to pay for assistance.

Evidence was given for the defence that plaintiff's injuries were very slight.

Mr. F. PERRY, of the mains department of defendant corporation, said as he and his men were hoisting the pole the bottom slipped from the base of the iron column, and the head, which was about 8ft. from the ground, veered round. While they were trying to get the pole in its proper position, the van containing the plaintiff ran into it.

The JUDGE: Had you a rope and blocks by which to raise the pole?—Yes.

Capt. WEBB, agent for defendants, said he offered to settle all claims for compensation in respect to the accident, and plaintiff agreed to leave the matter with him.

The JUDGE left the following questions to the jury: (1) Do you think defendants' workmen were guilty of negligence that caused the accident? (2) Do you think that the driver of the van was guilty of negligence that caused the accident? (3) Do you think that both the defendants' workmen and the driver of the van were guilty of contributory negligence?

The jury answered the questions in plaintiff's favour, and assessed the damages at £20, and judgment was given accordingly, with costs.

### Fletcher v. London United Tramways (Ltd.)—Arbitration.

At Brentford (Middlesex) County Court on Friday last Judge Bagshawe, K.C., heard an arbitration in which the plaintiff, a labourer named Fletcher, claimed £40 damages for injuries sustained while employed in laying the lines of the company's tramways through Ealing. The question of the company's liability turned upon whether a tramway is a railway within the meaning of the Workmen's Compensation Act and the Railway Act.

Counsel for the company urged that if it had been intended to include tramways in these acts they would have been specifically mentioned.

Plaintiff's counsel, on the contrary, endeavoured to show that the term "railway" includes more than what is generally understood by that word, and embraces both "tube" railways and tramways, whether overhead or underground. He urged that if the tube lines were held to be railways, then ordinary tramways must be so considered.

Judge BAGSHAWE pointed out that the difference in the case of the tube lines was that the permanent way was exclusively for the carriages of the tube railway while many conveyances made use of the permanent way of the tramways.

Judgment was reserved.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The Electric Lighting committee of the Hackney (London) Borough Council invite applications for the post of borough electrical engineer to take control of the electricity supply and refuse destructor undertaking of the Council. Commencing salary £400 per annum. Some further particulars will be found in an advertisement, and applications must be sent to Mr. George Grocott, town clerk, Town Hall, Hackney, by 4 p.m., Sept. 30.

An electrical engineer is required for service in the Public Works Department, Jamaica. Further particulars are given in an advertisement, and applications will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., up to Oct. 7. Information respecting the appointment may be obtained from the consulting engineers to the Crown Agents (Messrs. Preece and Cardew), 13, Queen Anne's-gate, London, S.W.

A lecturer in electrical engineering is required for a London technical institute preparing for City Guilds examinations. Applications to Mr. W. Keller, 70, Springbank-road, Hither Green, London, S.E., by Sept. 28. See advertisement.

A demonstrator in electrical engineering is required at Heriot Watt College, Edinburgh. Applications to the principal by Sept. 21. See advertisement.

Southampton Corporation require an electrical engineer and manager of their electricity department. An advertisement contains further particulars. Applications to the town clerk (Mr. R. R. Linthorne) by 30th inst.

A demonstrator in electrical engineering is required at University College, Nottingham. An advertisement contains further particulars and applications must be sent in, on forms supplied by the secretary, by Tuesday, Oct. 1. The commencing salary is £200 per annum, rising to £250. The previous holders of this appointment were Prof. Alfred Hay, D.Sc., now of Cooper's Hill, and Prof. W. H. Everett, who has been appointed professor of electrical engineering under the Indian Government. The duties include the taking charge of the organisation of teaching in the electrical laboratory at the college and the tutorial classes and in the practical applications of mathematics to engineering. The work of the session at Nottingham begins on Oct. 7.

A chief assistant is required in the meter and motor department of the Bradford electricity works. Applications to the city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. See advertisement.

Telegraph linesmen are required by the Government of Northern Nigeria. Applications to Crown Agents for Colonies, Downing-street, London, S.W., by Sept. 21.

Newcastle-upon-Tyne Tramways committee require a general manager. Salary £750 per annum. Applications by 25th inst.

Ashton-under-Lyne Corporation require a clerk of works to superintend the construction of electric tramway permanent way. Applications by 24th inst.

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Mr. J. R. W. Grainge has been appointed shift engineer at the Battersea (London) Borough Council's electricity works.

Mr. Arthur J. Abraham, of Wigan, has been appointed chief assistant electrical engineer at the Partick electricity works. There were 63 applicants.

Mr. E. F. Jones, at present with Messrs. W. H. Allen, Son & Co., of Bedford, has been appointed assistant engineer at the Wimbledon electricity works.

Dr. Alexander Galt has been appointed keeper of the technological department of the Edinburgh Museum of Science and Art. Dr. Galt was assistant at Glasgow University to Lord Kelvin for eight years preceding his lordship's resignation of his chair in 1899.

Mr. E. G. Bergersen has been appointed second assistant engineer at Battersea at £130.

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**Abertillery.**—A combined electric lighting and refuse destructor scheme is under the consideration of a committee.

**Acetylene.**—Application has been made to the Board of Trade for a licence to authorise the registration of the Acetylene Association with limited liability without the addition of the word "Limited."

**Alleged Extensive Robberies.**—At Southwark (London) Police Court, on Wednesday, seven men were charged with being concerned in various robberies. Two carmen named Dacey and Blorre were charged with stealing during the past year electric fittings value £5. 10s., belonging to the General Electric Co., and a man named Turner with stealing a quantity of copper wire the property of Rashleigh Phipps & Co., while two men named Waddington, carmen and contractors, were charged with receiving the stolen property. Prisoners were remanded.

**Barnstaple.**—An inquiry into the Council's application for sanction to borrow £27,000 for electric lighting will be held on 26th inst.

**Battersea (London).**—The formal opening of the electricity works has been fixed for 28th inst.

**Bath.**—The City Council have decided to purchase the existing tramways, which will then be leased to the syndicate which recently obtained powers to construct a light (electric) railway in the district.

**British Trade with United States.**—In a report of the trade of the United States for the year ended June 30 last it is stated that the export of scientific instruments (including telegraphic, telephonic and other electrical instruments) increased 14 per cent. on the year. The United Kingdom was the largest buyer to the extent of £425,000, an increase of 83 per cent. over 1900.

**Bury St. Edmunds.**—The scale of charges for electric current for motive power has been fixed as follows:—For 100 units per quarter, 3d. per unit; from 100 to 250 units, 2¾d.; from 250 to 750 units, 2½d.; from 750 upwards, 2¼d.

**Cadiz-Teneriffe Cable.**—The Spanish Government has granted extraordinary credits of 284,000 pesetas (about £7,600) for the purchase of new telegraph cable, material and apparatus, and 250,000 pesetas (about £6,750) for the repair of the cable between Teneriffe and Cadiz.

**Cardiff.**—At a recent meeting of the Electric Lighting committee the electrical and tramways engineer and manager (Mr. A. Ellis) said

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he had considered the question of "free" wiring, and intended to deal with it as soon as power to borrow money was received. He could not recommend the Corporation to actually do the wiring themselves. They had in the town about a dozen wiring contractors who made good canvassers. The Corporation would receive tenders and pay the cost, which would be charged to the consumer.

**Cash v. Cheque.**—In the City of London Court, on Wednesday, Mr. Pitt-Lewis, K.C., deputy-judge, called attention to a point of law of considerable interest in commercial transactions. He said that 200 or 300 years ago it was held that it could not be regarded as payment in satisfaction of a debt to offer £10 in discharge of a £50 liability. But the House of Lords had, he said, corrected that view, and had held that, while giving 10 sovereigns in payment of a debt of £50 was no such discharge, the tendering and acceptance of a cheque for £10 for a debt of £50 constituted "satisfaction" at law. A cheque was thus held to be a different instrument of payment to current coin of the realm. The cheque, when tendered and accepted for a smaller sum than that demanded was, it was decided, inferentially accepted in full payment of the larger sum, and, once accepted, the acceptor could not afterwards plead that the cheque was accepted "on account." This is not altogether new law to business men, who, in many cases, make it a rule to return such cheques, but usually this is done in cases where the debt is considered a good one, and where the return of the cheque may be safely taken as involving no likelihood of losing that proportion of the outstanding debt. It is, however, a very general practice to accept a cheque tendered by a debtor whose account is considered doubtful, and to acknowledge its receipt as payment "on account." Mr. Pitt-Lewis's decision will doubtless modify this practice, and will assuredly lead to the more frequent tendering, by persons of low credit or prone to dubious commercial methods, of cheques for smaller sums than are represented by the invoice for goods, &c. Supply houses with miscellaneous accounts should, therefore, be especially on their guard against such practices.

**Colchester**—The period for repayment of £3,900 sanctioned for the purchase of land and buildings for electricity supply works has been extended from 25 to 40 years.

**Croydon.**—It is anticipated the Norbury-Purley electric tramway route will be opened on 26th inst.

**Darlington.**—An inquiry has been held into the Council's application to borrow £12,250 for electric lighting extensions. At present the equivalent of 7,609 8 c.p. lamps is connected to the mains.

**Death from Electric Shock.**—At Jarrow on Friday last Mr. A. T. Shepherd held an inquiry into the deaths of two labourers, named Kelly and Keenan, who were killed at Palmer's shipbuilding yard on the previous Tuesday. Evidence was given that the deceased men were found lying in the electric motor house. Keenan was on the floor with Kelly on top of him. Kelly was in a semi-kneeling position, with his right shoulder against the switch box. A witness named Simpson said there were brass knobs on the switch box, and in trying to lift the men up he touched one of the knobs and fell over unconscious. He still felt the effects of the current in one hand. The deceased men had to get under a barricade to reach the switchboard. There were big letters on the switchboard warning persons not to touch. Keenan might have taken the other man into the motor house to show him round, as he had previously worked there. Arthur Ward, electrician at the works, said the voltage in the motor house was 410. The voltage was a little higher probably before 6 o'clock in the morning, but would not be more than 430. If the motor house had been completed there would have been a door on. The man who worked the motor knew of the danger, and took the necessary precautions. The deceased men had no business there, and would have to go on their hands and knees to get to the switchboard. They must have tampered with the switches, although there was nothing to indicate how they could have completed the circuit. Probably after one had received a shock the other went to his help. They had rubber gloves for dealing with switchboards. The electric plant had not been started when the men had gone to the house, and therefore they must have switched it on. The Coroner said there seemed no blame to be attributed to anyone connected with the works. The motor-house was in course of erection, but there was a barricade or obstruction at the entrance, and no one going casually about the place could come to any harm. It was evident that the men went where they had no business. The jury returned a verdict of accidental death ftom electric shock.

**Dumbarton.**—The council are applying for a provisional electric lighting order.

**Falkirk.**—Messrs. Burstall and Monkhouse are preparing a report upon electric lighting, and a company is to be asked the terms upon which they would establish electricity works.

**Fulham (London).**—On Wednesday the Council had under discussion a proposal of the London County Council to construct electric tramways from Putney Bridge through High-street, Fulham, Fulham Palace-road and Hammersmith to Harlesden. It was decided to approve of the scheme, and to contribute one-third of the cost of street widening necessary.

The Council also discussed a report from the consulting engineer (Mr. F. H. Medhurst) on extensions to the electricity supply works as under:—

| | | | |
|---|---|---|---|
| Mains, conduits, &c. | £23,357 | Sub-station equipment | £1,400 |
| Engine-room plant | 9,100 | Builders' work | 900 |
| Arc lamp-posts, &c. | 5,723 | Steam, exhaust and other pipes | 900 |
| Boilers, flues, &c. | 3,680 | Condensing plant | 800 |
| Engineering expenses, &c. | 3,680 | | |

Other electrical work brought up the total estimated expenditure to £74,400. The Council have approved the various extensions.

**Gillingham.**—The Council have applied for sanction to borrow £27,000 to purchase so much of the undertaking of the Chatham, Rochester and District Electric Light Co. as lies within the Gillingham district.

**Glasgow.**—The accounts of the electricity department for the year ended May have been issued and give the gross revenue as £79,449. 14s. 11d., expenditure £46,647. 4s. 11d., leaving £32,802. 10s., out of which the committee had to meet interest (£24 547. 4s 3d.) and sinking fund (£8,662. 19s. 4d.), leaving a deficit of £407. 13s. 7d., to which must be added the proportion of costs of lamps and fittings supplied to consumers consequent on change of voltage (£4,109. 13s. 4d.), making a total deficit of £4,517. 6s. 11d. To meet this there has been applied the amount standing at credit of reserve (£4,517. 6s. 11d.). From capital account there has been transferred to revenue £13,847. 9s. 3d., being amount expended during past three years for lamps and fittings supplied to consumers in consequence of the change of voltage, leaving £9,737. 15s. 11d., which has been placed to suspense account to be written off in four years. The committee regret that the result of the year's work has not been more favourable, which is due to increased interest and sinking fund charges on amount borrowed for new works and mains not yet wholly productive, and also to the special charge on account of lamps and fittings. The quantity of electricity sold to private consumers during the year was 6,290,819 units, compared with 3,788,795 during the previous year, an increase of 66·04 per cent. The number of consumers on May 31 was 4,031, compared with 2,852, an increase of 41,34 per cent. There were 185 consumers who consumed the equivalent of five hours or over per day of their maximum demand throughout the year. The number of motors was 427, with a total H.P. of 1,894, compared with 212 and 754 H P. in 1900. The number of arc lamps for street lighting was 248, compared with 265, and the quantity of electricity consumed for street and stair lighting 523,172 units, compared with 461,874 in 1900. The number of units consumed by private consumers, per lamp fixed, averaged out month by month, according to the date of connecting up, was 20·46, compared with 17·42 last year. The Port Dundas and Pollokshaws-road stations were inaugurated on Sept. 13. The Kelvinside works, purchased from the Kelvinside Electricity Co., have been overhauled, an additional 1,200 H.P. boiler and three 360 H.P. engines and dynamos having been laid down.

**Great Yarmouth.**—The receipts of the electricity department for the past quarter amounted to £1,152. 3s. 3½d. There are 548 customers, representing an equivalent of 26,586 8 c.p. lamps connected.

**Halifax.**—The electric tramway from New Bank to Southowram was opened for traffic on Thursday.

**Hucknall Torkard.**—The Nottinghamshire and Derbyshire Electric Power Co. are applying for a provisional order for this district, and the Council have appointed Mr. F. J. Warden-Stevens to prepare a report at a fee of 15 guineas.

**Johannesburg (South Africa).**—The Rand Central Electric Works have received cable advice that their works at Brakpan are expected to restart on 23rd inst.

**Kilmarnock.**—The Council were recommended on Monday to accept tenders amounting to £29,000 for electric lighting plant, &c. After a lengthy discussion, an amendment referring the matter back was carried by 12 votes to 10.

**Light Railway.**—The Worcester Extension Light Railways order has been submitted to the Board of Trade for confirmation. Objections by Oct. 4.

**Llandudno.**—The Council on Tuesday were advised to carry out the extension of plant at the electricity works contemplated in 1899 and for which a loan has already been granted. The engineer (Mr. Harold Morton) estimated that with the added plant the station could supply all current required for lighting and traction for some time to come. After a heated discussion a proposal to grant Mr. Morton additional remuneration on account of the proposed new work was rejected. Another recommendation that no reduction should at present be made in the price of electric current also aroused considerable discussion, but was ultimately adopted.

A report on the Great Orme electric tramway scheme will be considered by the Council at the next meeting.

**Maesteg.**—The Council have decided to engage an expert to report upon electric lighting.

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**Marconi Apparatus at Mullion.**—Considerable damage was done by Tuesday's gale at the Marconi station at Mullion, near the Lizard. It appears that the erection of 20 poles, each 220ft. high, connected by triatic stays, had been nearly completed when one of the links of the shroud became broken and 12 of the poles fell to the ground. The exposed nature of the coast at Mullion and the special character of the work will cause some time to elapse before the damage is repaired.

**Middlesbrough.**—An inquiry has been held into the Council's application to borrow £34,100 for extensions of the electricity generating plant and mains. There was no opposition, the application being supported by the deputy town clerk (Mr. Sockett) and the the consulting engineer (Mr. R. Hammond).

**Motor Service Notes.**—We are informed that it is intended to place upon the London streets early in 1902 a service of 200 electric motor vehicles for passenger traffic.

The popular season at Bournemouth having practically terminated, it has been decided to place a large number of the petrol motor vehicles, which have been a feature of the popular seaside resort, on the London streets. The vehicles are plying for hire between Piccadilly-circus and Putney at popular fares, and are well patronised. The London Motor Co. are responsible for the enterprise.

**Municipal Telephony.**—At a meeting of the Swansea Telephone committee last week it was reported that 159 local telephone subscribers had replied assenting to transfer their subscription to a municipal exchange. The Council are recommended to engage Mr. A. R. Bennett to report on the telephone question generally.

**Nelson.**—The application of the Corporation to borrow £25,000 for electricity supply was officially inquired into on Wednesday. It was stated that the scheme comprehends the erection of a new generating station near the refuse destructor, heat from which would be utilised for the electricity works. The present station would supply a considerable quantity of plant for the new scheme. It was proposed to change the system from the 2-wire at 110 volts to the 3-wire at 220 volts. The Corporation would supply current in bulk to Brierfield Council, and would also provide current for the tramway through Brierfield and Nelson and the new light railways to the boundaries of the borough at Colne and Barrowfield, and would also probably supply current for the light railways through Barrowfield.

**Northern Polytechnic Institute, Holloway, London, N.**—The prospectus for the session 1901-2 of this Polytechnic is ready, and can be obtained on application to the secretary (Mr. W. M. Macbeth). A considerable development has taken place in the day school work, and there are now four day schools at the Institute open to boys and girls specialising in science, commerce, building trades' technology, and other subjects. The fees are very low for a high-class secondary school. The increase in the number of students has necessitated consideration being given to the question of extension, a proof that the Northern Polytechnic is appreciated in the large district which it serves. First, second, and third year courses are given in electrical engineering, the lecturer for this section being Mr. V. A. Mundella, who also takes electric wiring and fitting. Evening classes are held in physics and electrical engineering every day except Saturday. There is a well-equipped mechanical laboratory, fitting, and machine shop, &c.

**Okehampton.**—Owing to friction between the Council and the local gas company the electric light company has been requested to submit estimates for electric lighting.

**Personal.**—Mr. Ivon Braby, A.M.I.E.E, of Braby and Tomlinson (Ltd.), has been appointed lecturer in electrical engineering at the Crystal Palace Co.'s School of Practical Engineering.

Mr. W. J. Poole, station superintendent of the Glasgow Corporation electricity works, left last week for the United States to study American electrical practice. He visits New York, Pittsburg, and other important centres of electrical industry.

**Redditch.**—The scale of charges for electric current for power has been revised, and in future will be 2d. per unit up to 10,000 units per annum, and between 10,000 and 35,000 units 1d.

**Rochester.**—The Council have increased their offer from £3,800 to £5,000 for the purchase of so much of the undertaking of the Chatham, Rochester and District Electric Lighting Co. as lies within the Rochester borough.

The Council have under consideration the advisability of obtaining Parliamentary powers to construct electric tramways.

**St. Andrews.**—The Council have resolved to apply for a provisional order.

**Salford.**—The Higher Broughton electric tramway route will be opened on Oct. 1. Progress is also being made with the Pendleton route and with the line along Cross-lane to the docks.

**Shrewsbury.**—An inquiry has been held into the application of the Corporation to borrow £16,526 for extensions of the electricity works. The application was supported by the town clerk (Mr. H. C. Clarke), and the borough electrical engineer (Mr. C. M. Johnston) gave technical details. There was no opposition.

**South Africa.**—All reports to hand point to a speedy return to business activity in the districts which have been and are being occupied by the British authorities, and plans are maturing for expending large sums upon new railways, new landline telegraphs, and renewal of old lines, the renewal, extension, and construction of new public works, and the establishment of electric tramways in many of the principal towns. The amounts to be expended on these works are variously estimated, but in all cases reach a very large figure, and point to a heavy demand for electrical plant, machinery, apparatus, instruments, material, accessories, and sundries. Our American competitors are keeping a keen eye on this business, and their consular agents are, we have authority for saying, collecting all possible information to aid American manufacturers in preparing for likely requirements.

**Southend.**—Owing to the success of the Council's electric tramways extensions to Shoeburyness, Rochford, Rayleigh and other districts are projected.

**Southwark (London)**—The Borough Council will apply for a provisional electric lighting order for the whole of the borough. At present these powers are confined to the Newington district.

**Telephone v. Fire Brigade at Glasgow.**—The telephone, the electric light, and the fire brigade are each municipal departments at Glasgow, and it might reasonably be assumed that these departments could be left to work amicably together. This is, however, hardly the case, as on Wednesday, when the workmen in the employ of the B.I.W. Co., contractors for the cable work of the Glasgow telephones, commenced operations in the High-street by raising the flagstones of the pavement, they were met by a squad of fire brigade men furnished with hose and all the necessary equipment for preventing the continuance of the work, and these were forthwith put into operation. It appears that a dispute arose between Mr. Firemaster Paterson, and Mr. A. R. Bennett, the telephone manager, and although the B.I.W. Co.'s men returned to the fray in oilskins and did their best to proceed with their work, the fire hose was too much for them, and they had ultimately to beat a retreat. It was a pretty little skirmish, and the rights and wrongs of the dispute are now being considered by the various corporation committees concerned.

**Walsall.**—The electric light mains are to be extended to Highgate at an estimated cost of £1,700. With regard to the application from Wednesbury Corporation for a supply of current in bulk, the Electric Lighting committee reported that as such supply would entail an expenditure of £8,000, and as it would be necessary for the Wednesbury Corporation to enter into a contract for 25 years, they could not offer sufficiently advantageous terms. The action of the committee has been confirmed.

**Walthamstow.**—At a special meeting of the Council last week the proposal to construct electric tramways was considered. The scheme involves the construction of about 11 miles of tramway on the overhead system. Decision in the matter has been deferred for a week.

**Willesden.**—An inquiry was held here last week into the application of the Council to borrow £143,000 for electricity works. The clerk of the Council (Mr. S. W. Ball) gave particulars of the rateable value, &c., of the district, and Mr. Pinkham, J.P., gave the history of the Council's electric lighting scheme. In 1897 application was made for a provisional order, which was obtained in 1898, when they appointed an electrical engineer (Mr. E. T. Ruthven Murray) to design a scheme. In 1900 a site in Taylor's-lane was acquired for a generating station for £2,462. A site was also purchased for a sub-station at £900. The estimates for the present scheme amounted to £143,000. The scheme had been in the main approved by Mr. E. Manville. The newly-elected Council had considered the scheme, and in July decided to proceed with it. They invited tenders for the erection of buildings and the supply of machinery and plant, and these would be considered at their next meeting. A large number of houses were already wired for the electric light, and some at Cricklewood were being supplied from a temporary installation, which would be transferred to the Council. The Council had attempted unsuccessfully to obtain a bulk supply from Hampstead. He estimated the loss on the undertaking would be £6,167 in the first year, £4,261 in the second, and £1,779 in the third. A private company had offered to take over the undertaking, and pay expenses and sinking fund for 10 years. However, they invited tenders, and hoped to get better terms. The electrical engineer (Mr. E. T. Ruthven Murray) supplied technical details, and said there would be distributing mains in 15 miles of streets to commence with, and 94 arc lamps for street lighting. The total cost would be £139,648. The plant would have a capacity of 1,000kw. There was every possibility of having 18,000 8 c.p. lamps connected the first year. He was convinced that the light would be in great demand by shopkeepers, small property owners and tenants. Mr. O. Claude Robson, engineer to the Council, said he had had many applications for electric current, and the delay had been generally complained about. Mr. A. C. Cockburn objected to a voltage of 240. It should not be over 200, and the maximum price per unit should be 6d. Mr. Stringer asked, if the companies would

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propose an alternative scheme, would the inspector delay decision until they came to some terms with a company, and so obviate another inquiry. The inspector said he would report later, and the inquiry closed.

**Windsor Castle.**—Considerable extensions of the electric lighting are being carried out by H.M. Office of Works. At present over 30 men are employed in wiring the State rooms, private apartments, kitchens, &c. Current will be supplied by the Windsor Electrical Installation Co., who have put down an additional cable to the castle.

**Wireless Telegraphy.**—The Cunard Company has decided to fit wireless telegraph apparatus on the "Campania," "Umbria" and "Etruria."

**Worksop.**—The electricity supply works were opened on Tuesday. The plant is capable of supplying current to the equivalent of 11,600 8 cp. lamps, and there are already applications (72) for about 2,000 lamps. The total cost of the works, which have been carried out under the direction of the Council's consulting engineer, Mr. A. B. Mountain, was £15,000.

**Outing.**—The employés of the British Thomson-Houston Co. engaged on the construction of the Croydon Corporation electric tramways had an outing at Boxhill and Dorking on Saturday. At the dinner a presentation was made to Mr. A. G. Livesay, who is leaving the company's employ to take up a position on the staff of the Leeds electric tramway department. The presentation (a fine silver non-magnetic stop watch, by S. Smith and Son) was made by Mr. F. S. Grogan, who succeeds Mr. Livesay as resident engineer at Croydon.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

### TENDERS INVITED.

*Newport* (Mon.) Corporation invite tenders for the supply and erection of winches for steel chimney shaft, outside coal handling, piping, switchboard, cables, cable-ways, overhead construction, complete electric motor car and repair shop equipment. An advertisement contains further particulars. Specifications, &c, of the consulting engineer (Mr. H. F. Parshall), 8, Prince's-street, Bank, London, E.C. Tenders to the town clerk (Mr. Albert A. Newman) by 5 p.m. Oct. 21.

*Kirkcaldy* Corporation invite tenders for the supply and erection of a main switchboard. Specification, &c., from the town clerk (Mr. Wm. L. Macindoe), and specifications can be seen at (but not obtained from) the offices of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to Mr. Macindoe by 10 a.m. Oct. 24. See advertisement.

*Huddersfield* Corporation invite tenders for the supply and erection of a 600kw. alternating electricity plant at the electricity works, St. Andrew's-road. Specifications, &c., of the borough electrical engineer at the works, and tenders to the town clerk, Mr. F. C. Lloyd, Town Hall, Huddersfield, by Sept. 30. An advertisement gives additional particulars.

*Leeds* Lighting committee invite tenders for a main switchboard. An advertisement contains further particulars. Specifications from the manager (Mr. Harold Dickinson), 1, Whitehall-road, Leeds, and tenders to the town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Oct. 8.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for twelve months' supplies of various articles, including iron castings, copper, ironmongery, rails, sundry tools, oils, &c. Further particulars are given in an advertisement, and forms of tender, &c., may be obtained on application at the stores department, Osborne-street, Manchester, where samples can be examined. Tenders to the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 7.

The Guardians of the *Greenwich* Union invite tenders for the proposed electric lighting installations at their new Homes for Children. An advertisement contains further particulars, and specifications, &c., may be obtained at the offices of the architect (Mr. Thomas Dinwiddy), 12, Crooms Hill, Greenwich, London, S.E. Tenders to the Union Offices, East Greenwich, S.E., before Oct. 10.

*Hull* Corporation invite tenders for two steam dynamos and wiring, &c., the West District destructor and sanitary department's stables for about 24 arc lamps and 120 incandescents. Forms of tender, &c., from the city engineer (Mr. A. E. White), and tenders (addressed Chairman of Destructor Sub-committee) to the town clerk's office, before noon, Sept. 27. An advertisement contains further particulars.

*Hull* Electric Lighting committee require two high-speed three-crank compound steam engines of 800 I.H.P. each, and four steel Lancashire boilers. Tenders to chairman by noon Sept. 26.

*Manchester* Electricity committee invite tenders for the supply and delivery of ampere-hour and watt-hour meters. Specifications, &c, from the secretary, Electricity Department (Mr. F. E. Hughes), Town Hall, Manchester, and tenders (addressed to Chairman) must be delivered by noon Oct. 2. Further particulars may be obtained from the chief engineer (Mr. G. F. Metzger), Dickinson-street electricity works. See also advertisement.

*Manchester* Electricity committee also invite tenders for foundations for engine beds and for steel work, &c., at Stuart-street generating station. Tenders by 26th inst.

Tenders are invited for the supply of a 50kw. alternator and engine for the *East London* (South Africa) Municipality. Specifications can be seen at the offices of the municipal agents (Messrs. Dyer and Dyer), 17, Aldermanbury, London, E.C. An advertisement gives further particulars, and tenders must be sent to the town clerk (Mr. R. N. Moir) by noon Nov. 26.

*Reading* Corporation invite tenders for the construction of new tramways and the reconstruction of existing tramways, including bonding of rails, provision and laying of conduits and drawing-in boxes, &c. Tenders to chairman Tramways committee by noon 28th inst.

*Oldham* Electricity committee invite tenders for construction of superstructure of new Greenhill generating station and erection of chimney shaft, also for stanchions, girders, and structural steel and ironwork. Tenders by Oct. 8.

*London County Council* require tenders for track and slot rails and fastenings, tie-bars, &c.; also roadwork and platelaying required for reconstruction on the conduit system of the tramway routes between Westminster, Blackfriars, and Waterloo respectively and Tooting. Tenders by Oct. 8.

*London County Council* require tenders for electric lifts, pumps, fans, &c., for the electrical equipment of the Greenwich footway tunnel and its approaches. Tenders by Oct. 8.

*London County Council* also invite tenders for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

*Greenock* Corporation invite tenders for two Babcock-Wilcox boilers and feed pump. Tenders by 23rd inst.

*Maidenhead* Corporation require three 60kw. steam dynamos, two Lancashire boilers with fittings, economiser with dampers, &c. Tenders to town clerk by noon 23rd inst.

*Poplar* (London) Libraries committee invite tenders for the installation of electric light in four public libraries. Tenders to town clerk by Oct. 1.

*Blackpool* Cleansing committee invite tenders for the erection of six additional cells to the refuse destructor, new boiler, &c. Tenders by 28th inst.

*Sheffield* Corporation require boilers, economisers, motors, fans, iron chimneys, brickwork or iron flues, &c. Tenders to Mr. S. E. Fedden, Commercial-street, Sheffield, by 30th inst.

Messrs. Siemens Bros. & Co. (Ltd.), Woolwich, Kent, invite tenders for erecting shop superstructure at their *Stafford* works. Tenders by 30th inst.

*Ross Electric Light and Power Co.* invite tenders for generating plant. Tenders to Bank Offices, Ross, by noon Oct. 21.

*Glasgow* Corporation invite tenders for the supply and laying of cables. Tenders to town clerk by 5 p.m. Sept. 25.

*Rochdale* Electricity committee require tenders for feeder and distributor cables. Tenders by noon Oct. 2.

*Bristol* Electrical committee invite tenders for wiring the Avonbank electric lighting station. Tenders by Sept. 25.

Tenders are required for public lighting at *Winchester* for three or five years. Tenders to town clerk by 24th inst.

Tenders are invited for the electric lighting of *Stockton* baths. Tenders to town clerk by 21st inst.

*Nottingham* City Council require tenders for 2,000 tons of steel girder tram rails and 100 tons of fishplates. Tenders by 30th inst.

*Rathmines* (Dublin) Electric committee invite tenders for 12 months' supply of meters and arc lamp carbons. Tenders by 23rd inst.

*Bray* (Ireland) District Council require tenders for electrical supplies. Tenders by Oct. 3.

### TENDERS RECEIVED AND ACCEPTED.

Lowestoft Tramways committee have accepted the tender of Messrs. Doulton & Co. for conduits at £449. 12s. 11d. There were four tenders received varying from £397. 7s. 6d. to £537. The tender of the British Insulated Wire Co. for poles, overhead equipment and rail bonding was accepted at £5,369. 14s. 6d. For this contract five tenders were received varying from the accepted to £6,391. 0s. 8d. For cables the tender of the Telegraph Manufacturing Co. was accepted at £1,993. 3s. 11d. Twelve tenders, varying from that accepted to £3,134. 10s. 9d. were submitted for this contract. Nine tenders were received for the storage battery, switchboard, &c.,

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and these ranged from £1,769 to £2,477, but as all the figures were in excess of the estimates fresh tenders are to be invited. The lowest tender for points and crossings was that of Messrs. Askham Bros. and Wilson, which was accepted.

Battersea (London) Borough Council have accepted the tender of Messrs. Mather and Platt for electric pumps, pipework, &c., for condensing water for their electricity works at £2,163, and the contract for river work, pipes, and pits for condensing water supply has been let to Messrs. Fraser and Fraser at £7,000. The specification for the latter has been slightly modified.

Partick Town Council have accepted the tender of the Brockie Pell Arc Lamp (Ltd.) (out of 24 tenders submitted) for arc lamp carbons, that of the Reason Manufacturing Co. (out of four tenders) for demand indicators, and that of the British Insulated Wire Co. (out of 10 tenders) for house fuse boxes. Nine tenders were received for meters, but the contract has not yet been let.

Newport (Mon.) Guardians have accepted the tender of the Walsall Electrical Co. for installing telephones, fire-alarms and domestic bells throughout the workhouse at £355.

The tender of Messrs. Handley and Shanks has been accepted for arc and incandescent lighting plant, including 150 H.P. engine, dynamo, switchboard, and wiring for 60 Jandus and 500 incandescent lamps for the Upper Forest Tinplate and Steel Works, Morriston, near Swansea.

Sunderland Corporation have accepted the tender of the Wear Electrical Co. for Wiring the Hylton-road electric lighting station. Thirteen tenders were received.

Hastings Town Council have accepted the tender of Messrs. Geipel and Lange for 11 three-way wattmeters at £125.

As stated in our last issue, p. 810, there were five tenders received by the liquidator to the Isle of Man Tramways and Electric Power Co. for the purchase of the company's undertaking. We learn that these tenders have been duly considered, but that neither of them is considered sufficiently favourable for acceptance.

## BUSINESS NOTICES.

Messrs. H. Patterson and C. R. Whipple, electrical and mechanical engineers, trading at 33, Moorfields and 5, Edmund-street, Liverpool, as Patterson and Whipple, and at 328, High-street, Bangor, as Patterson and Harford, have dissolved partnership. Debts by Mr. Patterson, who continues.

Mr. J. W. Garsden has been appointed manager of the Manchester branch of Messrs. Handley and Shanks.

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**Berrenberg Lamp Factory.**—Mr. F. J. Terry Horsey (Messrs. Fuller, Horsey, Sons and Cassell) last week disposed of the long leasehold premises at Standen-road, Southfields, London, S.W., which for some time past has been occupied by the Berrenberg Electric Lamp Syndicate (Ltd.). There was a good attendance and the bidding was fairly brisk. The auctioneer pointed out the advantages claimed for the patent plant established at the works, and said that already a considerable trade connection had been established. Ultimately the premises, plant and general equipment changed hands at £4,000. We understand that the works and plant had been purchased with a view to continuing the manufacture of incandescent lamps.

**Kensington and Notting Hill Companies' Joint Electricity Supply Works.**—Messrs. O. Berend & Co. inform us that the instruments they have supplied for the switchboard at this generating station include some Hartmann and Braun electrostatic voltmeters, and that on the accumulator board there are also several Hartmann and Braun moving-coil instruments.

**"Chisholm" Commutator Compound.**—We are asked for the address of the manufacturers of this compound.

**Fires.**—Early on Tuesday morning a fire was discovered in a large building on the works premises of the Telegraph Construction and Maintenance Co., Endersby's Wharf, East Greenwich. The building, 130ft. long by 60ft. wide, was used as engineers' workshops, pattern rooms and stores, and was completely destroyed. The fire, however, extended to no other building, even the boiler house adjacent fortunately escaping damage. The business of the company is in no way interfered with by the fire, which at no period threatened the company's extensive cable works.

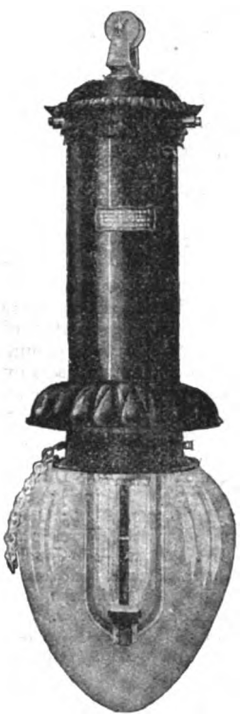
A fire occurred last week at the Sydney (N.S.W.) power house. The switchboard and dynamos were severely damaged and the tram service had to be suspended for several days.

**Wolverhampton Exhibition.**—We understand that numerous applications have been made for space at the exhibition which is to be opened at Wolverhampton next year. The Electric Construction Co. are included in the list. Boiler exhibits and the subject of interior decoration and furnishing are likely to be special features of the show.

**B.T.H. Plant.**—A pamphlet (No. 110) is issued by the British Thomson-Houston Co., describing and illustrating the GE/800 type of traction motor used at Middlesbrough.

**Customs Dues.**—Turbo-dynamos are imported into Victoria by a recent decision as "engines" under tariff No. 296, and bear a 30 per cent. ad val. duty.

**Jandus "Commercial" Arc Lamp.**—Competition in the arc lamp trade and the growing demand for Jandus lamps for general business purposes have led the Jandus Company to introduce the "Commercial" lamp, in addition to the more expensive and well-known "Standard" form. We illustrate the "Commercial" form of Jandus lamp, which is similar in all respects to the "Standard" lamp, except that the case is plainer and the trimming device is absent. The mechanism is identical with that of the original Jandus design, and all the parts are interchangeable. A large stock of these lamps is available to meet the anticipated demand. The price of the "Commercial" lamp is considerably below that of the "Standard" form.



**Messrs. Mavor and Coulson.**—Two lists are to hand from this firm, one dealing with "Dynamos and Motors," and the second with "Concentric Wiring." The first list opens with a view of Messrs. Mavor and Coulson's large erecting shop, and the subsequent illustrations show a number of generating sets with Willans, Bellis and Morcom, Alley and MacLellan, and Mavor and Coulson engines, as supplied to numerous local authorities and other electricity undertakings in this country and abroad. An instructive group of illustrations shows the applications of electric motors to pumping, ventilating and other uses. The concentric wiring list gives particulars and illustrations of the "C.C." system of concentric wiring and the mechanical and electrical details of which this system is comprised. Both lists are well got up, and much attention has been given to the preparation of the illustrations.

**Everett-Edgcumbe Volt and Ammeters.**—Messrs. Everett, Edgcumbe & Co., of Charterhouse-square, London, E.C., have recently placed upon the market a new type of volt and ammeter, of which the accompanying illustration gives a front view. It is claimed by the makers that these measuring instruments possess certain advantages in that they can be employed for either alternate or direct currents without readjustment, whereas ordinary voltmeters have been known to show an error of from 5 per cent. to 10 per cent. if changed over without readjustment. In many circumstances hot-wire instruments, which have been introduced to overcome this objection, are not applicable, altogether apart from the difference in price. A further claim for the instruments under notice is that they are particularly dead-beat, and therefore peculiarly suitable for gas engines or power circuits and for high voltages. The terminals have been so arranged in the base of the instrument that they are completely protected, and this allows of connection to be made either from the front or back of the board with equal ease and without the use of cable sockets. The instruments, as will be seen, are of the enclosed type, and it is said that they are practically unaffected by external fields, such as those due to 'bus bar connections, &c. They are well made and low in price.

**Electro-Medical Apparatus, &c.**—The General Electric Co. has issued section "O" of their main catalogue dealing with electro-medical apparatus, &c. A large assortment of this apparatus is listed. The catalogue also includes some particulars of automobile accessories recently introduced by the company. Spark coils for use with gas or oil motors for tricycles, voiturettes and larger motor cars and launches are included, and we illustrate one type of these coils, by the use of which a large quantity spark is guaranteed produced with a minimum battery power, and ensuring an immediate

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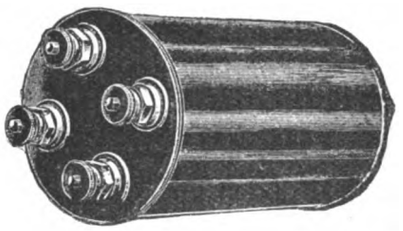
ignition of the explosive gas in the cylinders. These coils are fitted with large platinum contact points for continuous and heavy work, and are wound to work with two accumulator cells (=4 volts). Coils are supplied with or without tremblers to meet the requirements of



those who prefer to arrange the contact breakers on the revolving spindle of the motor, which is fitted to make contact and so produce a spark at the required moment.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 11 to 17, with the ports of destination :—

*Aden*, £56 (telegraph material). *Africa*—Alexandria, £644 (telegraph material); Beira, £188 (including £85 telegraph [material); Cape Town, £3,380 (including £439 telegraph material); Delagoa Bay, £40; Durban, £429; East London, £267 (including £219 telegraph material); Port Elizabeth, £387. *Australasia*—Lyttleton, £35; Melbourne, £131; Otago, £1,225; Perth, £457; Sydney, £1,086 (including £107 telegraph material). *Belgium*—Brussels, £120; Ostend, £70. *Brazil*—Rio Janeiro, £68. *China*—Shanghai, £180 (including £29 telegraph wire). *Holland*—Amsterdam, £35; Rotterdam, £19 (telegraph wire). *Hong Kong*, £27. *India*—Calcutta, £4,235; Madras, £759. *Japan*—Yokohama, £709. *Portugal*—Lisbon, £300 (telegraph material). *Straits Settlements*—Singapore, £172 (including £12 telegraph wire). *Sweden*—Stockholm, £186 (telegraph material). Total £15,205, against £22,964 in the corresponding week last year (Sept. 12 to 18).

## NEW COMPANIES, STATUTORY RETURNS, &c.

**LEEDS, WAKEFIELD, DEWSBURY AND DISTRICT ELECTRIC TRAMWAYS (LTD.)**—Reg. Sept. 10, capital £100 in £1 shares, to undertake the construction, maintenance and working of tramways, light railways, electrical and other railways and motors therefor, and to carry on the business of builders of and dealers in tramcars, &c., producers and suppliers of electricity, &c.

**POLLARD ELECTRICAL ENGINEERING CO. (LTD.)**—Reg. Sept. 11, capital £5,000 in £5 shares. To take over the business of electrical and mechanical engineers carried on at Hyde, Cheshire, as Stanley, Davies and Pollard, to trade as an electric light, heat and power supply company, and to manufacture and deal in cables, wires, accumulators, lamps, electrical apparatus and machinery, &c. The subscribers are :—J. Bailey, J. Pollard, electrical engineer, Mrs. B. Pollard, R. Pollard, electrical engineer, E. Hibbert, C. H. Brogden, and A. H. Gibbings, electrical engineer. The first directors are J. and R. Pollard and E. Hibbert.

**PORTSMOUTH AND GOSPORT MOTORS (LTD.)**—Reg. Sept. 12, capital £5,000 in £1 shares, to establish and maintain services of and generally to trade in motor omnibuses, cars and similar conveyances for locomotion and haulage, and to carry on the business of electrical and general engineers.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26$\frac{15}{16}$d. per oz. (Sept. 19). Consols (2$\frac{3}{4}$ per cent.) 93$\frac{1}{4}$—93$\frac{3}{8}$ for money, 93$\frac{1}{4}$—93$\frac{3}{8}$ for account; 2$\frac{1}{2}$ per cent. 94$\frac{1}{2}$—95 (Sept. 18). Consols Pay Day, Oct. 2; Stocks and Shares Continuation Days, Sept. 25 and Oct. 9; Ticket Days, Sept. 26 and Oct. 10; Pay Days, Sept. 27 and Oct. 11; Mining Share Carry-over Days, Sept. 24 and Oct. 8.

**ACCUMULATOR INDUSTRIES (LTD.)**—A prospectus is privately circulating inviting subscriptions to an issue of 2,000 7 per cent. cumulative preference shares of £5 each in this company, which has an authorised capital of £40,000 in 20,000 £1 ordinary and 4,000 £5 preference shares. The company was formed in September last year, to carry into effect certain agreements, and to manufacture electrical accumulators, controllers, motors and electrical vehicles. The company are owners of the "Leitner" accumulator and have offices in London and New York. The works are at Woking, where the automobile branch of the business is especially catered for. We learn that the increased capital now sought is to enable the company to extend their works at Woking in order to be in a position to execute a large contract for the supply of batteries to about 200 motor carriages that are to ply for hire in the principal thoroughfares of London early in 1902. The motor carriages are of American manufacture, but should the capital now sought be obtained the batteries for motive power will all be manufactured at Woking.

**COMPANIA ALEMANA TRANSATLANTICA DE ELECTRICIDAD (BUENOS AYRES).**—The directors' report states that there was an increase in the lamps connected of the equivalent of 25,000 16 c.p., and on Dec. 31 there were 75,000 lamps connected. The gross profits were £34,690.

**ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS (LTD.)**—The directors' report for the year to June 30 states that the output of cars has exceeded expectations, the works being fully employed and the prospect of new work satisfactory. After placing £4,000 to depreciation, the profit for the year is £21,206. 8s. 7d., to which must be added £3,914. 4s. 11d. from last year, making £25,120. 13s. 6d. The directors propose to write off preliminary expenses £7,342. 10s. 11d., to carry to reserve £2 000, to pay a dividend of 8 per cent. (less tax), absorbing £12,000, and to carry forward £3,778. 2s. 7d. Extra capital being required for the increased business, it is intended to issue £50,000 debentures, which will first be offered to existing shareholders.

**GLASGOW DISTRICT SUBWAY CO.**—At the meeting on Tuesday Mr. John Wilson, M.P., said that until the subway was worked electrically he had little hope of the directors ever being able to give shareholders a larger dividend than 1$\frac{1}{2}$ per cent. The chairman (Sir Wm. Laird) would not say that they would not adopt electric traction, but, if adopted, they must not expect cheaper fares as a result. He believe they were cheaper by the present system of haulage than they could afford under electric traction, but the time might come when, for greater speed, they might have to adopt electricity.

**GENERAL ELECTRIC CO. (U.S.A.)**—A quarterly dividend of 2 per cent. has been declared.

**MERSEY RAILWAY CO.**—The half-yearly report of the directors states that an agreement has been entered into with the British Westinghouse Electric and Mfg. Co. under which that company undertakes :—(*a*) To execute the works and provide the plant necessary to enable the traffic of the railway to be worked by electric traction within 18 months from July 15, 1901; (*b*) to guarantee interest on the existing 4$\frac{1}{2}$ per cent. redeemable first debenture stock, amounting to £249,276, until the works shall be available for public traffic by electric power, and to provide £249,276 not later than June 30, 1904, for redeeming the stock. The contract price for the works and financial obligations is £635,303, payable as to £620,000 in 4 per cent. Mersey Railway new first perpetual debenture stock (part of £703,750 authorised by the Acts of 1898 and 1900), and £15,303 in cash. It is (the report continues) believed that by the adoption of electric traction the receipts of the company will be greatly increased by the abolition of smoke and fumes caused by steam locomotives, and the running of a more frequent and quicker train service, and by substantial economies in cost of working. Under the powers of the 1900 Act the receivership and managership of the company has been terminated by order of the Court, and the management is now vested in the directors.

**OESTERREICHISCHE SCHUCKERT ELEKTRIZITATS AKTIENGESELLSCHAFT.**—This company, unlike the parent company, has paid a dividend of 7 per cent. for the past year.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange Committee has ordered the further issue of 30,000 6 per cent. cumulative preference £10 fully paid shares (Nos. 160,001 to 190,000) of the *British Electric Traction Co. (Ltd.)*, and 7,500 £10 fully paid shares (Nos. 1 to 7,500) of *Thomas Parker (Ltd.)* to be quoted in the official list.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. (*a*) | No. of weeks | A | TE. |
|---|---|---|---|---|---|---|
| | | | | | Amount | Dec. or (*a*) |
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Sept. 14 | 822 | + 79 | 15 | 13,171 | + 1,476 |
| *Birmingham Tramways. | ,, 14 | 4,811 | + 230 | 10 | 48,158 | + 3,546 |
| *Blackburn Corporation.. | ,, 13 | 583 | + 72 | 37 | 18,412 | + 1,813 |
| Blackpool Corporation.. | ,, 12 | 1,950 | + 458 | †24 | 29,482 | + 7,402 |
| Blackpool and Fleetwood | ,, 14 | 1,234 | − 95 | 11 | 15,946 | + 96 |
| Bolton Corporation ..... | ,, 15 | 1,556 | + 78 | 24 | 37,068 | + 4,128 |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ..... | ... | ... | ... | ... | ... | ... |
| *Bristol Trams & Carriage | Sept. 13 | 4,011 | + 328 | 10 | 41,452 | + 5,360 |
| *Buenos Ayres & Belgrano | Aug. 18 | 2,595 | + 342 | 7 | 18,147 | + 3,108 |
| Calcutta Trams. Co. ... | Sept. 14 | R21,395 | − R 109 | 11 | R124,902 | + R7,788 |
| Carlisle Trams. Co. ..... | ,, 14 | 191 | − 23 | 11 | 2,362 | + 108 |
| Central London Railway | ,, 14 | 5,658 | + 825 | 11 | 62,217 | ... |
| City & South London Ry. | ,, 15 | 1,836 | + 330 | 11 | 20,230 | + 3,702 |
| Cork Elec. Trams ..... | ,, 12 | 525 | + 22 | 36 | 17,285 | + 2,039 |
| Dover Corporation ..... | ,, 14 | 276 | ... | 24 | 6,146 | + 322 |
| Dublin & Lucan Rly. ... | ,, 15 | 117 | − 5 | 11 | 1,589 | + 259 |
| Dublin United ..... | ,, 13 | 3,794 | − 74 | ‡11 | 44,006 | + 1,455 |
| Dublin Southern Dist.... | ,, 13 | 968 | − 111 | ‡11 | 12,763 | |
| *Dundee Corporation ... | ,, 11 | 692 | + 208 | 11 | 7,850 | + 2,639 |
| *Glasgow Corporation ... | ,, 14 | 13,706 | +3,773 | 14 | 171,976 | +40,838 |
| Halifax Corporation..... | ¶ ,, 15 | 2,427 | + 565 | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ..... | ,, 14 | 1,637 | + 311 | 11 | 19,078 | + 4,427 |
| Liverpool Corporation... | ,, 7 | 9,831 | + 745 | 36 | 320,675 | +42,305 |
| *Liverpool Overhead Rly. | ,, 15 | 1,607 | − 112 | 11 | 18,966 | − 240 |
| *Manchester Corporation | ,, 14 | 2,166 | ... | §14 | 27,935 | − 55 |
| Perth (W.A.) Elec. Trams | ,, 13 | 775 | + 407 | ‡11 | 9,598 | + 5,539 |
| Portsmouth Corporation | ,, 14 | 1,047 | − 105 | ... | ... | ... |
| *Sheffield Corporation ... | ,, 15 | 3,815 | +1,170 | 11 | 41,718 | +13,152 |
| Southampton Corporat'n | ,, 11 | 959 | + 166 | 11 | 11,073 | + 3,377 |
| Southend Corporation... | ,, 14 | 344 | ... | 8 | 2,727 | ... |

Except where otherwise indicated, all amounts are in sterling.
(*a*) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Fortnight.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 11: | | Price Wednesday, Sept. 18. | | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending Sept. 18. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅜ | ⅜ | ⅜ | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) .. | 97 | 102 | 97 | 102 | ... | ... | ... | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. ..... | 12 | 13 | .2 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. ..... | 9½ | 10½ | 9½ | 10½ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) .... | 102 | 105 | 1'2 | 106 | 4 6 4 | ... | ... | ... |
| 19,681 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord ..... | 7½ | 8½ | 7½ | 8½ | 4 6 2 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 8½ | 8½ | 8½ | 8½ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) ..... | 7½ | 8 | 7½ | 8 | 2 3 9 | ... | ... | ... |
| 50,000 | 5 | 4 0 | Charing Cross & Strand Electricity Supply Corp... | 9 | 10 | 9 | 10 | 4 5 0 | February and August | 9⅜ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ..... | 5½ | 5½ | 5½ | 5½ | 3 18 3 | ,, ,, | 5⅝ | 5⅜ |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) ... | 103 | 105 | 103 | 105 | ... | ... | 104½ | 103⅜ |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary..... | 5½ | 6 | 5½ | 6 | 4 11 8 | March ..... | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) .... | 108 | 111 | 1'9 | 112 | 4 1 4 | June and Decembe r... | ... | ... |
| 70,879 | 10 | 6/0 | City of London Electric Lighting Ord. ..... | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8⅜ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. ..... | 11½ | 12½ | 11⅜ | 12½ | 4 16 0 | January and July ..... | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ... | 121 | 123 | 121 | 126 | 3 19 9 | June and December ... | ... | ... |
| £200,000 | Stock | 46/5 | Do, 4½% 2nd Deb. Stock Certs. (all pd.) .. .... | 101 | 103 | 101 | 1'3 | 4 8 0 | ... | 103 | 102 |
| 40,000 | 10 | 8/0 | County of London and Brush Prov. Ordinary... .. | 8 | 9 | 8 | 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference..... | 12 | 13 | 12 | 13 | 4 13 4 | March and September | ... | ... |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) ..... ..... | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary ..... | 5½ | 5⅝ | 5½ | 5⅝ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary..... | 7⅛ | 8⅛ | 7⅛ | 8⅛ | 4 14 2 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary ..... | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. ..... | 6⅞ | 7 | 6⅞ | 7 | 4 2 7 | January and July ..... | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.)..... [Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knytbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 1 | ... | ... | ... |
| 110,000 | 8 | ... | London Electric Supply Ordinary ..... | 1⅛ | 1⅜ | 1⅛ | 1⅜ | ... | ... | ... | ... |
| 42,840 | 5 | 3/0 | Do, 6 per Cent. Preference ..... | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ..... | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 98,767 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) ..... | 13 | 14 | 13 | 14 | 4 5 9 | April and October..... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage .. | 111 | 114 | 112 | 115 | 3 18 8 | June and December ... | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) ..... | 98 | 101 | 97 | 100 | 3 10 3 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary ..... | 15 | 16 | 15 | 16 | 4 7 6 | March ..... | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary ..... | 5⅞ | 6⅛ | 5⅞ | 6⅛ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock ..... ..... | 99 | 102 | 99 | 102 | 3 18 5 | ... | ... | ... |
| 500,000 | 1 | 1/6 | Rand Electric ..... | 7/16 | 7/8 | 7/16 | 7/8 | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. ... | 60 | 70 | 60 | 70 | ... | January and July ..... | ... | ... |
| £107,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 103 | 104 | 102 | 104 | 4 9 1 | April and October..... | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary ..... | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15⅜ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference ..... | 8½ | 9½ | 8½ | 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) ..... | 97 | 100 | 97 | 100 | 3 10 0 | ... | 100 | ... |
| 13,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary..... | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ..... | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary..... | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 109,518 | 5 | 5 0 | Westminster Electric Supply Ordinary ..... | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 17⅜ | 13½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) ..... .. | 4½ | 4⅝ | 4½ | 4⅝ | 4 11 5 | April and October..... | ... | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock..... . | 124 | 129 | 125 | 123 | 4 13 9 | ... | ... | ... |
| 20,000 | 10 | 4/0 | Barcelona Tramways Ordinary ..... | 8 | 9 | 8 | 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference .. ..... | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures ..... | 96 | 100 | 96 | 101 | 4 19 0 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) ..... ..... | 92 | 97 | 92 | 97 | 4 12 0 | ... | ... | ... |
| 15,000 | 10 | 1/0 | Blackpool and Fleetwood Tramways..... | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. ..... | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 70,000 | 5 | ... | Do. 5% Cum. Pref. ..... . ..... | 4½ | 5 | 4½ | 5 | ... | ... | 4 | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. ..... | 103 | 105 | 103 | 105 | 4 6 7 | ... | 104 | 103⅜ |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary ..... | 21½ | 22½ | 21½ | 22½ | 3 13 4 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) ..... | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures ..... | 112 | 115 | 112 | 115 | 3 9 9 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary..... ... | 6 | 6⅛ | 6 | 6⅛ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference ..... | 9⅛ | 9⅜ | 9⅛ | 9⅜ | 5 2 7 | May and November ... | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs.... ... ... ..... | 101⅞ | 103⅞ | 101⅞ | 103⅞ | 4 9 1 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary..... | 14 | 14½ | 14 | 15 | 6 6 4 | ... | 14⅛ | 14 1/16 |
| 90,000 | 10 | 6/0 | Do. 6% Cum. Pref..... | 11⅞ | 12⅛ | 11⅞ | 12⅛ | 4 18 0 | February and August | 12⅛ | 12 1/16 |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ..... | 124 | 125 | 123 | 126 | 4 0 4 | ... | 124⅛ | 121⅛ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary ..... | 1⅝ | 1⅞ | 1⅝ | 1⅞ | ... | ... | ... | ... |
| 40,000 | 5 | 2/0 | Do. 6% "A" Cum. Pref. ..... | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 2/6 | Do. "B" ..... | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 2 3 6 | ... | ... | ... |
| £230,000 | Stock | 5% | Do. 5 per Cent. Debentures ..... | 104 | 107 | 104 | 107 | 4 14 7 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) .. | 98 | 101 | 98 | 101 | 5 0 2 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) ..... | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 2 8 0 | ... | 11⅞ | ... |
| £250,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) ..... | 105 | 107 | 105 | 107 | 4 4 8 | ... | ... | ... |
| 400,000 | 1 | 1/2½ | Cape Electric Tramways Shares ..... | 1⅞ | 2⅛ | 1⅞ | 2⅛ | 2 16 6 | ... | 2 1/16 | 2 |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock ..... ..... | 102 | 105 | 102 | 105 | 3 16 2 | June and December... | 104 | 103½ |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock ..... ..... | 105 | 108 | 105 | 108 | 3 14 1 | ... | 107 | 106 |
| £440,100 | Stock | ... | Do. Deferred Stock ..... ... ..... | 99 | 102 | 98 | 101 | ... | ... | 99½ | ... |
| £686,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs ..... ... . | 113 | 118 | 113 | 118 | 3 7 10 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. ..... | 5⅛ | 5⅜ | 5⅛ | 5⅜ | 4 10 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. ..... | 103 | 103 | 103 | 106 | 3 16 7 | ... | ... | ... |
| £915,000 | Stock | 1½% | City and South London Railway Con. Ordinary ..... | 52 | 54 | 51 | 54 | 2 15 7 | February and August | 53 | 51½ |
| 47,500 | 10 | 2/0 1/2 | Do. Ordinary (Nos. 22,501 to 70,000) ;..... | 5⅛ | 5⅜ | 5 | 5⅛ | 2 1 9 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) ... | 129 | 124 | 139 | 134 | 3 14 8 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) ..... | 128 | 127 | 128 | 127 | 3 18 9 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ..... ..... | 113 | 118 | 113 | 118 | 3 8 0 | May and November ... | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary..... | 12 | 13 | 12 | 13 | 3 16 11 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference..... | 14½ | 15½ | 14½ | 15½ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) ..... | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tract'n. Pref. | 5⅛ | | — | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary..... | 21½ | 22½ | 21½ | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference..... | 14⅜ | 15 | 14⅜ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ..... | 111 | 113 | 111 | 113 | 3 19 8 | January and July ..... | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary ..... xd | 7 | 7⅛ | 7 | 7⅛ | 3 16 1 | Febru ary and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ..... ..... xd | 12⅜ | 13 | 12⅜ | 13 | 3 16 11 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture ..... ... | 103 | 104 | 103 | 104 | 3 16 11 | January and July ..... | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4½% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 14 9 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30 yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 7 9 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) ... | 100 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) ..... | 100 | 102 | 100 | 102 | 4 8 3 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary ..... | 3 | 3⅛ | 3 | 3⅛ | 5 14 4 | ... | ... | ... |
| 80,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference ..... | 4⅛ | 5 | 4⅛ | 5 | 6 0 0 | May ..... ..... | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary ..... | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 1 13 0 | ... | ... | ... |
| 20,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference..... | 9⅛ | 10⅛ | 9⅛ | 10⅛ | 4 15 8 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock ..... ... | 106 | 109 | 106 | 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord... | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) ..... ..... | ... | | ... | | ... | April and October..... | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) ..... | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) ..... | ... | | ... | | ... | January and July ..... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary ..... ..... ... | 92 | 95 | 92 | 95 | 3 2 8 | June and December ... | ... | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 11. | Price Wednesday, Sept. 18. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Sept. 18. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 9 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ 4⅛ | 3⅜ 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 56 | 53 56 | 5 11 9 | Feb., May, Aug., Nov. | 55⅛ | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 100 | 98 100 | 6 0 3 | ,, ,, | 99⅛ | 99⅛ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10½ 11 | 10⅝ 11⅛ | 2 4 6 | ,, ,, | 11 | 10⅞ |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 103 | 101 103 | 3 17 9 | ,, ,, | 102⅛ | ... |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 6 | 5 6 | 7 10 0 | February and August | 5⅛ | 5 |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 13½ 14½ | 13½ 14½ | 6 17 11 | ,, ,, | ... | ... |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ 104⅞ | 100⅞ 104⅞ | 4 7 0 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10⅜ 11⅛ | 10⅜ 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | 11⅛ | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. ) | 100 103 | 100 103 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 143 148 | 142 147 | 4 15 3 | Jan., Apr., July, Oct. | 145½ | 143 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 97 100 | 96 99 | 3 10 6 | ,, ,, | 99 | 97½ |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 115 118 | 113 116 | 3 9 7 | May and November | 117 | 115½ |
| 300,000 | 10 | 2/6 | Eastern Extension | 14 14½ | 14 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14⅜ | 14⅛ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 115 120 | 115 120 | 3 6 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 103 | 100 103 | 3 17 8 | February and August | 100½ | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101⅞ 104⅞ | 101⅞ 104⅞ | 3 17 7 | May and November | ... | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 30 32 | 30 32 | 4 13 9 | January and July | ... | ... |
| £78,006 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb.(wthnNos | 100 103 | 100 103 | 4 7 10 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red. | 41 45 | 41 45 | 5 11 1 | May and November | 42½ | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent.†Debs.,1904 | 102 105 | 102 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 1 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 99 102 | 99 102 | 4 17 10 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ¼ ⅜ | ¼ ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 100 103 | 3 18 1 | January and July | ... | ... |
| 88,321 | 10 | ... | West India and Panama | ⅛ ⅜ | ⅛ ⅜ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 6 | 5 6 | ... | ,, ,, | 5½ | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | ... | ,, ,, | ... | ... |
| £8[illegible],000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 16 2 | January and July | 102 | ... |
| 207,930 | 10 | 3/0 | Western Telegraph (late Br zil'n Submarine) | 14 14½ | 14⅛ 14⅜ | 4 14 11 | Mar., June, Oct., Dec. | 14½ | 14⅛ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 102 105 | 104 1 5 | 4 15 10 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 7 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) | 3⅛ 4 | 3⅛ 4 | 6 5 0 | August | ... | ... |
| 224,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | 2/6 3/6 | 2/6 3/3 | 4 5 9 | April and October | ... | ... |
| 72,680 | 1 | 2⅛% | Monte Video Telephone Ordinary | ⅛ ⅜ | ⅛ ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3⅜ 3⅝ | 3⅜ 3⅝ | 6 9 0 | February and August | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | 12⅜ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅜ 4¼ | 4⅜ 4⅜ | 5 2 7 | ,, ,, | 4¼ | 4 1/16 |
| £7,900,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 98 | 95 98 | 3 11 10 | June and December | 96⅛ | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 1 | ... | ... | ... |
| 171,504 | 1 | 0/8½ | Oriental | ¾ 1 | ¾ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5½ | 5 5½ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅜ 5⅛ | 4⅜ 5⅛ | 4 15 3 | June and December | ... | ... |
| £ 79,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 15 11 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ⅝ | ⅜ ⅝ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 7/16d 11/16d | 7/16d 11/16d | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ ½ | ⅜ ½ | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 8 9 | 8 9 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ 5¾ | 5¼ 5⅜ | 5 4 4 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¼ 5⅛ | 4¼ 5⅛ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅛ 1⅜ | 1⅛ 1⅜ | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2⅜ | Do. 3 per Cent. Pref. Non-Cum. | 2 2¼ | 2 2¼ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 102 105 | 102 105 | 4 5 9 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 8 3 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 16 | 15 16 | 4 13 9 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 6¼ 6½ | 6¼ 6½ | 4 0 0 | ,, ,, | 6⅛ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 110 114 | 110 114 | 3 19 6 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 95 | 92 95 | 4 14 9 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 5 0 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅛ 3⅜ | 3⅛ 3⅜ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.) | 100 105 | 100 105 | 4 15 3 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ¼ ½ | ¼ ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1⅛ 2⅛ | 1⅛ 2⅛ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 85 | 4 14 0 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 85 90 | 85 90 | 5 13 8 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 6⅛ 6⅜ | 6⅛ 6⅜ | 5 12 0 | Half-yearly | 6 | ... |
| 20,000 | 5 | 1/6⅛ | Do. 6% Cumulative Preference | 5⅜ 6 | 5⅜ 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 107 | 104 107 | 4 4 4 | ... | 105½ | ... |
| 112,100 | 2 | 1/2⅜ | Electric Construction Co. | 1⅝ 2 | 1⅝ 2⅛ | 5 6 8 | January and July | 1⅞ | ... |
| 31,300 | 2 | 2/9⅜ | Do. 7 per Cent. Cumulative Preference | 2⅛ 2⅜ | 2⅛ 2⅜ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 102 | 98 102 | 3 18 5 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅛ 10⅛ | 9⅜ 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 102 | 99 102 | ... | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary | 16⅛ 17⅛ | 16⅛ 17⅛ | 6 1 5 | February and August | 17⅛ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 6 | 5⅛ 6 | 3 15 0 | ,, ,, | 5⅜ | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 110 114 | 110 114 | 3 19 0 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21⅛ 22⅛ | 21⅛ 22⅛ | 4 8 11 | ,, ,, | 22⅛ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 9 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 38 42 | 38 42 | 5 0 0 | March and July | 40 | 38⅜ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 106 | 104 1 6 | 3 15 10 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10⅛ 11⅛ | 10⅛ 11⅛ | 5 4 4 | ... | 11 | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅛ 6⅛ | 5⅛ 6⅛ | 4 0 0 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | 11⅛ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | 6⅞ | 6⅝ |
| £ 00,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 2 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,237 | 10 | 4/6 | Globe Telegraph and Trust | 10⅛ 11 | 10⅞ 11⅛ | 4 13 2 | Jan., Apr., July, Oct. | 11⅜ | 10⅞ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 15⅛ | 15 15⅜ | 3 17 5 | ,, ,, | 15⅛ | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 127 132 | 127 132 | 4 11 8 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,219. [No. 23. Vol. XLVII.] FRIDAY, SEPTEMBER 27, 1901. PRICE SIXPENCE (by post, 6½d.)
*Abroad, 8d., or 16 cents, or 80c., or 70pf*


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## NOTES.

THE Corporation of the City of Glasgow has usually been considered a model of what corporations should be, but it is to be feared that, if we judge from the proceedings of their meeting last Friday, we must considerably alter our opinions on that point. The financial proposals laid before the Corporation by the Electricity committee, and finally accepted, are such as, if adopted by any commercial firm, would certainly give us serious doubts as to the competence of the directors to manage its affairs. It appears that the Electricity committee is called upon to face a deficit on the year of £4,517. 6s. 11d., made up of £4,109. 13s. 4d. as the cost of lamps and fittings supplied to consumers in consequence of the change of voltage, and £407. 13s. 7d., as excess of the interest and sinking fund charges above the actual balance of revenue over expenditure on the year's working. This deficit has been wiped out by a transfer from the reserve fund. But beyond this, the Corporation, finding that, after discharging their ordinary obligations and providing for interest on capital and sinking fund, their accounts were about square, have decided to leave the accounts balanced in that manner and pay no attention to depreciation. The convener of the Electricity committee found himself hard pushed to provide a satisfactory reason for this step, for while he argued that merely writing off so much for depreciation was a sham, he stated that they would resume this process so soon as they found themselves with a surplus. He also argued that in past years, when they had had surpluses, they have made such liberal allowances for depreciation that they can well afford to allow this year to pass without making any provision at all. Moreover, the reason given for the existence of the deficit—viz., the increased cost of commodities while the price of current was kept at the old figure—is not quite accurate, for the figures published in our analysis this week show that there has been a drop and not an increase in all the items of works costs; but there is a considerable decrease in the average revenue per unit sold.

WE should have thought the Glasgow Corporation would have refused to accept such a dangerous doctrine as that of allowing for depreciation only in years when there is a surplus. If such a principle be once admitted, no sound finance can be looked for; and it is noteworthy—and not a pleasant feature of the situation—that the finance of other departments of the Glasgow Corporation than that dealing with electricity is at present causing much discussion locally and a complete revision is being called for. The Gas committee, we notice, reports a deficit of over £54,000 on the year's operation; but that sum includes an allowance for depreciation. Why this should have been provided for in the one case and not insisted on in the other passes our comprehension. Electricity is well able to hold its own in Glasgow against gas; the accounts show that the number of consumers of electricity has increased during the year by 41 per cent., while the number of motors has been more than doubled. But no matter what the relative positions of the two rival illuminants be, we should be the last to desire to see the electricity undertaking bolstered up by bad finance. The evil, however, seems to be too common in municipal ventures. An abstract of the accounts appeared on p. 848 of our last issue; a full analysis of them is given on p. 874 this week and a report of last Friday's Council meeting on a later page.

THE Thomson-Houston system of train control formed the subject of an article in our issue of September 6th. This week we commence an account of the Sprague multiple unit system. Broadly speaking, both methods of control have the same object, namely, to operate a train with a number of motor cars from one position on the train; both systems have been largely used in the United States with conspicuous success, and now both systems are attracting a considerable

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amount of attention in this country. The principal difference in the electrical devices employed is, that in the one case a motor controller works directly a series of electromagnetic switches, in the other electromagnetic switches are only used in the control circuit, the actual operations in the main circuit being worked by a motor. The general arrangement of both systems can be compared by means of the diagrams shown on pages 744 and 865, though it may be mentioned that, in the method adopted by Sprague, the coast relay is often omitted, reducing the train line to four wires.

A FEW years back it was certainly a subject for great reproach to this country that it always obtained practically the whole of its electrical tramway equipment from the other side of the Atlantic. That stigma is, we are glad to say, now being wiped out, and during the present wave of imperialistic patriotism much has been done to rectify our previous supineness. This patriotism is well exemplified by the action of the historic town of Portsmouth, which is equipping its tramway system throughout with British plant, and successfully inaugurated the undertaking on Tuesday last, when the first four miles of track were opened. Further sections, comprising about eight miles of double track, will be opened in the course of the next week or two; the power house will be ship-shape by that time, and by the end of the year the whole undertaking should be completed. Both the Portsmouth Corporation and Messrs. Dick, Kerr & Co. (the principal contractors) are to be congratulated on the speed with which the work is being carried out.

To the casual inquirer there are two points that need explanation with regard to the system. At first sight the Corporation would appear to be ultra conservative in having adopted the overhead trolley in preference to a conduit system in a crowded district like the city of Portsmouth, and again, the Corporation would appear to be ultra-radical in having adopted the gauge of 4ft. 7¾in. The almost absolute necessity of using the overhead trolley at Portsmouth is due to the low-lying level of the town, which would have made effectual drainage of conduits impossible; the adoption of a gauge not used in England dates from the commencement of the horse tramways, and is due to the Mother of Parliaments, who enacted that certain streets were three-quarters of an inch too narrow for the standard track.

THE Urban District Council of Walthamstow is to be congratulated on its enterprise in using gas engines for the driving power in a public electricity supply works. Up to the present, the record of works of this class that have employed gas-driven dynamos has been anything but successful, and every one of them has either changed from the rope-driven gas dynamo to the direct-coupled steam dynamo, or has adopted this more conventional machine when making extensions. The new station, however, is different from the old gas-engine station in the important detail that the dynamos are directly coupled to three-crank vertical gas engines which to a casual observer might be mistaken for single-acting vertical steam engines. District councils should not make experiments; but we may be pardoned if we look forward with interest to the result of this new opportunity for the advocates of gas-engine-driven electricity supply works to prove that this type of station may yet have useful economical possibilities.

**Croydon Electric Tramway.**—The Board of Trade inspection of the Norbury–Purley section of these tramways was made on Friday last, and the opening ceremony duly took place yesterday.

**Long-Distance Telephony.**—The *Daily Telegraph* states that the Post Office has been successful in telephoning from Liverpool to Paris, but that a similar experiment from Leeds was not so successful.

**Automatic Translation on Submarine Cables.**—Automatic cable translation from section to section of cable has recently been established and is working successfully at Gibraltar on the cables of the Eastern Telegraph Co. The apparatus employed has been constructed under the patents of Mr. Herbert Taylor, Mr. S. G. Brown and Mr. Arthur Dearlove.

**The Institution of Junior Engineers.**—The summer meeting of this Institution took place at the Three Towns, Devonshire, last month (August 12th to 17th). Although the attendance was not so numerous as usual, on account of a number of the members reserving themselves for the Engineering Congress at Glasgow, the whole week's proceedings passed off in a highly successful manner, and afforded great interest and enjoyment to those present.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... | Mar. 2, 1900 ... | — |
| Cadiz—Teneriffe..... .... ... | Aug. 6, 1901 ... | — |
| Bolama—Bissao ..... | Aug. 16, 1901 ... | — |
| Trinidad—Demerara ..... | Aug. 27, 1901 ... | Sept. 20, 1901 |
| Curaçoa—Cora..... | Sept. 11, 1901 ... | — |
| Bolama ..... | Sept. 12, 1901 ... | — |
| Gibraltar—Tangiers ..... | Sept. 13, 1901 ... | — |

**Electricity in Warships.**—It is reported that the extension of the use of electricity in the Navy in place of steam for subsidiary purposes will be made the subject of a series of experimental tests in November next.

**Central London Railway.**—An unfortunate interruption to traffic occurred on the Central London Railway on Wednesday, owing to a train having run off the line near Shepherd's Bush station. For some considerable time the trains could only be run at a 20 minutes' headway, and as the occurrence took place at 7:30 in the morning much inconvenience was caused to City-going people. This was augmented by the fact that there was also a delay on the West London tramways, owing to an overhead wire having broken.

**Cable to Iceland.**—A number of reports have appeared in the daily journals of this country from time to time regarding the alleged intention of the Great Northern Telegraph Co. to lay a cable to Iceland in the near future. We are authorised to state that no such decision has been taken by the company, as the scheme for laying the cable has not so far met with the support from the Governments of the chief countries interested which is necessary to supplement the assistance promised by the Danish and Swedish Governments.

**The Taunton Tramways.**—A short line of tramways, about 1½ miles of single track (3ft. 6in. gauge) with turn-outs, including no gradients of importance but several curves, was opened for traffic at the end of last month by the Taunton and Somerset Tramways and Light Railways Co. (one of the companies affiliated to the British Electric Traction Co.). Five single-truck Brush cars are running at present at a headway of about seven minutes. Both the trucks and bodies of these cars have been made by the Brush Company, and they are of the new reversed stairway pattern, carrying 51 passengers. The cars are fitted with 800B (17 H.P.) motors, and H2 series-parallel controllers with solenoid blow-out and an electrical

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short-circuiting emergency brake fitted on the reversing handle. The usual hand brake is provided. The overhead construction is by Messrs. R. W. Blackwell & Co. Mr. C. J. Wharton was consulting engineer for the line. Current is supplied at 2d. per unit by the Corporation electricity works. As these works are on the single-phase alternating system, two small Newton six-pole generators have been put in for this purpose. They are driven by fast-speed engines, and one of them has a Thomson-Houston alternator connected on to the same main shaft.

**The Insurance of Electrical Machinery.**—The chief engineer of the Engine Boiler and Employers' Liability Insurance Co. in his report for 1900 mentions that there has been a large and steady increase in the branch of the company dealing with the inspection and insurance of electrical machinery, the number of insurances having increased three-fold during the year; on the other hand, the number of breakdowns has increased six-fold. The causes of these breakdowns may be classified as under :—

| | Dynamos. | Motors. |
|---|---|---|
| Accidental or unascertained | 46 per cent. | 45 per cent. |
| Negligence | 21 „ | 21 „ |
| Old defects and wear | 7 „ | 4 „ |
| Weakness or bad design | 26 „ | 30 „ |
| | 100 | 100 |

and their nature thus :—

| | | |
|---|---|---|
| Burning out of armatures | 50 per cent. | 63 per cent. |
| Burning out of magnet coils | 7 „ | 5 „ |
| Mechanical breakages | 32 „ | 17 „ |
| Faults in commutators and brush holders | 0 „ | 7 „ |
| Miscellaneous | 11 „ | 8 „ |
| | 100 | 100 |

**New Pacific Cable.**—The *Daily Telegraph's* New York correspondent states that the Commercial Pacific Cable Co. has been incorporated at Albany, with a preliminary capital of $100,000, to connect New York City with San Francisco by its own or other telegraph lines, and thence to run from California to Hawaii, the Philippines, and other Pacific islands. The directors are Messrs. John W. Mackay, Clarence Mackay, G. G. Ward, Albert Beck, William C. Cook, A. B. Chandler, Edward C. Platt, and George Clapperton. Mr. Mackay is stated to have said that the length of the cable would be about 8,500 miles, and that the first part would be laid from California to the Hawaiian Islands, 2,200 miles. He expected that this portion would be completed and in operation in nine months, and the entire line to the Philippines in two years. Mr. Mackay added that his application to Government for landing rights in California, the Hawaiian Islands, and the Philippines were still pending; but, in view of the fact that the new company was willing to construct and lay the cable without asking for any subsidy or guarantee, he believed there would be no trouble as to the terms and conditions upon which the cable will be landed when it reaches the Philippines. It will connect the present cable running to Japan, and also the cable running to China, thus establishing direct cable communication between China and the United States. Mr. Mackay also informed the correspondent that the present telegraphic rates from the States to the Philippines, China and Japan, would be reduced by this line from 80 to 60 per cent.

**Foreign Criticism on the Edison Secondary Cell.**—In a recent issue of the *Centralblatt für Accumulatoren und Elementenkunde*, Dr. Franz Peters submits the advantages claimed for the new Edison secondary cell to an exhaustive criticism. Basing his remarks upon the figures given in Dr. Kennelly's Paper read before the American Institute of American Engineers, Dr. Peters discusses first the relative discharge efficiency of the old and new forms of secondary cell. In place of Dr. Kennelly's figure of 13·28 watt-hours per kilogramme of cell weight, as the maximum discharge for the Planté cell, he states that he has himself obtained 260·04 watt-hours from a cell weighing 12·75kg., or a discharge efficiency of 20·39 watt-hours per kilogramme. The current density in this case was 1 ampere, as compared with 0·98 ampere per square metre of electrode surface for the Edison cell. While the latter gives, therefore, the higher discharge in watt-hours per kilogramme, a larger surface area of electrode is required to yield a given amount of energy. A battery made up of nickel superoxide and iron couples would require to be nearly twice the size of a battery of the usual type of lead-peroxide and lead couples for the same work. For motor purposes the number of cells in the battery would also have to be doubled, as the discharge potential of the nickel oxide cell is only 1·1 volts as compared with 1·97 volts for the lead-peroxide cell. The cost of manufacturing the new type of cell is, in Dr. Peters' opinion, likely to exceed the estimates that have been made, and he lays stress upon the fact that Edison himself has only expressed a "hope" that the final cost of energy from the new cell will not exceed that obtained with the old Planté cell. As regards the weight of sulphuric acid required for operating the Planté cell, Dr. Peters is of opinion that Dr. Kennelly's figures are 5 to 10 per cent. too high, while he considers that the weight required for operating the new cell has been under-estimated. Dr. Peters concludes his article by stating that, in his opinion, the Edison cell will not occasion any sudden revolution in the accumulator industry. Improvements in the manufacture of secondary cells may possibly come from further experiment and research along the path which Edison has chosen, but the Edison cell, he thinks, possesses too many defects to be considered a successful solution of the accumulator problem.

**High-Pressure Steam Pipe Joints and Flanges.**—Mr. James McKechnie, in a Paper recently read before the Institution of Mechanical Engineers on "Marine Engineering during the last 10 years," amongst other matters reviewed the progress in the designs of pipe joints and flanges in the Royal Navy. Solid drawn and lap-welded steel tubes are now used in place of copper pipes, and for large valve boxes and bends gun-metal is sometimes used; but cast steel would be used wherever possible, and more extensively, if castings as thin as considerations of strength would determine could be produced by steel makers. The full use of this material in this country is retarded by the apparent inability to produce sound thin castings. In the earlier warships, with high steam-pressure machinery—260lb.—all the steam pipes over 3in. in diameter are of steel; in the later vessels with 300lb. pressures the same material is used for all pipes over 1½in. diameter. Such steel pipes up to 6in. in diameter are solid drawn, with weldless steel flanges screwed on, while those over this size are lap welded, with a butt strap covering the weld, the flange being carefully riveted on. It was found possible to bend the steel pipes up to 4in., and it is to be hoped that progress will be made in this direction so as to reduce the number of expansion boxes. The higher pressures also involved change in connection with joints, and many experiments have been made. The steel flanges fitted to the steel steam pipes of H.M.S. "Powerful" have the surfaces only machine finished, the actual joint being made by a soft copper ring of triangular cross section. This system gave very satisfactory results under water test, but a few months' actual use brought about such pitting of the steel faces, due to galvanic action, that the joints would no longer keep tight. Another objection to the system was the dropping of the ring owing to its loosening as a consequence of the expansion and contraction of the line of pipe, and its being thus free to take a position eccentric to, and crossing the edges of, the bore. To overcome this the rings on H.M.S. "Amphitrite" had a recess formed in each flange to prevent the ring dropping too far out of place. This effected some improvement, but the trouble from corrosion unavoidable with copper and steel in contact led to the system being discarded. Flanges are now finished by hand-scraping, and the only material on the joint is a thin wash or paint of red lead and oil. This system has been adopted throughout H.M.S. "King Alfred," now building at Barrow-in-Furness. The author was of opinion that a simpler, cheaper, and efficient form of joint could be used in place of the hand-scraped flanges—viz., a joint made with asbestos paper—about the thickness of brown paper—soaked in oil, the faces of the flanges being only machined, with no scraping. Indeed, this material was adopted in several instances in the feed discharge pipes, in which the pressure is over 600lb. per square inch, the joints requiring to be re-made at sea.

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# WALTHAMSTOW MUNICIPAL ELECTRICITY SUPPLY WORKS.

The new electricity supply works of the Urban District Council of Walthamstow, which were formally opened last Friday, have been carried out to the specification and under the superintendence of Mr. J. Enright, consulting engineer to the Council. When completed the estimated cost of the undertaking, including expenditure on tramways, is about £250,000, but so far a loan of £41,000 has been granted by the Board of Trade. The station is of interest on account of the resurrection of the gas engine for electricity supply works, and the efficiency tests which will shortly take place will be looked forward to with interest.

Gas plant supplied by the Dowson Economic Gas and Power Co. of their standard pattern has been installed, and consists of two 5 H.P. boilers, generating steam at 40lb. pressure, which is passed into two generators. A store for about 30 to 40 tons of anthracite coal is placed at the back of the gas shed, and the usual hydraulic boxes, coke scrubbers, washers, and sawdust scrubbers are in use. The gas passes through a gasholder 25ft. diameter and 12ft. deep, into a 20in. main from which 5in. pipes branch off to the gas engines. Two stand pipes are fixed, one on each side of the main, to enable the gas to escape from the pipe when inspection is necessary.

The engines are of the Westinghouse three-cylinder vertical type, capable of developing about 100 B.H.P. at 168 revs. per min., and work on the Otto cycle. Separate inlets take the gas and air into the mixing chamber M (Fig. 2), the openings being fixed by the levers shown in Fig. 3. The top lever controls the gas supply, the lower one the air supply, and the ratio of the readings on the two scales shows the proportion of gas and air in the mixture. This mixture is conducted through a distributing chamber to the part N, the amount depending on the position of the regulating valve; this is worked by the governor shown to the right in Fig. 3. The port N supplies the mixture to the three cylinders in turn through the inlet valves J, the cranks being set 120deg. apart. The crank shaft and levers working the inlet valves B C, the exhaust valve E, the exhaust cam shaft A, guide lever G, exhaust pipe O and water-circulating pipes H K are also clearly shown. Electrical ignition is employed. Cams immediately adjacent to the inlet cams work a plunger through the guide D and break the circuit at

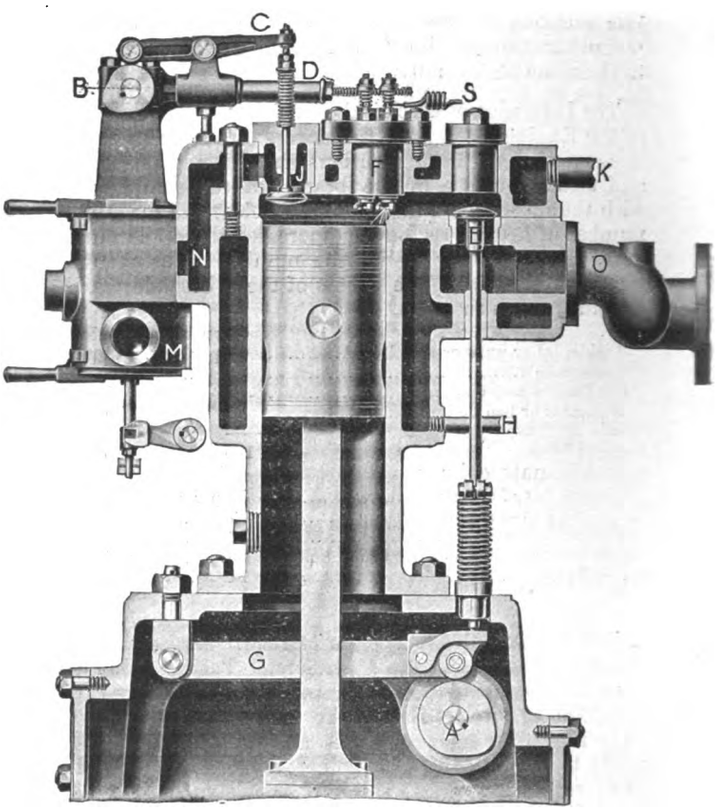


FIG. 2.—SECTION THROUGH CYLINDER OF WESTINGHOUSE GAS ENGINE.

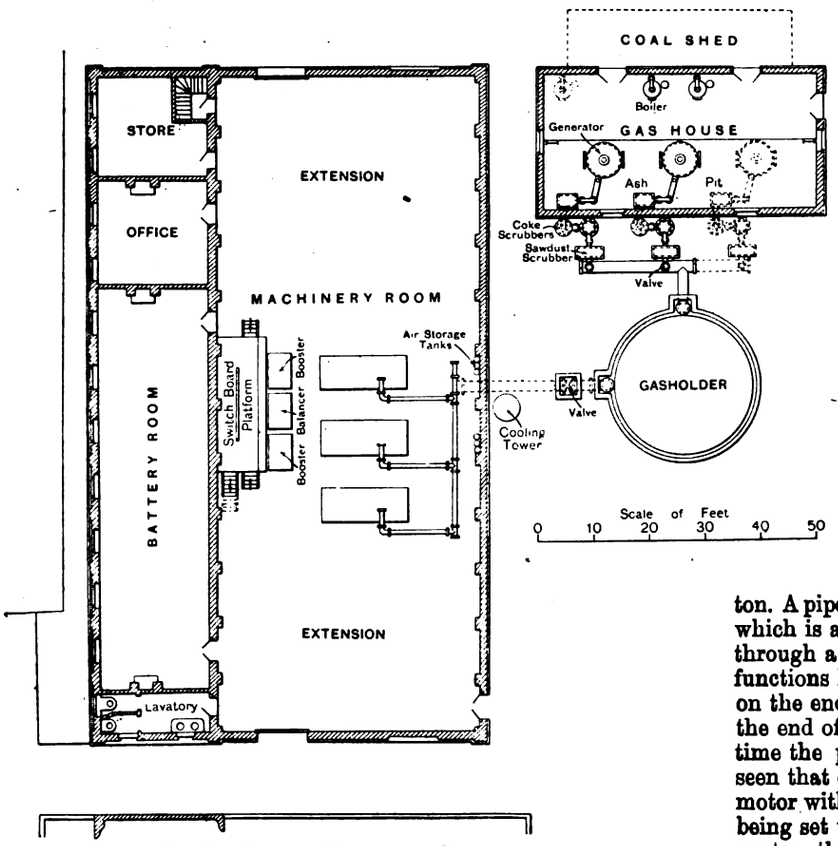


FIG. 1.—PLAN OF GENERATING STATION.

the terminals of the igniter F. Duplicate binding posts and circuit breakers are fixed, so that, in case of failure of the one, the wire S may be connected to the other. Current for the igniters is furnished by a small magneto machine driven by a motor, whilst a spare set is kept in reserve in case of a breakdown.

For starting, two batteries, each consisting of three air storage tanks, have been fixed. At present the batteries are charged by air compressors driven from pulleys on the engine but the air compressors will eventually be driven by motors. The air is compressed to 190lb. per square inch, and the supply in one tank is sufficient to start two engines. At the end of the upper cam shaft on the engine is a screw, which, on being given a few turns to the left, renders the admission valve of one cylinder inoperative for the time being, and on the back of the crank case is a short lever, which on being moved to the right throws out the regular exhaust cam and throws in a supplementary cam which keeps the exhaust valve open during every upstroke of the piston. A pipe leads from the air storage tank to the starting valve, which is attached to the end of the crank case, and thence through a check valve into the cylinder in which the valve functions have been altered. This valve is actuated by a cam on the end of the lower cam shaft where it projects through the end of the crank case, and is so timed as to open each time the piston starts on its downward stroke. It will be seen that one cylinder is thus converted into a compressed air motor without disturbing the rest of the engine. The engine being set with the corresponding crank a little past its upper centre, the air and gas supply properly adjusted, and the

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stop valve in the air pipe opened, it starts off and continues to run on air pressure until explosion takes place in the other cylinders. The air supply is then shut off, the inlet and exhaust valves put back in their normal working condition, and the engine is in full operation. When we inspected these engines they were running very silently; there was a slight puff from the exhaust, but the stream of gas was nearly continuous, and second and larger exhaust boxes are to be fixed to remove even this puff. The circulating water is taken up a 40ft. cooling tower, a draught being formed by a fan driven by a 2 H.P. motor, and a well is to be made to supply deficiencies.

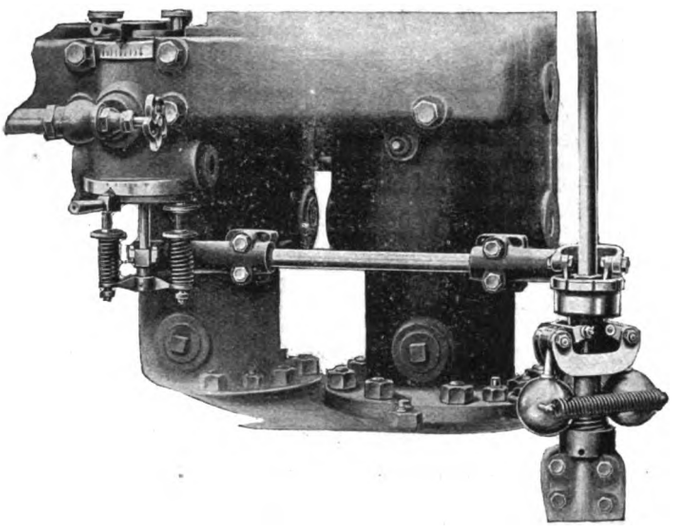

FIG. 3.—GOVERNOR OF GAS ENGINE.

The generators are of the multipolar "Helios" type, having a capacity of 66kw., supplied by Messrs. Frank Suter & Co., who are the contractors for everything in connection with the generating plant, the plant having been erected under Mr. S. J. Suter's supervision. The circular magnet frame of the dynamos is substantially built, and is divided horizontally, the lower half being cast with brackets by which the whole frame is supported on the bed-plate. It is provided with soft steel magnet poles bolted to the cast-iron magnet frame, and set in position by a feather on the pole piece which slides into a groove in the magnet frame. The field coils are former-wound, and held rigidly on the poles by the pole shoes.

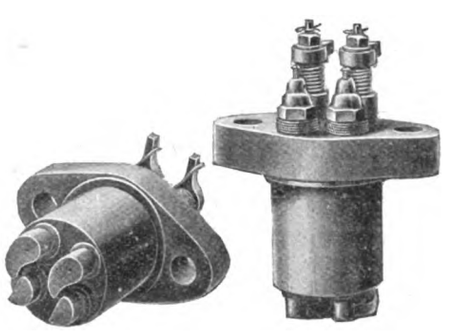

FIG. 4.—IGNITOR OF GAS ENGINE.

The armature is of the slotted drum type, the core-discs being mounted on a strong cast-iron spider keyed to the shaft. Each disc is slotted on the periphery to receive the windings, then shellacked and separated from the next by tissue paper. The commutator, which is of large diameter, is built up of hard-drawn copper segments, mounted on a cast-iron core, and insulated from the latter and from each other by mica. Its copper segments have lugs with milled slots, in which the ends of the armature windings are soldered.

The brush rocker ring is carried and guided by small bracket arms projecting from the magnet frame, so that it can be rotated by means of a hand-wheel and worm-gear. The brush-holders are of simple construction, and the pressure on the commutator can be varied by means of a screw and spring provided for the purpose. This spring does not convey the current, a flexible conductor being added for this purpose.

The bearings are cast separately, and are provided with self-adjusting brasses to ensure perfect alignment; they are fitted with ring lubrication. The brasses are lined with white metal.

The switchboard was made by Messrs. Frank Suter & Co., in England, and is very similar to the usual design of three-wire switchboards, the placing of all the electricity meters and recording meter on the front of the board giving it a very full appearance. In front of the board are two boosters, each capable of raising the pressure 120 volts, for charging a battery of 284 Tudor cells, and these cells are capable of discharging at

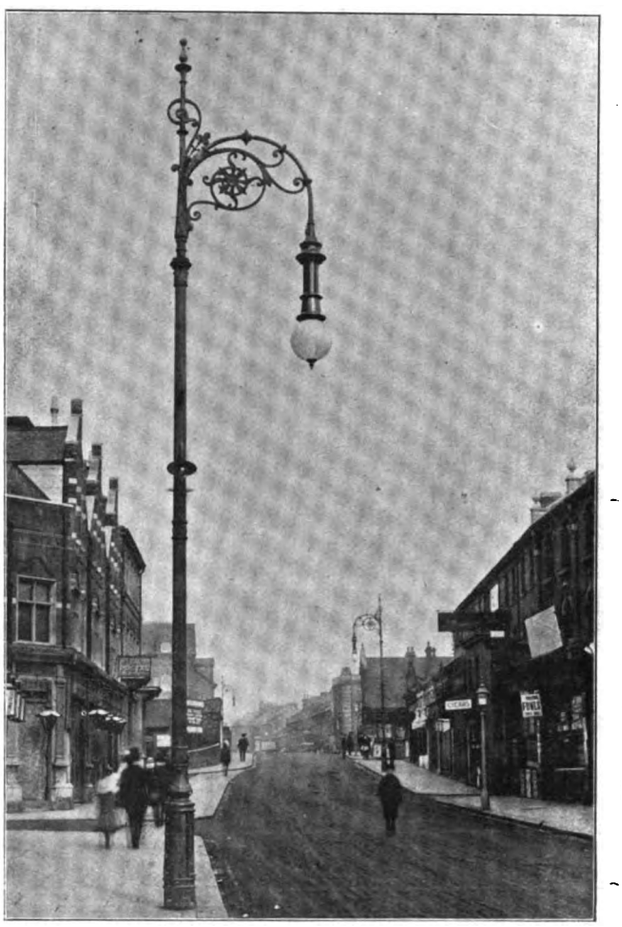

FIG. 5.—STREET LIGHTING.

the rate of 300 amperes for one hour. A "milking" booster has also been fixed, and a balancer capable of dealing with 50 amperes. A 10-ton travelling crane, to be worked by hand, runs the whole length of the engine-room.

The distribution is carried out on Henley's earthenware troughing solid system; four concentric 0·25 sq. in. feeders have been taken to points about ¾ mile from the station, and there are two separate middle wire 0·25 sq. in. feeders brought back to the station. A further feeder, 0·5 sq. in., is now being laid down, and five 7/20 triple concentric pilot wires run to the feeding points. These feeders, as well as the distributors, are paper insulated and lead covered. The distributing mains for private lighting are in all cases three single cables laid in one earthenware trough, filled in solid with special compound. With these is laid an arc lamp switch cable and also a switch cable for the incandescent street lamps. In addition to supplying and laying the cable, which is equivalent to over 60 miles length of single conductor, Messrs. Henley's also furnished the earthenware troughing

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and the joint and disconnecting boxes. The latter are placed in brick pits with surface covers.

Sixty-three public arc lamps have so far been fixed; these lamps are of the 10-ampere single-carbon open type, and capable of burning 18 hours with one trimming. They are of Messrs. Oliver & Co.'s manufacture (similar to those described in *The Electrician*, Vol. XLV., p. 207, but single-carbon instead of double-carbon lamps), and they run either nine in series across the outers or five across the 230 volt mains. The posts, made by Messrs. James Allan, Sen. & Son were fixed by Messrs. Oliver. Their general appearance may be seen from Fig. 4. The projection is 5ft., and a special safety catch is used in connection with the raising and lowering gear, by which, should the stranded wire rope break or any accident happen to the winch, the lamp would retain its position. Each part is fitted with two incandescent lamps and Oliver automatic switches to enable these lamps to be switched in after midnight in place of the arcs.

Fig. 6.—Laying Mains at Walthamstow.

The price fixed for supply is 5d. for an average consumption of 20 units per 8 c.p. lamp per year. Between 20 and 80 units the price is 4½d., and after this 4d. The price for "free" wiring is ½d. a unit, the "free-wired" installations being the property of the Council, but having been carried out for them by contractors in the usual way. At present the equivalent of 9,000 8 c.p. lamps are being connected to the mains, besides motors to the output of about 46 h.p. The price of gas in the district is 3s. 8d. per 1,000 cubic ft.

In conclusion, we must thank Mr. Enright for showing us over the station and supplying us with a large part of the information on which this article is based.

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(by our special correspondent.)

### MESSRS. SCHUCKERT'S WORKS.

(*Continued from page 825.*)

Among the new things shown us at the works was the revolving light synchroniser (on view also at the Glasgow Exhibition), a general view of which is given in Fig. 66. The synchroniser consists of a number of incandescent lamps, connected in a particular manner to the secondary of a three-phase transformer. Each of the primary coils of this transformer is connected to a 'bus bar, and to one terminal of the machine which is to be switched in in parallel with the others. The secondary coils of the transformers are connected in star as seen in Fig. 68, and the manner in which the lamps are connected to them is also shown in the diagram. So as not to crowd this figure, only half of the lamps are shown; each of the remaining lamps is connected in parallel with one of the others. Each of the secondary coils is divided into two parts by the lamp connections, and the point of connection is so chosen that the number of turns between this point and the common terminal of the star bears to the total number of turns on the winding the proportion sin 30° : sin 60°, *i.e.*, $1 : \sqrt{3}$. The pressure in the primary coils of the transformer

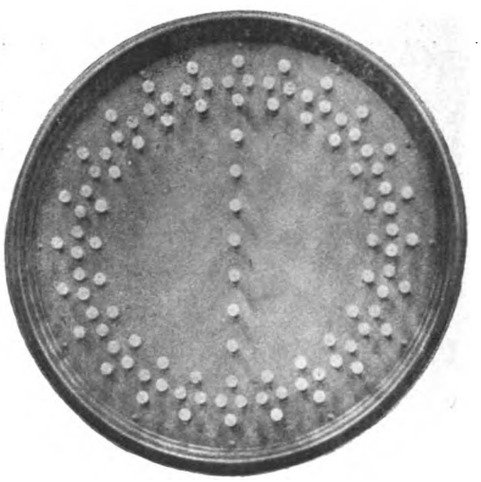

Fig. 66.—Revolving Light Synchroniser.

is at any moment the geometrical difference between the pressures delivered at the 'bus bar and the machine terminals. The pressure in the secondary coils is proportional to the primary pressure, and is equal to it if the numbers of windings in the primary and secondary coils are equal. This latter assumption is made in what follows, in order to simplify the explanation.

If the machines which are running and the one which is to be switched in are in synchronism but not necessarily in phase,

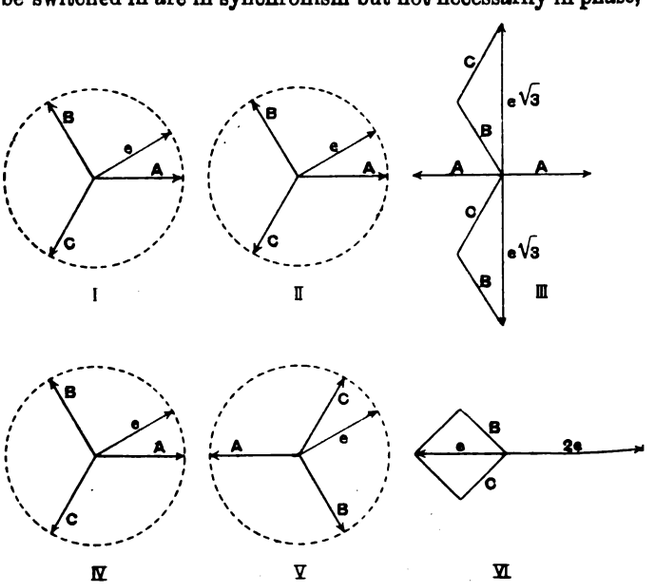


Fig. 67.

the distribution of the pressure in all the three coils is the same, and in consequence the lamps connected to the coils burn at the same pressure. The distribution of pressure among the individual lamps, however, varies. Certain lamps receive the maximum pressure and burn brightly; other lamps lamps receive less pressure and burn dimly, and in some lamps the pressure is zero. The distribution of the pressure to the lamps depends on the difference in phase between the primary

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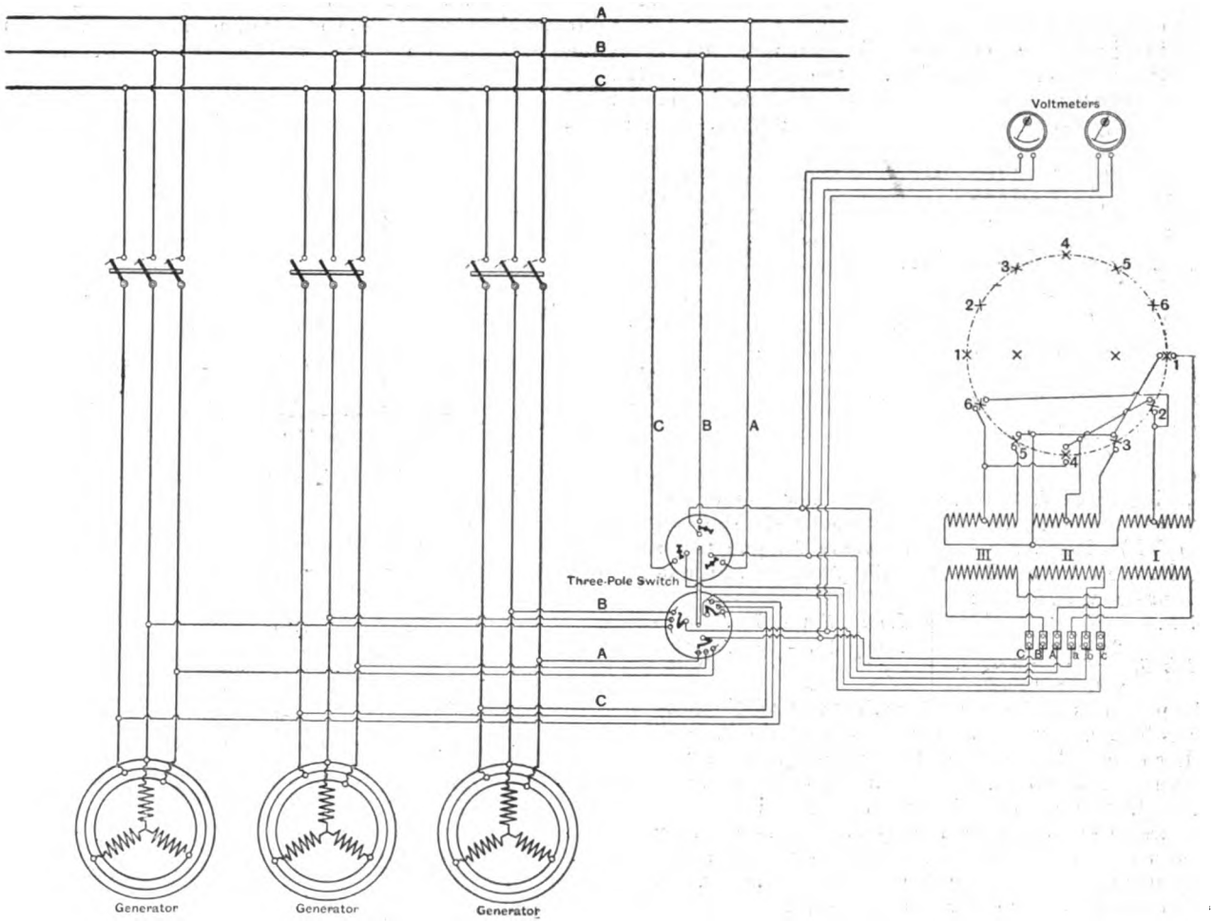


FIG. 68.—CONNECTIONS OF REVOLVING LIGHT SYNCHRONISER.

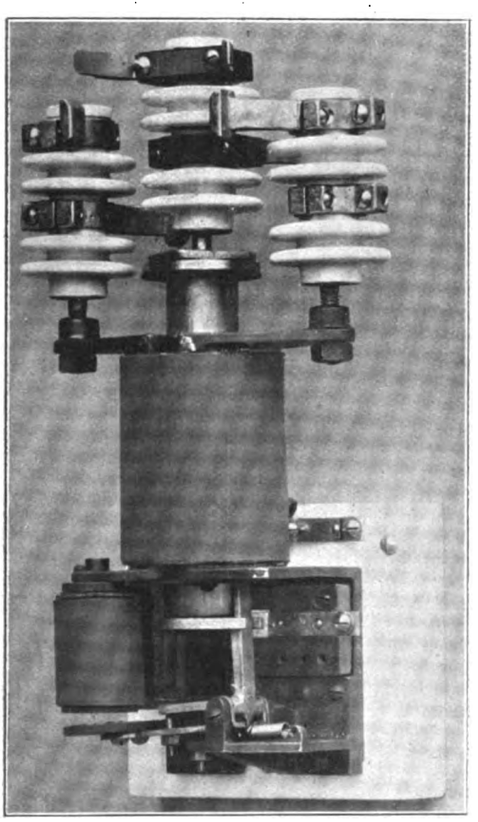

FIG. 69.—AUTOMATIC TRANSFORMER SWITCH. OPEN.

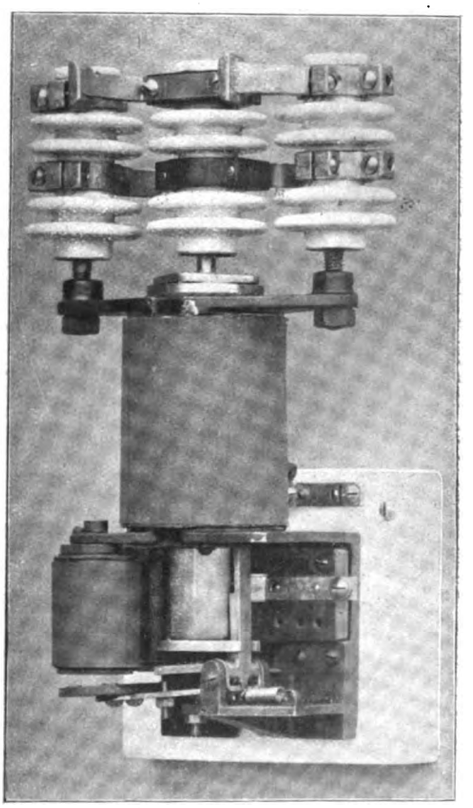

FIG. 70.—AUTOMATIC TRANSFORMER SWITCH. CLOSED.

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pressures. If there is similarity of phase, the pressure components in the three coils are represented by the diagrams I. and II. in Fig. 68. The geometrical subtraction of all the components is shown in diagram III. of the same figure. If the pressure between one of the 'bus bars or machine terminals and the neutral point be called $e$, the pressure in coil I. has the value 0 and the pressures in coils II. and III. the values $e\sqrt{3}$. From this it follows that the individual lamps have the following pressures :—

*Lamp 1*, 0.

*Lamps 2 & 6*, $e\sqrt{3}\frac{\sin 30\text{deg.}}{\sin 60\text{deg.}} = e$.

*Lamps 3* and *5*, $e\sqrt{3}$.

*Lamp 4*, $e + e = 2e$.

Now, $0 = 2e \sin 0\text{deg.}$,

$e = 2e\frac{1}{2} = 2e \sin 30\text{deg.}$,

$e\sqrt{3} = 2e\frac{1}{2}\sqrt{3} = 2e \sin 60\text{deg.}$

$2e = 2e \sin 90\text{deg.}$

The pressure on each lamp is thus proportional to the sine of its angular distance from the line $aa$. Thus lamp 4 burns brightest and lamp 1 not at all.

If the difference in phase between the pressure of the 'bus bar and the pressure of the machine to be switched in is 180deg., diagrams IV. and V. (Fig. 67) show the two components of the pressure. The geometrical subtraction (diagram VI.) gives for coil I. the value $2e$, and for coils II. and III. the value $e$. Therefore the pressures at the lamp terminals are now as follow :—

*Lamp 1*, $2e$.

*Lamps 2 & 6*, $\frac{2e}{\sqrt{3}} + \frac{e}{\sqrt{3}} = e\sqrt{3}$.

*Lamps 3* and *5*, $e$.

*Lamp 4*, $e - e = 0$.

Thus the pressures at the lamps bear the same relations to one another as before, only the distribution of pressure has become changed, so that the light of the lamps has been turned through an angle of 90deg. from the first position considered. For other differences of phase (between 0deg. and 180deg.) the light picture occupies correspondingly intermediate positions.

Now let us consider two alternating currents which are not in synchronism, and whose period is, therefore, different. These may be looked on as two currents whose difference in phase is changing every moment. Corresponding to this change, the light picture given by the lamps will rotate so long as the machine which is to be switched in is not running in synchronism. According as the period of this machine is too high or too low, the light will appear to rotate in a different direction, and the speed of rotation will depend upon the amount the machine is out of phase with the others. Thus,

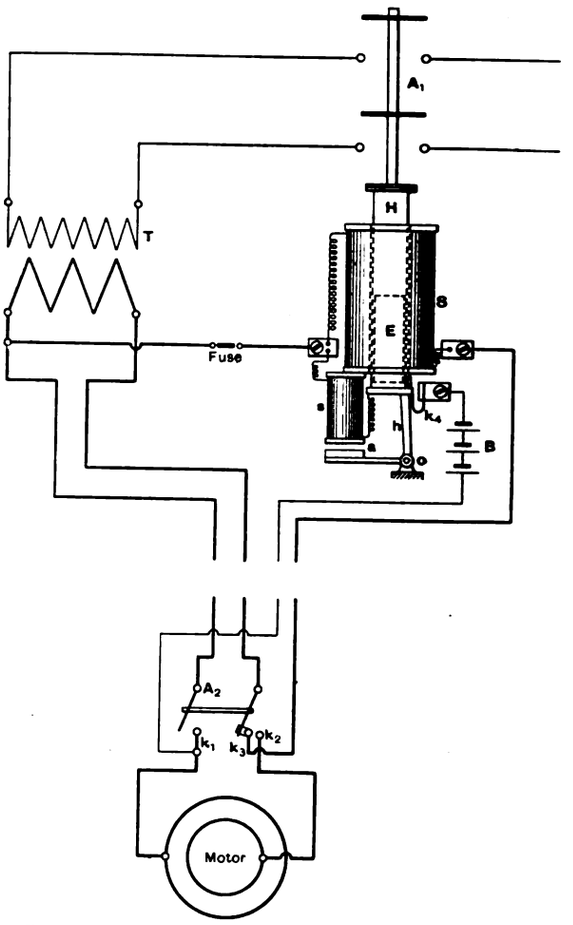


FIG. 71.—DIAGRAM OF SCHUCKERT AUTOMATIC TRANSFORMER SWITCH.

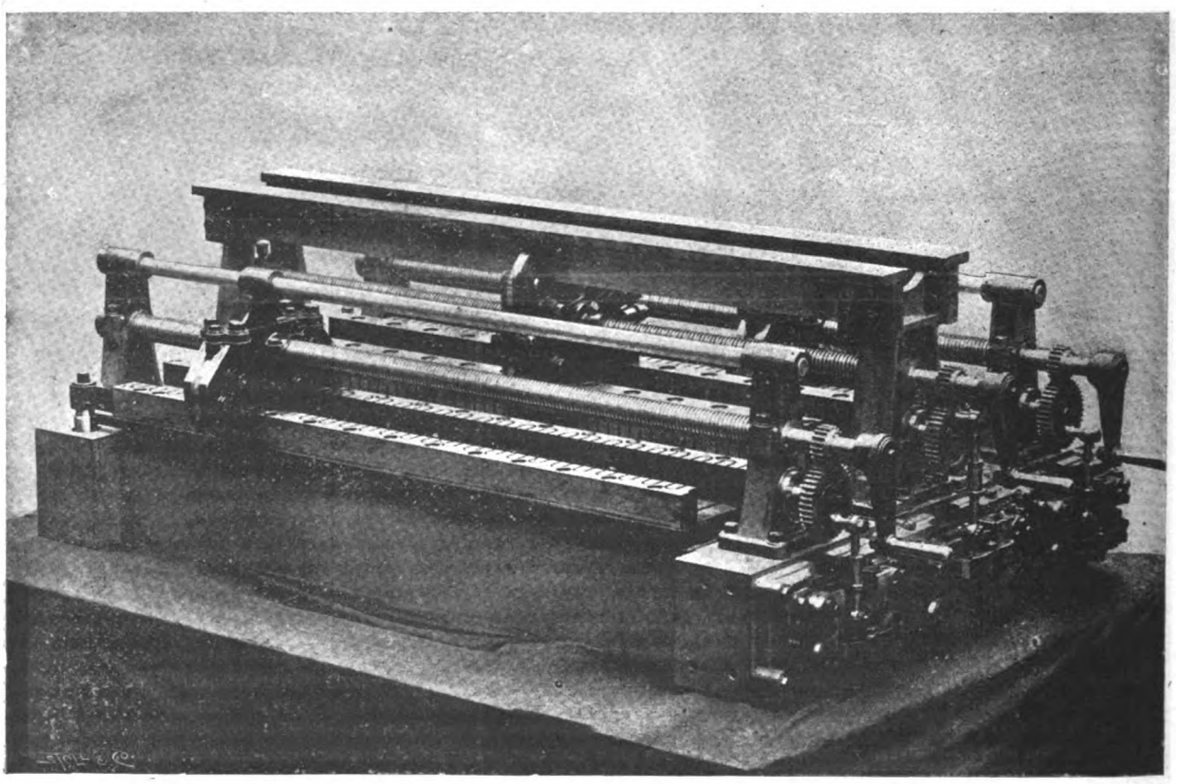

FIG. 72.—SCHUCKERT CELL SWITCH.

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in using this apparatus for synchronising machines, the switchboard attendant has to watch the lamp dial until the light stands still and rotates neither in one direction nor the other, and then to switch in. The lamps forming the diameter of the circle are connected as the lamps of an ordinary synchroniser, so that they burn at maximum brilliancy when the machines are in phase.

If the apparatus is to be used for connecting single-phase machines in parallel, a self-induction or capacity must be used as a phase-shifting device to provide an auxiliary phase, just as in the case of starting single-phase motors.

Another extremely interesting piece of apparatus shown to us was the transformer switch for switching out the primary circuits of transformers as soon as the secondary circuit is open, and switching in again as soon as it is closed. This apparatus has been tested on the networks at Frankfort, Nuremberg, and Cologne, and I was informed that in all these towns large numbers are in use, and that they have proved satisfactory in their working. All engineers of alternating-current supply stations will recognise what a wide field there is for this device. Figs. 69 and 70 show the switch open and closed, and Fig. 71 is a diagram of the connections for a single-phase transformer, whose secondary is connected to a motor.

T represents the transformer. If its secondary circuit is closed by the switch $A_2$, a circuit is made from the auxiliary source of current B, the contact spring $k_4$ and the magnet coil $s$. The armature $a$ is attracted, and the lever $h$ moves with it in a clockwise direction around $o$, releasing the sleeve H, which encloses the core E of the larger electromagnet S. H falls and closes the high-pressure switch at the top. When the circuit is opened again the contact $k_3$ is closed, and current from the secondary circuit traverses the larger coil S. This causes the coil E to be sucked in again, drawing H with it, and the high-pressure switch $A_1$ is again switched off. $h$ falls forward again, and prevents H from moving back by its own weight when current is switched off. As is seen in the illustrations, the break is extremely short, but as this is made when the secondary is on open circuit there is no energy to prolong the arc. A disadvantage in applying the apparatus for lighting circuit networks seems to be afforded by the necessity of a special switch, which, it would appear, must of necessity be the main switch, but I believe that this difficulty is being overcome by the use of a second relay.

Among minor accessories, the cell switch made by Messrs. Siemens and Halske is also interesting. The break does not take place on the sliding contacts, but on a switch at the end, which is moved up and down by spur gearing as the handle turns. The resistance is fixed and connected to the slide by flat bars, on which it slides. The spark or break is entirely taken by the switch at the bottom, which is fitted with easily replaceable carbon contacts. Fig. 72 represents a large triple switch employed in the Hanover electricity works. On account of its size this looks rather complicated, but in reality the action of each single switch is extremely simple. The mechanical contrivance which moves the carbon break switch is clearly seen in this illustration below each handle.

## THE SPRAGUE MULTIPLE UNIT SYSTEM.*

BY FRANK J. SPRAGUE.

Briefly, the Sprague system is a method to control railway motor controllers, whatever their number and wherever situated in a train, through a secondary electric circuit common to all the cars from or through which it is desired to exercise control. Each motor car is equipped with complete power-operated apparatus for its motors, and has, in addition, an independent train line by means of which it can be operated from other cars, as well as operate other cars. This train line terminates in shrouded couplers under the platform at each end of the car. The train lines on different cars, whether equipped with motors or not, are joined by detachable reversible jumpers.

To ensure reliability the train line carries only small currents, and has but four or five controlling wires. There is no ground wire carried through the train line. Provision is made for a relay line to be carried in the common cable for the operation of the air compressors. The wires are each thoroughly insulated, and the cable is protected from mechanical injury. The train line is completely isolated from the local circuits on each car. The operating relays, energised from the train line on each car, are each separately protected so that their failure cannot interfere with the operation of unaffected cars. The operation is in no way affected by changes in the sequence of cars.

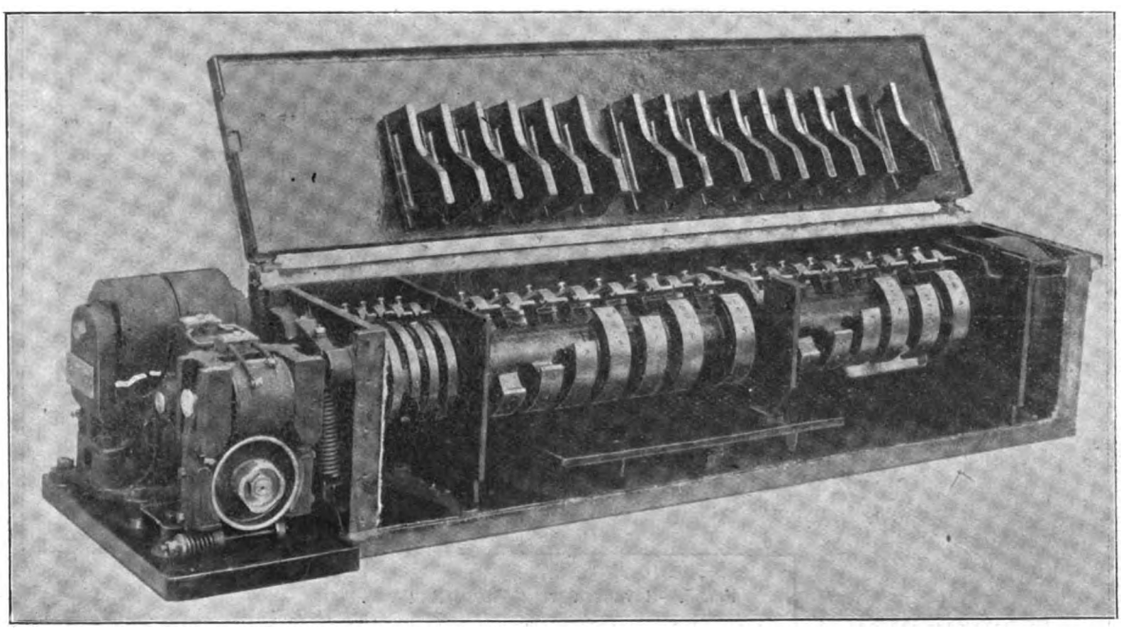

FIG. 1.—MAIN CONTROLLER.

The train line can be readily cut off from the local circuits on any car. The local pilot motor circuit and main motor circuits are independent of the train line, so that no derangement of main circuits or apparatus can be communicated to it. Each pair of motors is controlled by the joint operation of a speed controller and reverser. The main circuit is opened independently by each. Any derangement of either renders that car inoperative. This is secured by inter-connection of operating circuits, so that current cannot be continued through motors. Each car automatically governs the current input in the car, and insures the most efficient acceleration and

* From the *Street Railway Journal*.

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operation independent of the motorman. Means are also provided to restrain the current input at will by manipulation of the master switch. Protection is automatically provided against any improper

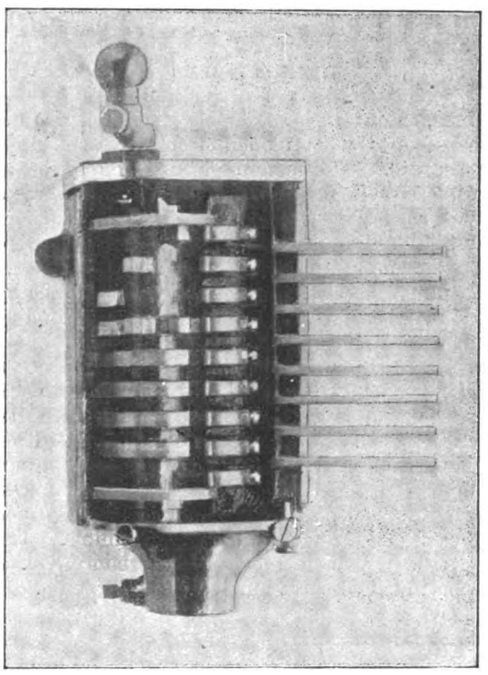

FIG. 2.—MASTER SWITCH.

operation at the master switch or misplacement or failure of any part of the system. In any case the indicated result will follow a movement of the master switch, or the main circuit will be opened and the apparatus rendered inoperative.

*Circuits.*—The system is illustrated by a typical circuit diagram, Fig. 4 showing also the development of the apparatus and corresponding schematic diagram, Fig. 5 showing controlling circuits only for single cars. The designations of parts, and the pecific descriptions of the apparatus as shown by the photographs which follow, will be readily understood. Reference to the diagrams show that on a fully equipped car there are four distinct circuits, which are shown by distinguishing lines. These are :—

*Car-Motor Circuit.*—This includes the main motors, the contacts with the supply circuit, and the reverser, rheostat, and motor grouping contacts which are in the circuit of the main motors.

*Local Operative or Controlling Circuit.*—This includes the relay or magnet coils, pilot motors, or whatever directly moves or controls the main motor controllers, or actuates main controlling contacts when the system is, as here shown, entirely electric, or controls the pilot mechanism if some other power than electricity is used to move the main controllers.

*Platform-Switch Line.*—This on a single car becomes a part of the local operative circuit, and on a train energises all the local operative or controlling circuits through the intermediary of the particular platform-switch in use, and the electrical train or governing lines on it and the other cars.

*Train or Governing Line.*—This is the continuing cable running from one car to another, which at one or more points is connected, on the one hand to the platform-switch line, and on the other to the local operative circuits. It is made up of the permanently placed train line on the several cars and the couplers or jumpers connecting them together. It may evidently be common to cars which are equipped with and to cars which are not equipped with motors. It is the independent means of transmitting an initial and governing impulse from any one of a number of points.

*Operation.*—The specific operation of the apparatus controlled by these circuits is as follows :—On each of the fully equipped cars there are two main motors. Each motor has a single unchangeable set of field coils and an armature. The motor connections and the current flowing therein are determined by three principal switches. There is a reverser for changing the armature connections of the two motors, a rheostat for varying the resistance in the circuit with them, and a motor switch for effecting series or parallel relation. These three pieces of apparatus can be separate, or any two or all three can be combined in one structure. As here shown, the two switches which determine speed form one structure, termed the main controller (Fig. 1), and the reverser (Fig. 3) the other.

These main switches are primarily controlled from a master switch (Fig. 2) on each platform of any equipped car, through a train line and

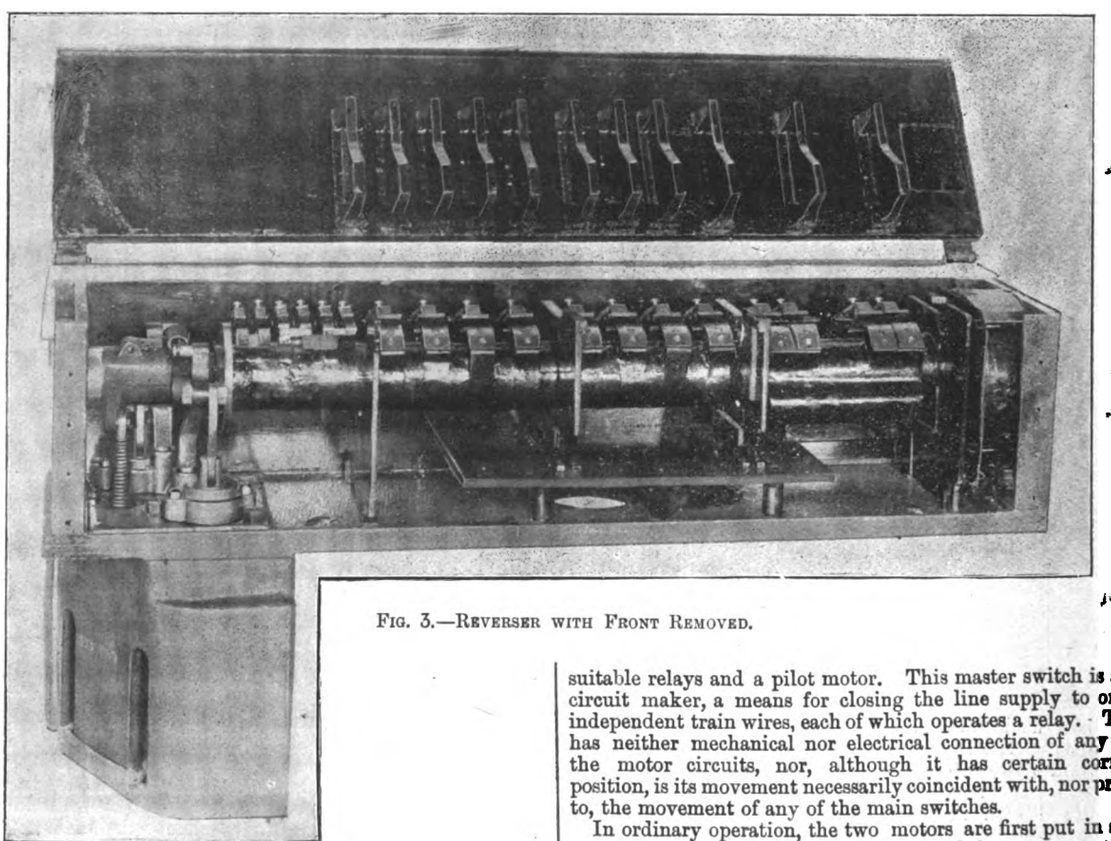

FIG. 3.—REVERSER WITH FRONT REMOVED.

suitable relays and a pilot motor. This master switch is a multiple circuit maker, a means for closing the line supply to one or more independent train wires, each of which operates a relay. This switch has neither mechanical nor electrical connection of any kind with the motor circuits, nor, although it has certain corresponding position, is its movement necessarily coincident with, nor proportional to, the movement of any of the main switches.

In ordinary operation, the two motors are first put in series with each other with suitable resistance, which is cut out until the full half potential is supplied to each motor, which is the half-speed combination. In going thence to full speed, the main circuits are first opened instantly at the main controller, or, if desired, progressively through resistances and independent main contacts, or they

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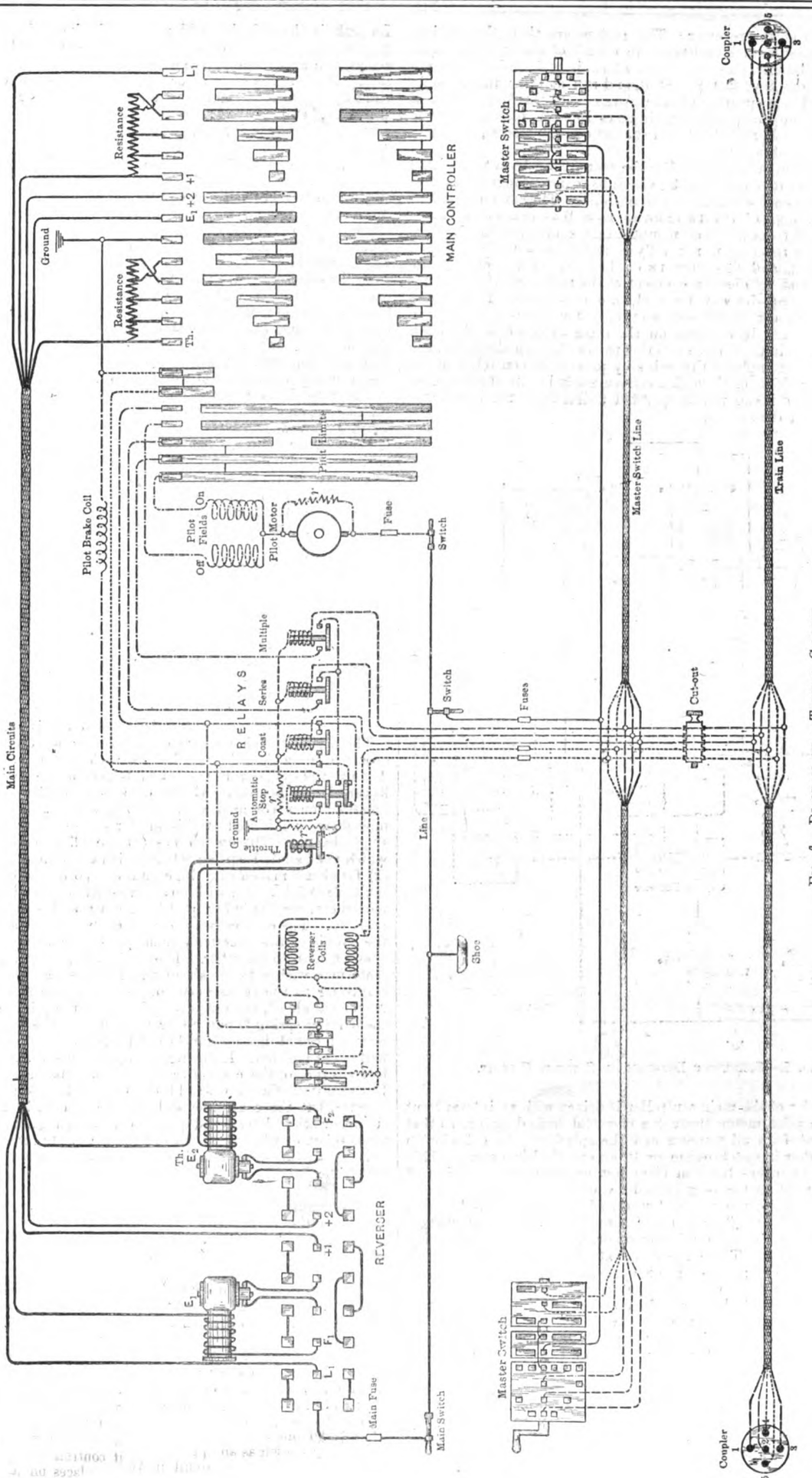


FIG. 4.—DIAGRAM OF A TYPICAL CIRCUIT.

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can be opened at the reverser. The motors are then thrown into multiple relation with a resistance in circuit of about one quarter that used in the first series position, which is progressively cut out until the motors have full potential, and run at their full capacity and speed. The quartering of the resistances on the first position is effected by using independent resistances in each motor, throwing them in series and parallel relation the same as the motors, and using the same progressive steps.

In any position of the controller the current can be cut off either instantly by the reversers (Fig. 3), which have independent main-line contacts, or progressively at the main controller. The reverser contacts for the armatures of the two motors, as well as two extra "line" contacts, are for convenience mounted on a common spindle. The cylinder of the reverser is normally retracted to a middle or open circuit position, and there are two solenoids, one for pulling the cylinder one way for ahead movement of the train, and the other for pulling it the opposite way for backward movement. Provision is made for dead-beat movement, and also for inter-connection of controlling circuits by contacts on the same cylinder as the main contacts. The circuit for the reverser passes through the automatic stop coil, and is completed through a by-pass on the controller in the first contact position, or through a contact made by the automatic, so that once opened it can not be operated unless the controller is in a safe position for the motors.

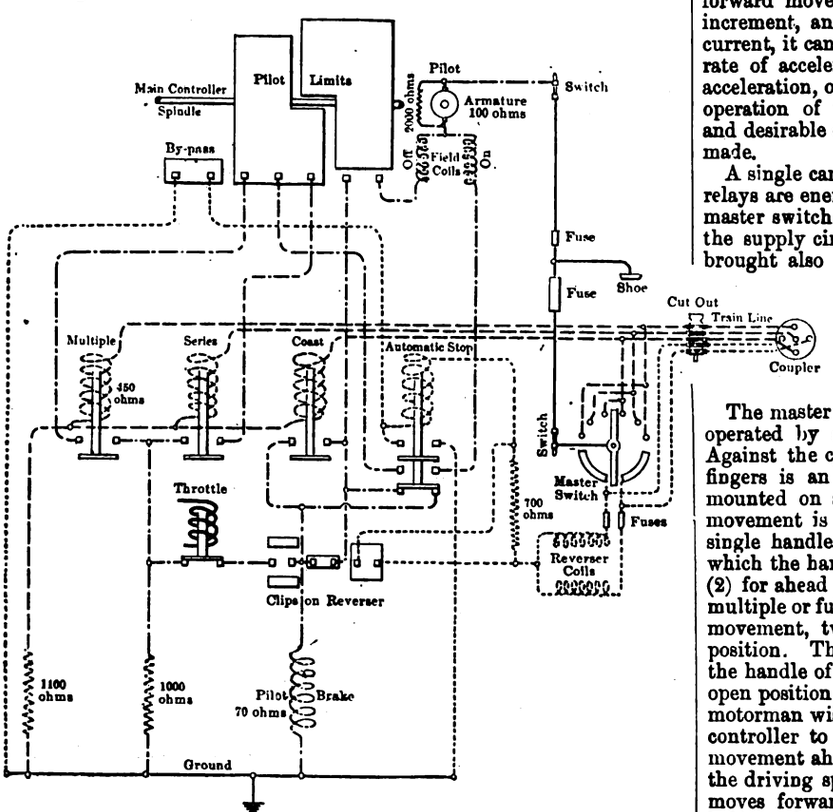


FIG. 5.—SCHEMATIC DIAGRAM OF CONTROL CIRCUIT.

The cylinder of the main controller is driven with an intermittent motion by a pilot motor through a powerful locked spring, so that the armature of the pilot motor and the spindle of the cylinder do not move either in synchronism or to an exactly like extent. This is necessary to insure freedom from hot contacts and dragging of arcs. The pilot motor is governed by either four or five relays called, respectively, the "coast," "series," and "multiple" relays, the "automatic stop," and the "throttle." Since the "automatic stop" also has coast relay contacts, the separate coast relay may be discarded. There are three allowable running positions for a pair of motors; the coast or open-circuit position, the series position, when the two motors are in series without any resistance in circuit, and the multiple position, when the two motors are independently across the line without any resistance. In addition, the motors can be run temporarily with more or less of the resistances in circuit for the purpose of switching. On heavy railroad work, such as on elevated and suburban roads, minor variation of running speed in either the series or the multiple relation of the motors by the use of resistances is rarely practised, and is never necessary save in starting. The apparatus is especially constructed to discourage any such variation of running speed.

The circuit which operates the pilot motor on each car is a purely local circuit, coming from the car shoes and returning to the track. Its path is through the field magnets, brake and armature of the pilot motor, through the contacts of the coast, series, or multiple relays, and also through the contacts of the throttle and automatic stop. If either the throttle or the automatic stop are in an open circuit position it is impossible for the pilot motor to move in one direction, and it is hence impossible for the controller to be advanced, although if in an advanced position it can be moved backward. The circuits through the relay contacts and the pilot motor also pass through limit switches on the controller cylinder. If this control cylinder is in "off" position, and the throttle and automatic stop are in proper positions, closure of the coasting relay would not cause any movement whatever, but closure of the series relay will allow the pilot, if otherwise uninterrupted, to move the controller to the series position, where it will automatically stop. In the same way closure of the multiple relay will move the controller either from the coast position or from the series position to the full multiple position, where it will be automatically stopped. Opening the throttle, however, will either arrest or retard the rotation of the pilot motor and the progression of the controller, and dropping of the automatic stop or opening of the reverser, which is also provided with a coasting contact, will at once return the controller to an open circut or any other determined position regardless of the motorman.

The throttle is operated automatically by the current in one of the motors, and serves a double purpose. It retards or stops the forward movement of the main controller at any desired current increment, and, since it responds to a determinate rise and fall of current, it can become an automatic switch for providing a definite rate of acceleration. It does not prevent any desired slower rate of acceleration, or in any way remove from the motorman the positive operation of the main controller at will within the limits of safe and desirable current inputs. Further reference to its action will be made.

A single car will first be considered. The coast, series and multiple relays are energised by platform-switch circuits, which terminate in a master switch or controller at the platform, at which a connection to the supply circuit is also made. To this same master switch are brought also the terminal wires of the solenoids operating the reverser. This master switch is the apparatus manipulated by the motorman, and except as he is limited by the automatic features, or hindered by circumstances which he can not, and is not intended to, control, all operation either of the particular car or the train is initiated at this point.

The master switch consists of a cylinder with suitable contacts operated by a handle interlocked with the top of the switch. Against the cylinder rest a set of fingers, and between each of the fingers is an insulating shield or separator, the separators being mounted on a common spindle. The speed and direction of car movement is initiated at this master switch by the movement of a single handle. The switch has (1) the off or normal position, to which the handle is spring retracted in case the operator lets go of it, (2) for ahead movement, three running positions, coast, series and multiple or full speed, with no contacts between, and (3) for the back movement, two running positions, coast and series or half-speed position. The car can be stopped and reversed by a single throw of the handle of the operator's or master switch from one side of the open position to the other. The ordinary operation is that when a motorman wishes to go ahead at half-speed he moves the master controller to the series position. The reverser is instantly set for movement ahead, the series relay is closed, the pilot motor starts up, the driving spring is put under tension, and the controller spindle moves forward intermittently until the pilot limits stop it at the half-speed position. If during this operation the throttle should lift, this advance of the controller cylinder will be retarded or stopped. If the automatic stop should drop, the advance not only will be stopped, but the controller will at once run backward to an open circuit or other determined position without regard to the set of the series relay, or what is the wish of the man at the master switch.

Being at the series position, if the motorman wishes to go at full speed, the handle of the master switch is moved to that position, when similar operations take place at the relays and pilot motor. Or the operator may move his switch handle at once from the open circuit to the multiple position without any regard to the series position, and the main controller, controlled by the throttle, will advance to full-speed position. Of course, the advance of the main controller may be made at will, step-by-step, by touch-and-go contact at the master switch, and its advance can be arrested instantly. If desirable, when a coast relay is used its connection can be changed so as to, at will, throw the throttle out of action, although this is not desirable.

By minor changes in the controlled circuits they can be arranged so that the operator can operate entirely with the motors in series or entirely in multiple, or either at will. This is because the controller has two circuit positions, one at the beginning of the series combination and one at the beginning of the multiple combination. It is what is known as an open-circuit controller, and provision is made for not only opening circuit in two places on its cylinder, but also independently on the reverser.

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The master switch has two running advance positions and one running back position, and movement of its handle between those two points in no way affects the main controller; the latter has several positions where it can rest with identically the same position of the master switch handle provided its motion is arrested before it has reached one of its limits; under certain conditions the controller will not make any motion whatever in response to a master switch; under certain other conditions it will make a partial response, then automatically stop, and without any change of movement of the master switch go ahead again and automatically stop; the controller, under other circumstances, will respond to the master switch, then stop, and immediately, or after an interval, go back to an open circuit or any other predetermined position; under changed circumstances it will advance intermittently to, or toward, some determined position indicated by the master switch, then stop, go backward to some other position, and then go forward again; or in passing from a coast or open circuit to a multiple position, the controller may or may not respond to closure of the series contact. If the motorman wishes to reverse the car while going ahead, with the motors in either the series or the multiple position, the master switch can be instantly thrown to the reverse series position, and the controller while immediately responding, will not in like degree, for as the master switch passes the off position the reversers will open, the main circuit of the motors will be instantly interrupted, the automatic stop on each car will run the controller back to some other determined position, the reversers will then close, and the series relay, which, although set by the master switch, has up to that moment been entirely inoperative, will now allow the pilot motor, controlled by the throttle, to intermittently move the controller to the reverse half-speed position. If the by-pass on the controller is of proper length the reverser will close circuit as soon as the controller has returned to, say, the first resistance position, and it will remain there until the current has dropped below the safe amount.

To connect two or more cars together, and to provide for the initiation of the operation of the controllers on such other cars as may be fully equipped from one or more of the master switches, an independent train line is provided, which is the extension of the platform-switch circuit from car to car, through fixed train cables on each car terminating in couplers at the ends of the cars, and flexible and reversible train cables, or jumpers, terminating in couplers with complementary contacts joining the several train cables together at the ends of the cars. These train lines and jumpers are so connected to the coupling heads that the controlling circuits are automatically paired to insure proper operation of the various main controllers from any master switch without regard to what are the abutting ends of the cars, or what is their number or sequence, or how the jumpers are reversed, or whether, as in practice, they are coupled indifferently on one side or other of the cars. All roads, of course, do not change their sequence in the make-up of trains, but on many the cars are reversed, as in the operation of open-end relays, cross-overs and loops and yards. It follows that not only must there be a pairing of the sets of speed and direction circuits, but the individual speed circuits must always be paired alike, while the individual direction circuits must at times be changed in connection.

The platform-switch circuits, the local operating or relay circuits, and the train-line circuits are joined together by switches which permit such independent connection on each car that controllers on any car can be operated from the master switch on its car, no matter how a train is made up, without the controllers on other cars being affected, or the controllers on as many cars as are desired can be operated from the master switch on another car without the controller on that car being operated, as well as the normal operation of all controllers from any master switch.

Normally, movement then of any master switch (the others for the time being inoperative and held at open circuit) closes like relays on each car, and starts the sequence of operations which I have indicated above for a single car.

Here again, however, the automotic variation of movement already described in regard to a particular controller, takes place independently on each car, and different kinds and degrees of movements of the controllers on different cars could take place simultaneously if necessary.

Not only that, but to provide for difference of wheel diameters, difference of tractive coefficients on different wheels, and to provide also against any irregular condition on any car, similar movements may be differently timed, and different controllers may take different relative positions when measured by time, each accommodating itself to the limiting current input determined for itself.

It, therefore, becomes possible, by this combination of positive and semi-automatic control, to combine cars having controllers of different sizes, motors of different capacities, resistances of different gradations, gears of different ratios, and wheels of different diameters, and to successfully operate them all from one or more controlling points, all of which, of course, would be absolutely impossible to a hand method of control, or anything approaching hand control.

*(To be continued.)*

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Induced Radio-Activity.*—J. C. MacLennan has found some further cases of the induction of a secondary radio-activity by the action of cathode rays. Villard was the first to describe how a piece of bismuth may be converted into a radio-active body by exposing it to cathode rays. After testing a number of sulphates and sulphides without effect, the author found that the sulphates and sulphides of calcium, strontium, and barium, as well as $K_2SO_4$, show a distinct induced radio-activity on heating slightly after exposure. None of these substances show thermo-luminescence, and on the other hand, some of the most intensely thermo-luminescent "solid solutions," such as $ZnSO_4$ + 1 per cent. $MnSO_4$, show no trace of an induced radio-activity. To give an idea of the quantitative effect, it may be mentioned that the radiation of a thin layer of calcium sulphate, spread over 20 sq. cm., discharged 2 or 3 units of positive electricity. No negative electricity was discharged by any of the bodies. The author supposes that they send out a number of negatively charged particles. W. Kaufmann remarks on the Paper that the phenomenon may be identical with that described by Hallwachs.

[J. C. MacLennan, *Physikal Zeitschr.*, September 7, 1901.]

*Ions in the Atmosphere.*—Since the researches of Elster and Geitel have made it appear certain that free positive and negative ions exist in the atmosphere, H. Ebert has attempted to arrive at a quantitative estimation of their number under different atmospheric conditions. He employed an aspirator in which air is sucked through between the armatures of a charged cylindrical condenser, the potential being such that the potential gradient suffices to drive the ions to the sides within the time taken by any portion of the air-stream to pass through the condenser. In the apparatus described by the author, this time was $\frac{1}{7}$th of a second, and the potential gradient would make an ion traverse the space between the armatures in $\frac{1}{137}$th of a second, so that there is ample assurance of their interception. The results show that the number of free ions is very much larger in clear sunny weather than in air filled with dust or moisture. The number is small in any case. The free charges in 1 cubic metre amount to about 1 electrostatic unit, or an amount which would be accounted for by the dissociation of $0{\cdot}3 \times 10^{-10}$ cubic cms. of hydrogen, or the dissociation of the 10,000 billionth part of the oxygen. This amount of ionisation is about the 100,000th part of that produced by feeble Röntgen rays.

[H. Ebert, *Physikal. Zeitschr.*, August 17, 1901.]

*Nature of Lightning.*—K. R. Koch has found that lightning conductors whose connections have become imperfect through rusting or otherwise, act, nevertheless, in quite an efficient manner in the case of a thunderstorm. This is, in his opinion, due to the oscillating character of lightning discharges. Electromagnetic waves are produced, which act upon the imperfect connections as upon a coherer, restoring their conductivity for a more or less long period. Lightning has hitherto been considered a continuous discharge, which often becomes apparently oscillatory by quick repetition. The author employs a rapidly revolving camera in order to test this question, but does not arrive at any definite conclusion, as the flashes photographed were all too distant.

[K. R. Koch, *Physikal. Zeitschr.*, September 14, 1901.]

*Preservation of Standard Magnets.*—Since the discovery of the new magnetic steels we have been enabled to make permanent magnets which keep a constant moment for a whole year within 0·1 per cent. The question as to the best means of storing them when not in use is raised and answered by I. Klemencic. He encloses the magnet in a glass tube filled with cotton wool, which in its turn is embedded in an iron box with sides 3mm. in thickness. This prevents both disturbances by jarring and by an external magnetic field. He finds that the protection ratio is 3. This is not very high, but it can, of course, be indefinitely increased by increasing the number of boxes.

[I. Klemencic, *Ann. der Physik*, No. 9, 1901.]



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Editorial, Publishing and Printing Offices,

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*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON

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## ELECTRIC POWER IN A MARINE ENGINE WORKS.

Electrical engineers for some time past have recognised the importance, both to themselves and to the industrial world in general, of the driving of factories and workshops by electric power. To the electrical engineer the realisation of this problem on a scale commensurate with the magnitude of our national manufacturing industries, would annex to his legitimate sphere of operations a territory far more extensive and important than that in which he competes with rival systems of lighting. For, not only would such a magnificent aggregate motor-load require the erection of power stations on a far larger scale than are required for lighting, but there would also be the valuable consideration that the motor-load is far steadier and more enduring than any mere lighting load. To the industrial world, on the other hand, this application of electricity offers many and great advantages over the older methods of driving machinery. These advantages are well known to the electrical engineer; it is superfluous for us to enumerate them now. But it is of as great if not greater importance that they should also be confidently recognised by the vast non-electrical industrial world—the prospective customers in this comparatively new yet rapidly growing branch of the industry. The old adage that "nothing succeeds like success" has an application here; for it is only through the advertisement gained by the marked success of earlier instances of the conversion of factories to electric power that the rank and file of manufacturers can be induced to "fall into line," as our trans-Atlantic confrères express it. Beyond question there exists in this country, as well as abroad, several examples of the electric driving of factories that leave no room for honest doubt as to the marked superiority of this form of factory driving. On almost every scale of magnitude, from the small shop taking scarcely 1 H.P. from a gas engine, up to the largest engineering works taking several hundreds of horse-power, electric driving has proved an economic success. Unfortunately, in the majority of these cases the results are not published, even to the engineering world, and consequently, although engineers are fully satisfied as to there being marked economies, there still remains much information to be desired as to

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the exact magnitude of these economies, and as to the precise conditions and factory arrangements under which they have been obtained. Exact knowledge of this nature is eminently desirable, but its acquisition is only possible as the result of the systematic accumulation of evidence from all sorts and conditions of particular instances. We ought to be grateful, therefore, for the publication of precise data and detailed information regarding any individual works that throws light on this important problem; and, as a case in point, we may cite the useful communication made by Messrs. J. CRIGHTON and W. G. RIDDELL to the recent Engineering Congress at Glasgow on the "Power Required to Drive a Marine Engine Works." We reprint this Paper in abstract in our issue this week.

There are many solutions of the general problem, and that described by the authors of this Paper possesses some uncommon if not unique features. Yet when we remember the immense diversity in the specific conditions of factory working, caused not alone by the great variety in the industries themselves, but also on account of the local and accidental arrangements of the floor space and machinery units, we must recognise that a special solution which may obviously not be of very general application might nevertheless afford the best and readiest method in certain cases. The works equipment described by Messrs. CRIGHTON and RIDDELL is not an instance of complete conversion from mechanical to electrical driving; it is rather an illustration of what may sometimes advantageously be done by a partial adoption of electric driving in conjunction with a consolidation and improvement in the methods of mechanical driving. Thus, with a particular instance before him, the electrical engineer may find there are financial or other reasons against the entire adoption of electric driving. It might be too costly in initial outlay, or it might involve a temporary dislocation of the daily work that circumstances might prohibit, or the advantages to be gained in certain parts of the works might not be commensurate with the capital outlay for those particular machines. In such cases the engineer might well imitate the practice of Messrs. CRIGHTON and RIDDELL. The works in question were originally driven by three separate engines taking steam from one marine boiler. These engines were all replaced by one steam engine of modern construction, taking steam from a new marine boiler. Further, this central engine was employed for both the driving and the electric lighting of the works. Two dynamos were arranged to be driven from this engine, for the lighting and the motors about the works; but, in addition to this, the engine was made to drive *direct*, by belting, the two main line shafts carrying the machines in proximity to the engine. The outlying machines and line shafts were provided with electric motors, and these could either be run off the works dynamos or from the street electric supply mains, the latter method in general being adopted when working certain machines late at night. For further particulars of these arrangements and for the tabulated figures showing the economy attained over the original method of driving, we must refer our readers to the abstract on another page. A somewhat striking basis for the comparison of costs has been adopted by the authors, the assumption being made—and it would appear to be a justifiable and convenient assumption—that the useful output of work from the cutting-machine tools is in proportion to the weight of metal removed—*i.e.*, of the turnings and borings, &c. Where this is estimated always for the same machines doing the same class of work, and the average or aggregate weights over a long period of time are compared, it should afford a satisfactory basis for such comparison. In the result the authors find that, whereas the cost on the old system for work represented by 1 ton of waste material was £5·21, the cost with the combined electric and mechanical driving by the new machinery was only £2·48 per ton of material removed, representing a saving of 52 per cent. in the cost of driving power. This result cannot be regarded otherwise than as satisfactory to all concerned, and it may fairly be claimed that it is in a large measure due to the adoption of electric driving for those remote parts of the works which it must have been so uneconomical and costly to drive on the old system. At any rate, electrical engineers should make a careful note of these results, for comparison with results obtained by similar or other electrical methods in other works.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

**A Pocket Book of Electrical Engineering Formulæ.** By W. GEIPEL and M. H. KILGOUR. Second Edition. (London: "The Electrician" Printing and Publishing Co.) 7s. 6d.

Geipel and Kilgour's pocket book, while retaining its original convenient shape and size, has undergone thorough revision. This is especially noticeable in the chapter on electric traction, which appears to have been entirely re-written and contains several new tables, having been revised by Mr. Justus Eck. After a short paragraph on systems of supply generally, a few indications are given of the plant to select for the power equipment, with a list of the apparatus usually erected on the various panels of the switchboard. A few pages are devoted to overhead equipment, and then follow directions for estimating the power required in the motors, and particulars of controllers with clear diagrams of series-parallel controller connections for a two-motor equipment, motor suspensions and car wiring. As in the previous edition, considerable attention has been paid throughout to the mechanical engineering data which are useful to electrical engineers; in fact, the book is to a certain extent open to the criticism that too much space has perhaps been devoted to this at the expense of electrical detail. Thus two and three-phase working is not adequately dealt with. There cannot be a doubt, however, that the compact little volume will continue to prove of great utility to electrical engineers whose work is chiefly in the "heavy" branch of their profession. The descriptive matter is clearly worded, the tables are set out in a practical manner, and the quality of the print, paper and binding is all that could be desired.

**An Introduction to the Practical Use of Logarithms.** By F. GLANVILLE TAYLOR, M.A., B.Sc. (London: Longmans, Green & Co.) 1s. 6d.

The author, in the preface, states that his object is to explain in the simplest language the practical side of logarithms, to bring the subject within reach of pupils in technical schools, and, at the same time, to satisfy the requirements of more advanced students. We are of opinion that the little volume before us amply fulfils the former object, and, at the same time, the advanced student who intends to turn his knowledge to practical account could not do better than read through the chapter on approximate calculation if he has not already mastered this important branch of elementary arithmetic.

**Electrical Designs.** (New York: "American Electrician" Co. 1901.

This book is a reprint of articles that were originally written for the *American Electrician*. It comprises instructions for the building up of small motors from ⅛ H.P. to 3 H.P., besides various other electrical apparatus, from a three-phase alternator to an experimental Nernst lamp and a Thomson astatic galvanometer. The volume should prove useful to gentlemen who have served their time in electrical shops and wish to take up the making of small machines as a hobby. Its title is too general.

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**Engineering Estimates and Cost Accounts.** By FRANCIS G. BURTON. 2nd Edition. (Manchester: The Technical Publishing Co., Ltd., 1900.) 3s. net.

The writer of this book, who was formerly secretary and general manager of the Milford Haven Shipbuilding and Engineering Co., naturally deals chiefly with the estimates and costs accounts for steamships, though chapters are devoted to boilers and engines. A very useful addition has been made in the second edition in the shape of a chapter on "Cost Accounts for Small Works," in which the accounts are slightly modified to reduce clerical labour. The book is meant for the practical rather than the examination student.

**Electricity in Mining.** By HENRY LOUIS. (The *Mining Journal*, 1901.) 3s. net.

This volume is principally a collection of short descriptions of electric mining machinery in various parts of the world. It is unfortunate that the type is poor, as the illustrations, which are all of English machines, are for the most part satisfactory.

## NOTES ON ROTARY CONVERTERS AND PHASE-SWINGING.

W. M. THORNTON, M.SC., M.I.E.E.

The name phase-swinging has been given to the oscillations of the current sheets in synchronous motors or rotary converters running under any load when this is suddenly changed. In its more general use it applies to the case when these oscillations have so disturbed other machines in the circuit that they exhibit the same effects, or when the generator is also affected.

In any dynamo-electric machine, when running under constant load, the ether displacement in and about the conductors due to the currents in them remain in practically fixed positions relatively to the field. Thus there exist, as it were, sheets of current of opposite direction, each occupying adjacent groups of conductors, and the mechanical forces on the conductors are fully determined when the magnitude of the currents, the size and position of the groups with respect to the poles, and the magnetic flux densities are known.

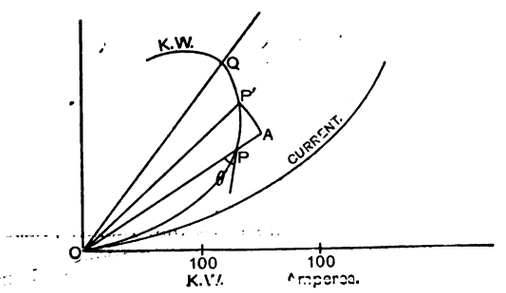


FIG. 1.

The effective voltage in the circuit is the vector resultant of the generator and motor voltages. Thus, knowing these, their phase relations and the electric constants of the circuit, the power supplied to the line and that received by the motor are known, and may be plotted for various differences of phase between motor and generator. The values so found are modified by the armature reaction, but the general form of the power curve is unchanged.

If, as in Fig. 1, we plot a polar diagram with angle of lag for angular ordinate and resultant power for radius vector, and allow for armature reaction in calculating the latter, we have a curve which shows to one scale values of the power and to another the total tangential forces on the armature when the change of phase is slow. At the point Q, where the power curve cuts the radius at right angles, the positions of the current sheets in the armature are unstable, and the motor "breaks step."

Consider any point, P, before this is reached. When a sudden continuous-current load is thrown on the converter the inertia of the armature prevents a sudden change of the angle $\phi$, and the power taken is more than corresponds to OP. Let the new power be OA. The displacement $\phi$ will change until the circle through A cuts the power curve as at P', and OP' is the new position of stability. The length of the arc PP' is proportional to the work $w$ done in a slow change, for this $= \int_{\phi_1}^{\phi_2} W \, d\phi$, W being the length of the radius vector; and the arc $= \int_{\phi_1}^{\phi_2} W \operatorname{cosec} \theta \, d\phi$, $\theta$ being the angle between the radius and the tangent to the curve, this being constant over a small arc. Thus $w = PP' \sin \theta$.

When, however, the load is thrown on suddenly the work required to cause the change of phase is $W' (\phi_2 - \phi_1)$, *i.e.*, the arc AP'.

The extra mechanical force on the conductors is $\delta E / \delta s$ where $\delta E$ is the change in kinetic energy of the armature corresponding to a displacement $\delta s$ of the periphery. If this force is unbalanced by a retarding force due to the use of damping coils placed around the poles, the armature will overshoot the position of stability and will oscillate about it. The period of this oscillation may be calculated if the moment of inertia of the armature is known and the change of tangential mechanical force corresponding to unit angular displacement of the armature.

Since the maximum displacement will be only a few degrees, this force F may be found by taking two points $q$, $s$ (Fig. 2) on the curve and projecting them on the line bisecting the angle $qos$. The lengths $os$, $oq$ represent to a given scale the extreme mechanical forces for an angular displacement $ros$ on either side of $or$.

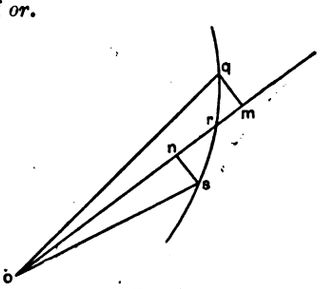


FIG. 2.

The linear displacement corresponding to a phase displacement $\phi$ is $r\phi/p$, where $r$ is the radius of the periphery and $p$ the number of pairs of poles.

The equation of undamped motion when F is proportional to the displacement, which is true for small disturbances, is

$$\frac{d^2\phi}{dt^2} = -\frac{Fpr}{I} \cdot \phi, \quad \ldots \ldots \quad (1)$$

$\phi$ being the displacement from the new position of steady working when the load is changed, and $Fr$ the restoring moment for one radian displacement of armature or $p$ radians of phase.

The period is thus $2\pi\sqrt{\frac{I}{pFr}}$ sec.,

and the frequency, $\frac{1}{2\pi}\sqrt{\frac{pFr}{I}}$ complete swings per sec.

Since I and $r$ are constant the frequency varies as $\sqrt{F}$, and F being greater for light loads than heavy, the phase swinging is quicker at light loads.

At the point of breaking step its frequency is zero, and from no load to this point the range of frequency is considerable. F may not be the same even for machines of the same size and type, depending as it does on the quality of the iron in the magnetic circuit. Let the phase-swinging frequency per minute be $m$, then

$$m = k\sqrt{F},$$

where $$k = \frac{60}{2\pi}\sqrt{\frac{r}{I}}.$$

In the machine whose curve is given in Fig. 1, $r = 18$in., $I = 200$ foot pound units. The speed $n$ is 600 revs. per min., and there are eight poles. Hence $m = 1{\cdot}6\sqrt{F}$; and F, as deter-

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mined from the output curve, $= W \times 737 \cdot 3/2\pi rn$ lb., where W is the kilowatts change per radian displacement of phase. Thus from Fig. 1 we have

At quarter load ..... $F = 27{,}000$ ..... $m = 262 \cdot 4$
,, half load ..... $F = 15{,}800$ ..... $m = 201$
,, full load ..... $F = 11{,}800$ ..... $m = 173 \cdot 6$
,, 50 per cent. overload $F = 10{,}000$ ..... $m = 160$

With this machine, if the engine is running at a steady speed of 90 per minute, there will be danger of phase-swinging when $m$ is a multiple or sub-multiple of the fluctuations of crank effort. If there are two cranks the critical points will be before reaching quarter load or full load, and at a heavy overload beyond 50 per cent.

A slow speed three-crank engine may cause more trouble than a higher speed two-crank, in spite of the more even turning moments if its crank effort synchronises with the normal phase-swinging. This probably explains the use in many American stations of compound two-crank engines driving converter circuits with success, the ordinary size of converter used having been found in practice to run as well with high-speed two-crank as with three-crank engines.

All risk of phase-swinging being cumulative throughout the circuit is prevented by the use of damping coils, consisting of high-conductivity metal frames placed around the poles close to the faces, their action being briefly thus. There is a sudden change in the demagnetising force due to the armature currents whenever the demand on the continuous side of the machine varies. This causes a change in the total flux through the pole, and, during the change, eddy currents. This change of flux induces a voltage in the damping coil, and, by reason of its very low resistance, a powerful current passes round the coil, reaching several thousand amperes for heavy loads. This current causes a strong wave of magnetic force parallel to the axis to pass radially into the core, where it sets up eddy currents, these being of much greater intensity than those due to the first changes of flux. The energy of the impulse given to the armature by the sudden load is dissipated partly in the coil but mostly in the core as heat. It is indicated by theory and has been shown experimentally by Prof. E. Wilson, *Proc.* Roy. Soc., January, 1901, that the intensity of magnetic force when an alternating current is passed round a large solid iron core is much greater at the circumference than the centre. The heating effect is thus greater at the circumference, and the damping coil may be regarded as a device for concentrating the eddy currents in the outer layers of the core, increasing the rate of dissipation of energy.

*Simple Theory of Damping Coil.*—Let $e$ be the voltage induced in the coil by the change in lines due to a load suddenly thrown on, and let $r$ be the resistance of the coil. The power absorbed in the coil is then $e^2/r$ watts, and, this being known, the damping torque can be found.

Kapp has given an expression for the demagnetising ampere turns of a single-phase alternator (vide "Dynamos, Alternators and Transformers") as $= 0 \cdot 0156 c i \phi^0$ where $c$ is the number of conductors under one pole, $i$ the current in them, and $\phi^0$ the phase displacement of the conductors from the pole. Assuming the main field current constant, any change in the pole flux must be due to change in the above expression, *i.e.*, to change in the product $(i\phi)$.

Let N be the total lines passing through any pole, and let R be the reluctance of one polar circuit. The change of ampere turns $= 0 \cdot 0156 \times 57 \cdot 3 \delta(i\phi)$ where $\phi$ is expressed in radians, and the corresponding change of flux.

$$\delta N = 1 \cdot 257 \times 0 \cdot 0156 \times 57 \cdot 3 \frac{C}{R} \delta (i\phi),$$
$$= k\delta(i\phi),$$

say, assuming the permeability of the core constant.

Thus
$$e = \frac{dN}{dt} = k \frac{d}{dt}(i\phi) 10^{-8} \text{ volts.} \quad . \quad . \quad . \quad (3)$$

Now, from Fig. 1 the current curve is seen to be only slightly curved at full load. If this be taken as straight for small displacements, the current may readily be expressed in terms of the power and angle at any particular load.

Let QP' (Fig. 8) represent the increase of current due to a change $\delta\phi$. Let $OP = i_1$, $QP' = i_2$, $QP' = \delta i$. PQ is struck from O as centre and is practically a straight line for small angles perpendicular to QP'.

Then
$$QP = i_1 \delta\phi,$$

and for small changes the ratio $\frac{QP'}{QP}$ is constant $= q$, say.

Thus
$$\delta i = q i_1 \delta\phi,$$

or
$$i = q i_1 \phi + b.$$

If the oscillations are taking place about QP, $\phi = 0$ when $i = i_1$, for $\phi$ is to be taken as the change of phase referred to the new position of stability as zero.

Hence,
$$i = i_1(1 + q\phi),$$

and
$$(i\phi) = i_1(\phi + q\phi^2),$$

thus
$$\frac{d}{dt}(i\phi) = i_1(1 + 2q\phi) \cdot \frac{d\phi}{dt},$$

and
$$e = k i_1 (1 + 2q\phi) \frac{d\phi}{dt} \cdot 10^{-8} \text{ volts,} \quad (4)$$

the power absorbed in one damping coil being

$$\frac{e^2}{r} = \frac{k^2 i_1^2}{r}(1 + 2q\phi)^2 \left(\frac{d\phi}{dt}\right)^2 10^{-16} \text{ watts;}$$

$r$ being in ohms; or in foot pound second units

$$w = \frac{0 \cdot 737}{10^{16}} \frac{k i_1^2}{r}(1 + 2q\phi)^2 \left(\frac{d\phi}{dt}\right)^2 \text{ ft. lb. per second.} \quad . \quad (5)$$

The extra torque on the armature due to this is

$$w/2\pi n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where $n$ is the speed per second.

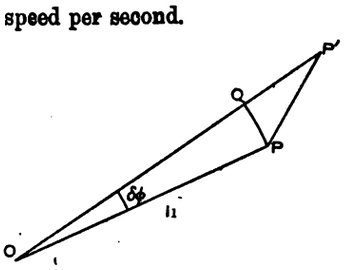


FIG. 3.

Thus the torque due to dissipation of energy in the coil is

$$= \frac{0 \cdot 737 k i_1^2}{2\pi n r}(1 + 2q\phi)^2 \left(\frac{d\phi}{dt}\right)^2 10^{-16} \text{ ft. lb.}$$

The equation of the damped oscillation is

$$\frac{I}{p} \cdot \frac{d^2\phi}{dt^2} + b\frac{d\phi}{dt} + a^2\phi = 0. \quad . \quad . \quad . \quad . \quad (7)$$

Where $a^2$ is the torque caused by one radian phase displacement of the current sheet, and $b$ that produced by the dissipation of energy when there is a change of phase of one radian a second, *i.e.*, $d\phi/dt = 1$.

Substituting this in (5) and (6)

$$b = \frac{0 \cdot 737 k^2 i_1^2}{2\pi n r}(1 + 2q\phi)^2 10^{-16} \text{ ft. lb. per radian per second,}$$
$$= A(1 + 2q\phi)^2, \text{ say.}$$

Thus
$$\frac{I}{p} \cdot \frac{d^2\phi}{dt^2} + A(1 + 2q\phi)^2 \cdot \frac{d\phi}{dt} + a^2\phi = 0. \quad . \quad . \quad (8)$$

This equation does not admit of exact solution. An approximation may be made as follows:—Writing (8)

$$\frac{d^2\phi}{dt^2} + \frac{pA}{I} \cdot \frac{d\phi}{dt} + \frac{pa^2}{I} \cdot \phi = -\frac{4Apq\phi}{I}(1 + q\phi)\frac{d\phi}{dt}, \quad (9)$$

a solution may be had for the left-hand side in the form

$$\phi = Be^{-\frac{pAt}{2I}} \cos(a't + \theta), \quad . \quad . \quad . \quad . \quad (10)$$

where
$$a' = \sqrt{\frac{pa^2}{I} - \frac{p^2A^2}{4I^2}}.$$

Let $\phi$ be zero when $t = 0$. Then the equation becomes

$$\phi = Be^{-\frac{pAt}{2I}} \sin a't. \quad . \quad . \quad . \quad . \quad . \quad (11)$$

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To determine the constant B let the angular velocity be $w$ when $t=0$.

$$\frac{d\phi}{dt} = -\frac{p\mathrm{AB}}{2\mathrm{I}} \cdot \sin a't + \mathrm{B}e^{\frac{-pAt}{2I}} \cdot a' \cos a't.$$

Thus, $$w = \frac{d\theta}{dt} = \frac{1}{p}\frac{d\phi}{dt} = \frac{\mathrm{B}a'}{p},$$

or $$\mathrm{B} = pw/a'. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

In order to find the value of $w$ for a given load thrown on or off the machine, consider the work done on the armature during a small change of current. Let F (Fig. 4) be the total tangential force at any phase position $\phi$. The work done during a small displacement $ds$ of the periphery is $(\mathrm{OP}' - \mathrm{OQ})ds$ and this $= (\mathrm{F}_2 - \mathrm{F})\frac{r}{p}\,d\phi$, where $r$ is the radius of the armature, $p$ being the number of pairs of poles.

Thus for a finite displacement the work done, $v$,

$$= \int_{\phi_1}^{\phi_2} (\mathrm{F}_2 - \mathrm{F})\frac{r}{p} \cdot d\phi.$$

Again, since the curve is practically straight for small arcs $\mathrm{F} = \mathrm{F}_1(1 + u\phi)$, where $u = \frac{d\mathrm{F}}{i_1 d\phi}$.

Hence $$v = \int_{\phi_1}^{\phi_2} (\mathrm{F}_2 - \mathrm{F})\,(1 + u\phi)\frac{r}{p}d\phi.$$

$$v = (\mathrm{F}_2 - \mathrm{F}_1)\frac{r}{p}(\phi_2 - \phi_1) + (\mathrm{F}_2 - \mathrm{F}_1)\frac{ru}{2p}(\phi_2^2 - \phi_1^2) \quad (13)$$

This is equal to the change of kinetic energy $\frac{1}{2}\mathrm{I}w^2$, where $w$ is the momentary change of angular velocity.

Then $$w^2 = \left\{\frac{2(\mathrm{F}_2 - \mathrm{F})r(\phi_2 - \phi_1)}{p\mathrm{I}} + \frac{(\mathrm{F}_2 - \mathrm{F})ru}{p\mathrm{I}} \cdot (\phi_2^2 - \phi_1^2)\right\}$$

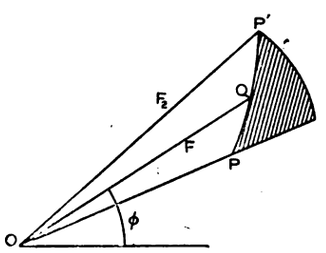


Fig. 4.

Referring to Fig. 1, $u$ is found to be 17·8 when $i_1 = 100$; and for a change from 80 to 100kw., $(\mathrm{F}_2 - \mathrm{F}_1) = 156$lb., $\phi_1 = 0{\cdot}3$, $\phi_2 = 0{\cdot}38$. Thus $w = 0{\cdot}57$ radians per second. Again, $pa^2/\mathrm{I} = p\mathrm{F}r/\mathrm{I}$, and from Fig. 1 the value of F is found for one radian displacement at $i = 100$. From this $pa^2/\mathrm{I} = 448$; and since the second term in $a' = \sqrt{\frac{pa^2}{\mathrm{I}} - \frac{p^2\mathrm{A}^2}{4\mathrm{I}^2}}$ is small compared with the first we may take $a' = \sqrt{\frac{pa^2}{\mathrm{I}}} = 21{\cdot}1$.

Hence, from (12) $\mathrm{B} = 4 \times 0{\cdot}57/21{\cdot}1 = 0{\cdot}108$ radians. Thus the initial amplitude of phase-swinging due to a sudden change in the load of 20kw., from 80 to 100, is 6·2deg.

The remaining undetermined quantity in equation (11) is A.

$$\mathrm{A} = \frac{0{\cdot}737}{2\pi nr}k^2 i_1^2 10^{-16},$$

and $$k = 1{\cdot}257 \times 0{\cdot}0156 \times 57{\cdot}3 \times \mathrm{C/R}.$$

From an actual case take C = 40 turns, R = 0·00097, $i_1 = 100$, $n = 10$ revolutions per second, and take $r = 0{\cdot}00006$ ohms. This value of $r$ is calculated assuming 1 sq. in. cross sectional area of damping coil.

Hence $$k = 4{\cdot}64 \times 10^4,$$

and $$\mathrm{A} = 0{\cdot}4.$$

Thus $$\phi = 0{\cdot}108e^{-0{\cdot}004t} \sin 21{\cdot}1t. \quad . \quad . \quad . \quad (14)$$

Substituting this value of $\phi$ in the R.H.S. of equation (9),

$$\frac{d^2\phi}{dt^2} + \frac{p\mathrm{A}}{\mathrm{I}} \cdot \frac{d\phi}{dt} + \frac{pa^2}{\mathrm{I}}\phi = \frac{-4p\mathrm{A}q\mathrm{B}}{\mathrm{I}}(1 + \mathrm{B}q \sin a't) \sin a't\frac{d\phi}{dt},$$

*i.e.*, using equation (11) and neglecting the damping term.

In the above the coefficient of $d\phi/dt$ is

$$\gamma = \frac{p\mathrm{A}}{\mathrm{I}}\{1 + 4q\mathrm{B}(1 + q\mathrm{B} \sin a't) \sin a't\}, \quad . \quad . \quad (15)$$

and the damping coefficient of the motion is $\gamma/2$.

$$\bar{\gamma} = \frac{4}{\mathrm{T}}\int_0^{\mathrm{T}} \frac{4p\mathrm{A}}{\mathrm{I}}\{1 + 4q\mathrm{B}(1 + q\mathrm{B} \sin a't) \sin a't\}dt$$

where $$\mathrm{T} = \frac{2\pi}{a'} = 0{\cdot}29''.$$

Thus $$\bar{\gamma} = \frac{4p\mathrm{A}}{1\mathrm{T}}\left(\frac{\mathrm{T}}{4} + \frac{4q\mathrm{B}}{a'} + \frac{q^2\mathrm{B}^2\mathrm{T}}{2}\right). \quad . \quad . \quad . \quad . \quad . \quad (16)$$

Here $p = 4$, $\mathrm{A} = 0{\cdot}4$, $\mathrm{I} = 200$, $q = 5$, $\mathrm{B} = 0{\cdot}108$, $\mathrm{T} = 0{\cdot}29$.

Hence, $\bar{\gamma} = 0{\cdot}026$.

Plotting the values of $\gamma$, as given by equation (15), during a quarter-period, a curve closely resembling a sine curve is obtained with straighter sides and more rounded top, the average working out the same as calculated by (16).

An approximate solution of equation (9) is, therefore,

$$\phi = \mathrm{B}'e^{-\frac{\gamma t}{2}} \cos(a'' + \theta')$$

where $$a'' = \sqrt{\frac{pa^2}{\mathrm{I}} - \frac{p^2\gamma^2}{4\mathrm{I}^2}}.$$

The frequency is thus practically unchanged by the damping.

The rate of decay of the motion may be seen by the time taken to fall to 1/eth of its initial value.

Let $\phi_1$ be the amplitude at $t_1$. Let $\phi_2$ be the amplitude at $t_2$.

Then $$\frac{\phi_1}{\phi_2} = e^{\frac{\gamma}{2}(t_2 - t_1)}, \text{ let this} = e.$$

Hence $$\frac{\gamma}{2}(t_2 - t_1) = 1. \quad . \quad . \quad . \quad . \quad . \quad (17)$$

and $(t_2 - t_1)'' = 2/\gamma$. In this case $(t_2 - t_1)'' = 2/0{\cdot}026 = 77''$. Thus, if the damping depended on the dissipation of energy in one coil alone, it would take the above time for the motion to diminish in the ratio 1/2·7. With a damping coil around each pole this time is proportionally diminished. With eight poles it becomes 9·6 seconds for the particular resistance of coil chosen.

The actual beats in a converter fitted with the coils die out more rapidly than this. It becomes necessary, therefore, to consider the effect of the energy dissipated in the core.

*(To be concluded.)*

## THE BATTERSEA ELECTRICITY SUPPLY WORKS.

The electricity supply works of the Battersea Borough Council, which will be opened to-morrow by Mr. A. M. Torrance (Chairman of the London County Council), supply a more or less fan-shaped area to the south of the river. Considering its position in a fairly populous part of London, this local authority has been a long time in giving its ratepayers the advantages of the electric light, the Battersea Vestry having obtained a provisional order in 1896. But now that the works have been erected, provision has been made for the distribution of electrical energy on a large scale. The supply station may be considered to be at about the centre point of the fan, being placed on the river, which affords considerable convenience, both for the delivery of coal and the condensing arrangements. The point of the district furthest from the generating station is 2¼ miles distant.

From the station five feeders branch out, the longest being 1½ miles in length. Two of these feeders are armoured and laid directly in the ground, and the others are laid on the Callender solid system in cast-iron troughs covered with tiles. This solid system is also adopted for the distributing network, all the feeders and distributors having been supplied and laid by Callender's Cable and Construction Co. The network is on the 2×230 volts three-wire system, and there is a large arc light load, 240 10-ampere street lamps, made by the General Electric Co., having been erected. These are placed

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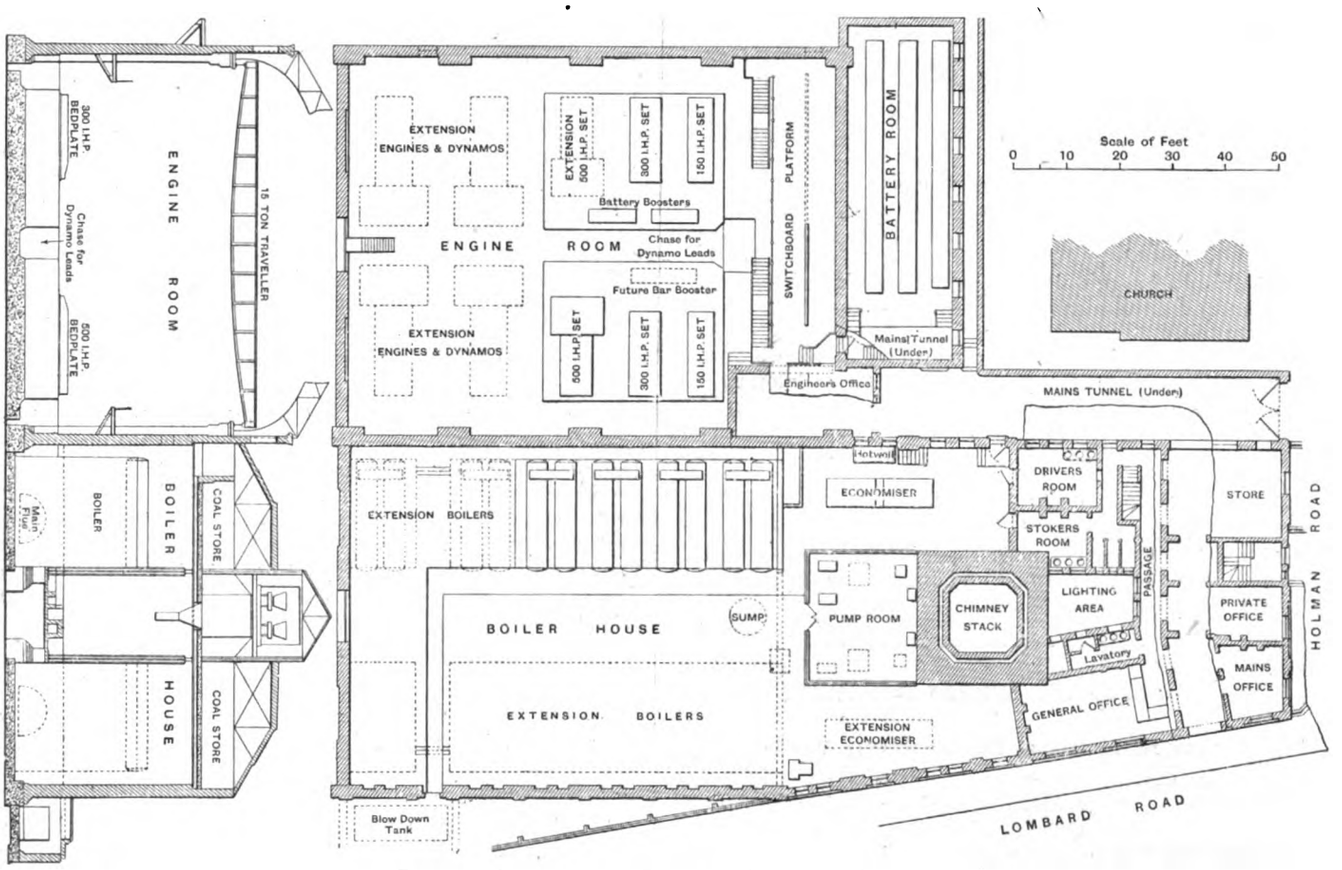
0 in series across the outer mains. They are of the "Angold" brake pattern, with rubber brake pads, a special arrangement being provided for compensating the wear. As there are arc lamps in all the main streets, practically all the distributing network is laid with five cables—three for the private lighting, one for the half-night and one for the all-night arcs. Only two sizes of distributors are used—viz., 0·15, 0·08 and 0·15 sq. in., and 0·1, 0·06 and 0·1 sq. in. The feeders are concentric, with conductors of 0·5 sq. in. section, and the middle wire is fed in two places by a 0·5 sq. in. feeder, from which is branched one of 0·25 sq. in. section. At the feeder boxes fuses are employed, but for the middle wire feeder connections and the network boxes there are copper connecting links.

Messrs. Kennedy and Jenkin are the consulting engineers to the Battersea Borough Council, and the works are more or less in accordance with the general design usually adopted by them. Particular attention has been paid to the leading-in of the mains and the connections from the machines to the switchboard, there being an extremely roomy subway for these, in which a man can stand upright. worked by a hand-wheel on a vertical pillar at the edge of the gallery in front of the switchboard through bevel gear. Similar hand-wheels are used for the exciter rheostats, these rheostats being placed vertically under the pillars and fixed to the lower side of the floor of the gallery. One turn of the hand-wheel moves the rheostat slider one contact. The voltmeter switches on the board are provided with a key common to all, instead of handles, so that the attendant should not switch on the voltmeter to two 'bus bars at once. The switchboard has been made by the Edison and Swan United Electric Light Co., and is fitted with edgewise instruments made by Messrs. Nalder Bros. and Thompson.

In the battery room is a 1,000 ampere-hour Hart battery, consisting of lead-lined wooden cells placed in two tiers. The connections for the regulating cells are painted copper rods. In a room off the battery room a complete little switchboard and a small motor generator, furnishing 2kw. at from 2 to 10 volts, are provided for "milking."




PLAN AND SECTION OF THE BATTERSEA GENERATING STATION.

The feeders end in joint boxes, where they enter the subway, and from there are led by single cables to behind the switchboard. The switchboard itself stands on a gallery overlooking the engine room, and is reached from the engine room by two stairways, and from the accumulator room behind it by a staircase. The board itself stands some little distance from the wall, the generator and feeder switches not being placed on the board, but against the wall behind it, and being worked by levers standing up from the floor in front of the board. There are two 'bus bars and provision for a third, so that eventually it will be possible to maintain three separate feeder pressures. Connection between these and the switches is made by plugs fitted with a revolving shield, so that only the corresponding plugs can be inserted at one time, and a short-circuit is impossible. The combined cell and hand-locked booster switch employed in some of the recent Kennedy stations is not fitted here, possibly on account of the large number of regulating cells. The cell switch is placed in a cupboard with glass windows in the battery room, and is

The first feature which strikes one in the engine room is its extreme height, which is 55ft. 6in. to the top of the roof, the height of the travelling crane girders being 34in. 10in. from the floor. In its other dimensions the engine-room is also very large, measuring 92ft. by 71ft. 6in., and it is spanned by a Spencer 10-ton travelling crane with a 69ft. span. The reason for an engine-room of such roomy dimensions is that a large increase of plant is anticipated in the near future, it being contemplated that generating sets of 1,500 H.P. capacity may eventually be put in. The room is extremely well lighted both naturally and artificially, there being a sloping glass roof and side windows near the top to assist ventilation. It is of white glazed brick embellished with some rows of light blue glazed bricks. The artificial lighting is provided for by lamps of Messrs. Johnson & Phillips enclosed, long-burning "Ark" pattern, fitted on brackets of a bold and not unpleasing design projecting from the walls. The plant at present consists of one 500 H.P. (324kw.) set, two 300 H.P. (192kw.) sets, and two 150 H.P. "double enders" for balancing, each of



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the latter having a 46kw. dynamo on either side. The engines are all Willans triple expansion three-crank engines, and the dynamos Mather and Platt machines erected across the combination bed-plates. Two boosters are provided, these being two-pole under-type machines, whose dynamo parts are able to furnish 20kw. at from 20 to 110 volts. They run at 800 revs. per min. Possibly a booster will be added for the purpose of boosting up the pressure from one set of 'bus bars to another, in order to feed at more than one pressure, as already mentioned. The steam pipe arrangements are also devised with a view to considerable extensions in the future. The main pipe runs right round the engine room, and this is to meet the eventuality of a second boiler house being built on the opposite side of the engine room to the existing one.

The present boiler house contains Babcock and Wilcox boilers with two Babcock and Wilcox chain grate furnaces. Each boiler is specified to evaporate 11,000lb. of steam per hour from and at 212°F. Condensing plant is being fitted. Ledward ejector condensers are provided on each engine, but the contract for the condenser pumps has only just been let. An economiser is employed and a Berryman feed heater, the scrapers of the economiser being driven by two small Reavell engines. The pumps are by Messrs. G. & J. Weir and are steam driven. All this auxiliary plant, including the feed heater, economiser, pumps, condensers and tanks, was supplied by the Sir Hiram Maxim Electrical and Engineering Co., who also furnished the pipe work. At present no coal-conveying gear is employed, the coal being simply dumped down on the boiler house floor, but hoppers and shoots are provided to enable an overhead coal-conveying plant to be fitted later.

The Council has done its own building work, and the various contractors for the plant have been mentioned in the course of the article.

So far the total capital expenditure has been, roughly, £150,000, which works out at about £150 per kilowatt. It must be pointed out, however, that the engine room is large enough for over three times the plant at present installed, and thus the cost of the buildings has considerably increased the total sum.

In conclusion, we would acknowledge the courtesy shown us on the occasion of our visit to the station by Mr. H. R. F. Mackay, the Borough Council electrical engineer, and Mr. F. I. Thomas, who has been superintending the work on behalf of Messrs. Kennedy and Jenkin.

## ELECTRICITY WORKS ACCOUNTS.

### Glasgow Municipal Electric Supply Works.

This undertaking continues to make most satisfactory progress both in economical working and expansion of business. The accounts of the last financial year show that a general reduction of the costs has taken place—including even the fuel item—with the result that, without exception, the figures displayed are excellent.

When we come to the financial results, however, we find a deficit of £407 as the net outcome of the year's operations, caused by the very low average selling price of 2·8d. per unit. It is becoming an interesting experiment, this policy of Glasgow's, of reducing the price to a point which was last year below what it could perhaps afford financially. That the low tariff is fruitful in the results probably aimed at is evident from the advances in the output, the lamp connections and the load factor. The two first quantities show increases respectively of 60·3 and 52·5 per cent., while the last has risen from 11·4 to 12·34 per cent.

Nothing was placed aside for depreciation last year. There was incurred by the revenue account a charge of £13,847 transferred from the capital account, being the amount expended during the past three years on lamps and fittings supplied to consumers in consequence of the change in pressure. A proportion (£4,110) was met last year by the reserve of accumulated profits, which amounted to £4,517, the balance of this reserve fund being taken to meet the year's deficit of £407. To deal with the remainder of the above charge of £13,847 a suspense account has been formed.

It is hardly necessary to point out that in our analysis we have excluded the above instalment of £4,110 from the revenue account, as it is hardly an ordinary charge, and to include it would be to vitiate the value of the cost figures for purposes of comparison. Nevertheless, in considering the financial results it has to be remembered that this charge and the remainder now in suspense were chargeable on revenue; that although the ordinary expenditure out of revenue was lower, the net results of last year's operation were that nothing was set aside for depreciation, and the accumulated net profits of former years, amounting to £4,517, was wholly swallowed up to make ends meet. It is in view of these facts that we think we were justified in remarking that, in effect, the tariff has been reduced to a point that cannot be afforded by the undertaking. We reprint at the bottom of this page figures from the committee's report for the last two years, showing how the revenue from ordinary consumers has been built up.

The number of motors in use and supplied by the department with power was 427 (1,894 H.P.) at May 31st last, as compared with 212 (754 H.P.) at the same date in 1900.

The extension of the Port Dundas plant of 5,000 H.P. is nearly finished, and when completed the total engine power will be 16,380 H.P. In addition, we understand there are two sets of 1,100 H.P. each in the Exhibition, at the close of which are to be erected in the Pollokshaws-road station.

For the year 1901–2 the following scale of charges has been decided upon by the committee:—

FOR LIGHTING PURPOSES.

1. *Shops, warehouses, offices, and all other premises except those specified under heads* 2, 3, and 4 to be charged on the maximum demand system at 6d. per unit for the first 365 hours' use per annum of the maximum demand, and 1d. per unit after for 250 volt supply, 1½d. for 200 volt supply and 2d. per unit for 100 volt supply.

2. *Domestic consumers*, and 3, *Theatres, halls, and other places of entertainment.*—A uniform charge of 3½d. per unit for 250 volt, 4d. per unit for 200 volt and 100 volt supply.

4. *Churches.*—3d. per unit.

FOR MOTIVE POWER PURPOSES.

Uniform charge of 1½d. per unit for 250 and 500 volt supply and 2d. per unit for 200 volt supply.

### Aberdeen Municipal Electric Supply Works.

At Aberdeen this year again the cost figures are highly creditable. With the natural exception of the fuel item, the several items of expenditure, as well as the aggregates, are well under the average of municipal stations of similar output and load-factor. Most of the costs have fallen slightly, but, owing chiefly to the coal item, the total expenditure shows a rise of 0·39d. per unit. According to the engineer's report, coal of a lower calorific value than that formerly used was consumed, owing to its producing less smoke, in order to minimise the complaints arising from the smoke nuisance.

With 176 new consumers the lamp connections have risen from the equivalent of 71,995 8 c.p. lamps to 79,663, *exclusive* of the tramway equivalent—an advance of 10·65 per cent. The year's output, at 1,199,913 units sold, showed an increase of nearly 42 per cent., while the load factor rose from 12·62 to 16·6 per cent. The total number of motors on the mains is now 126, representing 485 H.P.

| Year. | Units sold to consumers (total). | Units sold at | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 6d. | 4d. | 3½d. | 3d. | 2½d. | 2d. | 1½d. | 1d. |
| 1899–1900 | 3,788,795 | 1,314,259 | .. | ... | 13,252 | 635,338 | 923,875 | 902,071 | ... |
| 1900–1901 | 6,290,819 | 1,249,362 | 151,684 | 550,630 | 31,460 | 369,952 | 963,130 | 2,509,906 | 464,695 |

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| | GLASGOW. | | ABERDEEN. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Glasgow Corporation. | | Aberdeen Corporation. | |
| *Date of Commencement of Supply* | March, 1892. | | March, 1894. | |
| *System of Supply* | 3-wire continuous-current with batteries. | | 3-wire continuous current. | |
| *Chief Engineer* | W. A. Chamen. | | J. A. Bell. | |
| **YEAR ENDED** | MAY 31, **1900.** | MAY 31, **1901.** | JULY 31, **1900.** | JULY 31, **1901.** |
| **QUANTITIES—** | | | | |
| Units generated | 5,226,818 | 8,254,146 | 1,005,505 | 1,389,385 |
| „ **SOLD (TOTAL)** | 4,250,669 | 6,813,991 | 846,012 | 1,199,913 |
| „ sold to consumers | 3,788,795 | 6,290,819 | 781,375[a] | 1,043,665[j] |
| „ sold for public lighting, &c. | 461,874 | 523,172 | 64,637 | 156,248 |
| „ used on works | 155,294 | 626,151 | 28,933 | 61,054 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 21·3 | 31·6 | 23·4 | 23·3 |
| Maximum supply demanded | 4,258 kilowatts | 6,308 kilowatts | 765 kilowatts[b] | 826 kilowatts |
| Number of public lamps | 265 arc | 348 | 76 arc, 80 glow | 145 arc, 80 (25 c.p.) glow |
| Number of consumers | 2,852 | 4,031 | 602 | 778 |
| Connections to mains in 8-c.p. lamps | 241,625 | 368,342 | 71,995[c] | 79,663[c] |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 200,000 | 215,500 | 36,100 | 51,600 |
| **CAPACITY OF PLANT IN KILOWATTS** | 6,402 | 6,900 | 1,156 | 1,620 |
| **CAPITAL—** | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. | Total. / Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £700,000 / £109 | £900,000 / £130 | £82,000 / £71·0 | £185,000 / £114 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 700,000 / 109 | 900,000 / 130 | 82,000 / 71·0 | 185,000 / 114 |
| **RECEIVED (TOTAL)** | 640,000 / 100 | 885,000 / 128 | 81,953 / 70·9 | 112,310 / 69·3 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 640,000 / 100 | 885,000 / 128 | 81,953 / 70·9 | 112,310 / 69·3 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 60,000 / 9·37 | 15,000 / 2·17 | 47 / 0·041 | 72,690 / 44·9 |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | 60,000 / 9·37 | 15,000 / 2·17 | 47 / 0·041 | 72,690 / 44·9 |
| **REPAID (TOTAL)** | 11,500 / 1·80 | 27,366 / 3·97 | 5,185 / 4·49 | 6,892 / 4·25 |
| **RESERVE OR SINKING FUND** | 6,285 / 0·982 | — / — | 2,610[n] / 2·26 | 4,844[n] / 2·99 |
| **DEPRECIATION FUND** | 47,555 / 7·43 | 47,555 / 6·89 | 7,874 / 6·81 | 10,547 / 6·51 |
| **EXPENDED (TOTAL)** | 657,040 / 103 | 883,702 / 128 | 101,240 / 87·5 | 125,051[o] / 77·2 |
| Lands and buildings | 140,749 / 22·0 | 156,183 / 22·6 | 17,688 / 15·3 | — / — |
| Plant | 189,020 / 29·5 | 265,827 / 38·5 | 39,363 / 34·1 | — / — |
| Mains | 326,722 / 51·1 | 458,921 / 66·5 | 44,189 / 38·2 | — / — |
| Miscellaneous | 550 / 0·086 | 2,772 / 0·402 | — / — | — / — |
| **BALANCE OF CAPITAL ACCOUNT** | −17,040 / −2·66 | 1,298 / 0·188 | −19,287[d] / −16·7 | −12,741[d] / −7·86 |
| **REVENUE—** | Total. / Per unit sold. | Total. / Per unit sold. | Total. / Per unit sold. | Total. / Per unit sold. |
| **TOTAL** | £59,762 / 3·373d. | £79,450 / 2·800d. | £13,926 / 3·953d. | £18,879 / 3·777d. |
| Revenue from supply | 55,471 / 3·132d. | 74,524 / 2·626d. | 12,793[e] / 3·630d. | 18,316 / 3·663d. |
| „ meters, &c. | — / — | — / — | nil / — | nil / — |
| „ public lighting | 4,291 / 0·242d. | 4,925 / 0·174d. | 993 / 0·282d. | 502[i] / 0·100d. |
| „ sale of lamps, &c. | — / — | — / — | 9 / 0·003d. | 6 / 0·001d. |
| „ miscellaneous sources | — / — | — / — | 131[f] / 0·037d. | 54 / 0·011d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £35,000 / 1·976d. | £46,647 / 1·644d. | £5,321[g] / 1·510d. | £9,489 / 1·898d. |
| **WORKS COSTS** | 27,132 / 1·531d. | 37,404 / 1·319d. | 4,266 / 1·211d. | 7,465 / 1·494d. |
| *Generation of electricity* | *21,001 / 1·186d.* | *30,843 / 1·087d.* | *4,013 / 1·138d.* | *6,841 / 1·369d.* |
| Fuel (including cartage, &c.) | 12,997 / 0·734d. | 19,667 / 0·693d | 2,429 / 0·690d. | 4,698 / 0·940d. |
| Oil, waste, water, stores | 1,073 / 0·061d. | 1,559 / 0·055d | 296 / 0·084d. | 384 / 0·077d. |
| Wages at station | 4,859 / 0·274d. | 6,637 / 0·234d. | 932 / 0·265d. | 1,146 / 0·229d |
| Repairs and maintenance at station | 2,073 / 0·117d. | 2,139 / 0·075d. | 356 / 0·101d. | 613 / 0·123d. |
| *Distribution of electricity* | *5,007 / 0·283d.* | *5,018 / 0·177d.* | *253 / 0·072d.* | *624 / 0·125d.* |
| Wages, &c. } Repairs, renewals of mains, &c. | 5,007 / 0·283d. | 5,018 / 0·177d. | — / — ; 253 / 0·072d. | 624 / 0·125d. |
| *Public lighting* | *1,124 / 0·064d.* | *1,543 / 0·054d.* | — / — | — / — |
| Attendance } Renewals | 1,124 / 0·064d. | 1,543 / 0·054d. | — / — ; — / — | — / — ; — / — |
| **MANAGEMENT AND PROPERTY CHARGES** | 7,867 / 0·444d. | 9,243 / 0·326d. | 1,512 / 0·429d. | 2,024 / 0·405d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *4,549 / 0·257d.* | *5,080 / 0·179d.* | *740 / 0·210d.* | *797 / 0·159d.* |
| *Management* | *3,318 / 0·187d.* | *4,163 / 0·147d.* | *772 / 0·219d.* | *1,227 / 0·245d.* |
| Salaries | 1,564 / 0·088d. | 2,445 / 0·086d. | 345 / 0·098d. | 416 / 0·083d. |
| Stationery, &c. | 467 / 0·026d. | 422 / 0·015d. | 118 / 0·033d. | 251 / 0·050d. |
| Establishment charges | 1,287 / 0·073d. | 1,296 / 0·046d. | 216 / 0·061d. | 263 / 0·053d. |
| Law charges, &c. | — / — | — / — | 93[h] / 0·026d. | 297[m] / 0·059d. |
| **FINANCIAL RESULTS—** | Total. / % to mean cap. exp'nded | Total / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded | Total. / % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £24,762 / 4·76% | £32,803 / 4·26% | £8,605 / 9·76% | £9,390 / 8·31% |
| Sum carried to Depreciation Fund | 3,222 / 0·619% | nil / — | 2,439 / 2·77% | 2,673 / 2·36% |
| Sum carried to Reserve or Sinking Fund | 6,285 / 1·21% | 8,663 / 1·12% | 1,336 / 1·52% | 1,707 / 1·51% |
| Net interest on loans (incl. Debenture charges) | 15,256 / 2·93% | 24,547 / 3·19% | 2,343 / 2·66% | 2,842 / 2·51% |
| **BALANCE FROM LAST ACCOUNT** | — / — | — / — | −204 / −0·231% | — / — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — / — | — / — | 2,284 / 2·59% | 2,169 / 1·92% |
| *Deficit* | — / — | *407 / 0·053%* | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 58·6% | 58·7% | 38·2% | 51·5% |
| Expenditure per kilowatt capacity | £5. 9s. 5d. | £6. 15s. 2d. | £4. 12s. 0d. | £5. 17s. 0d. |
| **REVENUE PER KILOWATT CAPACITY** | £9. 6s. 7d. | £11. 10s. 2d. | £12. 1s. 0d. | £11. 13s. 0d. |
| Expenditure per 8-c.p. lamp capacity | 3s. 6d. | 4s. 4d. | 2s. 11½d. | 3s. 8d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 5s. 11½d. | 7s. 4½d. | 7s. 8½d. | 7s. 4d. |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 4s. 11¼d. | 4s. 3¾d. | 3s. 10½d. | 4s. 9d. |
| Price charged for lighting, per unit } Price charged for power, per unit | 6d. to 1½d. | 6d. to 1½d.[a] ; 2d. to 1½d.[b] | 6d. to 3d.[i] ; 3d. to 1d.[i] | 6d. to 3d.[k] ; 3d. to 1d.[k] |
| Price charged for public lighting | — | — | 1·93d. per unit[i] | 6d. to 3d.[k] |

**GLASGOW.**—REMARKS—*a* 6d. per unit for first 365 hours per annum of maximum demand and for all in excess 2½d. per unit at 100 volts, 2d. at 200 volts and 1½d. at 250 volts pressure; or alternatively 4s. 6d. per 32 watt lamp or its equivalent on consumers' premises for 100 volt supply, 4s. 4d. per 32 watt lamp for 200 volts, and 4s. per 32-watt lamp or equivalent for 250 volt supply, the charge being spread uniformly over the 12 months, plus 1½d. per unit by meter. For churches 3d. per unit and for domestic consumption a uniform charge of 3½d. per unit for 250 volt supply and 4d. for 100 and 200 volt consumers. *b* 1½d. per unit to 250 volt consumers and 2d. to 200 volt consumers.

**ABERDEEN.**—REMARKS—*a* Inclusive of 131,173 units sold to tramways. *b* Inclusive of tramway demand. *c* Exclusive of the equivalent of the tramways. *d* Over-expended. *e* Includes £1,093 from tramways for electricity for traction. *f* For attendance on harbour lamps after deducting £169 labour and material. *g* After deducting £457 amount received from tramway department for services of electrical engineer and staff in construction of Woodside line. *h* £39 insurance, £15 auditing and £39 compensation for damages. *i* On maximum demand system, "public lighting being computed." *j* Includes 250,489 units on traction. *k* Maximum demand system, public lighting reduced since to 6d. and 2d. *l* Attendance on harbour lamps £400 and on "additional lamps" £102. *m* £40 insurance, £15 auditing, £230 special services and repairs to motors. *n* Surplus funds not sinking fund. *o* Includes £22,417 on Ferryhill works.

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## POWER REQUIRED TO DRIVE A MARINE ENGINE WORKS.*

BY MESSRS. JAMES CRIGHTON AND W. G. RIDDELL.

It is not the intention of the authors to attempt to describe a model engine works or driving plant, but rather to enumerate and show the result of a few improvements which have been adopted by the firm with which they are connected. About three years ago it was decided to re-arrange the works in a thorough manner and to fit up a new power installation. The works had gradually grown during upwards of 30 years, and most of the buildings were in excellent condition and in no need of reconstruction. The problem to be solved then was how to lay down an economical driving plant which would conform to the existing conditions, and which would not lead to an unnecessary sacrifice. At that time the motive power of the works consisted of one marine type boiler working at 80lb. pressure, and supplying steam to three vertical compound engines for driving the machinery, and one vertical compound engine for lighting purposes. The points in favour of so many units were the saving in steam when running one or two machines at night, which might be driven by one of the small engines, and also the fact that in the event of a breakdown of one engine, the other parts of the works were not affected. It was, however, decided to put in one engine capable of driving and lighting the entire works, and to meet the difficulty of late work, by driving those machines, which experience showed were the most likely to be needed at night, by motors which could be connected with current from the Glasgow Corporation. The engine was made to a simple design, in order to make the fear of a breakdown very remote. A cylindrical marine boiler, designed to work under either forced or natural draught, was selected as the most suitable type, and has proved itself both economical and reliable. The position of the power station was fixed to a certain extent by circumstances.

The works are situated in a busy part of the City of Glasgow where ground is costly and economy of floor space essential. There is no direct communication with any railway, so that all material has to be carted to and from the works. Close proximity to the street was therefore an importaut factor in settling the position of the boiler. The engine was placed as near the boiler as possible, with the crank-shaft parallel to two of the main lines of shop shafting. Two dynamos were laid down for lighting and driving purposes, and these and the two lines of shating were connected to the main engine shaft with belts, and all so arranged as to be easily disconnected. Motors were laid down to drive all outlying shafting.

The existing conditions having been treated in a general way, the driving plant will now be described in detail. The boiler is of the cylindrical marine type, 13ft. 6in. mean diameter by 12ft. 6in. long, and is fitted with three Morrison suspension furnaces 3ft. 1in. inside diameter by 8ft. long. The working pressure is 200lb. per square inch. The firebars are 5ft. long, and the grate area is 46·2 sq. ft. There are three separate combustion chambers and 316 tubes 2½in. external diameter by 8ft. long. The total heating surface is 2,040 sq. ft., being 44·2 times the grate area. The length of the chimney above the firebars is 65ft. A 60in. fan is provided to blow air into the furnaces through fronts of the Howden type, and the boiler tubes are fitted with retarders. The boiler is covered all over with non-conducting material, and the loss from radiation is so small that 3 to 5cwt. of coal is sufficient to keep up the steam pressure during the night when the engine is not working. A Craig's combustion tester is kept in the boiler room, by means of which the percentage ot carbonic acid gas in the uptake may be read at sight, and the air supply reduced to the point where efficiency begins to decrease. The feed water is heated by exhaust steam, and enters the boiler through a Kennedy water meter at a temperature of 205°F. Numerous evaporative tests were carried out with different kinds of coal. The coal and ashes were measured, and the capacity of the measure was frequently tested, and the water meter was read at regular intervals. It was, however, found that even the absence of a desire for phenomenal results did not prevent the weight of the coal burned at the tests from being apparently less than the weight passed over the weigh-bridge. The difference was sometimes as great as 5 per cent. after deducting coal used for keeping up fires at night and for lighting fires at the beginning of the week. Measuring was therefore discontinued, and the weight of coal passed over the weigh-bridge taken as the amount burned. The water meter was read at stopping time each Saturday, and continuous weekly returns showing the cost per 100 gallons of water evaporated were made up from the figures thus obtained.

The tabulated tests of the boiler were made when the alterations to the driving plant were incomplete, and the amount of steam required was greater than is used in ordinary circumstances. It is probable, however, that, owing to additions to the works and new machine tools, the quantity of water evaporated at these tests will ultimately be required. Now that all the power in the works is derived from one engine, less steam is being used and the rate of combustion per square foot is less and the efficiency slightly greater. Notwithstanding this the tests taken at the higher rate of combustion have been used in this Paper as the basis for calculating the cost of power, as, in course of time, the conditions prevailing at these tests will be the normal working conditions of the boiler.

Trials of the boiler were carried out for four consecutive weeks with a different kind of coal each week. The coal was tested daily during the four weeks with a Thomson's oxygen calorimeter. During the first week the cheapest quality of coal which would give the required amount of steam was used. This cost 8s. 10d. per ton, and goes by the local name of "washed singles." It had a low calorific value of about 10,000 B.T.U. per pound. The rate of combustion was fully 40lb. per square foot of grate per hour, and when burning this quantity great volumes of black smoke were given off. "Washed doubles" or "nuts" was the next quality tried. It costs 1s. per ton more than "singles," and had a slightly higher calorific value, but its evaporative power was not worth the extra 1s. The third test was made with "steam coal triping" at 10s. 6d. per ton. The great defect of this coal was the large proportion of fine dust contained in it. An air pressure of ⅝in. had to be maintained in the ash pits in order to burn it quickly enough, and this carried the dust away before it was burned. It lodged in crevices of the smoke box, where it took fire and did damage. The fourth and last coal tried was steam coal at 11s. 6d. This coal had a calorific value of 14,320 B.T.U., and gave all-round satisfactory results. The cost of evaporation was slightly higher with this coal than with "washed singles"—7·49d. per 100 gallons against 7·36d. per 100 gallons, but this was more than saved in wages. One fireman was able to attend to the boiler all day when firing steam coal, but had to be relieved when firing singles, the rate of combustion being so much higher with the latter.

In Table I. a deduction of 2 tons was made in each case from the weekly coal consumption when finding the rate of combustion per square foot of grate. This is the amount used for keeping up steam at night and lighting the fires at the beginning of the week. The total weekly consumption was the weight taken in finding the other figures. It may be added that, after allowing for the error in measuring the coal, an equivalent evaporation of 11·5lb. from and at 212°F. was frequently maintained for several hours at a time, but the losses due to stoppages for meal hours and cleaning fires reduced this to the figures given in the table. The grate area of the boiler is 46·2 sq. ft. and the heating surface 2,040 sq. ft. The feed temperature was 205°F., and the steam pressure 200lb. during all trials.

**Table I.**

| —— | Kind of coal. | | | |
|---|---|---|---|---|
| | Washed singles at 8s. 10d. | Doubles at 9s. 10d. | Steam coal triping at 10s. 6d. | Steam coal at 11s. 6d. |
| Coal burned per week.....tons | 47·15 | 46·25 | 40·4 | 37·3 |
| Coal burned per square foot of grate per hour .....lb. | 40·5 | 39·7 | 34·5 | 31·4 |
| Percentage of ash in coal ..... | 15 | 12 | 16 | 8 |
| Total water evap. per week .. ...lb. | 715,000 | 713,300 | 715,400 | 715,000 |
| Water evaporated per lb. of coal actual .....lb. | 6·76 | 6·88 | 7·9 | 8·62 |
| Water evaporated per lb. of coal from and at 212°F. .....lb. | 7·16 | 7·29 | 8·36 | 9·13 |
| Water evaporated per square foot heating surface .....lb. | 6·55 | 6·47 | 6·58 | 6·55 |
| Temperature of uptake .....F. | 630° | 635° | 650° | 617° |
| Air pressure in ashpits .....inch | ½ | ½ | ⅝ | ⅝ |
| Cost of carting away ashes...shillings | 10·6 | 8·3 | 9·7 | 4·4 |
| Cost of fuel for evaporating 1,000lb. water .....pence. | 6·99 | 7·65 | 7·1 | 7·14 |
| Total cost of 1,000lb steam, including cost of water, coal and cartage of ashes.....pence | 7·36 | 8·02 | 7·46 | 7·49 |

The engine is of the vertical double-acting compound type, and is at present non-condensing. A cooling tower is being erected, but owing to its position in the centre of the works it could not be completed sooner without disorganising the establishment. The engine has cylinders 12½in. and 23in. diameter by 21in. stroke, and working at 200lb. pressure per square inch. The cranks are placed directly opposite each other, and the slide-valves of both engines are actuated by one eccentric and one valve spindle. At present the exhaust steam passes through a receiver to the atmosphere, the receiver being so constructed that it could be easily converted into a surface condenser when the cooling tower is ready, and this is now being done. The feed water meets the exhaust steam in the form of a spray, and is heated to 205°F. It then falls by gravity to the float tank of a Weir's feed pump, and is pumped through a Kennedy water meter direct into the boiler. In the design of the engine simplicity of parts and ample bearing surface were aimed at in order to minimise, as far as possible, any risk of breakdowns.

* Abstract of Paper read before Section III. (Mechanical) of the International Engineering Congress at Glasgow.

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The two main lines of shafting are driven direct by means of belts from pulleys on the main engine shaft. Another belt is taken from the flywheel on the engine crankshaft to a countershaft, which countershaft in turn drives the electric generators. The generators are two in number, of the Schuckert type, designed for 110 volts and an output of 70 kg. each, which may be used alternatively for lighting and power. From a series of trials it was found that the engine was developing 147·27 I.H.P. when driving the electric lights alone. This represented a mechanical efficiency at the generator terminals of 0·68, which may be considered fairly good, seeing that the engine was only working at slightly more than half load, and including, as it does, the losses in friction of the engine itself, dynamo countershaft and dynamo.

In order to find the power absorbed by the line shafting in the work a series of trials was carried out. At the first trial only the line shafting and loose pulleys were run. The machines and countershafts were run along with the shafting at the second trial, and the final trial was made with the machines cutting at their normal rate. The average diameter of the line shafting in the works is 3¼in., and its speed is from 140 to 150 revs. per min. It runs in white metal self-oiling pedestal bearings, spaced about 12ft. apart. The total length of line shafting in the works is 2,300ft., and the weight is 37 tons 8 cwt. 2 qrs. The engine indicated 61·75 I.H.P. at the first trial, 141 I.H.P. at the second, and 210 I.H.P. at the third. From these powers it will be seen that the line shafting absorbs 29·3 per cent. of the total power, the countershafts and machines 67 per cent., and that only 33 per cent. is actually applied to the cutting tools.

Before instituting a comparison between the old and new systems of driving the works, it may be well to enumerate briefly the various units which made up the old installation. These were—1st. A marine type boiler working at a pressure of 80lb. per square inch. The feed water for the boiler was heated to 205°F., as in the new boiler. 2nd. Three compound non-condensing engines indicating collectively 151·2 I.H.P. for driving purposes. 3rd. One compound non-condensing engine for lighting purposes of 64·66 I.H.P. The boiler evaporated about 6·75lb. of water per pound of coal, and the engines used 43·8lb. of water per I.H.P. per hour. This gave an average coal consumption of 6·4lb. of coal per I.H.P. per hour. In calculating the cost of a horse-power for a year, the coal used for raising steam for smithy hammers and blower engines has not been taken into account, but the steam for electric lighting has been charged in each case, as it was almost impossible to obtain accurate figures without doing so. The proportion of steam used for smithy hammers was found by working the smithy under normal conditions for three nights of 12 hours each. The blower engines were also run at their normal speed during this test. It will be seen that the power for electric lighting is much greater in the new than in the old system, and it may be contended that the greater efficiency of 1 H.P. in the new system of driving is partly due to the better lighted workshops, but this is a refinement into which the scope of this Paper does not permit of investigation.

**Table II.**—*Cost of* 1 I.H.P. *per year of* 3,000 *hours under Old System.*

| | | | |
|---|---|---|---|
| Coal—1,545 tons at 11s. 6d. per ton | £888 | 7 | 6 |
| Wages for steam raising | 176 | 2 | 0 |
| „ „ engine tending | 194 | 1 | 0 |
| Maintenance of engines and boilers | 80 | 10 | 0 |
| Oil waste and sundry stores | 23 | 16 | 0 |
| Water—2,172,133 gallons at 30s. per 100,000 gallons | 32 | 8 | 0 |
| Cartage of ashes | 11 | 11 | 0 |
| Total | £1,406 | 15 | 6 |

$$\frac{\text{£1,406. 15s. 6d.}}{\text{Mean I.H.P. } 165{\cdot}2} = \text{£8·5 per I.H.P. per year.}$$

**Table III.**—*Cost of* 1 I.H.P. *per year of* 3,000 *hours under New System.*

| | | | |
|---|---|---|---|
| Coal—1,360 tons at 11s. 6d. per ton | £782 | 0 | 0 |
| Wages for steam raising | 92 | 0 | 0 |
| „ „ engine tending | 200 | 0 | 0 |
| Maintenance of engine and boiler | 25 | 0 | 0 |
| Oil waste and sundries | 28 | 10 | 0 |
| Water—2,750,000 gallons at 30s. per 100,0000 gallons | 41 | 5 | 0 |
| Cartage of ashes | 10 | 4 | 0 |
| | £1,178 | 19 | 0 |

$$\frac{\text{£1,178. 19s.}}{\text{Mean I.H.P. } 271{\cdot}3} = \text{£4·34 per I.H.P. per annum.}$$

**Table IV.**—*Old System.*

| | |
|---|---|
| Material removed per annum | 245 tons. |
| Material removed per I.H.P. per annum | 1·61 „ |
| Cost of removing 1 ton of material | £5·21 |

**Table V.**—*New System.*

| | |
|---|---|
| Material removed per annum | 367 tons. |
| Material removed per I.H.P. per annum | 1·74 „ |
| Cost of removing 1 ton of material | £2·48 |

It now remains to be shown by how much the new system is better than the old, or, in other words, at how much smaller cost it produces work. Since the power in an engine works is expended in removing material from rough castings and forgings, a figure may be found by which different systems may be compared; the system by which a given weight of material is removed at the smallest cost being the most efficient. In order to make the grounds of comparison similar, the cuttings produced by machines whose scrap is not in proportion to the power expended—such as shearing machines and band saws—are not taken into account, but the weight of all turnings, &c., for a fixed period is divided by the cost of 1 H.P. for the same period, and a money value for the power per ton removed can thus be obtained. From Tables III. to V. it will be seen that the cost of removing one ton under the old system of driving was £5·21, and under the new system £2·48, showing a saving by the new system of 52 per cent. Notwithstanding the saving, it is clear that when the surface condenser is fitted the cost of the 1 I H P. will be much further reduced. It is hoped that the figures given may help to provide a basis on which to calculate the relative efficiency of the driving plant in similar works.

## ON THE CHANGE OF CONDUCTIVITY OF METALLIC PARTICLES UNDER CYCLIC ELECTROMOTIVE VARIATION.*

BY PROF. JAGADIS CHUNDER BOSE, M.A., D.SC.

*(Concluded from page 832.)*

*Characteristic Curve of a Single Point Iron Receiver.*

In order to reduce the conditions of experiment to their simplest, I first studied the effect of E.M. variation on contact at a *single* point. All change was thus confined to the molecular layers at the point of contact. [For a still more ideally-simple experiment see below, on single point self-recovering receiver]. The contact consisted of a sharp point of iron, pressing against a convex iron surface, the pressure being capable of very delicate adjustment by means of a micrometer acting on springs. Five different experiments were carried out with the same receiver.

The initial adjustments were made with an E.M.F. of 0·05 volt. The only difference made in the several experiments is as regards the initial current, caused by change in the pressure of contact.

In Curve A (Fig. 3) the initial current had the lowest value of the series. The pressure of contact was adjusted till the initial current at 0·05 volt was $2 \times 10^{-5}$ ampere. The E.M.F. was now continuously increased by the turning of the winding wheel, and the curve obtained in the manner previously described.

It will be seen that the curve is not straight, but concave to the axis representing the current. As the E.M.F. is increased, the current increases in a greater ratio. I may say here, in anticipation, that this appears to be a characteristic of the positive class of substances, i.e., of those which, like iron, exhibit a diminution of resistance under electric radiation.

Thus the resistance of the receiver is not constant, but undergoes a *continuous* diminution with increasing E.M.F. Conversely, the conductivity is increased with the rise of E.M.F. Under feeble E.M.F. this conductivity is very small, the curve becomes steeper as the E.M.F. is increased, and the conductivy undergoes a rapid and continuous increase.

Hence it is seen that in this case conduction does not obey Ohm's law. The resistance is not independent of the E.M.F., but varies with it. We find here a remarkable analogy with the phenomenon of magnetic conduction. Just as the magnetic permeability of iron is not constant, but varies with the magnetic force acting on it, so the conductivity of metallic particles is not constant, but varies with the E.M.F. acting on them. The characteristic curves given herewith bear also a remarkable resemblance to the curves of magnetisation. Other parallelisms will be noted later on. These similarities are probably due to the fact that in both cases we are dealing ultimately with phenomena of molecular deflection or distortion, taking place in one, under the action of magnetising force, in the other, under E.M.F.

As the absolute values of the current and the E.M.F. are known, it is easy to find the resistance of the receiver for any given E.M.F. The different values of the resistance can also be determined by the *method of substitution*. After the curve is drawn, leaving the paper still on the platform, a resistance box is substituted for the receiver, and the whole operation is repeated, with this difference, that now we have to change the resistance continuously in order to keep the galvanometer spot on the curve. The values of these resistances at definite points of the curve now correspond to the resistances of the receiver at those points. We can thus find the value of the resistance of the receiver at any point in the curve. This way of

* Paper read before Section A of the British Association.

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finding the resistance was used to supplement that of direct calculation $\left(R=\frac{E}{C}\right)$—from the known values of the E.M.F. and the corresponding current—and the two results were found practically identical. This had the further object of testing the accuracy of the experimental arrangements.

I give below a table showing the variation of resistance with E.M.F. for the A curve :—

**Table I.**—*Showing the Variation of Resistance with E.M.F.*

| E.M.F. (volt). | Current (in $10^{-6}$ amps). | Resistance (ohms). |
|---|---|---|
| 0·05 | 2·0 | 2,500 |
| 0·10 | 4·1 | 2,440 |
| 0·15 | 6·6 | 2,270 |
| 0·20 | 9·2 | 2,100 |
| 0·25 | 14·0 | 1,770 |
| 0·30 | 20·0 | 1,500 |
| 0·35 | 28·5 | 1,230 |
| 0·40 | 44·6 | 860 |
| 0·45 | 69·0 | 640 |

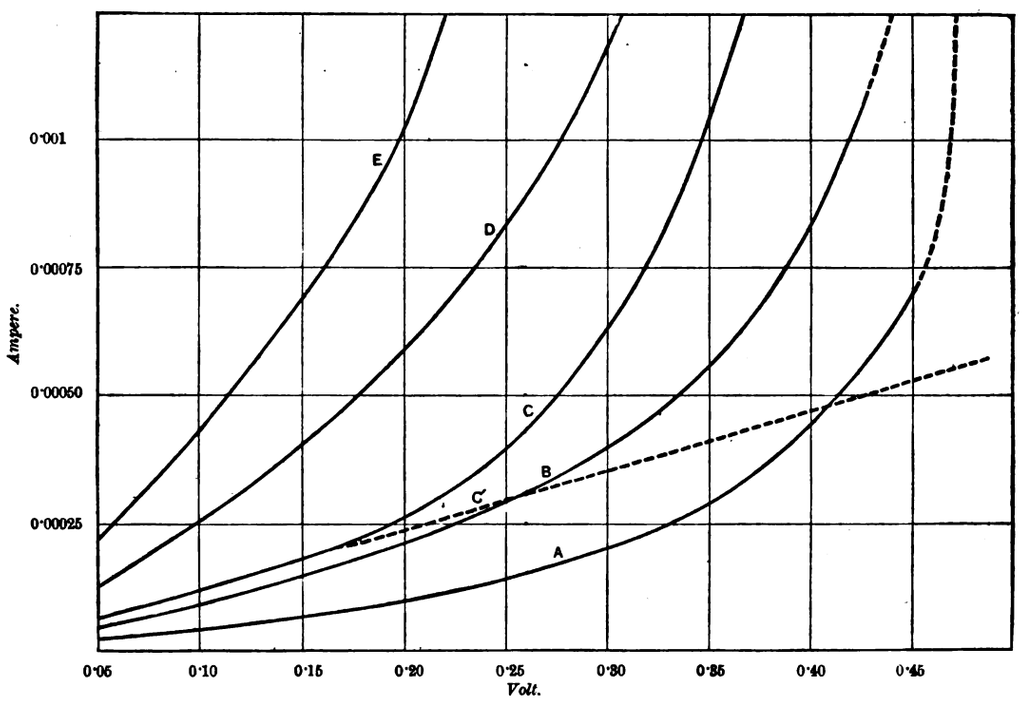
It will be seen from the above table that as the E.M.F. is increased from 0·05 volt to 0·45 volt the resistance falls continuously from 2,500 to 640 ohms—*i.e.*, about one-fourth its original value, and *this diminution of resistance or increase of conductivity is not abrupt, but continuous.*

slight additional impetus precipitated a fall. It will thus be seen that if the E.M.F. acting on the receiver be so adjusted as to be near the critical point, a slight electromotive variation will produce a great and irreversible change, and this will be exhibited by a very considerable increase of conductivity. It is interesting to note in connection with this that I found in practice that the sensitiveness of receivers to electric radiation could be greatly enhanced by raising the E.M.F. acting on the circuit to a point as high as they could bear, short of electric instability.

*Influence of Intensity of Initial Current in Modifying the Characteristic Curve.*

When at the beginning of an experiment the receiver is adjusted at a definite low E.M.F., say, 0·05 volt, we may have any initial current, according to the adjusted pressure of contact, the current increasing with increase of pressure. Thus we may start with a large or small initial current, the initial E.M.F. being constant.

In order to study the effect of initial current, which is probably dependent on the pressure, successive experiments can be carried out on the same receiver with different values of initial current. It must, however, be remembered that in doing this it cannot be assumed that the molecular conditions of the receiver in successive experiments are exactly similar, inasmuch as the past history of the receiver is different in each case. All one can do is to begin each experiment after subjecting the receiver to mechanical vibration, so as to disperse the residual effects of the previous experiment. The conclusions given below are in conformity, not with a single set of




A, B, C, D, E are different curves for different initial currents. C' is the curve for a constant resistance.

FIG. 3.—Characteristic Curves of a Single Point Iron Receiver.

In the lower portion of the curve, where the E.M.F. is low, the resistance is great and its variation small; but the curve soon becomes steep; the current increases, and the resistance falls, at a rapid rate. With a higher E.M.F. the change, to which the conductivity variation is due, proceeds very rapidly. This change is so great when a certain critical value of E.M.F. is reached as to be almost abrupt. This is well seen in curve A a little beyond 0·45 volt.

It will be shown presently that the changes which cause these variations of conductivity are irreversible in the case of non-recovering receivers like iron—that is to say, when the E.M.F. is brought back to its initial low value, it is found that a permanent change of conductivity has been produced. Such changes become very marked when the electromotive variation is carried beyond the critical point. It is superfluous to add that these conductivity variations are independent of the direction of the current.

It will be seen from curve A, that if the E.M.F. be adjusted to fall just short of the critical point, say, at 0·4 volt, then a slight superposition of E.M.F., say +0·1 volt, will cause a very great variation of current; whereas if the E.M.F. had been so adjusted as to fall very much below the critical point, say, at 0·3 volt, a superposed electromotive variation of the same amount 0·1 volt, would have produced a relatively small variation of current. In the former case, conditions stood as it were on the brink of a precipice, and a

experiments, but with a large number undertaken at different times, and all having a distinct tendency to confirm these results.

In the curve B the initial current is a little more than double that for A. It will be seen that the curve has become distinctly steeper, and the critical point is lowered—that is to say, the point at which the conductivity change takes place with excessive rapidity is now lowered to about 0·43 volt, instead of about 0·46 volt, as in the last case. The sudden bend in the curve also is not so pronounced. In connection with the lowering of the critical point by pressure, it is also interesting to note that by increasing the pressure within certain limits, I obtained increased sensitiveness of the receiver to the action of electric radiation.

In the curves C, D, and E the initial currents were increased, and as a consequence we find increasing steepness.

In order to test further the accuracy of the adjustments, I have taken on the same record the curve for a constant resistance. In C, the resistance of the receiver at 0·15 volt was found to be 830 ohms. A resistance box having the above resistance was substituted for the receiver, and a curve traced in the usual manner. This curve C' is seen to be a straight line.

I give below a table showing the results of four sets of experiments on the variation of the resistance of the receiver with increasing E.M.F.

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**Table II.**—*Showing the Diminution of Resistance of the Receiver, with increasing E.M.F.*

| E. in volts. | B | | C | | D | | E | |
|---|---|---|---|---|---|---|---|---|
| | Current in $1/10^5$ amps. | Resist. in ohms. | *c* | *r* | *c* | *r* | *c* | *r* |
| 0·10 | 9 | 1,136 | 12 | 830 | 25 | 400 | 43 | 232 |
| 0·15 | 14·2 | 1,060 | 18 | 830 | 40 | 375 | 69 | 217 |
| 0·20 | 20·5 | 970 | 26 | 770 | 59 | 340 | 102 | 196 |
| 0·25 | 29·5 | 850 | 40 | 625 | 83 | 300 | ... | ... |
| 0·30 | 40 | 750 | 63·5 | 472 | 118 | 254 | ... | ... |
| 0·35 | 56 | 620 | 105 | 333 | ... | ... | ... | ... |
| 0·40 | 85 | 470 | ... | ... | ... | ... | ... | ... |

It will be seen that in all the above cases the resistance undergoes a continuous diminution with the increase of E.M.F. Thus the diminution of resistance due to electromotive variation is not an abrupt, but an essentially continuous process.

*Experiments with Receiver Immersed in Kerosine.*

In order to find out whether the exclusion of atmospheric action would change the general nature of the result, I took observations with a single point iron receiver immersed in kerosine.

**Table III.**—*Showing the Diminution of Resistance with Increasing E.M.F. in a Receiver immersed in Kerosine.*

| E in volt. | Current in $10^{-6}$ amps. | Resistance in ohms. |
|---|---|---|
| 0·05 | 15 | 3,333 |
| 0·10 | 35 | 2,857 |
| 0·15 | 56 | 2,678 |
| 0·20 | 78 | 2,564 |
| 0·25 | 124 | 2,016 |
| 0·30 | 182 | 1,648 |

It will be observed that under the above conditions also there is a continuous diminution of resistance with an increase of E.M.F.

*Time-lag.*

The changes which give rise to the conductivity variation take a short time for their completion. The curves were taken when the electromotive variation was produced at a moderate and uniform speed. But

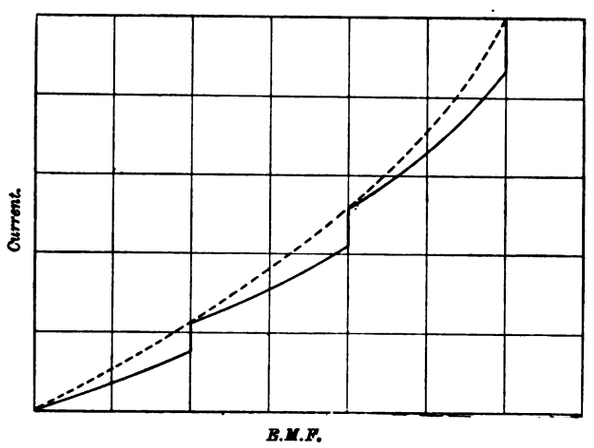


Fig. 4.—Effect of Lag.

if the electromotive variation is produced quickly and step by step, each step being followed by a pause, then there is an immediate effect, followed by a permanent effect, the galvanometer deflection creeping up to this permanent value. (See Fig. 4.) This creeping effect becomes more marked with higher E.M.F. I give below a record where this effect is shown. The vertical portions of the curve represent the creeping effect during pause. The conductivity variation thus lags slightly behind the impressed electromotive variation. Certain effects due to this will be noticed later.

*Characteristic Curves given by a Mass of Iron Filings.*

Owing to the multiplicity of contacts the conditions here are not so simple as in the case described above. It will, however, be seen from the curves given below (see Fig. 5), that the results are of the same general nature. The resistance undergoes diminution with increasing E.M.F. The curves are steeper with stronger initial currents. Greater intensity of initial current appears also to have the effect of lowering the critical point. I obtained similar results with Mg and Ni.

It is difficult in one curve to represent adequately the variation of conductivity caused by small, moderate, and excessive increase of E.M.F. Broadly speaking, the curve may be divided into three parts. In the first, when the E.M.F. is low, the change is slight. The curve then becomes very steep in the second part; the conductivity variation being rapid. The increase of conductivity, however, reaches a limit, after which there is little further change. The whole curve is thus somewhat *ſ* shaped.

*Conductivity Variation with Cyclic Variation of E.M.F.*

When conducting particles of the non-recovering, positive, or iron type, are subjected to sudden electric variation due to radiation, a residual effect is observed in the increase of conductivity.

I now tried experiments to see whether similar residual effects could be observed when the particles are carried through a cycle of

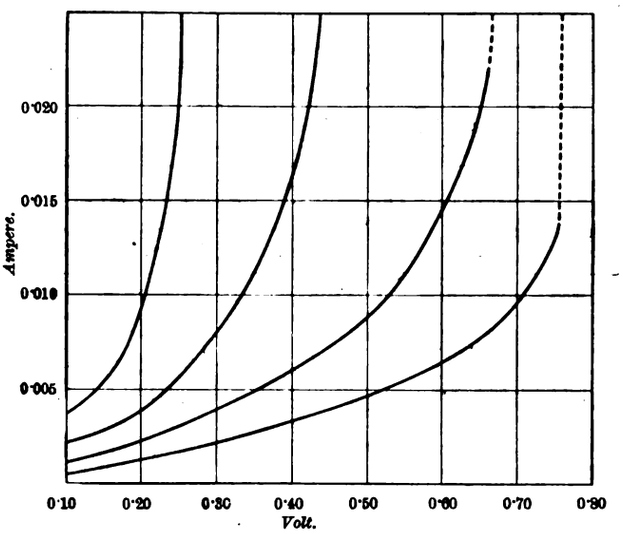


Fig. 5.—Curves for Filings.

electromotive variation. The experiments were repeated with single and multiple contacts.

As was said before, the E.M.F. can be continuously increased by turning the winding wheel which moves the platform uniformly in one direction; the E.M.F. is continuously diminished by turning the wheel in the opposite direction, and thus reversing the motion of the platform. By this means the receiver can be subjected to a cyclic electromotive variation through large or small range at will. I give herewith curves of cyclic variation taken with filings, when

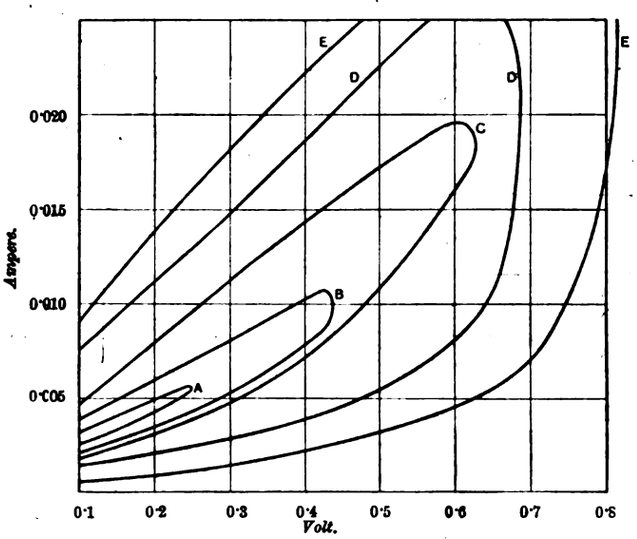


Fig. 6.

the range of electromotive variation is increased from (0·1 – 0·25 volt) to (0·1 – 0·81 volt). These will give a good general idea of the phenomena. Afterwards I will give a series of readings for cyclic variations taken with a single point receiver (see Fig. 6).

First, I tried the effect of cyclic variation through a small range, from 0·1 to 0·25 volt. It will be seen that the forward and return curves do not coincide, but enclose a small area. The receiver, in as far as conductivity is a criterion of its physical state, does not regain its original condition. There remains a residual conductivity variation, just as in iron there is a residual magnetism after it has been subjected to a cyclic variation of magnetic force. As in this

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case, again, the residual magnetism disappears on tapping, so also the residual conductivity effect can be dissipated by the same means.

In curve B, where the range of electromotive variation is still larger, from 0·1 to 0·43 there is a greater divergence between the forward and return curves, and the area enclosed is further increased. An interesting effect, due to *lag*, will be noticed at its far end, where we see that after E.M.F. has reached its maximum and when the platform is on its return course, producing a diminution of E.M.F., the current nevertheless continues for a short time to rise. It is thus seen that whatever be the change to which the conductivity variation is due, it lags behind the impressed electromotive variation.

We see from the curves C, D and E, that as the range of electromotive variation is greater, the greater is the area enclosed between the forward and return curves.

I give below detailed readings taken on two occasions with a single point iron receiver (1) when the range of cyclic variation was small, (2) when the range was comparatively large.

**Table IV.**—*Showing the Variation of Current and Resistance with Cyclic Electromotive Variation of Small Range.*

| E.M.F. in volts. | Galvanometer readings. $1 \cdot dn = 1/10^6$ amperes. | | Resistance in ohms. | |
|---|---|---|---|---|
| | Direct. | Return. | Direct. | Return. |
| 0·05 | 10 | 12 | 5,000 | 4,166 |
| 0·10 | ↓ 25·5 | 27 | ↓ 3,920 | 3,703 |
| 0·15 | ↓ 47 | 49·5 ↑ | ↓ 3,191 | 3,030 ↑ |
| 0·20 | ↓ 70 | 75·5 ↑ | ↓ 2,856 | 2,648 ↑ |
| 0·25 | 103 | 114·5 | 2,427 | 2,183 |
| 0·30 | 171 | 197·5 | 1,754 | 1,520 |
| | → | | → | |

It has been shown that the resistance of the receiver at a higher E.M.F. is less than that at a lower E.M.F. As the E.M.F. is reduced by the reversed motion of the slider, there will be a tendency towards the recovery of the higher resistance which it had at the lower E.M.F. The recovery, however, is not perfect, owing to hysteresis. (There is still less recovery if the critical E.M.F. has been exceeded.)

There is thus a residual effect left. In the case given the initial resistance was 5,000 ohms, and the resistance after cyclic variation through a range of 0·25 volt was 4,166 ohms, or $\frac{8}{10}$ths of its original value.

The lag and creeping effects are also noticeable in the forward and return readings.

While the slider moved up to 0·30 volt, the immediate galvanometer reading was 171 divisions, and by the time the slider had commenced its backward movement to the left (producing a diminution of E.M.F.), the current value had risen from 171 to 197·5; the conductivity had gone on increasing, the resistance having fallen from 1,754 to 1,520 ohms.

I now give a table of results for electromotive variation of wider range from 0·1 to 0·6 volt.

**Table V.**—*Showing the Current and Conductivity Variation of a Single-point Iron Receiver, due to Cyclic Electromotive Variation of Comparatively Large Range but Short of Critical Point.*

| E in volt. | G. deflection. Direct. | $1\ dn = 1/10^6$ amperes. Return. | Resistance in ohms. Direct. | Return. |
|---|---|---|---|---|
| 0·05 | 1·5 | 13 | 33,333 | 3,846 |
| 0·20 | ↓ 8 | 58 ↑ | ↓ 25,000 | 3,448 ↑ |
| 0·35 | ↓ 34 | 145 ↑ | ↓ 10,294 | 2,414 ↑ |
| 0·50 | 154 | 346 | 3,246 | 1,445 |
| 0·60 | 320 → | | 1,875 → | |

In the previous case it was shown that with a cyclic variation of the moderate range of 0·25 volt, the resistance was reduced to $\frac{8}{10}$ths; in this case, at double the range, the reduction is very much greater, for the resistance falls to nearly $\frac{1}{10}$th of its original value.

It is thus seen that the observation previously made, to the effect that the greater the range of electromotive variation the greater is the reduction of resistance, holds good here in so far as two successive experiments on the same receiver can establish it.

*Self-Recovering Receiver.*

It has been shown that receivers which exhibit a diminution of resistance under electric radiation give a characteristic curve which is concave to the axis representing the current, and that in the non-recovering type noticed hitherto the forward and return curves do not coincide, but enclose an area. I was now interested in finding out what would be the peculiarities of the characteristic curve of receivers showing self-recovery.

I have, as previously mentioned, described a self-recovering receiver of the negative type, made of silver particles, in a Paper read before the Royal Society. I also exhibited a self-recovering single point receiver of the positive type at the Friday evening discourse given before the Royal Institution on May 10th last. I hope to publish a detailed account of it on another occasion.

I give below galvanographic records of successive responses to brief flashes of electric radiation. (See Fig. 7.)

In working with receivers which have been at rest for long periods it is often noticed that the response at first is feeble. The sensitiveness soon improves, and may even become excessive; it finally reaches a moderate and uniform condition.

All these phases are well seen in Fig. 7, where (*a*) exhibits the preliminary stages, and (*b*) the steadier condition, with more uniform response. The straight-rising portions show the increase of current

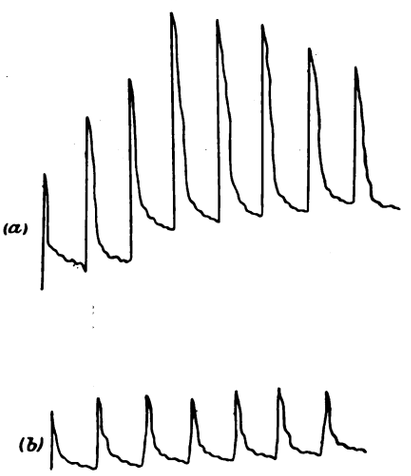


Fig. 7.—Response Curves to Single Flashes of Radiation in Self-Recovering Receiver.

under the flash of radiation, and the falling and concave portions the recovery on the cessation of radiation. In self-recovering receivers of the negative type the response curves are the reverse of these, in the sense of being seen as reflected in a mirror.

*The Characteristic Curve of the Self-recovering Receiver of Positive Type.*

I now subjected the receiver to a continuously-increasing electromotive variation, and traced the curve. I was not prepared, however, for results so remarkably perfect.

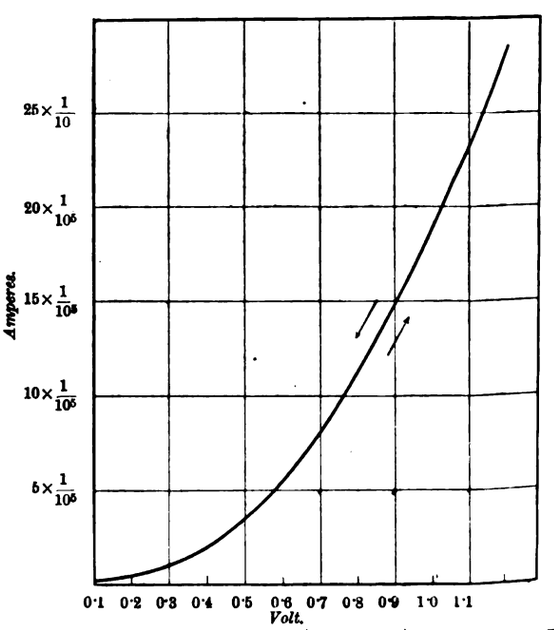


Fig. 8.—Characteristic Curve of Self-Recovering Receiver of Positive Type.

In obtaining the previous curves I had to spend much labour in the proper adjustment of the receiver, and owing to the presence of residual effects no one curve could be exactly reproduced. But in the present case I was not only able to obtain the most important and characteristic effects with great ease and certainty, but also to repeat them, the results of successive experiments being practically identical.

The extreme regularity of the observed effect is seen at a glance in Fig. 8. I give below a table which shows how continuously the resistance is diminished with increasing E.M.F.

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**Table VI.**—*Showing Variation of Current and Resistance in Self-recovering Positive Receiver with Increasing E.M.F.*

| E.M. volt. | Current. $5dns = 1/10^5$ amps. | Resistance in ohms. |
|---|---|---|
| 0·2 | 2 | 50,000 |
| 0·3 | 5 | 30,000 |
| 0·4 | 10 | 20,000 |
| 0·5 | 17 | 14,700 |
| 0·6 | 27 | 11,100 |
| 0·7 | 40 | 8,750 |
| 0·8 | 55 | 7,270 |
| 0·9 | 73 | 6,160 |
| 1·0 | 94 | 5,320 |
| 1·1 | 115 | 4,780 |
| 1·2 | 141 | 4,245 |

It will be seen that whereas at 0·2 volt the resistance is 50,000 ohms, at 1·2 volt it has undergone an uninterrupted fall to 4,255 ohms, or $\frac{1}{12}$th of its original value. There has been no sudden break down at any intermediate point.

Here follows a curve which exhibits the variation of resistance described in the table. (See Fig. 9.)

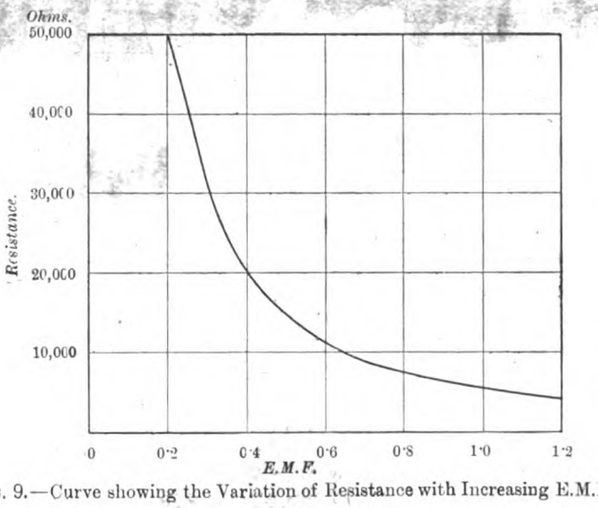


Fig. 9.—Curve showing the Variation of Resistance with Increasing E.M.F.

*Effect of Cyclic Variation of E.M.F.*

But the most astonishing thing about the action of the receiver was that when I came to take the return curve, I found it practically coinciding *in every part* with the forward curve, so that when the E.M.F. was brought back to its initial value 0·1 volt, the receiver had completely returned by its original path to its first condition, there being no residual effect. I repeated the experiment many times in succession, but the curves obtained, whether forwards or backwards, were in every case merely superposed on the original. Since the condition of the receiver is exactly the same after many cycles as at the beginning, it would appear that the conductivity variation cannot be due essentially to any chemical change, for such changes are irreversible.

The increase of conductivity with increase of E.M.F. is not due to any sudden breakdown, such as fusion between the contact surfaces, for the process described above is anything but abrupt. Again, fusion would have produced a permanent conductivity change, but in the case under review the change is not permanent. Thus, for example, when the applied E.M.F. was 0·2 volt the current was represented by a deflection of two divisions, and the resistance was 50,000 ohms. When the E.M.F. was raised to 0·7 volt the current increased to 40 divisions, and the resistance fell and remained at the definite value of 8,750 ohms. If the E.M.F. is again reduced to its original value of 0·2 volt the current falls to two divisions, and the resistance rises to exactly its original value of 50,000 ohms. It would thus seem that—

1. For every value of E.M.F. there is a definite value of conductivity.

2. When in a given part of the curve the E.M.F. is increased by a definite amount, the conductivity is also increased in definite quantity. The increased stress produces a definite conductivity distortion, and on the removal of the stress there is a quasi-elastic recovery of its original conductivity.

3. As the seat of these changes is in the molecular layers at the definite and steadily held single-point of contact, it would appear that the conductivity variation and its recovery are due to molecular distortion and ultimate elastic recovery.

What has been said above of the conductivity change under electromotive variation and the complete recovery is true only when the cycle is completed at a moderate speed, under which circumstances time is allowed for the completion of, or the recovery from, the change. But if the cyclic variation be carried out with very great rapidity, the phenomenon of lag would come into play. The conductivity variation will then lag behind the impressed electromotive variation, and the receiver will not instantaneously recover its original resistance.

For example, in the case of the self-recovering receiver which at 0·2 volt gave a current represented by two galvanometer divisions—the resistance being equal to 50,000 ohms—when it was quickly carried through a cyclic electromotive variation from 0·2 volt to 1·2 volt and back to 0·2 volt, the immediate value of the current at this last point was not two, but six, divisions of the galvanometer. Thus the receiver, owing to lag, does not instantaneously recover its original resistance. But the deflection soon creeps back to two, exhibiting a complete recovery.

*Résumé.*

Space does not allow of my entering now into greater detail regarding the peculiarities of the curve given above. I shall have much to say on this subject on a future occasion, especially in reference to the influence of various external agencies in modifying the relation between the E.M.F. and the resulting current—a research which is rendered possible by the extraordinary certainty with which the results may be obtained.

1. Under the action of electric radiation the conductivity of metallic particles exhibits variation. In the positive class, like iron, there is an increase, and in the negative, like K, &c., a diminution, of conductivity. Each class again falls into two sub-classes (*a*) sensitive substances which undergo self-recovery, and (*b*) sensitive substances which do not. In the case of self-recovering substances the conductivity distortion varies with the intensity of radiation. Under the continued action of radiation, the distortion attains a maximum, balanced by force of restitution, and on the cessation of radiation there is an elastic self-recovery.

2. The three classes of substances, positive, negative and neutral, may be distinguished by their peculiar characteristic curves.

3. The change produced in the sensitive substance by the action of radiation is not, normally speaking, chemical.

4. The conductivity change is produced, not only by very rapid, but also by comparatively slow electric variation. Generally speaking, all the conductivity variation effects produced by electric radiation can be reproduced by comparatively slow cyclic electromotive variation.

5. These conductivity changes under cyclic E.M. variation may be continuously recorded by means of the conductivity curvograph.

6. Electric conduction in metallic particles sensitive to electric radiation does not obey Ohm's law. The conductivity is not constant and independent of the E.M.F., but varies with it. In the positive class the characteristic curve—in which the ordinates represent the currents, and the abscissæ the E.M.F.—is concave to the axis of the current. The conductivity increases *continuously* with increasing E.M.F. The variation of conductivity in the lower portion of the curve is small, but increases with great rapidity in the upper portion.

7. The curve obtained with strong, is steeper than that with feeble, initial current.

8. There is found, especially when the initial current is feeble, a critical E.M.F., at which the conductivity change becomes so rapid as to produce an almost abrupt bend in the curve. Stronger initial current appears not only to lower the critical point, but also to mitigate the abruptness of this change.

9. The effect of E.M.F. in modifying the conductivity of the conducting layer is well seen in self-recovering substances. There is a definite conductivity corresponding to a definite E.M.F. As the E.M.F. is increased, the sensitive molecular layer is strained, and a definite increase of conductivity produced. When the increased stress is removed, the corresponding strain also disappears, and there is an elastic recovery to its former molecular and conductive state. Hence, when it is carried through a complete cycle of electromotive variation, with moderate speed, the forward and return curves coincide, and the substance remains, at the end of the cycle, in its original molecular condition.

10. This is the case where there is complete recovery on the removal of the stress. With non-recovering substances we find an outstanding residual effect. In a curve taken with cyclic electromotive variation, the forward and return curves do not coincide, but enclose an area. There is a hysteresis. The larger the range of the electromotive variation the greater is the area enclosed. There is a residual conductivity variation, at the end of the cycle, which may be dissipated by vibration.

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**The Lighting of Workshops.**—Mr. William Thomson, in his Paper "Some Factors Affecting the Economical Manufacture of Marine Engines," read before the recent International Engineering Congress, mentions that since the Bethlehem Company introduced electric light into their boiler shop the average gain due to increased attendance was 1·5 per cent., or three-quarters of an hour per week per man. The shop in question is 3,700 sq. yds. in area, and is lighted by 22 pairs of 10 amp. and four pairs of 15 amp. open type arc lamps.



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## CORRESPONDENCE.

### MORLEY MEMORIAL COLLEGE FOR WORKING MEN AND WOMEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May we ask your kind assistance in making the following appeal on behalf of the above institution as widely known as possible:—

In the course of the 12 years the Morley College has been at work in South London the demands made upon us have exhausted the reserve fund with which we started. Our fees have always been low, so as to bring higher education within the reach of all, and we cannot raise them without driving away the bonâ fide working men and women whom it is our special object to assist in useful studies, and whom we certainly have succeeded in reaching. Our instruction is given in literary and scientific subjects and in such technical subjects as can be dealt with in class-rooms with ordinary lecture-room apparatus. We do not compete with the large Polytechnics in subjects that require workshop fittings, machinery, &c. We have recently done much to improve our electrical classes, and we are proud of being the only college in London that has given instruction to farriers on the structure and the suitable shoeing of the horse's hoof, and to stablemen, drivers, &c., on the care of the horses under their charge. Our students have the advantage of free attendance at the Tuesday evening lectures of the Royal Victoria Hall and of the use of the college library and recreation rooms.

We have to supplement our small endowment and grants not only by subscriptions of friends, but also by letting the class rooms for use during the day. This latter source of income cannot always be depended upon, and we now run the risk of a considerable loss of income unless we are successful in finding new tenants to replace the day school that has been in temporary occupation, but which goes into permanent quarters in February next.

Our present appeal is for help in one or both of the following ways:—

1. *Increased Donations and Annual Subscriptions.*—An addition of £300 or £400 a year to our income would help us over many difficulties with which we are at present met in providing sufficient qualified teachers, apparatus, &c.

2. *Volunteer Teachers.*—Either ladies or gentlemen will be welcome. University graduates and others occupied in the Civil Service or other business, who have leisure to take a class regularly once a week for an hour, or to give occasional lectures, help and advice in the athletic clubs or the arrangement of visits to museums, &c., can afford most valuable aid.

In conclusion we would mention that the number of our students has averaged in recent years from 600 to 700 (men and women) and that our work has been uniformly commended by H.M. and L.C.C. inspectors. We have every reason to believe that the college forms a useful and necessary part of the educational and social life of South London. We trust that help will be forthcoming now to save us from any serious restriction of the work of the college. Time presses, as the class arrangements for next sesssion, 1901-2, are about to be taken in hand.—Yours, &c.,

CAROLINE A. MARTINEAU, Principal.
EMMA CONS, Hon. Secretary.
F. W. BLACK, Chairman of Council.

P.S.—We welcome visitors to the college on any evening during session, and we shall be glad to send tickets (to any persons who may apply) for the presentation of certificates by Sir Philip Magnus, on October 1st, in the Royal Victoria Hall, adjoining the college.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Calendar of the Durham College of Science, Newcastle-upon-Tyne, for the 1901-1902 Session." (London: A. Reid & Co.)

"Proceedings of the Royal Society." No. 449. Vol. LXVIII (London: Harrison and Sons.) 4s.

"Science Abstracts" for September. Edited by W. R. Cooper. (London: E. and F. N. Spon.) 2s.

## LEGAL INTELLIGENCE.

### Legality of Picketing.

In the Chancery of Lancashire on Tuesday Mr. Taylor, deputy vice-chancellor, resumed the hearing of an application by Messrs. Bannister Bros. and Moore for an interim injunction to restrain the president, secretary and certain members of the Blackburn Weavers', Winders', and Warpers' Association from picketing during a strike at plaintiffs' mills.

Mr. GRANT, for applicants, was willing that the application should stand over until trial if an undertaking were given not to do anything illegal and not to picket the works except for obtaining or communicating information.

Mr. MANSFIELD, for defendants, having declined to give any undertaking, various affidavits were read, and

Mr. GRANT submitted that all it was necessary for him to do was to make out a *prima facie* case of illegality, and that he contended he had done. Plaintiffs were suffering serious loss (reaching £250 per week) owing to the action of defendants in picketing their works, and an interim injunction could not damage defendants. He referred to the Taff Vale case, and held that, as the circumstances were similar it should rule the present application.

Mr. MANSFIELD opposed the application, and referred to the statement that plaintiffs were losing £250 a week owing to picketing. There was no evidence in support of such a statement. People were justified in law in striking if they were not satisfied with the wages they were receiving, and it was also quite legal for defendants to pay people who were out on strike. The association were entitled to picket and talk to people going to the mill, to tell them that there was a strike on, and to give them information about the strike, and that was all they had ever done.

The DEPUTY VICE-CHANCELLOR said it was not necessary for him to determine whether defendants were acting illegally. That would be determined at the trial of the action, but there appeared to him to be reasonable suspicion that certain actions not strictly in accordance with the law were being done by defendants, and he considered there was sufficient ground to justify the grant of an interim injunction. An interim injunction in terms similar to those in the Taff Vale case, restraining defendants from picketing, except merely to obtain or communicate information, would be granted.

### Re British Electric Works Co. (Ltd.).

As a result of negotiations between the solicitors engaged in the case "Glynn *v.* Atherton" (reported in *The Electrician* for Aug. 16) an arrangement has been come to by which the original allottees in the British Electric Works Co. (Ltd.) will receive repayment in full for the shares which they still hold. At a meeting of all parties concerned last week it was announced that the promoter and directors were prepared to pay 20s. in the pound to all original allottees, the payments to be spread over a term. One quarter will be paid on Oct. 31, another on Dec. 31, and the balance within two years. A deed to be drawn up embodying the terms of this settlement. The offer was accepted. Four trustees are to be nominated, two by shareholders and two by directors. Mr. W. Glynn, plaintiff in the action, and Mr. L. S. Cohen, ex-mayor of Liverpool, have been selected as shareholders' trustees.

### National Telephone Co. v. Richards.

At Wolverhampton County Court last week, before Judge Howland Roberts, the National Telephone Co. sued Mr. W. Richards to recover £18, two years' rental of the telephone.

Mr. S. R. RHODES, for plaintiffs, said defendant entered into an agreement with the company in Feb. 26, 1900, to supply him with telephonic communication for four years at the annual rental of £9, each year's rent to be paid in advance. Although the written agreement was only for four years, it was in reality a continuing agreement until terminated by six months' notice on either side. Clause 7 of the company's regulations provided that if the annual rental at any time became in arrear for the period of one calendar month, or a subscriber became bankrupt, or for other specified causes, the company might terminate the agreement at any time by giving notice in writing. By another clause the company reserved the right to disconnect any subscriber whose rent was in arrear.

In June the advance rent due in February not having been paid by defendant, the company disconnected his telephone. But this did not exonerate defendant from continuing rent, he not having given the six months' notice required to cease his connection. The company, therefore, claimed two years' rental, from February, 1900, to February, 1902.

For the defence it was urged that defendant having been disconnected by the company on June 19 he was no longer liable for rent. The contention that the agreement was a continuing one was disputed. The agreement was for four years only, dating from June, 1896, when telephonic connection first commenced, to June, 1900. For the company to terminate the connection and then to claim a continuing rental for the subsequent two years was, it was urged, a most arbitrary proceeding.

The JUDGE found for the company for one year's rental only, holding that the company, having terminated the agreement by disconnecting the supply, were only entitled to the rent for the current year in which such disconnection took place. At the same time his Honour offered to state a case for appeal on the point as to whether the company were entitled to claim rental for the second year.

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The Electric Lighting committee of the Hackney (London) Borough Council invite applications for the post of borough electrical engineer to take control of the electricity supply and refuse destructor undertaking of the Council. Commencing salary £400 per annum. Some further particulars will be found in an advertisement, and applications must be sent to Mr. George Grocott, town clerk, Town Hall, Hackney, by 4 p.m., Sept. 30.

A demonstrator in electrical engineering is required at University College, Nottingham. An advertisement contains further particulars and applications must be sent in, on forms supplied by the secretary, by Tuesday, Oct. 1. The commencing salary is £200 per annum, rising to £250.

Wimbledon District Council require a chief assistant engineer for their electricity works. Applications to the electrical engineer to the Council (Mr. F. Barnes Spencer), Broadway, Wimbledon, by Oct. 4. See also advertisement.

The Tramways department of the Liverpool Corporation require a superintendent for their electric tramcar construction and repairing department. Some particulars are set out in an advertisement. The commencing salary is £300 per annum, subject to certain conditions. Applications to the town clerk (Mr. E. R. Pickmere), Municipal Offices, Dale-street, Liverpool, by first post, Saturday, Oct. 12.

A chief assistant is required in the meter and motor department of the Bradford electricity works. Applications to the city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. See advertisement.

There is a vacancy for a shift engineer and a switchboard attendant at the Blackburn electricity works. Applications to the electrical engineer (Mr. Albert S. Giles) by Oct. 4. See advertisement.

A lecturer and demonstrator in electrical engineering and general physical laboratory work is required for the City of Norwich Technical Institute. Applications to the principal (Mr. W. Gannon, M.A.).

An electrical engineer is required for the Public Works Department, Jamaica. Applications to Crown Agents for the Colonies, Downing-street, London, S.W.

Southampton Corporation require an engineer and manager of their electricity department. Applications to town clerk by 30th inst.

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Mr. W. H. F. Murdoch has been appointed demonstrator in electrical engineering at the South-Western Polytechnic, Chelsea, London, S.W. Mr. Murdoch was in charge of the estimating department of the British Schuckert Electric Co., and was previously with Messrs. Drake and Gorham, the Faraday Co., Walter Dixon & Co. and H. McAlpine & Co. He is a B.Sc. of Glasgow, and holds a diploma in electrical engineering from the Glasgow Technical College, and first-class (honours) City and Guilds certificate for transmission of power.

Mr. Norman A. Thompson, A.I.E.E., has resigned the secretaryship of the Tramways and Light Railways Association, and has taken up an appointment with the Allgemeine Electric Co. as commercial electrical engineer. Mr. Thompson is proceeding to Berlin, where he will remain for two or three months with the Allgemeine Elektricitäts Gesellschaft.

Mr. Cyril E. Browne, M.A., has been appointed secretary of the Tramways and Light Railways Association.

Finchley District Council have appointed Mr. Edward Calvert, of Buxton, resident electrical engineer at a salary of £300 per annum. Mr. Calvert will commence his duties on Dec. 2.

Mr. C. Hutchinson, late with Messrs. Belliss and Morcom (Ltd.), has been appointed assistant electrical engineer at Barnes at a salary of £120 per annum.

Mr. S. Cameron Gibson, of Wimbledon, has been appointed resident electrical engineer at Nuneaton.

## EDUCATIONAL NOTICES.

**Finsbury Technical College.**—As announced in our last issue, the winter session of the Technical College, Finsbury, begins on 30th inst. Prof. S. P. Thompson will lecture on Mondays on "The Design of Generators and Motors." On Wednesdays the lectures by Prof. Thompson or by Mr. Verity will deal with "Electromagnetism and Electric Measurement." A special course of six lectures on "Insulation" will be delivered on Thursdays, commencing Oct. 10, by Mr. Mervyn O'Gorman.

**Borough Polytechnic Institute.**—A special course of about 20 lectures, with laboratory work, will be given by Dr. John Henderson on "Electrical and Magnetic Measurements," on Fridays, from 7:30 to 10 p.m., commencing Oct. 4.

**Merchant Venturers' Technical College, Bristol.**—Particulars will be found on another page of courses in civil, mechanical, electrical and sanitary engineering, &c., at this college.

**Glasgow and West of Scotland Technical College.**—At a meeting of the governors of this college, on Tuesday, diplomas in electrical engineering were presented to James Gray (with the Sir John Pender gold medal and scholarship of £30), Frederick E. Robertson and Johann Stich.

Mr. W. R. Copland presided at the meeting, and after referring to the extensive scheme of building which had been approved in connection with the extension of the College, read the report made by the inspector of the Scottish Education Department on the teaching work of the college. The inspector's report was as follows:—

> Nowhere else in Scotland is there a school in which so full, varied, and practical courses of study can be found in mechanical, electrical, and civil engineering, building construction, metallurgy and mining, chemical industries, &c., as are offered in the Glasgow and West of Scotland Technical College, both in day and evening classes. The staff is worthily held in high reputation, and its members are distinguished not only on account of their scientific attainments, but equally by the zeal, ability and success with which they conduct the work of their classes. One evidence of this lies in the increasing popularity of the college. Last session over 600 students were enrolled in the day classes, while nearly 4,000 entered for evening instruction, and it appears that a large number had to be refused admission owing to lack of further accommodation. . . . Good apparatus, models, and testing engines of different kinds are in plenty; but the laboratories are poorly fitted and exceedingly inconvenient, places in which the students are often enough crowded, to the jostling of each other at their experiments.

It is satisfactory to note that subscriptions to the amount of £100,980 have been received towards the building of the new college. This is about half the sum that will be ultimately required for the college and its equipment.

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**Accrington.**—An inquiry was held here last week into the application of the Council to borrow £8,893 for electric lighting extension, and £200 for wiring the technical school. The town clerk (Mr. A. H. Aitken) supported the application, and technical details were supplied by the electrical engineer (Mr. Gray), who said the equivalent of 5,670 8 c.p. lamps was connected to the mains, and the demand was steadily increasing, so that it was absolutely necessary to carry out the proposed extensions.

**Ayr.**—The official inspection of the electric tramway from Prestwick Cross to St. Leonard Church (about 4 miles) took place yesterday (Thursday) after which cars were run for traffic.

**Batley.**—The Council have passed a resolution calling upon the Dewsbury, Batley and Birstall Tramways Co. to sell to the Corporation the portions of their undertaking within the borough limits.

**Bedford.**—Last week the Electric Light and Traction committee reported that the applications for the position of chief electrical engineer had been again considered, and they recommend the Council to appoint from the following:—

Mr. Cecil Barkham, at present chief assistant at Bedford.
Mr. Oswin Hansom, of Fleetwood.
Mr. Harold Morton, of Llandudno.
Mr. R. W. L. Phillips, of Bristol.

The final decision was again deferred.

**Benwell (Newcastle-on-Tyne).**—The local electric supply companies have been asked to state their terms for supplying electric current for public and private lighting.

**Boyle (Ireland).**—The electricity works were opened on Saturday. The public lighting is effected by means of six arcs in the principal thoroughfares and incandescents in the side streets. Water power is employed in the generation of electricity, the proprietor of the works being Mr. H. Stewart, with whom the Township Commissioners have entered into a three years' contract for the public lighting at £80 per annum.

**Brussels-Antwerp Electric Railway.**—The Government have approved the plans of a Belgian engineer for the construction of an electric railway between Brussels and Antwerp, and the scheme will shortly come before the Chamber for confirmation.

**Chipping Norton.**—The Council have come to an arrangement with Mr. W. Popham for obtaining a provisional order and establishing electricity works. Mr. Popham intends to form a company to carry out the scheme.

**Church Lighting.**—Mr. F. Satchwell, M.I.E.E., who has made a special study of church lighting, has recently designed and carried out the work of lighting St. Andrew's Church, West Kensington, London. The fittings are in scroll black ironwork, and the effects of the lighting are in strict keeping with the architecture of the building. The fittings throughout are of the simplest character consistent with the surroundings, and the lighting has proved very effective. There are about 140 lights in all.

**City and South London Railway.**—The opening of this company's extension to Islington has been provisionally fixed for Nov. 1. With the new extension the Company's total mileage will be 6¾.



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**City of London Electric Lighting.**—The serious dispute between the Corporation of the City of London and the City of London Electric Lighting Co. has advanced a stage towards compromise. Negotiations extending over a period of from March to August this year have resulted in a definite proposal being submitted by the company to the Corporation in regard to the situation created by the results of the recent ligation between the parties, which litigation, it will be remembered, has left matters affecting the company's status in regard to certain contracts in an unsettled condition. The company finds itself in undisputed possession of a valid contract for lighting the eastern portion of the City of London while the contracts affecting the western and central divisions have been declared invalid. In the circumstances, well known to our readers, this state of affairs was unsatisfactory from every point of view. The company were in a position to have withdrawn their supply from the western and central districts, but the Corporation authorities, apparently satisfied that the company would take no such course, have allowed matters to remain in much the same state as before the decision of the Courts was given. An interview between the directors of the company and a sub-committee of the Streets committee of the Corporation was arranged in May but was postponed indefinitely, and, later, the company were asked to submit any proposals they might have to make to the Streets committee for consideration. These proposals were placed before the committee as far back as Aug. 1. The company offered to continue the public lighting in the two districts affected on the same conditions and at the same charge as hitherto, on the understanding that the arrangement as to the public lighting in all the districts which the company at present supply shall be fixed until 1914, when the Corporation first has power to step in and purchase the company's undertaking. This is the proposal which is now before the Streets committee, who are not, apparently, exercising any undue haste in their decision, for we learn that no further progress has been made since Aug. 1. The next step is, consequently, due from the Streets committee, who placed before the Corporation at its meeting yesterday the proposal of the City Company.

**Cold Storage Equipment.**—On Oct. 1 an extensive range of cold stores erected at the St. James's Market by the Bradford Corporation will be formally opened. The storage rooms are lighted throughout by electricity, the contract for the installation having been placed with Messrs. Collinson Bros., of Bradford. Two large motors have been supplied by the Phœnix Dynamo Co., and the refrigerating machinery has been manufactured under the patents of the Linde British Refrigerating Co., of London.

**Croydon.**—The first section of the electric tramways, from Norbury to Purley, about 5¾ miles, was formally opened yesterday (Thursday). The line is equipped on the overhead system and is being worked under lease from the Corporation by the British Electric Traction Co.

**Electric Traction in Germany.**—The works included in the concession for the construction and working of an electric railway between Halle and Merseburg, which was granted by the Prussian Government in 1900, are actively proceeding, and it is expected that the Halle-Ammendorf section will be completed by November. The total length of line comprehended by the concession is over 10 miles. Water power from the river Saale is being utilised.

An electric railway between Leipzig and Halle has for some time past been in contemplation, and negotiations have progressed almost to the point of a concession being granted, but it is now stated that the Governments of Prussia and Saxony have recently refused to grant the necessary powers.

A concession for constructing and working an electric railway between Mainz and Wiesbaden has been secured by the South German Railway Co., Mainz.

**Electric Tramways in Surrey.**—In reply to a suggestion that the London United Tramways should construct electric tramways between Haslemere and Farnham, by a route connecting Hindhead, Grayshott, Headley, &c, Mr. J. Clifton Robinson, managing director of the company, has stated that when the question of future extensions is considered the suggestion will be kept in view.

**Fiji.**—A telephone line has been constructed from Suva to Ba, a distance of 120 miles.

**Glasgow.**—The accounts of the electricity department, abstracted in our last issue, were presented by—

Bailie MACLAY, who said that, after discharging obligations and providing for interest and sinking fund, the accounts were about square, and nothing was left for depreciation. The committee considered that, as last year was an exceptional year, every article of consumption having advanced in price, and as they had continued to supply current at the old price, nothing should be set aside for depreciation. When they had a surplus they wrote off depreciation so liberally that when they spread it over the whole period since they began business it would amount to about 4 per cent. per annum. Unless money was taken out of revenue, it was no depreciation at all. During last financial year revenue from sale of current had advanced 66 per cent. The number of consumers had increased 41 per cent., and the number of motors connected had considerably more than doubled. They had put down 6 miles of new feeders and 23 miles of distributing mains on the north side of the river and 2 miles of new feeders and 9 miles of distributing mains on the south side. They had therefore made ample provision for the future. They considered their undertaking only now required a little time to develop.

Bailie STEVENSON moved that the accounts be referred back.

Treasurer MURRAY thought the accounts should be sent back. The committee admitted that if they had had the means depreciation would have been written off. He was surprised a committee formed largely of the same members as the Gas committee should have made such a statement. The Gas committee accounts showed a deficiency of £54,000, but that did not prevent them writing off depreciation. He wished to ask what was the actual deficiency on the electricty accounts. A statement appeared in the report that the result of the year's operations would have been more favourable but for increased charges for interest and sinking fund, but he held that statement was incorrect. They were paying a smaller rate of interest, and the sinking fund, instead of bearing a larger proportion to their unproductive capital than in prior years, bore a similar proportion.

Mr. PATON said that as a matter of fact there had been depreciation because during the year there had been £227,000 of unproductive capital, upon which they had been paying interest and sinking fund. It was a common thing for municipalities and private companies to charge interest on unproductive capital to capital account.

Mr. HUGH ALEXANDER said if they were right in writing off depreciation in 1896-97, they must be wrong now in failing to do so. They should face the situation, and admit that they had supplied electricity at a loss.

The minutes were ultimately approved by 29 to 19.

Col. Von Donop on Wednesday inspected the permanent way of the tramway extensions from Castle-street to Alexandra Park and on to Bridgeton Cross, and also the Shettleston and Tollcross extensions and various parts of the old lines which have been converted. The electrical equipment will be inspected in a few days.

**Greenock.**—The permanent way of the electric tramways between Port Glasgow and Ashton has been officially inspected.

**Grimsby.**—The electric tramways were officially inspected on Friday.

In a report on the progress of the electrical department the borough electrical engineer (Mr. W. A. Vignoles) states that on Sept. 10 the equivalent of 7,089 8 c.p. lamps was connected and there were applications in hand for 3,161 further. The station was designed to supply 12,000 lamps wired, or 7,500 lamps in use. It was estimated that the whole 12,000 would be wired by March 1 next, and to meet that increase additional plant would be required. This additional plant would complete the station as designed by Dr. Kennedy. The buildings would then be entirely occupied and would have to be extended to receive any further plant. The Council's decision has been adjourned.

**Inverness.**—Last week the Council debated Mr. J. Fraser's scheme for the erection of water-power electricity works, and it was decided to appoint a small committee to ascertain whether the Canal Commissioners were prepared to allow the Council to use the waters of the canal, and on what terms; and to inquire on what conditions the necessary ground and wayleaves would be given.

**Johnstone (N.B.).**—Mr. W. M. Murphy has intimated to the Council that the work of constructing electric tramways in the district will shortly be commenced. In the meantime negotiations are proceeding in regard to the Paisley tramways and the purchase of electric current.

**Lancaster.**—A lengthy report has been received from the consulting engineer (Mr. E. Manville) in which the Council are recommended to increase the pressure of supply for lighting from 100 to 200 volts, and to adopt one set of machinery for lighting and traction.

**Leicester.**—At the meeting of the Council on Tuesday Councillor Flint presented the half-yearly statement of the Gas and Electric Lighting committee, and referred to the loss the department had suffered in the death of Ald. Lennard. The net profit on electric lighting, after paying interest, was £2,065. 12s. 6d., and of this £1,068 had been allocated to sinking fund, the balance (£997 9s. 6d.) being placed to reserve.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Wakefield and District Light Railway Order.

An inquiry into the application of the Auxiliary and Light Railways and Tramways Co. for an order to construct a light (electric) railway from Lytham to Preston was held on Tuesday. Blackpool Corporation, the L. and N. W. and the L. and Y. Railways and other companies and authorities in the district opposed. Mr. C. Chadwell, engineer to the promoters, gave technical details. He said that the order was being promoted by the Electric Tramways Construction and Maintenance Co., who were also promoters of the Preston and Horwich line. It was intended to carry goods and coal. For the opposing companies it was urged that there was no proof of the financial ability of the promoters to carry out the scheme. It was merely a syndicate established in London, whose financial position was unknown. The Earl of Jersey said the Commissioners had decided not to proceed with the order, being dissatisfied with the

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way in which the financial position of the company had been put before them.

An inquiry into the application of the same company for authority to construct a light railway from Horwich to Preston was withdrawn, but the scheme is, we understand, to be revived in a modified form.

An inquiry was held at Crewe on Monday into the application of the British Electric Traction Co. to construct light (electric) railways in Crewe and from Crewe to Haslington. Mr. S. Morse said the company proposed to construct about 6 miles of line, on the trolley system, the estimated cost being £73,000. In 1897 the present promoters obtained an order from the Commissioners to construct lines in Crewe, but afterwards the Corporation attended before the Board of Trade and got conditions inserted in the order which the company could not carry out with prospect of reasonable profit. The company then offered to surrender their order to the Corporation at the price it had cost them to get it, but this was not accepted, and the company did not take up the order. The Corporation afterwards proceeded with a scheme of their own, but the Commissioners refused to sanction it. The L. and N. W. Railway Co. had stated that they would oppose any scheme for constructing light railways at the expense of the ratepayers, and the promoters had agreed, if they got their order, not to sell the undertaking to the Corporation. Mr. S. Sellon, engineer to the company, gave technical details. For the Town Council, Mr. E. H. Lloyd said the necessity for tramways for the borough was generally admitted. The Corporation had never opposed a tramway scheme, and the first application of the promoters fell through owing to the action of the Corporation in requiring safeguarding clauses. The Corporation would, however, strongly protest against handing over their streets to any company. The witnesses admitted the profits of the tramways would be £3,750 per year, and he asked why that money should not be earned by the Corporation by their own scheme? After hearing evidence, the Commissioners intimated that they considered, in face of the unanimous feeling of the town, they could not force the scheme upon them, and the application must be refused.

The Lancashire Light Railways Co. have abandoned the proposal to construct light railways through Bradshaw, Tottington, Ramsbottom and Rawtenstall.

The Glamorgan County Council recently instructed Mr. Sinnott to prepare detailed estimates of the cost of constructing light electric railways from (1) Aberdare to Bridgend; (2) Swansea to Loughor; (3) Swansea to Ystalyfera; (4) Morriston to Neath Abbey; (5) Briton Ferry to Taibach. The length and estimated cost of the line are as follows:—

| | Miles. | Construction. | Widening. | Equipment. |
|---|---|---|---|---|
| No. 1 ..... | 28 | ... £142,624 | ..... £42,273 | ..... £110,190 |
| No. 2 ..... | 5½ | ... 28,809 | ..... 4,803 | ... .. 21,746 |
| No. 3 ..... | 9⅛ | ... 49,600 | ..... 21,516 | ..... 38,250 |
| No. 4 ..... | 4¼ | ... 23,026 | ..... 4,104 | ..... 19,051 |
| No. 5 ..... | 4¼ | ... 22,261 | ..... 4,228 | ..... 20,033 |
| Total | ... 51⅛ | ... 266,320 | ..... 79,924 | ..... 212,270 |

To which is added 10 per cent. for contingencies. The necessary notices to apply for powers have been given.

Darlington Town Council will apply to the Light Railway Commissioners for an order to construct additional electric tramways.

**Longton.**—The formal opening of the electricity works took place on Wednesday. The generating plant, which has been put down by the Electric Construction Co., consists of two 145kw. E.C.C.-Belliss sets. There is also a battery of chloride cells. The works, which cost about £21,000, have been designed and carried out by Mr. W. Langford, the Corporation gas manager and electrical engineer.

**Malta.**—£6,700 out of a total expenditure of £76,668 for public works was spent in electric lighting in 1900.

There are no Civil Government telegraphs at Malta.

All the Government departments, charitable institutions, and other public buildings are telephonically connected by lines, the property of the Melita Telephone Exchange, a private enterprise. Communication with Gozo is effected by telephone under the management of the military authorities.

**Manchester.**—A matter of considerable interest was discussed at the meeting of the City Council on Wednesday.

The subject was introduced by Mr. Scott, who moved—

"That it be an instruction to the several committees of the Council that all letters and recommendations from members of the Council in support of or in relation to the applications of persons seeking employment be not dealt with by the officials, but be presented direct to the committee concerned at the meeting next following their receipt, and that attention be then called to them."

He had always refused to give letters of recommendation to people who called upon him. Members of the Tramways committee, which had become a large employer of labour, repeatedly had applications made to them, and he had got sickened and wearied with such applications. Applicants had told him that other councillors gave notes, and they did not see why he should not. He got a motion carried in the Tramways committee that applications of men who presented notes of recommendation from members of the Corporation should not be entertained, and that candidates for employment who applied in a legitimate way should have distinct preference. He was assured by a member of the Council that the resolution in committee would be strongly opposed unless he would give notice of a resolution in the Council dealing with the matter as a whole, and thus try, if possible, to put a stop to a system which was detrimental to the interests of ratepayers. The notes complained of were often given because the persons presenting them had voted for a particular councillor, had gone round with a book, or for some such excuse. The consequence was that most inefficient labour was recommended to the Corporation, and an inefficient staff was the result. This matter was almost getting to be a public calamity, and he thought it was very largely responsible for the fact that merchants and prominent commercial men would not enter into public life.

Mr. Lambert said he knew from personal experience of the introduction of unqualified men into the service of the Corporation by members of the Council. He knew that in the case of the Electricity committee some two or three years ago the same difficulty existed. The then superintendent and engineer of the department expressed to the committee the difficulty he was in in consequence of members of the committee and other members of the Council who were not members of the committee, sending down men with instructions that they were to be taken on and places found for them, and it reached such an extent that the number of such men sent amounted to hundreds in the course of a year. Mr. Wordingham, having men sent to him who were utterly incompetent and incapable of doing the work, asked the Electricity committee to authorise him to have printed some forms of recommendation, so that any member of the committee or other members of the Council wishing to send a man to be taken on should fill up one of those forms. No doubt Mr. Wordingham's idea was that with these printed forms to be filled members would hesitate to send men down. He thought if the records of the Dickinson-street works could be looked into it would be found that there were hundreds of those forms there now.

Mr. Johnson said there was, not long ago, in the employ of the Watch committee an inspector getting £120 a year. That man, at 46 years of age, retired upon a pension of £80 a year. The Watch committee knew nothing of what he was going to do—officially at any rate—but it turned out that he went to the Tramways committee and got full pay in addition to his pension. But no member of the Tramways committee knew anything about the matter.

Sir Bosdin Leech said that the system was wholly demoralising. It demoralised a department and filled it with cripples. The officials formed the opinion that if they refused a member's request he would be their enemy in the future and his influence would be used against them when they applied for an advance of salary. It was most important, now they were municipalising to such an extent, to guard against corruption.

Dr. Bishop said he preferred the original resolution passed in the Tramways committee.

Mr. Boyle said the inspector of police who had been pensioned off and had obtained employment in the Tramways Department was entitled to his pension, and applied for the position under the Tramways committee. It was the custom in large warehouses to look out for men with pensions—and especially men who had served in the police force with credit during 25 or 26 years—and to place them in positions of responsibility as watchmen, and that was what had been done in that case. With regard to the general question, the difficulty had arisen to a large extent in consequence of the development in recent years of large works like those of electricity and tramways.

The resolution was adopted.

Owing to the failure of the negotiations between Manchester and Salford in regard to through traffic the Manchester Tramways committee propose that the Board of Trade be called in to arbitrate, but should Salford decline arbitration separate bills will be promoted for power to permit the rival cars to run over certain specified lines.

**Municipal Telephony.**—The Executive Council of the Derby Chamber of Trade are issuing circulars to their members, to subscribers to the National Telephone Co., and other ratepayers, asking them to become subscribers to a municipal exchange at an annual subscription not exceeding £5. 10s.

**Nairn.**—On the advice of ex-Bailie Mackenzie, of Edinburgh, the Council have decided to apply for a provisional order.

**Obituary.**—We regret to learn that Ald. Samuel Lennard, who was for many years a member of the Electricity committee of the Leicester Corporation, and was closely associated with the inception and development of the electricity undertaking of that town, died suddenly on Sept. 14, aged 50. He was a much respected member of the Corporation, had filled all the important municipal posts, and had devoted much of his time and attention to Corporation matters.

**Parliamentary Notices.**—Manchester Corporation are promoting an omnibus bill in which powers are sought to construct additional lengths of tramway to authorise the generation of electrical energy on land belonging to the Corporation at Queen's-road, Cheetham, and Hyde-road, Ardwick, &c.

Parliamentary powers are sought for the construction of an electric railway from London to Brighton. At present engineers are surveying the projected line of route, which is said to be about 46¾ miles in length. It is intended, under the scheme, to run a half-hourly service of trains from both ends. The London terminus is to be at Westminster, and the Brighton station on the front near the Hotel Metropole. Power is to be supplied from two generating stations designed for an output of 10,000 H.P. The chief engineer to the project is Mr. H. F Cheswright.

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**Presentation.**—Mr. H. W. W. Dix, assistant chief draughtsman to Messrs. Crompton & Co., was presented on Friday last by the members of the technical staff and others with a stationery cabinet and dressing bag and an illuminated address, expressing their appreciation and respect. The presentation was made by Mr. F. H. Somerville. Mr. Dix has been with Messrs. Crompton & Co. for the past nine years.

**Rome.**—A recent report on the trade of Rome and district for 1900 refers to the financial results of the working of the Roman Tramways and Omnibus Co. This company's lines of tramways are being rapidly converted to electric working, and working expenses have been reduced from 84·83 per cent. in 1897 to 69·72 per cent. in 1900.

The Electric Railways and Tramways Co. is the title of a company recently started in Rome with the object ofconstructing and equipping electric tramways in addition to those already owned by the Roman company. The new company proposes to connect Rome with the small outlying towns, most of which are favourite summer resorts for Italians. The Mediterranean Thomson-Houston Co. are closely identified with the new venture, which has an authorised capital of £60,000, only half of which, however, has been called up. The company has done very little work at present beyond a survey of the proposed lines.

The Anglo-Roman Gas Co. has presented an excellent report for 1900, showing a net profit of £52,000. The company does not appear to feel in its gas branch the continued extension of electric lighting in this district. The company has obtained a concession for supplying electric current in Rome, and the profits above given include those obtained from the supply of electricity.

It may be noted that throughout Northern Italy electricity is rapidly succeeding gas for illuminating purposes, and that a good market is here available for British-made electric apparatus and accessories of all kinds.

**Salford.**—The inspection of the permanent way of the first section of the Corporation electric tramway system takes place to-day (Friday), and the electrical equipment will be inspected on Monday. The opening is fixed for Oct. 1.

**Telephones in Hotels.**—The fact that proprietors of hotel premises are placed upon the same footing with regard to their subscriptions to the telephone service as ordinary subscribers, notwithstanding that, in the nature of things, considerably greater use is made of the instruments installed upon such premises, does not appear to have been fully appreciated, and we understand the National Telephone Co. have serious cause to complain that in many cases hotels, with their buffets and bars, have been turned into call offices for the use of customers other than the regular visitors to the hotel. This has led to the attention of hotel proprietors being called to the conditions under which their subscriptions are accepted, and in one or two cases we believe it has been found necessary to disconnect the premises. This has been made a cause of complaint against the National Company, but it is clearly within the right of those who provide the service to see that no improper use is made of subscribers' instruments. The matter is one of some importance, and doubtless the Post Office authorities will give due attention to the subject when announcing their arrangements for subscriptions to the Post Office telephone service. The National Company propose to place such subscribers on the toll system, which will be most satisfactory for all parties.

**Tottenham.**—The Council on Tuesday resolved to apply for a provisional electric lighting order.

**Warrington.**—An inquiry has been held into the Council's application to borrow £15,000 for electric lighting extensions. There was no opposition, and the town clerk (Mr. Whittle) said powers to borrow £44,966 had already been obtained and exhausted. The additional loan was necessitated by the increasing demand for electric current. The electrical engineer (Mr. Grimsdale) said that in January last there were 546 8 c.p. lamps connected, and now 10,910. In February next, when the tramways commenced to run, there would be a largely increased demand, and there was also every prospect of an increase in the requirements for lighting. Major Cardew (Messrs. Preece and Cardew) said it was the best policy to have an adequate supply in advance of the demand, as, should the Corporation be unable to give a prompt supply, dissatisfaction was caused and some time elapsed before confidence was restored.

**Water Power Utilisation in Italy.**—The King of Italy is about to visit Milan to inaugurate the great water power installation on the River Tessin. 15,000 H P. will be available for lighting the City of Milan and to supply power for industrial uses in the district.

The A.E.G., Berlin, has just erected in the valley of Pompeii, near Naples, three 150 H.P. horizontal turbines, and three large three-phase alternators are provided to transmit current to Pompeii, Sorno and Torre Annuaziata, where a number of large macaroni factories use electric power.

# TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

## TENDERS INVITED.

*Stepney* (London) Electrical committee require tenders for arc lamp columns, lamps, fittings, &c., and switchboard for controlling supply on the three-wire system. An advertisement contains further particulars. Specifications, &c., from the consulting electrical engineer (Mr. Arthur Wright) after Oct. 3. Tenders (addressed Chairman) by noon Oct. 17.

*Wakefield* Electricity committee invite tenders for the supply and erection of a 550 B.H P. high-speed enclosed engine and a 400kw. two-phase alternator. Specifications, &c., from the city electrical engineer (Mr. Robert Blackmore), and tenders (addressed Chairman) to the electricity works, Calder Vale-road, Wakefield, by Oct. 15. See advertisement.

*Manchester* Electricity committee invite tenders for the supply, delivery and laying of cables of an approximate length of 147¾ miles, further particulars of which are set out in an advertisement. Specifications from the secretary of the electricity department (Mr. F. E. Hughes), and specifications and drawings may be inspected at, but not obtained from, the offices of the chief engineer (Mr. G F. Metzger), who will supply all further information. Tenders (addressed Chairman) to the Town Hall, Manchester, by noon, Oct. 9.

*Manchester* Electricity committee also invite tenders for ampere-hour and watt-hour meters. Tenders to Chairman by noon Oct. 2.

*Kirkcaldy* Corporation invite tenders for the supply and erection of a main switchboard. Specification, &c., from the town clerk (Mr. Wm. L. Macindoe), and specifications can be seen at (but not obtained from) the offices of the consulting engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders to Mr. Macindoe by 10 a.m. Oct. 24. See advertisement.

*Glasgow* Tramways committee are prepared to consider designs for mechanical point-shifting appliances, and inventors are invited to communicate with the general manager (Mr. John Young), 88, Renfield-street, Glasgow. See advertisement.

*Blackpool* Corporation invite tenders for poles, plinths, cables, &c., overhead materials, trolley wire and bonds and 20 electric car equipments. An advertisement contains further particulars. Tenders (addressed Chairman, Tramways committee) by noon Oct. 21.

*Extension of Time.*—The time for tenders to be sent in for the electric lighting of *Fayoum* (*Egypt*) has been extended from Sept. 15 to Oct. 1. Particulars of this contract were given in our issue of Aug. 30, p. 730.

*London County Council* require tenders for track and slot rails and fastenings, tie-bars, &c.; also roadwork and platelaying required for reconstruction on the conduit system of the tramway routes between Westminster, Blackfriars, and Waterloo respectively and Tooting; also for electric lifts, pumps, fans, &c., for electrical equipment of the Greenwich footway tunnel and approaches; and for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for twelve months' supplies of various articles, including iron castings, copper, ironmongery, rails, sundry tools, oils, &c. Forms of tender, &c., from the stores department, Osborne-street, Manchester, where samples can be examined. Tenders to secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 7.

*Newport* (Mon.) Corporation invite tenders for winches for steel chimney shaft, outside coal handling, piping, switchboard, cables, cable-ways, overhead construction, complete electric motor car and repair shop equipment. Tenders to town clerk by 5 p.m. Oct. 21.

The Guardians of the *Greenwich* Union invite tenders for electric lighting installations at their new Homes for Children. Tenders to the Union Offices, East Greenwich, S.E., before Oct. 10.

*Poplar* (London) Libraries committee invite tenders for the installation of electric light in four public libraries. Tenders to town clerk by Oct. 1.

*Sudbury* Corporation invite terms for taking a lease of their electric lighting order, 1900.

*Sheffield* Corporation require boilers, economisers, motors, fans, &c. Tenders to Mr. S. E. Fedden, Commercial-street, by 30th inst.

*Rochdale* Electricity committee require tenders for feeder and distributor cables. Tenders by noon Oct. 2.

*Huddersfield* Corporation invite tenders for a 600kw. alternating electricity plant. Tenders to town clerk, by Sept. 30.

*Leeds* Lighting committee require a main switchboard. Tenders to town clerk by Oct. 8.

*Leeds* Corporation require tenders for 50 electric motor-cars. Tenders by noon Oct. 15.

*Huddersfield* Corporation invite tenders for six car bodies mounted on trucks and electrically equipped complete. Tenders by Oct. 2.

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*Hackney* (London) Workmen's Club invite tenders for electric lighting. Tenders to Secretary, Haggerston-road, N.E., by Oct. 7.

Tenders are invited for a 50kw. alternator and engine for the *East London* (South Africa) Municipality. Specifications can be seen at the municipal agents (Messrs. Dyer and Dyer), 17, Aldermanbury, London, E.C. Tenders to town clerk (Mr. R. N. Moir) by noon Nov. 26.

*Boulder City* (Western Australia) Council require tenders for the construction of about 3½ miles of electric tramway and the right to construct and work tramways within the municipality. Tenders to the mayor by Nov. 23.

## TENDERS RECEIVED AND ACCEPTED.

**Correction.**—In our last issue we stated that the *Lowestoft* Tramways committee had accepted various tenders for conduits, cables, overhead equipment, &c. The tenders referred to were accepted by the *Great Yarmouth* Corporation.

The liquidator of the Isle of Man Electric Tramways and Power Co. (Mr. W. H. Walker) has accepted the offer of the Douglas Corporation to acquire the company's horse and cable lines within the borough boundary at £50,000, and the Manx Chancery Court has authorised the liquidator to complete the sale. The Council, who intend to convert both lines to electric traction, will apply to the Tynwald Court for leave to borrow the necessary money for carrying out the scheme. The total cost is estimated at about £105,000.

Southend Town Council have accepted the tender of Callendar's Company for the supply and laying of cables at £11,891. 12s. 2d.

Ingleton Parish Council have accepted the tender of the Ingleton Electric Light and Power Co. for the electric lighting of the streets by 33 32 c.p. lamps at £66. 16s. per annum.

Heckmondwike District Council have accepted the tender of Messrs. Babcock and Wilcox for an additional boiler, pipe work, &c., for the electricity works.

Hammersmith Borough Council have received the following tenders for pipework and tanks in connection with the condensing plant being provided for the electricity works :—

| | | | |
|---|---|---|---|
| Stephens, Smith & Co.... | £2,879 5 | Aiton & Co. ..... | 2,185 0 |
| Fraser and Fraser ..... | 2,746 0 | Körting Bros..... | 2,150 0 |
| Rosser and Russell ..... | 2,199 0 | Sir Hiram Maxim Co. ... | 1,881 15 |

No tender has yet been accepted, but the subject will be considered by the Council at its meeting on Wednesday next.

Messrs. Brown, Boveri & Co., Baden, have secured a contract for the establishment of an electricity generating station at Bessigheim. Water power is to be utilised, with a steam reserve. Current will be supplied for lighting Bessigheim, Freudenthal and Walheim, and power will be available for factory driving at Löchgau.

## BUSINESS NOTICES.

The British Thomson-Houston Co. will shortly remove the majority of their staff from the present offices at Cannon-street and Bush-lane, London, to the extensive new works at Rugby, where the head office will in future be situate, a branch office only being retained at 83, Cannon-street, London.

Messrs. H. W. Ellis and F. A. Jackson (trading as Ellis and Ward), electrical engineers, 113, Edmund-street, Birmingham, have dissolved partnership. Debts by Mr. H. W. Ellis, who continues.

Messrs. J. W. and J. S. Smith (trading as J. W. Smith), electrical engineers, 52, Bridlesmith-gate, Nottingham, have dissolved partnership. Debts by Mr. J. W. Smith.

The General Electric Co. (of New York) remove their general offices on October 1 from 110 to 83, Cannon-street, London, E.C.

## RECEIVING ORDER.

A receiving order has been made against J. A M. Collier, electrical engineer, Claremont-grove, Gateshead.

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**For Sale.**—The Dublin United Tramways Co. have for sale complete electric generating plants of 450 and 560kw. capacity respectively. Particulars from the secretary, Mr. R. S. Tresilian. See advertisement.

The Postmaster-General is inviting tenders for the purchase of about 40 tons of gutta-percha, 100 tons of old copper wire, plates, &c., a quantity of metals, indiarubber-covered copper wire, glow lamp tops, accumulators, dry batteries, &c. Forms of tender from the controller of stores (Mr. Chas. E. Stuart), G.P.O., E.C. Tenders by 10 a.m. Oct. 16. See advertisement.

The Keighley Electrical Engineering Co. have a stock of motors (enclosed and open types), from 1 to 14 H.P., also electric fans and a compound wound dynamo for sale. See advertisement.

Two 70kw. Elwell-Parker alternators, Willans high-speed compound engine and two horizontal high-speed engines are for sale by Mr. Thomas Johnson, Prescott-street, Wigan. See advertisement.

**Sturtevant Electric Controlling Apparatus.**—A very complete catalogue of automatic devices for dynamo and motor starting and speed regulating has been prepared by the Sturtevant Engineering Co., 147, Queen Victoria-street, London, E.C., who have for some time past made a special feature of this class of apparatus. It is generally agreed that safety in dynamo and motor working can only be assured when the machine is automatically protected by its controlling rheostat, and that an automatic starting switch is necessary to effectually shield the motor from harm when, through accident, inattention or careless handling on the part of the attendant current is interrupted, or when the motor is overloaded or is subjected to an

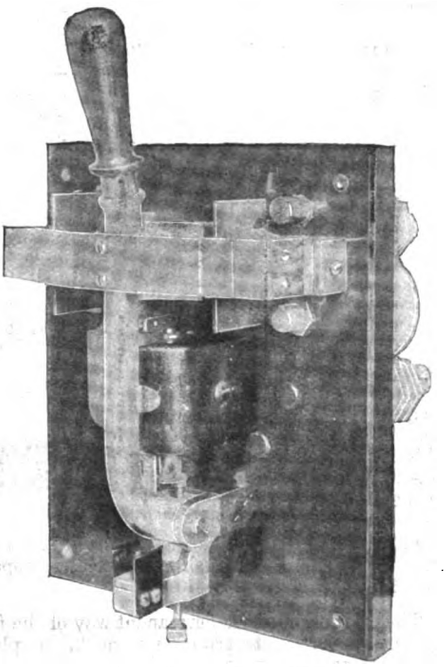

FIG. 1.—SWITCHBOARD TYPE, SINGLE POLE, W.T.L. CIRCUIT-BREAKER.

excessive supply of current. It is claimed by the makers of the Sturtevant rheostats that the automatic "no-load release" and "overload release" devices attached to the Sturtevant switches give this protection and afford every possible means of securing complete control. We illustrate in Figs. 1 and 2 recently-introduced types of Sturtevant automatic controllers. Fig. 1 shows the automatic reversible lift controller, which is operated electrically from the car. L is the

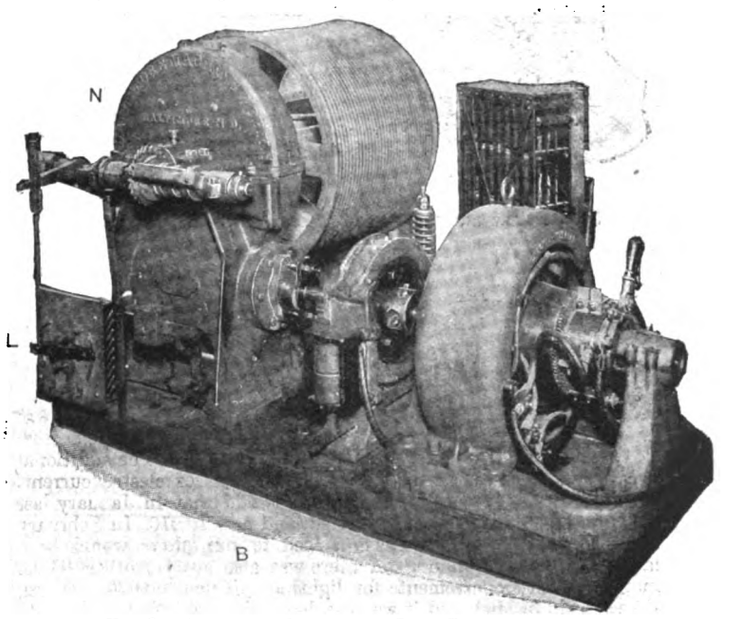


FIG. 2.—AUTOMATIC REVERSIBLE LIFT CONTROLLER.

limit switch, N the controlling nut, and B the solenoid brake. Fig. 2 is the W.T.L. switchboard type of circuit-breaker, with time limit and magnetic blow-out. It is fitted with back actions, and is suitable for working with 600 volts or under. This type of circuit-breaker does not open on the occurrence of temporary overloads that are not dangerous to the motor, but will open immediately on a short circuit or dangerous overload, or if any overload is unduly prolonged. The magnetic blow-out is provided to prevent arcing, and has carbon tips for breaking the circuit. The multiple leaf copper strips of which the main contacts are made afford perfect contact and will not

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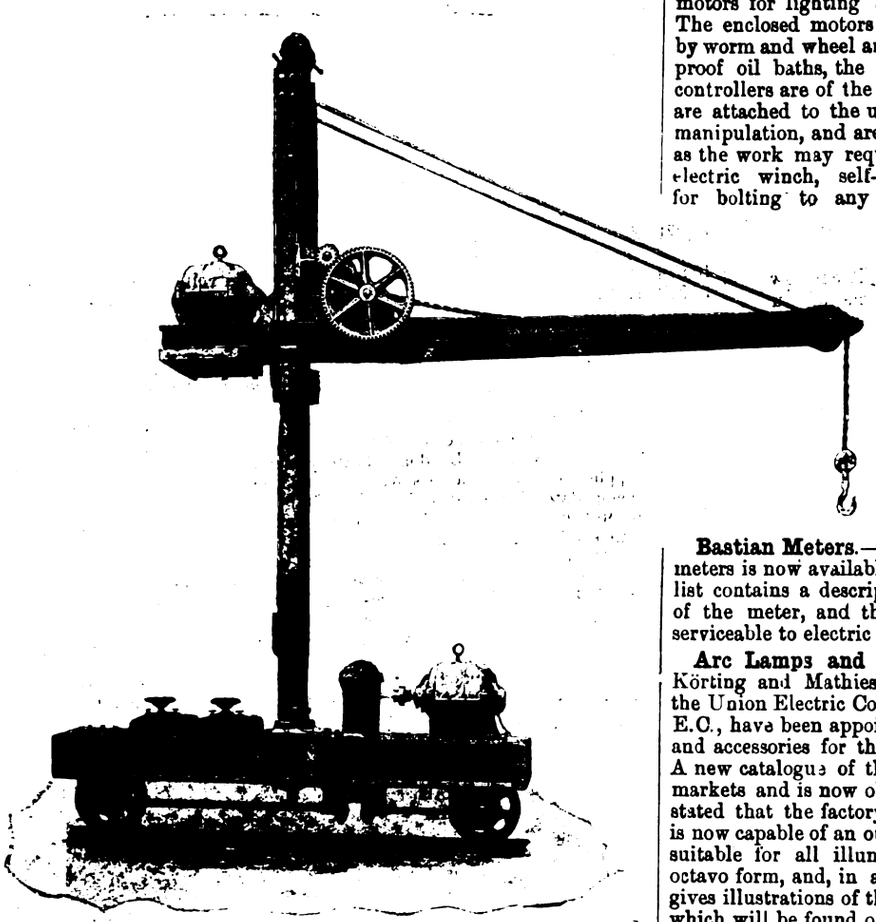
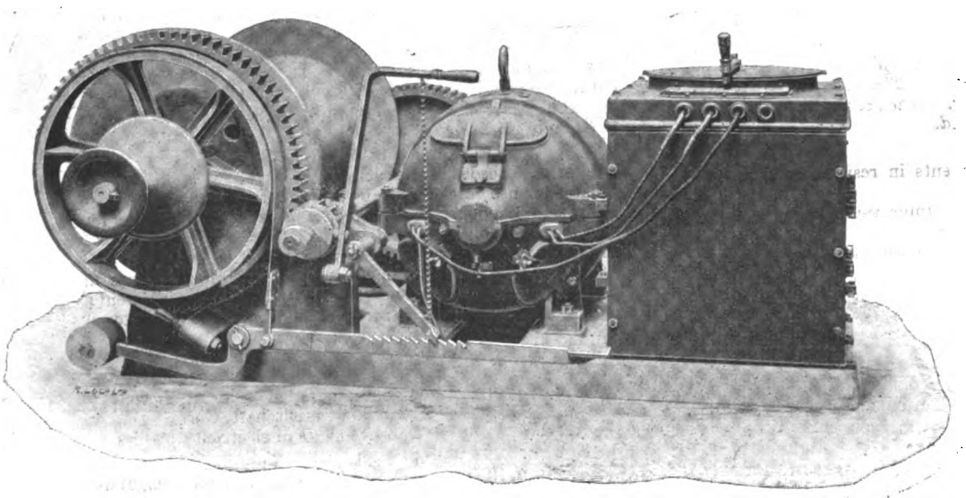
stick or freeze. This apparatus is supplied with enamel or copper finish and for from 75 to 1,500 amperes. The illustrations are intended to show the latest forms of Sturtevant controlling apparatus. Many forms of these rheostats are favourably known to engineers in this country, as they have been on the market for many years. The catalogue describes a large number of these Sturtevant devices, and is well arranged, provided with a large number of excellent illustrations (including connection diagrams), and is altogether a very complete list of controllers for all classes of work.

**Electric Cranes and Hoisting Machinery.**—A small but well-arranged catalogue of this class of machinery has been prepared by Messrs. Jessop and Appleby, of Leicester and London, in which a number of illustrations of the latest forms of electric hoisting machinery and travelling cranes is included. We have selected for the purposes of this brief review two examples. Fig. 1 is an electric "walking" crane which travels on a single rail (usually flush with the floor) and is held in its vertical position by a roller at the top of the post, which runs between a pair of guides held in position at the top by beams, or attached to an upper floor, as circumstances best permit. The crane shown is of 1½ tons power, the radius of jib 12ft. 6in., and the height from floor to top of post 18ft. 6in. These proportions can, of course, be varied to suit the conditions of the work. The top roller, jib, and tie-rods rotate freely on steel ball bearings, the centre column being of steel, bored centrally to take the conductors, and keyed in the massive centre piece shown between the side frames. Electric current is collected from the main conductor near the top of the post and is conveyed to the motors for lighting and for travelling by well-insulated fittings. The enclosed motors are fixed as shown, and transmit their power by worm and wheel and spur gear, machine cut and enclosed in dust-proof oil baths, the bearings being fitted with ball thrusts. The controllers are of the metallic type with large cooling areas. These are attached to the under carriage in positions most convenient for manipulation, and are adapted for operating either quickly or gently as the work may require. In our second illustration we show an electric winch, self-contained, with solid base plate suitable for bolting to any foundation. The particular machine illustrated lifts 10 cwt. at any speed up to 200ft. per minute. The electrical appliances, lifting gear and lowering brake are mounted on a substantial bed plate with side frames and bearings for the shafts. Power is transmitted by spur-gear throughout, and a feature of these machines is that the brake drum forms part of the main wheel on the rope or chain barrel. The brake strap is worked by pedal, leaving the driver's hands free for controlling the other levers. Series wound, reversible, enclosed motors are employed with these winches, with a finely graduated metallic resistance of ample capacity.



30cwt. Electric "Walking" Crane on Single Rail.

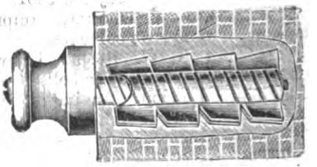


Electric Winch to lift 10cwt. at Speeds up to 200ft. per Minute.

**Bastian Meters.**—A new price list of Bastian patent electricity meters is now available. Over 5,000 of these meters are in use. The list contains a description of the principle, construction and action of the meter, and the particulars given will be found especially serviceable to electric lighting contractors.

**Arc Lamps and Accessories.**—We are informed by Messrs. Körting and Mathiesen, of Leutzsch, near Leipzig, Germany, that the Union Electric Co. (Ltd.), of 151, Queen Victoria-street, London, E.C., have been appointed sole selling agents for Körting arc lamps and accessories for the United Kingdom and the British colonies. A new catalogue of these goods has been prepared for the British markets and is now obtainable from the Union Electric Co. It is stated that the factory at Leutzsch has been largely extended, and is now capable of an output of 40,000 complete arc lamps per annum suitable for all illuminating requirements. The catalogue is in octavo form, and, in addition to prices of many types of arc lamps, gives illustrations of the interior mechanism and general particulars which will be found of service.

**Electrical Accessories List.**—The Electrical Trades Supply (Ltd.), of Birmingham, have issued some advance sheets of electric lighting accessories, &c. Included in these sheets are some particulars of Treppmann's patent clawed dowels, which are used as fasteners for porcelain insulators, circuit closers, feeding devices, &c. The accompanying illustration shows this device. A hole is made in the wall and filled up with plaster or cement when the dowel is pressed into the soft substance and the surface smoothed. It is claimed that after a few minutes' hardening of the plaster or cement the screw may be withdrawn, and the insulator or other fixture be then securely mounted.



Treppmann's Patent Dowel.

**Electric Launches.**—The Thames Valley Launch Co., of Weybridge, report a successful season's trading, the revenue of the hiring department having been considerably in advance of previous years,

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as has also the revenue from sales. The season's experience with boats fitted with the company's new gear for electric launches justifies them in equipping during the coming winter a further large number in this way. This form of gear requires only one lever, handle or wheel which can be fixed in any convenient position for entirely controlling all operations on the boat. The motor used always runs one way, and the system is said to obviate the use of any complicated switch. A demonstration is, we understand, shortly to be given of this gear.

**Water Softening and Purification Plant.**—We learn that the Desrumaux Water Softening Co., of 5, Queen Victoria-street, London, and Bradford, have recently secured contracts for water softening apparatus from the following :—

| | | |
|---|---|---|
| South Hutton Colliery Co., Sunderland ..... | 120,000 gals. | in 12 hrs. |
| Southport Corporation's electrical power house | 96,000 | ditto. |
| E. Ripley & Sons (Bradford Dyers' Association) | 77,000 | ditto. |
| John Cheetham & Sons, Brighouse ..... | 17,600 | ditto. |
| Brighton & Sussex Steam Laundry Co., Brighton | 11,000 | ditto. |

The Desrumaux Company is erecting for the North-Eastern Railway Co., at Hessle, apparatus for treating over a million gallons per day for drinking purposes and for steam raising, and are erecting at Warsop Junction an installation for the Lancashire, Derbyshire and East Coast Railway. A new catalogue of this type of plant is now available.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 18 to 24, with the ports of destination :—

*Africa*—Alexandria, £363 (telegraph material); Cape Town, £565 (including £171 telegraph material); Chinde, £22; Durban, £122; East London, £262; Port Elizabeth, £33. *Argentina*—Buenos Ayres, £150 (telegraph material). *Australasia*—Adelaide, £2,615 (including £2,539 telegraph material); Brisbane, £131; Christchurch, £41; Fremantle, £404; Hobart, £59; Melbourne, £50; Perth, £86; Wellington, £309 (telegraph material). *Azores*—St. Michael, £24 (telegraph material). *British Guiana*—Demerara, £190. *Canary Islands*—£10,140 (telegraph cable). *Chili*—Valparaiso, £60. *Denmark*—Copenhagen, £184 (telegraph wire). *France*—Bordeaux, £13; Boulogne, £48. *Holland*—Amsterdam, £137; Rotterdam, £91 (telegraph material). *Hong Kong*, £479. *India*—Bombay, £50 (telegraph material); Calcutta, £943. *Japan*—Nagasaki, £6,500 (telegraph material); Tokyo, £243; Yokohama, £706. *Malta*, £400 (telegraph material). *Norway*—Christiania, £37 (telegraph wire). *Portugal*—Lisbon, £450. *Russia*—St. Petersburg, £231 (including £150 telegraph material). *Siam*—Bangkok, £36. *Straits Settlements*—Penang, £253 (telegraph material); Singapore, £389. *Sweden*—Stockholm, £544 (including £84 telegraph wire). Total £27,360, against £39,291 in the corresponding week last year (Sept. 19 to 25).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

May 23, 1901.

10,654. T. E. WEAVER. Manchester. Improvements in resistances for the control of electric currents.

10,655. G. BELL and G. W. BELL. Liverpool. Improvements in or connected with electrolytic bells or apparatus.

10,686. W. EDGAR. London. An improved street lantern for gas and incandescent electric lighting.

10,687. H. COONEY. London. Prepayment apparatus for the supply of gaseous, electric, or other fluids for a given period of time.

10,700. R. HACKING, A. W. HANCOCK and J. LEIGHTON. London. Improvements in electric tram and railways.

10,733. THE BRITISH THOMSON-HOUSTON CO. (LTD.) London. Improvements in high potential electric switches.

10,734. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in train control systems for electric railways. (Frank E. Case, United States.)*

10,735. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric circuit breakers. (Samuel B. Stewart, Jun., United States).*

10,736. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in high potential electric switches. (W. Le Roy Emmet, E. M. Hewlett, and C. C. Badeau, United States.)*

10,737. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric circuit breakers. (S. B. Stewart, Jun., United States.)*

May 25, 1901.

10,743. E. W. MAYER. London. Improvements in electrical engines for surgical and dental purposes.

10,756. B. M. DRAKE, C. C. GARRARD, G. S. RAM and THE NERNST ELECTRIC LIGHT (LTD.). London. Improvements in magnet coils or solenoids.

10,757. C. C. GARRARD and THE NERNST ELECTRIC LIGHT (LTD.). London. Cutouts for incandescent lamps with glowers consisting of conductors of the second class.

10,758. G. S. RAM and THE NERNST ELECTRIC LIGHT (LTD.). London. Improvements in electric incandescent lamps in which the glower or light-giving body is a conductor of the second class.

10,766. A. P. S. MACQUILTEN. Glasgow. Improvements in electro-magnetically controlled looms and kindred textile machinery.

10,769. R. B. JENTZSCH and G. VON ALVENSLEBEN. London. Improvements in prepayment devices for telephones.

10,793. W. J. POLYBANK. London. Improvements in electric indicators.

10,795. W. SUNTER. Edinburgh. Generating electricity for the propelling of machinery or for other similar and useful purposes.

10,848. A. W. TONKINS. Improvements in apparatus for winding coils for continuous-current dynamo and motor electric machines.*

10,869. C. D. ABEL. London. Manufacture of incandescence bodies for electric lighting. (Siemens and Halske Aktien Gesellschaft, Germany.)

10,871. F. G. T. PARSONS and D. H. STURMAN. London. Improvements in telegraph and telephone systems.

10,879. W. K. L. DICKSON. London. Improvements in voltaic cells.

10,887. H. O. SCHMIDT. London. Improvements relating to electric arc lamps.*

10,888. F. W. BUSCH. London. Improvements relating to electric switches.

May 28, 1901.

10,903. E. J. PLUMMER. Midlothian. Improvements relating to the electrolysis of salt.

10,933. A. E. TANNER and W. P. J. FAWCUS. Manchester. Improvements in joints and like boxes for electric cables.*

10,951. C. B. SCHOENMEHL. London. Battery elements support. (Date applied for under Patents, &c., Act, 1883, sec. 103, Oct. 30, 1900, being date of application in United States.)*

10,960. M. MÖLLER. London. Circuit-closing device for the winding gear of electric clocks and the like.*

10,961. M. MÖLLER. London. Electric striking clock.*

10,967. V. I. FEENY. London. Improvements in stationary armatures and inductors. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

10,971. H. H. LAKE. London. Improvements in and relating to controllers for electric railway and like vehicles. (W. W. Tice, United States.)

10,974. P. M. JUSTICE. London. Improvements in and connected with electrodes for electrolytic cells. (Castner Electrolytic Alkali Co., United States.)*

10,957. P. M. JUSTICE. London. Improvements in electrodes for electrolytic cells. (Castner Electrolytic Alkali Co., United States.)*

10,976. P. M. JUSTICE. London. Improvements in electrolytic cells. (Castner Electrolytic Alkali Co., United States.)*

10,988. E. F. FROST. London. Improvements in telephone circuit systems.*

11,000. E. KASTNER. London. Improved electric heating device.

11,003. G. F. R. BLOCHMANN and C. E. BICHEL. London. Improvements relating to apparatus for transmitting and receiving electric signals.

11,007. A. BENSON and J. P. PRICE. London. An improved combined electrical and mechanical motor.*

11,013. F. KUHLO. London. Improvement in circuit-closing and interrupting devices.

May 29, 1901.

11,034. T. E. WEAVER. Manchester. Improvements in starting switches for electric motors.

11,050. E. M. BARNES. London. Electric arc lamp.

11,071. J. GRAY. London. Improvements in electrical connections.

11,076. H. LAMM. London. Improvements in and relating to means for extinguishing electric arcs, applicable to lightning arresters, switches, and the like.*

May 30, 1901.

11,112. D. B. FOSTER. Leeds. Improvements in trolleys and junction frog plates for use on electric railways and tramways.

11,120. B. F. WYLER. London. Improvements in galleries or holders for gas, electric light, oil lamp, and the like globes or shades.

11,132. H. BIELENBERG. London. Improvements in phonographs.

11,134. C. B. THURING and C. G. WIBORG. London. Improvements in rail bonds for electric railways. (Date applied for under Patents, &c., Act, 1883, sec 103, November 10, 1900, being date of application in United States.)*

11,135. S. H. JOHNSTON. London. Improvements in or relating to electric arc lamps.

11,168. V. I. FEENY. London. Improvements in vehicles driven by electricity (Allgemeine Elektricitäts-Gesellschaft, Germany)*

11,172. M. KALLMANN. London. Improvements in electricity meters.

May 31, 1901.

11,214. H. SHORMAKER. London. Improvements in wireless telegraphy. (Date applied for under Patents, &c., Act, 1883, sec. 103, January 17, 1901, being date of application in the United States.)*

11,237. SOCIETA GENERALE ITALIANA EDISON DI ELETTRICITA. London. Improvements in or relating to electric arc lamps. (Date applied for under Patents, &c., Act, 1883, sec. 103, November 26, 1900, being date of application in Italy.)

11,242. Sir W. G. ARMSTRONG, WHITWORTH & Co. (LTD.) and C. H. MURRAY. London. Improvements in electrical primers.

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## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

12,380. LAKE (MacCoy). Workmen's time recorders.
12,709. LEWIS Electric arc lamps.
13,199. MUIRHEAD and EDGAR. Röntgen ray and like apparatus.
13,533. DRAULLETTE. Electric motor road vehicles.
13,679. DRAKE, SHEPPARD, and NERNST ELECTRIC LIGHT (LTD.). Holders for electrolytic incandescent lamps.
15,718. LAKE (Fay). Preparation of conducting material chiefly designed for the manufacture of brushes for dynamo-electric machines.
16,291. ABEL (Soc. Anon des Anciens Etablissements Panhard et Levassor). Electro-magnetic regulator of the admission valves of gas or oil motors.
16,299. SCHULZ. Construction of electric switch.
16,534. BÜHNE. Manufacture of porous metal plates for electric accumulators.
23,155. FEENY (Allgemeine Elektricitäts Gesellschaft). Arrangement and connection for single and multiplex wireless telegraphy.

1901.

5,017. HEIDEL. Electric batteries.
8,395. HUGHES. Telephone transmitters.
10,275. BRITISH THOMSON-HOUSTON CO. (LTD.) (Day). Controlling electric motors.
10,459. APPLE. Storage batteries.
10,506. EDISON ORE MILLING SYNDICATE (LTD.) (Edison). Magnetic separating apparatus.
10,933. TANNER and FAWCUS. Joint and like boxes for electric cables.
10,975. JUSTICE (Castner Electrolytic Alkali Co.). Electrodes for electrolytic cells.
10,976. JUSTICE (Castner Electrolytic Alkali Co.). Electrolytic cells.
11,277. BOYD. Apparatus for utilising electric lamps in the heating of plates and other domestic utensils and in the boiling of water and other liquids.
11,280. DE KANDÓ. Electrical reversing switches and mechanism for operating them.
11,422. CEREBOTANI and BERNSTEIN. Devices for automatically unrolling the paper ribbon in Morse apparatus.
12,119. GORTON. Method of and combination of apparatus for translating and relaying telegraph cable signals.

# COMPANIES' MEETINGS AND REPORTS.

## Electric Tramways Construction and Maintenance Co. (Ltd.).

A dinner was given on Friday last, at which Sir J. KENNETH D. MACKENZIE, Bart., presided, those present including Sir A. Binnie (L.C.C.), Mr. J. Fell, Mr. G. Flett (Messrs. Dick, Kerr & Co.), Mr. A. A. Bassett Hopkins, Mr. S. B. Cottrell (Liverpool Overhead Railway), Mr. R. Green, and Mr. A. Dickinson (Birmingham Tramways).

To the toast of "The Electric Tramways Construction and Maintenance Co. (Ltd.)," the CHAIRMAN said he had the pleasing duty of announcing a dividend of 6 per cent. and a bonus of 1s. 2d. per share, or about another 6 per cent., making altogether a dividend at the rate of about 12 per cent. on the company's shares. A larger distribution had been urged, and would have been popular with those who always look at the cash balance as a guide as to how much dividend is to be paid. The company had close on £100,000 on deposit and in hand at its bankers. He did not propose to disclose all the enterprises in which the company was interested, but it was an open secret that the company had, perhaps, as many miles of tramways and railways, either confirmed by municipal and urban district boards and for which orders had been granted, or projects for which orders were now before the Light Railway Commissioners and Parliament, as perhaps any other tramway construction company in the country. The four principal projects in which the company was concerned, and which form a network of electric tramways, were known as the Lancashire Grand Trunk Electric Tramway, the Yorkshire County Electric Tramway, the Nottinghamshire Electric Tramway, and the City and North-East Suburban Electric Railway. In the matter of capital the position was simplified by the co-operation of certain American firms, who proposed to back them with the necessary capital for construction purposes. They were thus placed in the best possible position to undertake financing and carrying out the construction of electric tramways, either for private companies, public corporations, or municipalities. The Lancashire system comprised over 50 miles of main lines and branches and town tramways, which would connect such towns as Burnley, Padiham, Whalley, Great Harwood, Blackburn, Preston, Chorley and Wigan, and would give an outlet to all Lancashire. This was only one of the projects before the company, and it represented more than £1,000,000 in capital. Their Yorkshire scheme was an extensive one, for which they had received orders from the Light Railway Commissioners. Their Leeds, Wakefield, and Dewsbury project was under consideration by the Light Railway Commissioners. These Yorkshire schemes represented about £2,000,000 capital for their proposed electric tramways. In Nottinghamshire they had the Mansfield order, and schemes were being prepared to connect Nottingham with the surrounding towns. The City and East London Suburban Railway would provide a rapid service of electric trains to Chingford, Walthamstow, Waltham Abbey, and Epping. If their Lancashire and Yorkshire tramways could be completed within the next three years, the L. and Y. Railway would have running by it, practically side by side, and in many senses serving it, a system of electric tramways that would, approximately, be as important to the public convenience as the L. and Y. Railway itself. In connection with the statistics of electric traction it was interesting to note that it had been recently calculated that the average number of passengers carried in the trains running in the United Kingdom was only about 40 per train per journey, and this was about the average seating capacity of electric tramcars large and small. Still more astonishing figures had been published, showing the results of passenger traffic by electric tramways in our large towns. In Liverpool more passengers had been carried by electric traction in one year than had been carried by all the railways in Scotland and Ireland during the same period (over 100,000,000). In Leeds electric tramway profits amounted to £133,449 last year. In Glasgow they had increased by £156,000, and in Sheffield similar satisfactory results were anticipated. At Dec. 31 last the total mileage of tramway lines in Great Britain was 1,121, an increase of 20 per cent. over 1890. The number of cars had increased from 3,801 to 6,500, and the passengers carried exceeded 1,000,000,000, or double those of 1890. The first electric tramway he remembered was erected by a London firm in the Paris Exhibition in 1881, or 20 years ago That was the first tramway ever shown, and now in South America and Canada these lines were running everywhere. Water power was available there, which made the cost of working very low, and the public could ride 20 miles for 2½d.

Mr. JOHN FELL, J.P., proposed "Electric Traction." He said he was the oldest man in traction present, for he came on the scene before even steam was supposed to be a marketable commodity so far as traction was concerned, but the great hopes held about steam had not been realised. Then the Americans came to show us the way to work our tramways. Not that we did not know, but their Government allowed them to show the way, and they knew it, and we were irritated and annoyed that we could not deal with the question as they did. They were not more forward in their policy than we were, it was only that they had greater facilities. With regard to systems of electric traction, experience had shown that what was known as the trolley system was the only one to be seriously considered. The great fight against the trolley system, by those who wished for something picturesque and beautiful, showed that you could not secure these blessings in connection with traction, and now municipal corporations were coming along with their ideas. Having been trained by the capitalists, they were preparing to reap the reward of other men's brains, to utilise a power so economic that it was possible to traction 9 tons for 1d. The municipalities had taken advantage of all that had been done, and had given absolutely nothing in return. But corporations could not serve anyone but themselves, and it was necessary for companies like those whose shareholders were present that day to connect the links between corporations and corporations on purpose to make the network of electric traction one system throughout. The traction companies would, in his opinion, do more than the municipalities in this direction.

Sir ALEXANDER BINNIE (whose name, with those of Mr. S. B. Cottrell and Mr. A. Dickinson, was coupled with the toast) said it was at the Polytechnic, in Regent-street, London, before the year 1860, that he first saw anything in the shape of electric traction, when the late Prof. Pepper showed them a very rudimentary way of hauling vehicles by electricity. Referring to the great engineering enterprises of the past, the speaker said that all such great enterprises in which novelty was concerned—he spoke from many years of municipal experience—must always be promoted by those who were prepared to take the risk of financial failure or to obtain pecuniary advantage. As to electric traction, which he had studied for many years, he considered electric traction the traction of the future, and he was not prepared to limit himself to tramways in particular. Tramways at the present time were proving a profitable and very useful adjunct in forming means of communication between dense masses of population and as connecting links between the existing systems of traction which were now propelled by steam or other means. So far as the London County Council on the one hand, and the City of London on the other, were concerned, both those august bodies were agreed that if the traction of this great City of London was to be carried on properly in the future it must be by means of electricity. The days of steam traction in large towns, whether underground or overground, had gone. They have got to the point when great municipalities had come to the conclusion that their internal traffic must be carried on electrically. The question of the particular system to be adopted must, he thought, be decided by local circumstances. To carry on the enormous traffic of Fleet-street and Cheapside by means of overhead wires branching out in many directions he considered almost impossible, but in suburban districts the overhead system would possibly prove the ultimate solution of that question. They had still many lessons to learn. Electric tramways running to suburban districts were about to encounter a very formidable rival. There were persons, backed by money and well acquainted with the engineering conditions, who believed that motor vehicles of some kind would prove the cheapest mode of conveying the dense population of London into the suburban districts. Sir Alexander concluded an interesting speech by a frank endorsement of the London County Council's engineering policy and a feeling tribute to its comparatively non-political and wholly honest conduct of public affairs.

Mr. S. B. COTTRELL, who also responded, said the Liverpool Overhead Railway was the first electric overhead railway in the world worked on ordinary railway principles. When that railway was promoted it was estimated that the traffic would be 2,500,000 passengers per annum. The prospectus suggested this might be increased to 5,000,000 passengers per annum. They were now carrying nearly 11,000,000. Workmen were carried on that line 14 miles for 3d. They were now running an electric tramway in conjunction with their railway through a suburban district with an estimated population of about 30,000. On that tramway they were carrying 1,800,000 passengers per annum, or practically the whole population 60 times over, while the Liverpool Corporation were carrying the whole

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population practically 100 times over per annum on the electric tram ways. He believed they would shortly see electric traction applied to a very large extent to our present steam railways, for if the railway companies wished to maintain their local traffic their only salvation was electric traction on their suburban lines within a radius of 40 or 50 miles of any big city. Frequency and speed could be attained by electric traction which were not possible with steam. He had, in fact, recently been making some very elaborate experiments with a train with this object. On the Liverpool Overhead line they had 17 stations in 7 miles, therefore rapid acceleration was a most important item, and a representative of the firm that had equipped for him a train which was accomplishing the highest rate of acceleration, either on this side or on the other side of the "pond," was present in the person of Mr. Flett, of Messrs. Dick, Kerr & Co. He (Mr. Cottrell) was much interested in the proceedings in connection with the mono railway, and on that occasion he stated that he could obtain an acceleration of nearly 1·15ft. per cent. per second, which is all that could be claimed for the mono rail. His recent test worked out at nearly 3ft. per cent. per second. Therefore the evidence before the mono rail Parliamentary Committee had been fulfilled.

Mr. A. DICKINSON said Mr. Fell had very kindly referred to him as being one of the pioneers in electric traction. He did claim to be one of the pioneers of traction for tramways—horse, steam, cable, and electric. It was not a matter of opinion, but a matter of fact, that electric traction would work tramways at a profit where it is impossible to work them by any other system. He was the first English engineer who put up an overhead electric system, and he thought that system fulfilled a certain condition; but there were possibilities for the surface contact system and for all kinds of electric systems for tramways. A conduit system was all right where there is a sufficient traffic to maintain a three-minute service; but an overhead system would give greater profit to the people finding the money. In the Far East he was putting down a tramway to carry the Chinese. He was also putting down a tramway in Cape Town running up grades without any rack system to 1 in 8½, and he was perfectly certain all that would be accomplished with perfect safety. Wherever it was possible to work any kind of power up a gradient it could be best done with electric traction.

The proceedings terminated with a hearty vote of thanks to the chairman.

## Willans and Robinson (Ltd.).

The accounts of this company for the half-year to June 29 show that after writing off as depreciation £5,614. 4s. 3d., and paying interest on debenture stock, the credit balance (including £7,412. 6s. 6d. brought forward) is £34,089. 15s. 6d. Out of this sum the directors propose that dividends be paid at the rate of 6 per cent. per annum on the preference and 10 per cent. per annum on the ordinary shares, requiring £18,682. 16s. 3d. The amount payable to the original directors is £3,449. 18s. 2d., leaving a balance of £11,957. 1s. 1d. It is proposed to carry £2,000 to debenture redemption fund, and £3,500 to reserve, leaving £6,457. 1s. 1d. to be carried forward.

16,666 preference and 16,666 ordinary shares of £5 each were offered to the shareholders, pro rata, in April last, at £6 and £8 per share respectively, and the shares were placed without difficulty, those not taken up by the allottees being largely over-applied for by other shareholders. On Dec. 31 the balance of premiums on shares account stood at £27,440. 2s. 4d. A further £43,968 has been received during the half-year, and the directors have written off the whole of the goodwill, which stood at £37,879. 14s. 11d. The whole of the patents account, standing at £3,335. 15s. 10d., has also been written off, also a balance on Paris Exhibition account (£171. 18s. 10d.) and the expenses of the last issue of shares (£1,028. 17s. 11d.). The reserve has been increased by £25,000, invested at the low prices recently prevailing, and there remains a balance of £3,991. 14s. 10d. to carry forward.

The Admiralty has ordered another of the new armoured cruisers of 22,000 H.P. (the "Berwick") to be fitted with Niclausse boilers by the company's licensees, and the directors look forward to the time, now fast approaching, when the company will be able to undertake such work for itself.

The directors regret the loss to the company of the services of Lieut.-Gen. Sir R. H. Sankey, K.C.B., R.E., who resigns his directorship owing to pressure of other engagements. To fill the vacancy thus occasioned the directors strongly recommend the election of Mr. Arthur Lazenby, who has been in the service of the company since 1890. Mr. A. Lazenby (who is the holder of 1,249 shares) has for some years been charged with an important section of the administrative work. It is proposed that an agreement be entered into with Mr. A. Lazenby, binding him to give his exclusive services to the company in the same manner as the present managing directors, at a suggested remuneration of £800 per annum, increasing by periodical increments (subject to re-election) to £1,200, together with 3 per cent. of the profits remaining after 7 per cent. has been earned upon the ordinary shares.

**BRITISH ALUMINIUM CO. (LTD.)**—At the meeting on Wednesday the chairman (Mr. R. W. Wallace, K.C.) said that during the period under review the price of coal was abnormally high, and at Larne, Greenock and Foyers, in so far as they used coke for the production of carbide of calcium, the high price of coal had a great effect upon their profits. The great bulk of their power was obtained from water. If the same rise had taken place in water power and they had had to pay for the production of aluminium and carbide by steam instead of by water power, the result would have been that they would have made a serious loss for the year. On the carbide of calcium account there was a loss of £3,143. Another question which materially affected their dividend-earning capacity was that they had a large amount of money invested in things which at present were unremunerative. Administration expenses had been reduced. They had written off a certain amount for depreciation and increased the amount for repairs and maintenance as far as the plant and works were concerned. If the sales of aluminium had been greater they would have been enabled to use their water power for that purpose and not have required to go into other matters. They had still a great deal of spare water power, and it was necessary for them to look into those new matters and keep abreast of the times. After a tremendous fight in both Houses of Parliament they were enabled to obtain Parliamentary sanction for carrying out the water power works at Loch Leven. They had taken what they considered to be the only remunerative portion of the scheme, and they had got that which would give them some 18,000 H.P. of the best power in the United Kingdom, which would be developed in the course of the next three or four years. With reference to the petition for the prolongation of their patent, the Privy Council did not see their way to grant the prolongation. They had, therefore, to make arrangements with other producers of aluminium. The American patent existed for some little time longer, and France and America were also protected by protective tariffs, so that they had to fight in an unfair and unequal position. That was why he went to Var to get as good terms as possible for the company, and also to America. The Government were waking up to the necessity of ordering aluminium, and had sent them a large number of things which they had to get made in that metal. The report and accounts were adopted.

**JOHNSON-LUNDELL ELECTRIC TRACTION CO. (LTD.)**—The report of the directors for the period from April 17, 1900, to April 30, 1901, states that the revenue was insufficient to meet expenses, and the accounts show a deficiency of £4,927. 0s. 1d. While, nominally, the company began its existence on April 17, 1900, it was not ready for business for many months after. Owing to development of unexpected complications and consequent delays in the transfer of patents and the temporary default of some of the underwriting, several months elapsed before the directors felt warranted in incurring any material expenditure. Whereas (the report continues) some of the company's inventions had already been put in marketable form, others had only been incorporated in experimental form. It was anticipated that immediate business could be done with the former while the latter was being commercially standardised. But the difference between English and American engine speeds had not been taken into account in these calculations, and the consequent necessity for re-standardising the whole line of generators to conform to English requirements. This involved delay. The work of standardising has been completed, and the company's inventions now comprise (1) dynamos, (2) motors and controllers, and (3) tramway surface contact system. As to dynamos, a fair beginning has been made in the introduction of this apparatus, and sample equipments of two distinct types of motors are now in England and about ready for formal trial, which has been arranged to take place upon the Blackburn tramways. The third and highest development of the company's type of railway motors is in process of construction under the supervision of Mr. Lundell in America, and the company's surface contact system will shortly be put in practical operation on a commercial scale in this country.

**MERSEY RAILWAY CO.**—At the half-yearly meeting on Wednesday, the chairman (Mr. J. Falconer) referred to the contract for the conversion of the line to electric traction, and said steam traction was not suitable for a tunnel railway such as theirs. After some preliminary investigation they had resolved to apply to Parliament for power to work the line electrically, to re-arrange the capital, and to raise capital by issuing first debenture stock. Their 1900 Act, he thought, provided for all those matters. The company were free from the burden of arrears which had accumulated, were authorised to construct electrical works, to raise the necessary capital, and had five years in which to extricate themselves from their unhappy position. They had to find capital to pay off the redeemable stock of £249,000, to enter into a contract for converting to the best system of electric traction suited to the line, and to find capital to pay the contract price for the work. Considering all the circumstances, the board resolved to enter into an agreement with the British Westinghouse Electric and Mfg. Co., and as the result of lengthy negotiations a system of electric traction suitable for working the railway was devised. The design was prepared by the engineers of the Westinghouse Company, the directors had had various reports upon it from railway men and engineers, and it had also been carefully considered by their own traffic manager and other members of their staff. The contract contained a guarantee that the line should be worked at a cost not exceeding 6¾d. per train mile, compared with 1s. 3d. at present. The total amount to be paid to the Westinghouse Company for the financial obligations undertaken by them and for the execution of the works was £635,303, payable to the extent of £620,000 in 4 per cent. first perpetual debenture stock and the balance in cash. The contractors were to find the money with which to redeem the redeemable stock (about £250,000) and also to guarantee interest during construction. He thought the Westinghouse Company would make a good profit out of the contract, but they incurred very serious responsibilities. The period for completing the works was 18 months from the signing of the contract, and the directors hoped that early in 1903 the Mersey Railway would be worked by electric traction. Smoke and fumes would be abolished, there would be a much more frequent service, the length of the trains could be adapted to the traffic to be accommodated from time to time throughout the day, their speed could be increased, and, above all, the company would have well lighted stations and carriages, and be able to give a clean, comfortable and expeditious service, which would compare with any other method of travelling between one side of the Mersey and the other. There would be a substantial reduction in working expenses, and the improved conditions would cause a great increase in the traffic. The receivership was terminated on the 7th ult., and the directors were again in full control of the company's affairs. The report was adopted.

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## NEW COMPANIES, STATUTORY RETURNS, &c.

**ILFRACOMBE ELECTRIC LIGHT AND POWER CO. (LTD.)**—Reg. Sept. 16, capital £15,000 in £5 shares, to carry on the business of electrical engineers, electricians, manufacturers of electrical apparatus, producers of light, heat, sound and power by electricity, &c. The subscribers are F. E. Gripper, engineer, A. Anderson, engineer, H. J. Read, electrical engineer, F. Payton, G. F. Barrow, H. J. Stewart, L. A. Hard, electrical engineer.

**JOHN SAXBY (LTD.)**—Reg. Sept. 20, capital £20,000 in £1 shares, to acquire the business carried on by Mr. J. Saxby, at Creil, France, and to carry on the business of railway and other signal manufacturers, mechanical and electrical engineers, &c. The first directors are J. Saxby, J. Saxby, jun., Jas. Saxby and W. E. Brock.

**BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.)**—On Sept. 4 the capital was £50,000 in £1 shares, 40,000 of which have been taken up. £1 per share has been called and paid on 20,000 and 20,000 shares are considered as fully paid. No mortgages or charges.

**CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)**—The capital at June 28 was £120,000 in 60,000 ordinary and 60,000 preference shares of £1 each, all taken up. £1 per share has been called up and paid on 100,000 shares, and the remaining 20,000 are considered as fully paid. No mortgages or charges.

**COLUMN PRINTING TELEGRAPH SYNDICATE (LTD.)**—In the return to Aug. 14 the capital is given as £25,000 in 500 shares of £50 each, 289 of which have been taken up. £50 per share has been called upon 189 shares and £8,940 has been received, leaving £510 in arrears. £5,000 is considered as paid on 100 shares. No mortgages or charges.

**CHILI TELEPHONE CO. (LTD.)**—The capital on Aug. 16 was £250,000 in 50,000 shares of £5 each, 44,000 of which have been taken up and paid for in full. Mortgages and charges £56,000.

**CROMPTON & CO. (LTD.)**—The capital on Aug. 15 was £300,000 in £3 shares, 85,000 of which have been taken up. £2 per share has been called up on 52,000 and £2. 10s. per share on 31,000 shares. £6,000 is considered as paid on the remaining £2,000 shares. No mortgages or charges.

**EXCHANGE TELEGRAPH CO. (LTD.)**—The annual return to Aug. 14 gives the capital as £246,250 in 8,125 "A" and 16,500 "B" shares of £10 each. 8,023 "A" and 16,200 "B" have been taken up. £9 per share has been paid up on 6,000 "A" and £1 per share on 2,023 "A" shares. 16,200 "B" are considered as fully paid, and £8 per share is considered as paid on 2,125 "A." No mortgages or charges.

**GLOBE TELEGRAPH AND TRUST CO. (LTD.)**—On Aug. 13 the capital was returned at £5,000,000 in 250,000 preference and 250,000 ordinary shares of £10 each, of which 180,042 preference and 180,227 ordinary have been taken up. £10 has been called and paid on each share. No mortgages or charges.

**JANDUS ARC LAMP AND ELECTRIC CO. (LTD.)**—The return to July 30 gives the capital as £30,000 in 3,000 shares of £10 each, 2,041 of which have been taken up. £5 per share has been called on 1,195 and £10 per share on 250 shares. 596 shares are considered as fully paid. Mortgages and charges, £7,094. 4s. 7d.

**LANGDON-DAVIES ELECTRIC MOTOR CO. (LTD.)**—The return to Aug. 12 gives the capital as £70,000, in 20,000 preference and 50,000 ordinary shares of £1 each, of which 16,100 preference and 49,274 ordinary have been taken up. £1 per share has been called up on 17,907, and £17,907 has been received. No mortgages or charges.

**SUNBEAM LAMP CO. (LTD.)**—In the return to Aug. 23 the capital is given as £25,000 in 2,500 shares of £10 each, 1,765 of which have been taken up. £10 per share has been paid up on 903 shares and 857 are considered fully paid. Mortgages and charges, £5,150.

**THOMAS PARKER (LTD.)**—The annual return to July 22 gives the capital as £75,000 in 7,500 £10 shares, all taken up. £10 per share has been called up and paid on 5,750 shares, and the remaining 1,750 are considered as fully paid. Mortgages and charges, £57,000.

**UNITED RIVER PLATE TELEPHONE CO. (LTD.)**—The capital on July 15 was £500,000 in 40,000 preference and 60,000 ordinary shares of £5 each, of which 40,000 preference and 58,000 ordinary shares were taken up. £5 per share has been called up and paid on 40,000 preference and 42,000 ordinary shares. 16,000 ordinary shares are considered as fully paid. Mortgages and charges, £179,947.

**WEST AFRICAN TELEGRAPH CO. (LTD.)**—The annual return to July 19 gives the capital as £400,000 in 40,000 shares of £10 each, 23,109 of which have been taken up and paid for in full. Mortgages and charges, £139,300.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26⅞d. per oz. (Sept. 26). Consols (2¾ per cent.) 93—93⅛ for money, 93—93⅛ for account; 2½ per cent. 94¼—94⅜ (Sept. 26). Consols Pay Day, Oct. 2; Stocks and Shares Continuation Days, Oct. 9 and 23; Ticket Days, Sept. 26 and Oct. 10; Pay Days, Sept. 27 and Oct. 11; Mining Share Carry-over Days, Oct. 8 and 22.

**BRITISH INSULATED WIRE CO. (LTD.)**—This company announce that transfers can now be certified and lodged for registration at the company's London office, Lennox House, Norfolk-street, Strand, W.C.

**CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.)**—An issue is being made of 10,000 £5 shares to provide capital for the new generating station in the Alipore district and for extensions of mains. The issue is made at a premium of £1, and existing shareholders are to have the first option of subscribing.

**DIRECT SPANISH TELEGRAPH CO. (LTD.)**—In addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., tax free, on the ordinary shares for the half-year ended June 30 has been declared, payable Oct. 1.

**DIRECT WEST INDIA CABLE CO.**—A meeting of this company was held yesterday.

**EASTERN TELEGRAPH CO. (LTD.)**—A dividend at the rate of 3½ per cent. per annum, less tax, on the preference stock of this company is announced for the quarter ending Sept. 30, and the usual interim dividend of 1½ per cent. on the ordinary stock, tax free, in respect of profits for the quarter ended June 30. The transfer register will be closed from Oct. 7 to 15 inclusive.

**EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)**—An interim dividend of 2s. 6d. per share, tax free, for the quarter ended June 30, is payable on 15th prox. The share register will be closed from 7th to 14th prox. inclusive.

**ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)**—A meeting of debenture holders of this company was held last week for considering resolutions to postpone date for repayment of existing debentures from Oct. 1, 1901, to July 1, 1904, and empowering the company to issue further first debenture stock for £25,000. The chairman (Mr. J. MacFarlan) said the industrial crisis in Germany, and a tightness of money in England had proved two adverse factors for the company in its financial operations. The company's business continued to increase. The proposals submitted by the directors were approved.

**EVERED & CO. (LTD.)**—An interim dividend at the rate of 7½ per cent. per annum for the half-year to June 30 has been declared.

**GLOBE TELEGRAPH AND TRUST CO.**—An interim dividend of 1s. 9d. per share has been declared on the ordinary shares.

**HALIFAX AND BERMUDAS CABLE CO.**—A meeting of this company was held yesterday.

**LEAMINGTON AND WARWICK TRAMWAYS AND OMNIBUS CO.**—The directors announce that a provisional order for working the tramways by electricity in Leamington has now been granted, and arrangements for converting the line are in progress. Mr. E. Garcke has been appointed chairman in place of Mr. R. C. Heath.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange Committee has appointed Oct. 2 as a special settling day in the further issue of 10,436 ordinary £5 fully-paid shares (Nos. 40,501 to 50,936) of the *Chelsea Electricity Supply Co. (Ltd.)*, and has ordered the same, together with the further issue of £100,000 4½ first debenture stock of the *Calcutta Tramways Co. (Ltd.)* to be quoted. The committee has also been asked to allow the further issue of £100,000 4 per cent. first mortgage debenture stock of the *London United Tramways (Ltd.)*, and the further issue of 10,000 6 per cent. cumulative preference £5 fully paid shares (Nos. 70,001 to 80,000) of *Willans and Robinson (Ltd.)* to be quoted.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | .. | .. | ... | ... | ... |
| *Birmingham Tramways. | Sept. 21 | 4,916 | + 233 | 11 | 53,074 | + 3,829 |
| *Blackburn Corporation.. | „ 20 | 570 | + 71 | 38 | 18,983 | + 1,883 |
| Blackpool Corporation... | „ 19 | 1,573 | + 215 | †25 | 31,056 | + 7,618 |
| Blackpool and Fleetwood | „ 21 | 1,003 | - 37 | 12 | 16,954 | + 59 |
| Bolton Corporation ..... | „ 22 | 1 502 | + 122 | 25 | 38,570 | + 3,733 |
| Bradford Corporation... | „ 15 | 1,314 | + 708 | 24 | 26,523 | +14,196 |
| Brisbane Trams ..... | Aug. 7 | 1,867 | - 419 | 32 | 65,359 | + 8,500 |
| *Bristol Trams & Carriage | Sept. 20 | 4 130 | + 575 | 11 | 45,582 | + 5,935 |
| *Buenos Ayres & Belgrano | Aug. 25 | 2,625 | + 603 | 8 | 20,772 | + 3,711 |
| Calcutta Trams. Co. ... | Sept. 21 | R21,109 | +R6,973 | 12 | R146,011 | +R14,759 |
| Carlisle Trams. Co. ..... | „ 21 | 182 | - 26 | 12 | 2,543 | + 81 |
| Central London Railway | „ 21 | 5,873 | + 982 | 12 | 68,090 | ... |
| City & South London Ry. | „ 22 | 2,040 | + 521 | 12 | 22,270 | + 4,223 |
| Cork Elec. Trams ..... | „ 19 | 564 | + 87 | 37 | 17,850 | + 2,126 |
| Dover Corporation ..... | „ 21 | 256 | - 29 | 25 | 6,402 | + 293 |
| Dublin & Lucan Rly. ... | „ 22 | 99 | - 8 | 12 | 1,638 | + 251 |
| Dublin United ..... | „ 20 | 3,686 | + 20 | ‡12 | 47,693 | + 1,314 |
| Dublin Southern Dist.... | „ 20 | 833 | - 117 | ‡12 | 13,616 | |
| *Dundee Corporation ... | „ 18 | 688 | + 213 | 12 | 8,533 | + 2,852 |
| *Glasgow Corporation ... | „ 21 | 13,959 | +4,145 | 15 | 185,935 | +44,983 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation..... | „ 21 | 1,658 | + 352 | 12 | 20,736 | + 4,779 |
| Liverpool Corporation... | „ 14 | 9,649 | + 602 | 37 | 330,324 | +42,906 |
| *Liverpool Overhead Rly. | „ 22 | 1,565 | - 224 | 12 | 23,531 | - 464 |
| *Manchester Corporation | „ 21 | 2,128 | ... | §15 | 30,063 | - 38 |
| Perth (W.A.) Elec. Trams | .. | ... | ... | ... | ... | ... |
| Portsmouth Corporation | „ 21 | 952 | - 107 | ... | ... | ... |
| *Sheffield Corporation ... | „ 22 | 3,688 | +1,058 | 12 | 45,406 | +14,210 |
| Southampton Corporat'n | „ 18 | 999 | + 234 | 12 | 12,072 | + 3,611 |
| Southend Corporation... | „ 21 | 286 | ... | 9 | 3,013 | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
*Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 18. | | Price Wednesday, Sept. 25. | | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending Sept. 25. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'ckb'rn & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ... | ... | ... | ... | ... | ... | ... | ... |
| £100,000 | Stock | 33/3 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 97 | 102 | 97 | 102 | ... | ... | ... | ... |
| 7,500 | 10 | 12 0 | Bournemouth and Poole Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ | 10½ | 9½ | 10½ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 106 | 102 | 105 | 4 6 7 | ... | ... | ... |
| 15,661 | 5 | 2/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ | 8¼ | 7⅞ | 8¼ | 4 4 10 | ... | ... | ... |
| 12,000 | 5 | 2/6 | Do. 7 per Cent. Preference | 8¼ | 8¾ | 8¼ | 8¾ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅞ | 8 | 7⅞ | 8 | 2 3 9 | ... | 7⅞ | 7¼ |
| 50,000 | 5 | 4 0 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 5 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5½ | 5¾ | 3 18 3 | ,, ,, | ... | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 103 | 105 | 103 | 105 | 3 15 11 | ... | 104¾ | 103¼ |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5½ | 6 | 5¾ | 5¾ | 4 15 8 | March | 5⅛ | 5⅛ |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 1 4 | June and December | ... | ... |
| 70,579 | 10 | ... | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | ... | February and August | 8¾ | 8¾ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11½ | 12½ | 11½ | 12¼ | 4 16 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 121 | 126 | 121 | 123 | 4 0 2 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | 4 8 4 | ... | 103 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8 | 9 | 4 8 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 12 4 | March and September | ... | ... |
| £400,000 | Stock | 4½% | Do. 4% Deb. Stock (all pd.) (red.) | 103 | 106 | 103 | 106 | 4 5 11 | ... | ... | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5½ | 5¾ | 5½ | 5¾ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅞ | 8¼ | 7⅞ | 8¼ | 2 10 0 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 8 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6¾ | 7 | 6¾ | 7 | 4 5 9 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) (Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 17 6 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensts. & Knghtbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 103 | 105 | 103 | 105 | 3 17 8 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 42,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £280,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 98,767 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13 | 14 | 4 5 9 | April and October | 13½ | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 8 | June and December | ... | ... |
| £260,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 3 | ... | ... | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15 | 16 | 4 4 10 | March | 15¾ | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5¾ | 6¼ | 5¾ | 6¼ | 3 16 11 | ,, ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 | 102 | 99 | 102 | 3 19 0 | ... | ... | ... |
| 400,000 | 1 | ... | Rand Electric | ⅞ | 1 | ⅞ | 1 | ... | ... | ... | ... |
| £135,000 | Stock | ... | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 60 | 70 | 60 | 70 | ... | January and July | ... | ... |
| £107,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mort. Debs. | 102 | 104 | 102 | 104 | 4 8 5 | April and October | ... | ... |
| 40,000 | 5 | 5 0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15¾ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9¾ | 8¾ | 9¾ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 6 | ... | ... | ... |
| 13,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 90 | 90 | 86 | 90 | 4 9 6 | ... | ... | ... |
| 66,000 | 5 | ... | South London Electric Supply Ordinary | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 109,513 | 5 | 5 0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 12½ | 12½ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4½ | 4⅝ | 4½ | 4⅝ | 4 11 5 | April and October | 4⅝ | ... |
| £220,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 125 | 128 | 125 | 128 | 4 14 10 | ... | 125⅜ | ... |
| 20,000 | 10 | ... | Barcelona Tramways Ordinary | 8 | 9 | 8 | 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 96 | 101 | 96 | 101 | 4 19 9 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 18 6 | ... | ... | ... |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 13 | 14 | 4 19 10 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | 4⅜ | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 103 | 105 | 103 | 105 | 4 6 7 | ... | ... | ... |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary | 21½ | 22½ | 21½ | 22½ | 3 13 4 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 113 | 115 | 113 | 115 | 3 10 2 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 | 6¼ | 6 | 6¼ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9¼ | 9⅝ | 9¼ | 9⅝ | 5 2 7 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 101⅝ | 103⅞ | 101⅞ | 103⅞ | 4 9 1 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 14 | 15 | 14 | 15 | 6 0 0 | ... | 14⅛ | 14⅛ |
| 90,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11⅞ | 12½ | 11⅞ | 12⅛ | 4 18 0 | February and August | 12⅛ | 12 |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 123 | 126 | 123 | 123 | 4 1 0 | ... | 124⅛ | 123⅛ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅜ | 1⅞ | 1½ | 2 | ... | ... | 1⅝ | ... |
| 40,000 | 5 | 2/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5⅝ | 5¼ | 5⅝ | 5 4 4 | ... | 5⅝ | ... |
| 27,500 | 5 | 2/6 | Do. "B" | 5¼ | 5⅝ | 5¼ | 5⅝ | 2 3 6 | ... | ... | ... |
| £230,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 14 7 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 98 | 101 | 93 | 101 | 5 0 2 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11½ | 12½ | 11½ | 12½ | 2 8 0 | ... | 12 | 11½ |
| £350,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 105 | 107 | 105 | 107 | 4 5 1 | ... | 105½ | ... |
| 400,000 | 1 | 1½ | Cape Electric Tramways Shares | 1⅛ | 2⅛ | 1⅛ | 2⅛ | 2 16 6 | ... | ... | ... |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock | 102 | 106 | 104 | 105 | 3 16 2 | June and December | 104⅜ | 102⅜ |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 105 | 103 | 105 | 108 | 3 14 1 | ... | 106⅜ | 105⅜ |
| £440,100 | Stock | ... | Do. Deferred Stock | 93 | 101 | 93 | 101 | ... | ... | 99⅜ | ... |
| £666,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 118 | 118 | 113 | 118 | 3 8 3 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ | 5⅝ | 5¼ | 5⅝ | 4 6 11 | ... | 104⅝ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 103 | 106 | 103 | 104 | 3 6 11 | ... | ... | ... |
| £315,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 51 | 54 | 51 | 54 | 2 15 7 | February and August | 51 | ... |
| 47,500 | 10 | 2/0 | Do. Ordinary (Nos. 22,501 to 70,000) | 5 | 5½ | 5 | 5½ | 3 1 9 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 | 134 | 129 | 134 | 3 15 2 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 128 | 137 | 128 | 137 | 3 19 2 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 | 118 | 113 | 118 | 3 8 6 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 12 | 13 | 12 | 13 | 3 16 11 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 17 5 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 21½ | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 111 | 113 | 4 0 6 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 7 | 7½ | 6¾ | 7 | 3 13 7 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference xd | 12½ | 13 | 12½ | 13 | 3 16 11 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 104 | 103 | 104 | 3 17 8 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 15 6 | ... | 105 | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 8 6 | ... | ... | ... |
| £80,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908) | 100 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) | 100 | 102 | 100 | 102 | 4 8 11 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 | 3½ | 3 | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | 1 12 0 | ... | ... | ... |
| 20,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10½ | 4 15 3 | February and August | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 106 | 109 | 106 | 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | ... | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | ... | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 92 | 95 | 91 | 94 | 3 3 10 | June and December | 92⅜ | 92 |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 19. | | Price Wednesday, Sept. 25. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Sept. 25. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ | 4⅛ | 3⅜ | 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 | 83 | 78 | 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 | 56 | 53 | 56 | 5 11 9 | Feb., May, Aug., Nov. | 54⅜ | 53½ |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 | 100 | 98 | 100 | 6 1 3 | ,, ,, | 99½ | 98½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10⅜ | 11⅛ | 10⅛ | 10⅜ | 2 6 6 | ,, ,, | 10⅛ | ... |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock | 175 | 185 | 175 | 185 | 4 6 8 | Jan., Apr., July, Oct. | | |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 18 1 | ,, ,, | 102½ | 101⅜ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 | 6 | 5 | 6 | 7 10 0 | February and August | .. | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 13½ | 14½ | 13⅜ | 14½ | 6 17 11 | ,, ,, | ... | ... |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ | 104⅞ | 100⅞ | 104⅞ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10⅜ | 11⅛ | 10⅛ | 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | 11 | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 | 103 | 100 | 103 | 4 8 4 | June and December | ... | ... |
| £1,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 142 | 147 | 142 | 147 | 4 15 3 | Jan., Apr., July, Oct. | 145 | ... |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 99 | 96 | 99 | 3 11 0 | ,, ,, | 96½ | 16 |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 116 | 113 | 116 | 3 10 0 | May and November | 116 | ... |
| 300,000 | 10 | 2/6 | Eastern Extension | 14 | 14½ | 14 | 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14⅞ | 14⅞ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 115 | 120 | 114 | 119 | 3 7 6 | February and August | 114 | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 18 1 | February and August | 100½ | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 18 3 | May and November | ... | ... |
| 150,000 | 10 | 5 0 | Great Northern of Copenhagen | 30 | 32 | 30 | 32 | 4 13 9 | January and July | ... | ... |
| £78,006 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (within Nos | 100 | 103 | 100 | 103 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red. | 41 | 45 | 41 | 45 | 5 11 1 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 102 | 105 | 103 | 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 18 5 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 99 | 102 | 99 | 102 | 4 17 10 | March and September | 103½ | .. |
| 30,008 | 2½ | ... | West Coast of America | ¼ | ¾ | ¼ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 18 5 | January and July | ... | ... |
| 88,321 | 10 | ... | West India and Panama | ¼ | ½ | ¼ | ½ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 | 6 | 5 | 6 | ... | ,, ,, | 5¼ | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 | 5 | 3 | 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 | 104 | 101 | 104 | 4 17 4 | January and July | ... | ... |
| 20,930 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 14¼ | 14⅝ | 14¼ | 14⅝ | 4 14 11 | Mar., June, Oct., Dec. | 14 11/16 | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 | 105 | 103 | 106 | 4 15 6 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 103 | 103 | 3 16 2 | ... | 105 | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) | 3½ | 4 | 3½ | 4 | 6 5 0 | August | ... | .. |
| 224,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | ... | | 2/6 | | 6 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¼ | ½ | ¼ | ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | ... | .. |
| 590,000 | 5 | 2/6 | National | 3⅝ | 3⅞ | 3⅛ | 4⅛ | 6 1 3 | February and August | 4 | 3 15/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 | 14 | 12 | 14 | 4 5 9 | ,, ,, | 13 | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 | 14 | 12 | 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4⅜ | 4⅝ | 4¼ | 5 | 5 0 0 | ,, ,, | 4 15/16 | 4⅜ |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 | 98 | 95 | 98 | 3 12 0 | June and December | ... | ... |
| £500,000 | Stock | 4% | * Do. 4 per Cent. Debenture Stock (red.) | 95 | 98 | 95 | 98 | 4 2 6 | ... | ... | ... |
| 171,504 | 1 | 0/8½ | Oriental | ¾ | 1 | ¾ | 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 | 5½ | 5 | 5½ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅜ | 5⅛ | 4⅜ | 5⅛ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 16 5 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅝ | ¾ | ⅝ | ¾ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 7/16 | 9/16 | 7/16 | 9/16 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅝ | ¾ | ⅝ | ¾ | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 8 | 9 | 8 | 9 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 5 4 4 | January and July | 5¾ | ... |
| 110,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ | 5¼ | 4¾ | 5¼ | 5 14 3 | ... | 5 | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅝ | 1¾ | 1⅝ | 1¾ | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 | 2¼ | 2 | 2¼ | 5 6 8 | ,, | 2 1/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 102 | 105 | 102 | 105 | 4 5 9 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 | 102 | 99 | 102 | 4 9 1 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 | 18 | 15 | 16 | 4 13 9 | ,, ,, | 15⅜ | 15½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¼ | 6¼ | 5⅜ | 6¼ | 4 0 0 | ,, ,, | 6 1/16 | 6 |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 19 6 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 | 95 | 92 | 95 | 4 15 6 | ... | ... | ... |
| 60,000 | 1 | 1/0 | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 5 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3¼ | 3⅜ | 3⅛ | 3⅜ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red. | 100 | 105 | 100 | 105 | 4 15 8 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ¼ | ½ | ¼ | ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ | 2½ | 1½ | 2½ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 | 85 | 80 | 85 | 4 15 3 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 85 | 90 | 85 | 90 | 5 14 3 | ... | ... | ... |
| 35,350 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5¾ | 6¼ | 5⅜ | 6¼ | 5 12 0 | Half-yearly | 6 | ... |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5½ | 6 | 5½ | 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 | 107 | 104 | 107 | 4 4 4 | ... | 103 | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. | 1⅞ | 2⅛ | 1⅞ | 2⅛ | 5 6 8 | January and July | ... | ... |
| 31,300 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅛ | 2⅜ | 2⅛ | 2⅜ | 5 1 10 | July | 2 1/16 | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 | 102 | 98 | 102 | 3 18 10 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅞ | 10⅛ | 9⅞ | 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 27/10 | Do. 4% 1st Mortgage Debentures | 99 | 102 | 99 | 102 | 3 19 7 | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary | 16½ | 17½ | 16½ | 17½ | 6 1 5 | February and August | 17½ | 17 |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 110 | 114 | 110 | 114 | 3 19 3 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21½ | 22½ | 22 | 23 | 4 6 11 | ,, ,, | 22⅝ | 22½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) xd | 101 | 104 | 100 | 103 | 3 17 7 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 38 | 42 | 38 | 42 | 5 0 0 | March and July | 40½ | 39 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 | 106 | 104 | 106 | 3 16 2 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ | 11¼ | 10½ | 11½ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¾ | 6¼ | 5¾ | 6¼ | 4 0 0 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 | 11 | 10 | 11 | 5 9 0 | April and October | 10¾ | 10 |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ | 7 | 6½ | 7 | 4 5 9 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 7 | May and November | 107 | 103 |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 | 6 | 5 | 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 10⅞ | 11½ | 11 | 11⅝ | 4 11 4 | Jan., Apr., July, Oct. | 11¾ | 11 |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15⅝ | 14⅞ | 15⅝ | 3 18 8 | ,, ,, | 15 15/16 | 14 15/16 |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 127 | 132 | 127 | 132 | 4 12 6 | ,, ,, | 129 | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these

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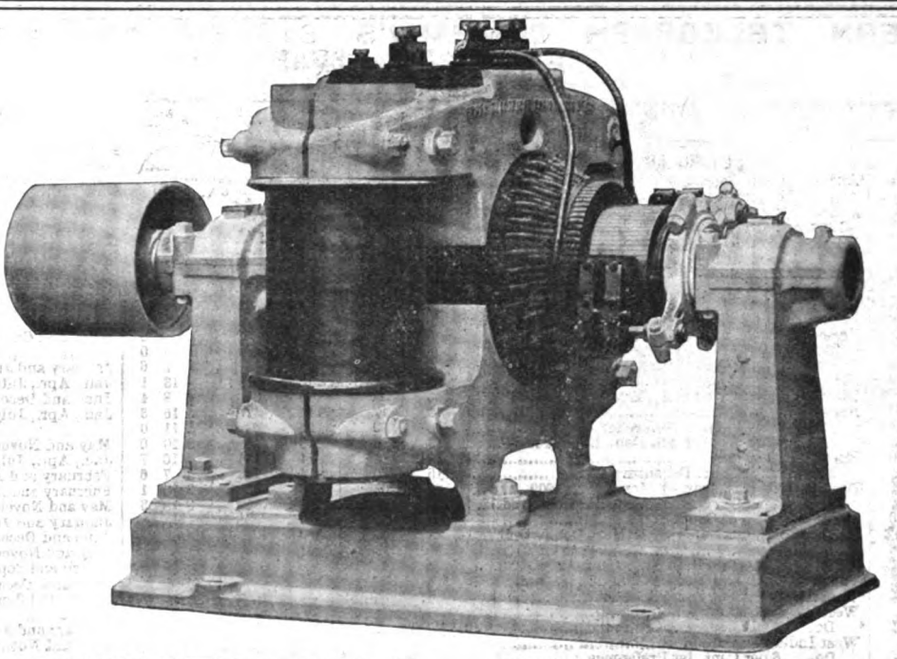

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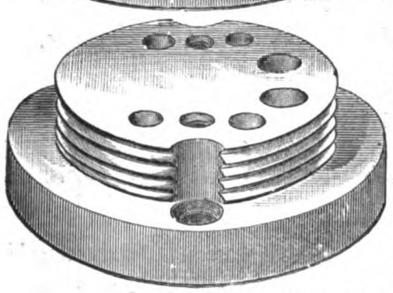

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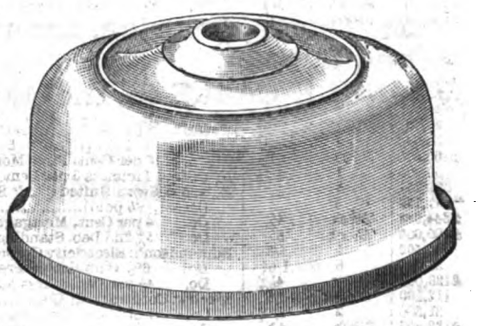

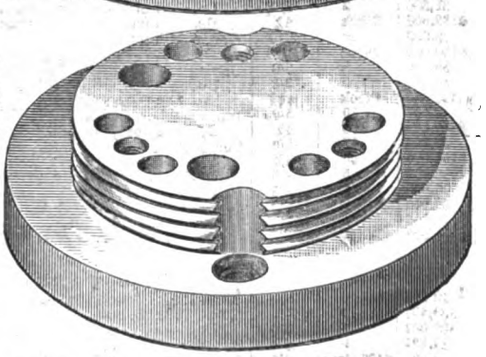

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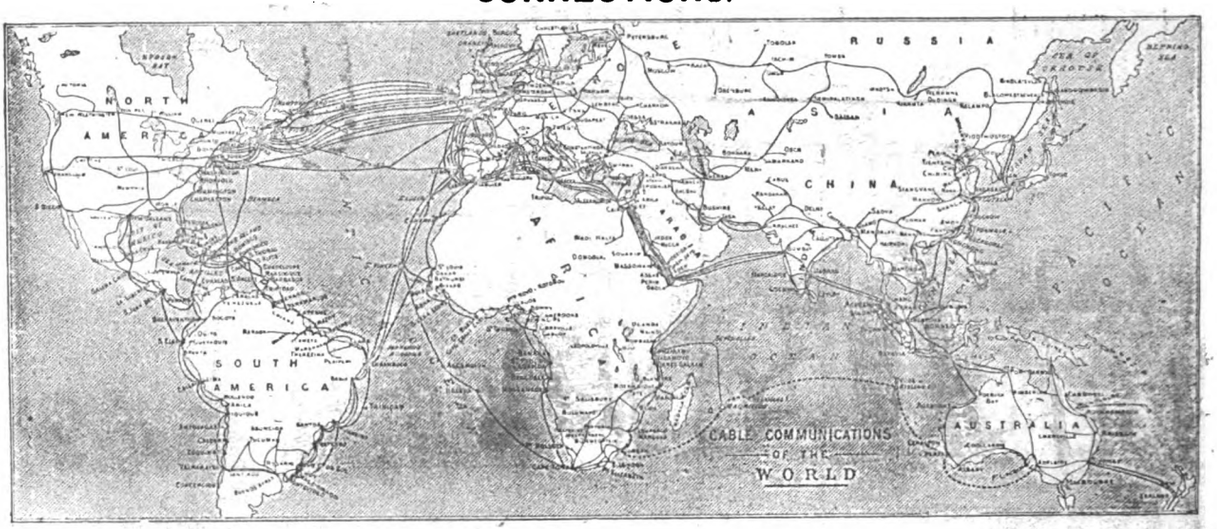


THE

# EASTERN TELEGRAPH COMPANY

IN CONNECTION WITH THE (LIMITED).

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,220. [No. 24. Vol. XLVII.] FRIDAY, OCTOBER 4, 1901. PRICE SIXPENCE (by post, 6d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.


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## NOTES.

As forecasted in our issue of Sept. 20, the Hon. A. LYTTELTON has been appointed arbitrator by the Board of Trade to settle the disagreement between the Metropolitan and Metropolitan District Railway Companies as to the system to be adopted for the electrical equipment of the Inner Circle. The first sitting is to take place next Monday. Our sympathies are with Mr. LYTTELTON in the difficult and intricate problem before him; and if, as may be anticipated, he finally arrives at a satisfactory solution, he will have earned the thanks not only of the London public, but also of the electrical engineering profession.

JUDGING from recent correspondence in *The Times* the parties to this grave disagreement are still at complete variance. Each side professes to feel the most sincere desire for an early settlement of the difficulty—but only if the settlement is to be in full accord with its own prejudged plans. Thus the deadlock must be carried unchanged into the arbitration room. Meanwhile the element of personal animosity has lamentably crept into the discussion, one side accusing the other of "delaying the plans for electrifying (*sic*) the underground railways," and the other side charging its opponent with having "prevented Messrs. GANZ from coming to London to start on the arbitration." Acrimonious wrangling can do nothing to advance the interests of either party, but must, on the contrary, tend to delay the final happy settlement. It is to be hoped that the proceedings within the arbitration chamber will be rigorously kept free of any tinge of it.

NOT only is this dispute causing delay in the long-needed electrical equipment of the Inner Circle, it is also exerting an injurious influence in other quarters. Probably the full extent of this injury will never be known, but, at any rate, the taunt was flung in the teeth of electrical engineers by the chairman of the Mersey Railway Co. at the recent shareholders' meeting that they "were not agreed upon the best system of electric traction." Fortunately, the directors have overcome this difficulty by entering into a contract with the Westinghouse Company, though it is quite conceivable that if the urgency for electrical equipment had not been so pressing, they might have decided to wait until the rival electrical systems had finished their duel. Doubtless not a few railway directors in this country have complacently adopted this passive attitude of mind—to the detriment of electric railway progress. The electrical engineering profession may justly plume itself on the flexibility and elasticity of its methods, and on the fact that it possesses more than one string to its bow; but it must not forget ÆSOP's fable which records the triumph of the cat with only one shift.

To the current number of *Traction and Transmission* Dr. J. A. FLEMING contributes an interesting and timely article on "The Education of Electrical Engineers," in which he embodies conclusions from his own personal experiences as a teacher. According to Dr. FLEMING the education of "the young electrical engineer" should begin "in the cradle." This does not err on the side of delay, but the practical difficulty occurs to us, as to how the fond parents are to know that the cradled infant *is* a "young electrical engineer." Perhaps he is a young Archbishop or Lord Chancellor. The same difficulty arises in connection with the derided teaching of Latin and Greek grammar when the boy is at school. Are *all* boys to forsake the classical languages and "commence with mechanical drawing taught on the drawing board," in order that the few who ultimately become engineers may look back upon a thoroughly technical and utilitarian education extending through their school days? If not, how are the embryo engineers to be discerned and separated from the rest of the flock by an anxious head-master? In fine, do not many educational reformers overlook the fact that special education, as such, can only begin at the age when a special career has been selected, or when the bias towards it has been clearly shown? This age is rarely below 15 or 16 in

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boys of the middle class. With the programme drawn up by Dr. FLEMING for the student, after he enters upon his special studies, we are in perfect accord. He gives excellent reasons why the technical college course should precede and not succeed the works training; and he recommends about three or four years at the technical college and one or two at works. The concluding portion of the article gives an admirable description, with illustrations, of the Pender electrical engineering laboratory and other engineering departments, at University College, London.

IN the Queensland Court of the Glasgow Exhibition there is exhibited a boiler which should be interesting to engineers, inasmuch as it embodies a radical departure from the usual principles of boiler construction. It is the invention of Mr. BRABY, of Queensland. The essential feature of this boiler is the reduction of water space to the lowest possible limit, and the substitution of massive copper slabs as the reservoir of heat, in place of heated water. The chief source of danger in a boiler is the hot water it contains under pressure, and the larger the water space the more damage will a boiler do when it explodes. On the other hand, the hot water, serving as a reserve of steaming power, enables the boiler promptly to meet any sudden increase in the demand for steam. Several inventors have devised inexplosive boilers by removing practically all the water space and causing the boiler to evaporate a thin stream of water directly this is injected on to the heating surface. Such boilers are practically full of steam. But it has been reserved for Mr. BRABY to modify this type of boiler by providing it with a much greater heat capacity than the ordinary design, at the same time retaining the inexplosive character.

THE heating surface in the Braby boiler consists of large slabs of copper through which the steam passages are drilled out. These slabs are placed in the furnace and are exposed to the hot gases on their outer surfaces. The feed water, having been previously heated in a cooler part of the furnace, is forced by a pump into the passages through these copper slabs, and is instantly raised to steam. Should any sudden demand for more steam arise, Mr. BRABY claims that all that it is necessary to do is to turn on more water, the reserve of heat stored in the mass of the copper slabs promptly evaporating the required larger amount. It is impossible not to admire the ingenuity with which Mr. BRABY has thus provided the inexplosive boiler with a valuable feature which it ordinarily lacks, and we can quite readily perceive that the Braby boiler would have much greater stability of steaming power than the ordinary inexplosive boiler. On the other hand, copper is by no means so good a heat reservoir as water; the intrinsic thermal energy of 1lb. of water at the boiling temperature is far greater, and its steaming value is therefore greater, than is the case with 1lb. of copper. Moreover, the cladding of the heating surfaces with masses of copper will diminish the temperature gradient, or, in other words, increase the thermal resistance, between the furnace and the steam sides of the heating surfaces, and the effect of this will be to reduce the efficiency and steaming power of each square foot of that surface. Accordingly, we should expect that a much larger proportion of heating surface would be necessary in the Braby type of boiler. Nor should the extra expense due to the large masses of copper be altogether ignored. Meanwhile, we await the results of independent expert trials of this boiler; and if these should justify all that is claimed for it, there is no doubt that it will find a welcome place in the engineering market.

THE congratulations of the electrical profession throughout the empire are to be tendered to Sir JOHN DENISON-PENDER and those who, with him, have received recognition and honour from their King for services rendered to their country in connection with the campaign in South Africa. As the chief of a world-embracing telegraph cable system, the high honour of a K.C.M.G. bestowed on Sir JOHN DENISON-PENDER is a well-merited recognition of the invaluable assistance which submarine telegraphy has rendered during an over-sea campaign of long duration and Imperial importance. It is an honour conferred on the British telegraphic profession in its entirety. Similarly, the importance of electric lighting and other branches of land electrical engineering in the South African military operations is recognised in a just and liberal spirit by the conferring of a C.B. on Col. R. E. B. CROMPTON, of whose valiant services every electrical engineer is proud.

**The Electrical Engineers (R.E.) Volunteers.**—Included in the latest list of distinctions in connection with the South African War are the following:—Companion of the Order of the Bath: Lieut.-Col. R. E. B. Crompton. Distinguished Conduct Medal: Sergeant W. S. Entwistle and Lance-Corporals R. W. Holliday and J. Rook.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cadiz—Teneriffe | Aug. 6, 1901 |
| Bolama—Bissao | Aug. 16, 1901 |
| Curaçoa—Cora | Sept. 11, 1901 |
| Bolama | Sept. 12, 1901 |
| Gibraltar—Tangiers | Sept. 13, 1901 |
| Zanzibar—Mombasa | Sept. 27, 1901 |

**Wireless Telegraphy in the Navy.**—According to the *Morning Post*, a letter received on Wednesday at Plymouth from the Channel Squadron at Berehaven states that two cruisers successfully advised Roche's Point signal station by wireless telegraphy of the arrival of the vessels at the rendezvous, one being 134 miles away, and the other 162 miles. 162 miles is believed to be a record distance between ship and land.

**Long-distance Electrical Transmission.**—In a Paper read before the recent Convention at Buffalo, Mr. F. A. C. Perrine says that in a line of 100 miles in length, operating at a voltage of 50,000 or 60,000 volts and a frequency of 50, the charging current amounts to something in excess of 2,000 kilovolt-amperes, and employs such a proportion of the capacity at the station for charging the idle lines as to make the introduction of units smaller than 2,000kw. inadvisable, rendering commercially impracticable the transmission of powers less than about 3,000kw., unless the capacity effect be neutralised by the use of reactive coils.

**Fatality at Chatham.**—A coroner's inquest was held at Chatham on Tuesday into the death of James Gray, foreman cable jointer to the Chatham, Rochester and District Electric Lighting Co.

It appeared that Gray had to make some alterations in a sub-chamber in High-street, Chatham. He went into the manhole and knelt on the transformer with the object of temporarily cutting off the electric current. He had an indiarubber glove on the right hand, but a high-tension fuse which he had to remove evidently hung, and in attempting to ease it with his naked left hand he came into contact with the live cable. A fellow

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workman in attempting to pull Gray away received a severe shock and became partially insensible. The movement, however, freed Gray, but death took place immediately. A verdict of accidental death was returned, with a rider that men engaged in such work should wear gloves on both hands.

**A Collision Prevention Device.**—The *Standard* is responsible for the statement that experiments are being made at St. Petersburg with a new device for preventing collisions on railways. The apparatus consists of a pilot bogey which runs some hundred yards in front of the locomotive, to which it is connected electrically. In the event of any obstacle on the line meeting the pilot bogey, the force of the impact, by means of the electrical connections, automatically applies the Westinghouse brake on the entire train. Although the invention is not claimed as an absolute preventative of collisions, it is contended that it will prove most serviceable in foggy weather and under conditions where special caution is required.

**Extension of the Snoqualmie Falls Power Plant.**—We learn from the *Railway and Engineering Review* of Chicago that the Snoqualmie Falls Power Co. has placed an order with the Pittsburg Reduction Co. for 250,000lb. of aluminium wire cable for increasing the capacity of its transmission line between the Snoqualmie Falls and Seattle and Tacoma. The generating station is being enlarged by the addition of a penstock, which will increase the capacity of the plant about 50 per cent. This penstock will feed three water-wheel sets, each one of which will drive a direct-connected Westinghouse 5,000 H.P. generator. The underground cavity will be extended eastward about 150ft. to accommodate the increase. Contracts have been let also for terminal sub-station structures in Tacoma and Seattle, which will probably be completed in 1902. The Snoqualmie plant, when this increase is made, will have a capacity of 25,000 H.P.

**Electric Haulage on Canals.**—We gather from the *Railway and Engineering Review* of Chicago that construction work has been commenced on the Miami and Erie Canal Railway. By the new system of propulsion the boats will be towed by trolley cars running on a standard gauge track laid on the old tow-path. The motor cars will be equipped with 150 H.P. motors and will be capable of hauling 10 heavily loaded canal boats at a speed of 10 miles an hour. This speed will not be maintained, however, the State charter stipulating a maximum speed of 4 miles per hour. The cars will be 7ft. 10in. long and will be about 5½ft. high from the floor to the roof. Doors will open from either side of the car. Steps will also be placed at the ends, where they will connect with a running board at the foot of the car. A railing will extend down both sides. 18 of the cars will be built at once. Each of the cars will weigh 30 tons. They will receive power from the Edison Lighting Co. of Cincinnati, and will be operated from 14 sub-stations scattered along the route.

**Opening of the Longton Electricity Supply Works.**—The inauguration of the new Corporation electricity supply works at Longton took place on September 25th. The site of the station is on the same plot of ground as the gas works, and Mr. W. Langford is both borough gas and electrical engineer. The transformation from gas workshops into engine and battery rooms took place without interfering with the outside form of the buildings. Two Babcock and Wilcox boilers, working at 160lb. pressure, each capable of evaporating 4,200lb. of water per hour, have been installed, and have been specially fitted with Scotch furnaces for the combustion of bituminous coal. A 96-tube Green's economiser is used, and the same firm has supplied the feed pumps, which are of the Cameron type. E.C.C.-Belliss 145kw. steam dynamos are used, the generators being of the inverted bi-polar type, and supply current at 465 volts. A booster balancer combination is employed, and the Chloride battery of 244 cells has the normal capacity of 900 ampere-hours and a maximum discharge rate of 400 amperes. The mains are laid on the Callender solid vulcanised bitumen system, and at present there are three feeding points.

**The Tramway Earthing Arrangements at Poole.**—We have recently had an opportunity of inspecting the arrangement of earth connections on the Poole tramways, which we mentioned on page 316 of the present volume was in accordance with a modification of the Board of Trade regulation which required the earth plates to be fixed at the generating station. At Poole the length of the tramway line is 3¾ miles, the nearest point being 700yds. from the station, and, as the line and rail feeders are connected to the system about 1⅛ miles from the station, under the old conditions there would have been very considerable leakage, which would have probably necessitated the use of a second rail feeder. As it is, the earth plates are fixed at the junction of the feeders with the tramways. An ammeter shunt is placed between the earth-plates and the rail. Two 7/22 S.W.G. pilot wires are brought back to the station to an ammeter, and the maximum reading of this ammeter is recorded each day for the use of the Board of Trade. The method has proved completely satisfactory; the maximum earth current so far registered has been ¾ ampere, and the maximum rail voltage drop has been 5 volts, the usual drop being only 1¾ volts. The line has been working since the commencement of April.

**The First British Submarine.**—We learn from *The Times* that the first submarine boat built for His Majesty's Navy was launched from the yard of Vickers, Sons & Maxim, at Barrow, on Wednesday. She is the first of five similar craft of the Holland type building at the Barrow yard. The launching ceremony was kept as private as possible, and the new boat received neither a name nor a number. She showed great buoyancy. She was towed into the Devonshire dock to be completed, and is there under the guard of the "Hazard." Her dimensions are 63ft. long and 11ft. 9in. beam. She is specially designed on lines to minimise resistance when cruising on the surface, where she will be propelled by a gasoline type of main engine capable of maintaining a maximum speed of about 9 knots on a run of about 400 nauts. When she is submerged an electric main motor will give a speed of 7 knots for a four hours' run. This motor will be worked by means of storage batteries, for the charging of which gearing is provided. The vessel is lighted by portable incandescent electric lamps. Stored compressed air secures the air supply and ventilation, and the gasoline vapours from the engine will be carefully excluded by suitable arrangements. Steering and diving can be regulated either by mechanical or hand appliances. The submarine will undergo experimental trials in waters near Barrow in the course of a few weeks. The other four boats are in a forward state, and will be launched this year.

**Electric Motor Cars at Vienna.**—The *Centralblatt für Accumulatoren und Elementenkunde* gives some details of the electric motor cars shown at the second International Automobile Exhibition in Vienna. The firm of Engl and Hœrde exhibit a waggonette driven by two series motors of the four-pole type. The battery weighs 656kg., and contains 44 Engl cells. The capacity is 258 ampere-hours, with a discharge of 30 amperes or 225 ampere-hours at 50 amperes. One charge suffices for a run of 90-120km. at a speed of between 25km. and 30km. per hour. In a test run the waggonette covered 32·5km. when loaded with seven passengers and 114kg. of sand, in 1 hour 35min. The waggonette empty weighs 2,130kg., or about 2·1 tons. The Genossenschaft Automobil exhibit a voiturette for two or three persons, the weight, without the battery, being 400kg. A 1·6 H.P. series motor is used for driving this vehicle. A second exhibit by this firm is a phæton for two persons, the battery for driving which contains 40 cells, and has a capacity of 55 ampere-hours, with a discharge rate of 18⅓ amperes. The maximum speed of this phæton is 22½km. per hour. A lorry, shown by the same firm, is driven by two 3½ H.P. motors, and weighs empty 2,700kg. and loaded 3,900kg. The battery suffices for a run of 40km. with a load of 1,200kg., and the lorry can take gradients of 12½ per cent. In this case and in that of the phæton the driving is effected through gearing and the rear wheels of the vehicle. The Oesterreichische Elektromobilwerke exhibit a beer waggon, which is designed to carry a load of 5 tons. This vehicle is driven by two 5 H.P. motors. The battery weighs 1,140kg., and has a capacity of 400 ampere-



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hours. When fully charged and loaded, this waggon can accomplish a run of 60km. The waggon and battery weigh together 3,400kg., or nearly 3½ tons.

**Recent American Electric Tramway Practice.**—From a recent article in *Engineering News* of New York, we take some interesting statistics of recent American tramway practice :—

Curves of 75ft. to 150ft. radius are used on suburban and country lines. City lines have curves of 30ft. to 125ft. radius, and sometimes these curves are transitioned. In Philadelphia, curves of 400ft. radius have transition curves 60ft. long, with an initial radius of 3,400ft. ; 33ft. curves have transition curves running out to 180ft. and 368ft. radius at the ends. These transition or spiral curves are now very generally adopted. On sharp curves where guard rails are required, the guage may be widened a sufficient amount to prevent the flange of the wheel from cutting into the tread of the outer rail. Some double-track electric cars have trucks 17ft. 9in. centre to centre ; truck wheel-base, 4ft. 6in. ; wheels, 33in. diameter ; width of tread, 2¼in. ; flanges, ¾in. deep and 1in. thick ; axles, 4½in. diameter. Terminal loops of 33ft. radius have the guage widened ½in., but no elevation is required as the speed is invariably slow. On curves up to 100ft. radius, the guage may be widened ¼in., but beyond that standard guage is commonly used. Curves of 250ft. and 300ft. radius on high-speed lines are sometimes elevated 3½in. to 4in., using a guard rail on the inside. In city streets an elevation of 2in. can sometimes be obtained on sharp curves without undue interference with the paving ; but curves at intersections can have little or no elevation. In Boston the rail is elevated for a speed of 15 miles an hour, where the street construction will permit of using the formula $E=(GV^2)\div(32{\cdot}2R)$. As to the grades, cable railways are operated having grades of 15 to 20 per cent. Electric tramways operate successfully on grades of 8 to 12 per cent., while 5 to 6 per cent. grades are common. Where very heavy grades are encountered, a counterbalance system may be used to assist cars in ascending and to control them in descending. Under the track is a conduit, with a cable connected to a heavy counterweight truck running on rails in another parallel conduit, the cable passing over sheaves at top and bottom of the grade, and suitable apparatus being used for taking up the stock. The car has a grip which seizes the cable, and in ascending it is counterbalanced by the weight running down the conduit, while in descending it has to haul the weight up the grade. This system is used on grades of 16 per cent. at Seattle, Wash., and St. Paul, Minn., and 14 per cent. at Providence, R.I. Such systems might well be more generally employed on grades of 10 per cent. and over, or the grades reduced, as runaway accidents on steep grades are of rather too frequent occurrence.

**A New Photometer.**—According to the *Western Electrician*, a new form of photometer, designed for the rapid measurement of the mean spherical candle-power of incandescent lamps, is now being manufactured under the patents of Messrs. Houston and Kennelly. This instrument is a modified design of the arc light photometer recently described by Prof. R. A. Fessenden. Employing this instrument, it is possible to measure accurately with one setting of the sight box the mean spherical candle-power of any incandescent lamp, regardless of the shape of the bulb or filament. The instrument consists of a funnel-shaped hood, carrying a small mirror in the rim. This hood is mounted in ball bearings, on a substantial iron base, and arranged so that it can be rotated at any desired speed by means of a belt and suitable power. At the bottom of this funnel, and rotating with it, is mounted another mirror, the mechanical construction being such that the beam of light from the incandescent lamp falls on the mirror in the rim of the hood and is reflected to the centre mirror ; from here the beam passes through an opening in the axis of the apparatus and down the photometer track to the screen. At the far end of the axial opening is arranged a circular metallic disc, which revolves at twice the speed of the mirrors. This disc is perforated with different-sized slots, which consecutively pass through and intersect the beam of light, and at regular intervals cut off more or less of it. It is also possible to measure the candle-power of the lamp at any inclination to its axis by merely removing the disc and not rotating the lamp, making the setting at which it is desired to measure the candle-power by means of the scale on the edge of the hood and pointer beneath the lamp. To make a measurement for mean spherical candle-power the lamp to be tested is placed on the adjustable bracket and rotated about its vertical axis at its usual speed for mean horizontal measurements. The hood is set so that the mirrors occupy the same position as in the illustration, and the potential at the lamp terminals so adjusted that the rated candle-power is produced. The hood is then rotated at a suitable speed, between 200 and 300 revs. per min., and another measurement made. This reading will indicate the mean spherical intensity at the same voltage at which the lamp gave the mean horizontal candle-power of 16.

## SIR JOHN DENISON-PENDER, K.C.M.G.

Last Friday's *Gazette* contains the announcement of the bestowal by His Majesty the King upon Mr. John Denison-Pender of the Knight Commandership of St. Michael and St. George. It is well known that important services have been rendered to the Government and the country in many parts of the world in connection with submarine telegraphy, and Sir John is to be congratulated on this early recognition of his efforts to make our wide-spread cable enterprise conspicuous for certainty of communication, speed, accuracy, and secrecy. We believe the distinction has been conferred more directly in recognition of the invaluable services so rendered to the country in connection with the war in South Africa and the military operations in China, and while it acknowledges the good work done by Sir John personally, as administrative head of the telegraph companies, we are in a position to know that it is looked upon by him in great part as a gracious acknowledgment of the faithful services performed by the various members of the staff both at home and abroad throughout the whole period of the war. The distinction so spontaneously conferred must, therefore, be a source of great satisfaction, not only to Sir John, but also to all who, by doing cheerfully more than strict duty demanded, have materially helped their indefatigable chief to fulfil successfully his duty to the King, the Government and the Empire.

When war broke out, the companies fully realised the great importance of maintaining at all costs telegraphic connection with South Africa, and Sir John Denison-Pender at once adopted extraordinary measures to attain this end. His efforts were entirely successful, for, notwithstanding the liability to accident to which cables are at all times subject, the Government were never unable to communicate telegraphically with their military chiefs, and in many instances the rapidity of communication between the home Government and the commanders on the field of battle was unprecedented.

The public can never realise the difficulties with which the companies had to contend, owing to the abnormal conditions under which the traffic had to be handled ; and while this inevitable state of affairs exposed the companies to attack from certain quarters, they continued to do their duty, and private interest had necessarily to a certain limited extent to be subordinated to the demands of the nation.

Sir John Denison-Pender—the youngest son of the late Sir John Pender, who was made a G.C.M.G. in 1892 for similar services—was born in 1855, and was educated at Eton. His early training was purely commercial, and the varied experience thus gained, more especially in connection with shipping, has been of considerable assistance in the efficient management of the large cable fleet belonging to the telegraph companies he represents. He married in 1879 Beatrice Katherine, only daughter of the late Cuthbert Ellison, Esq., and has two sons. In 1881 he was elected to a seat on the board of the Eastern Telegraph Co., and acted as assistant managing director. On the death, in 1893, of Sir James Anderson (who was knighted in connection with early submarine cable work) he succeeded him as managing director, and was also elected vice-chairman of the Company in 1896, on the Marquis of Tweeddale becoming chairman. Sir John is also chairman of the West Coast of America Telegraph Co., managing director of the Eastern and South African and West African Companies, and a director of the Eastern Extension, Western, Direct Spanish, Europe and Azores, London Platino and Brazilian, and Globe Telegraph and Trust Companies, and a trustee of the Submarine Cables Trust. He has been the recipient of several foreign Orders bestowed by the Governments of Denmark, Turkey and Portugal. Those who know Sir John do not doubt he will prove that his success in the field he has chosen for his life-work is but begun, and we cordially felicitate him on this well-deserved honour, the dignity of which he will well uphold.

Lady Denison-Pender will worthily share the honour bestowed upon her husband. Apart from the interest she at all times takes in his work, she has, throughout the present war, devoted herself assiduously to the welfare of the wives and families of our killed and wounded soldiers.

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# CROYDON CORPORATION ELECTRIC TRAMWAYS.

A horse system of tramways was originally started in Croydon in 1878, gradual additions being made between 1878 and 1894. The Corporation considered the question of purchasing the system in 1897, and called in Mr. H. G. Harris, of the firm of Messrs. Bramwell and Harris, to advise on the matter, and by a deed dated January 22, 1900, the whole undertaking was transferred to the Corporation. It was

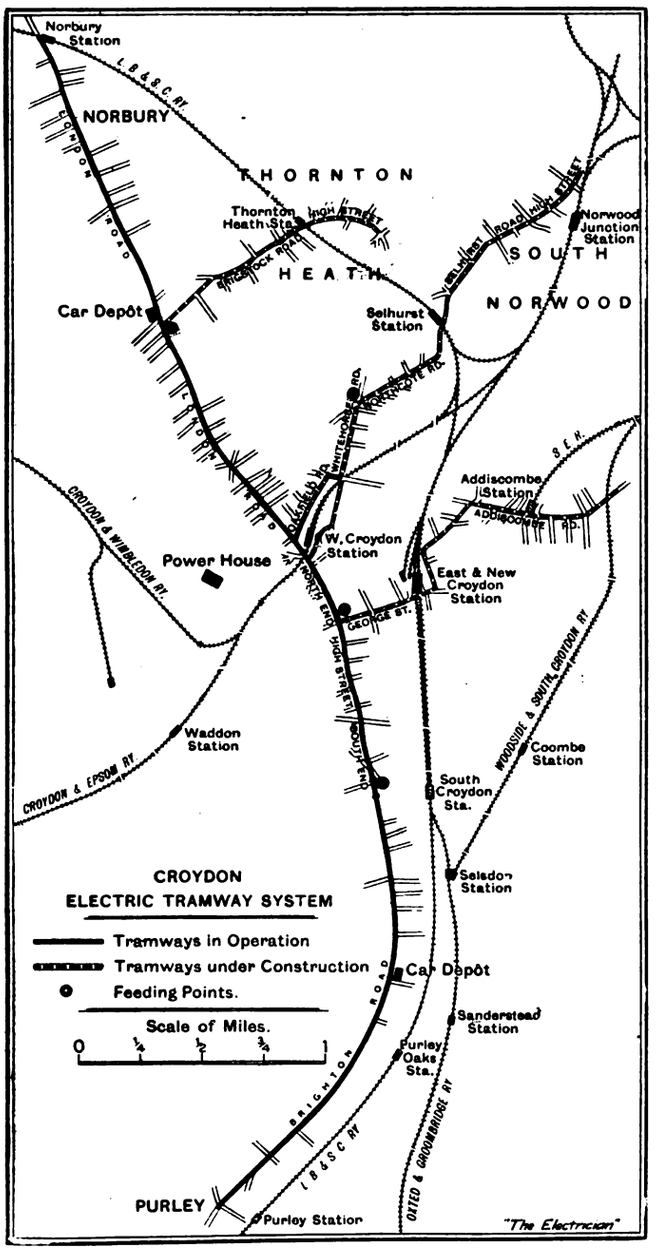


FIG. 1.—MAP OF TRAMWAY SYSTEM.

decided to electrically equip the line, and Mr. E. W. Monkhouse, of the firm of Messrs. Burstall and Monkhouse, was appointed consulting engineer. The Corporation were now approached by the British Electric Traction Co., who asked for a lease of the undertaking, and this was finally agreed to on the terms that the company should take energy from the Corporation at the rate of 2d. per Board of Trade unit on a 25 years' lease, the Corporation having the power to terminate the arrangement at the end of five-yearly periods, the company paying 6½ per cent. interest on capital outlay. When completed the total length of route served by the tramways will be about 10½ miles, of which about 5 miles will be equipped with double track, and about 5½ miles with single track and turn-outs, involving the construction of about 17½ miles of tramway when expressed in single track.

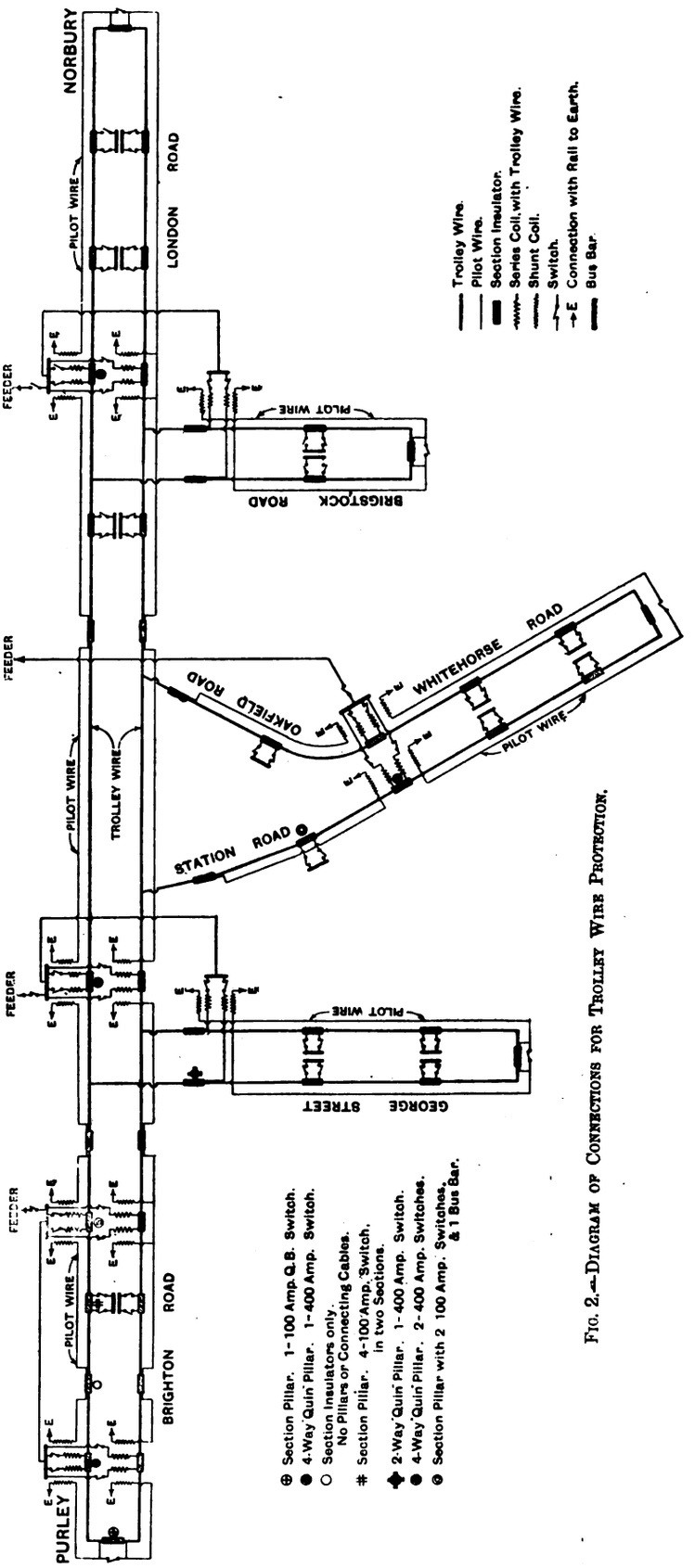


FIG. 2.—DIAGRAM OF CONNECTIONS FOR TROLLEY WIRE PROTECTION.

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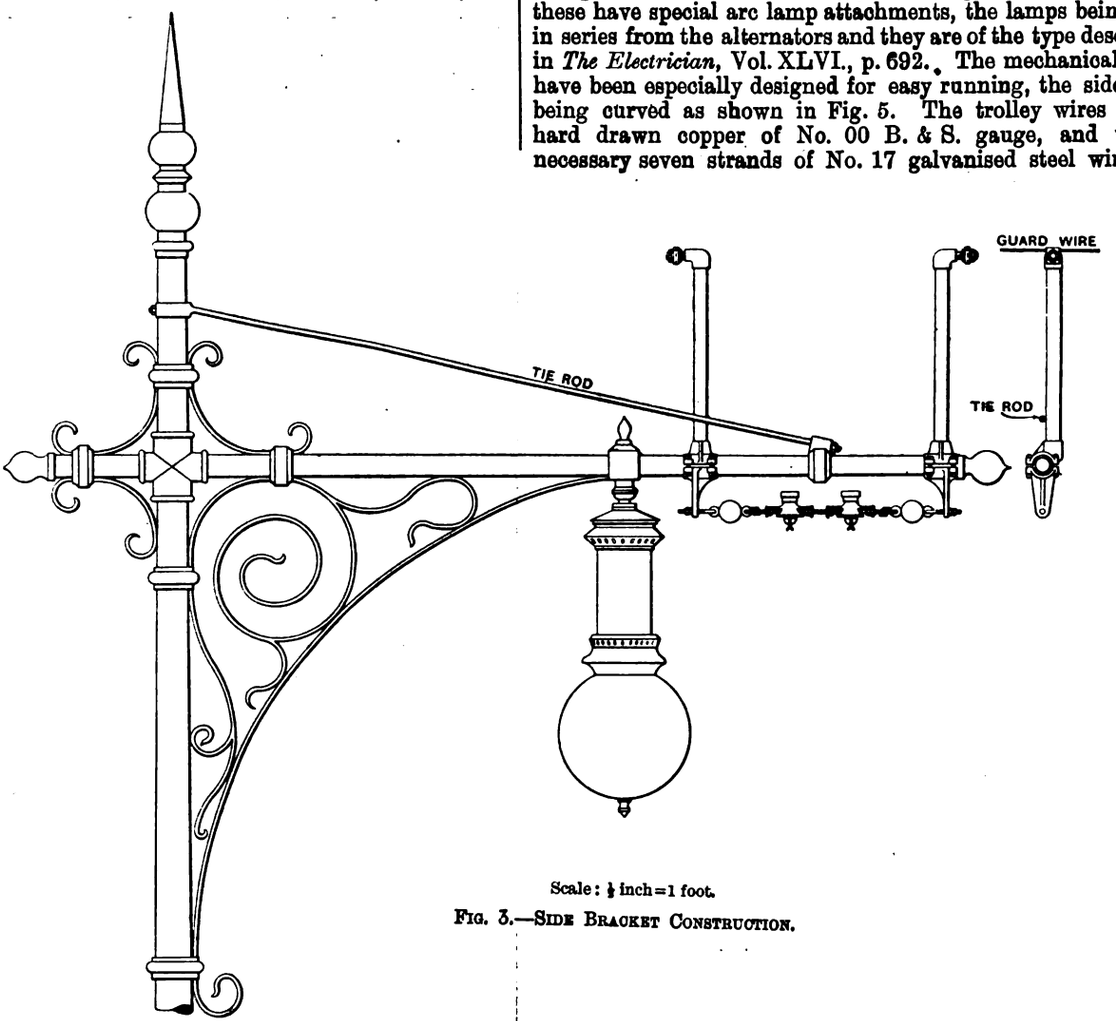
The map of the system, Fig. 1, clearly shows the completed route that was formally opened on the 26th ult. and handed over to the British Electric Traction Co.—it is, in fact, the main line of route—about 4¾ miles in length, and extends from Norbury railway station to the southern boundary of the borough of Purley. The branch lines are being now rapidly pushed forward and will soon be completed. The reconstruction of the track and the electrical equipment of the tramways is being carried out under the superintendence of Mr. Monkhouse, and the work of laying the track is being carried out by Mr. E. F. Morgan, the borough road surveyor, under a joint committee formed of some members of the Roads and Tramways committees.

Following is a list of the contractors and sub-contractors:—

| | |
|---|---|
| British Thomson-Houston Co... | Overhead equipment, bonding, and motor-car equipment, generators and boosters. |
| Callender's Cable and Construction Co. | Feeders and underground works. |
| Belliss and Morcom ..... | Engines. |
| George F. Milnes & Co..... | Car bodies. |
| Askham Bros. & Wilson ..... | Points and crossings. |
| Walter Scott (Ltd.) ..... | Rails, fish-plates, &c. |
| British Mannesman Tube Co. ... | Poles. |
| James Smith & Sons..... | Car sheds. |
| George Sands & Co. ..... | Ironwork. |
| Edwards Electrical Co..... | Switchboard. |
| Reason Engineering Co. ..... | Arc lamps. |

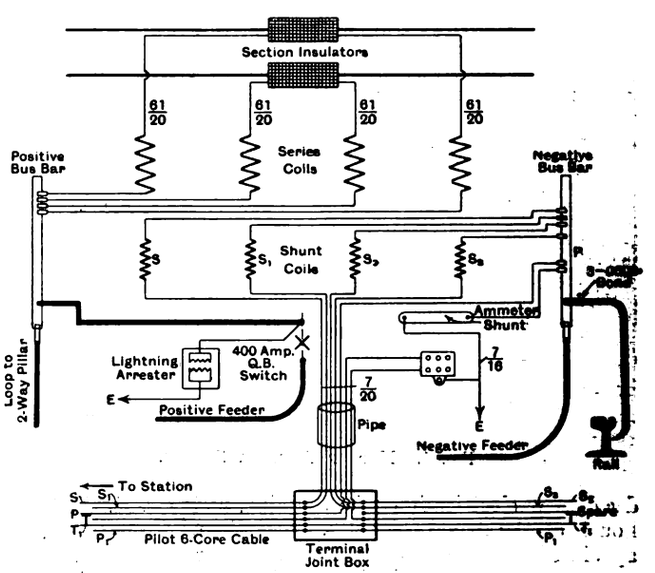
The track consists of 7in. girder rails weighing about 95½lb. per yard run. Phœnix joints are used, and the track is paved almost throughout with wood. Jarrah blocks form an edging along both sides of the rails to reduce the wear, and over the rest of the surface creosoted deal is employed. At George-street corner and on one or two of the grades basaltic lava setts are used. Every rail joint is carefully bonded with two No. 0000 B. & S. Chicago bonds, and the rails are cross-bonded every 80yds.

The overhead equipment is on the side bracket system, except at a few junction points where span wires are employed. The poles are of weldless steel, 31ft. long, and about 200 of these have special arc lamp attachments, the lamps being run in series from the alternators and they are of the type described in *The Electrician*, Vol. XLVI., p. 692. The mechanical frogs have been especially designed for easy running, the side arm being curved as shown in Fig. 5. The trolley wires are of hard drawn copper of No. 00 B. & S. gauge, and where necessary seven strands of No. 17 galvanised steel wire are employed as a guard wire. In the case of the telegraph wires, two guard wires are run 1ft. 6in. above the trolley wire and 9in. outside the trolley wires on each side; but in the case of the telephone wires only a single wire is used. In all cases the guard wire construction is very substantial, special




Scale: ½ inch = 1 foot.

FIG. 3.—SIDE BRACKET CONSTRUCTION.




S, $S_1$, $S_2$, $S_3$ = Shunt Coils and Shunt Wires to Distant Points or Dead Ends.
P = Test Wires for Home End. $P_1$ = Test Wires for Distant End.
T, $T_1$ = Telephone Wires.

FIG. 4.—ARRANGEMENT OF CIRCUITS IN A FOUR-WAY QUIN PILLAR.

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brass clamps being employed at each post. The arrangement of guard-wire clamps, bowstring suspension, arc lamp fixing, &c., is clearly shown in Fig. 8, and the general appearance of the

tively, and the rail feeders will be 0·35, 0·35, 0·2 and 0·35 sq. in., and these are laid in Doulton stoneware conduits and cast-iron pipes.

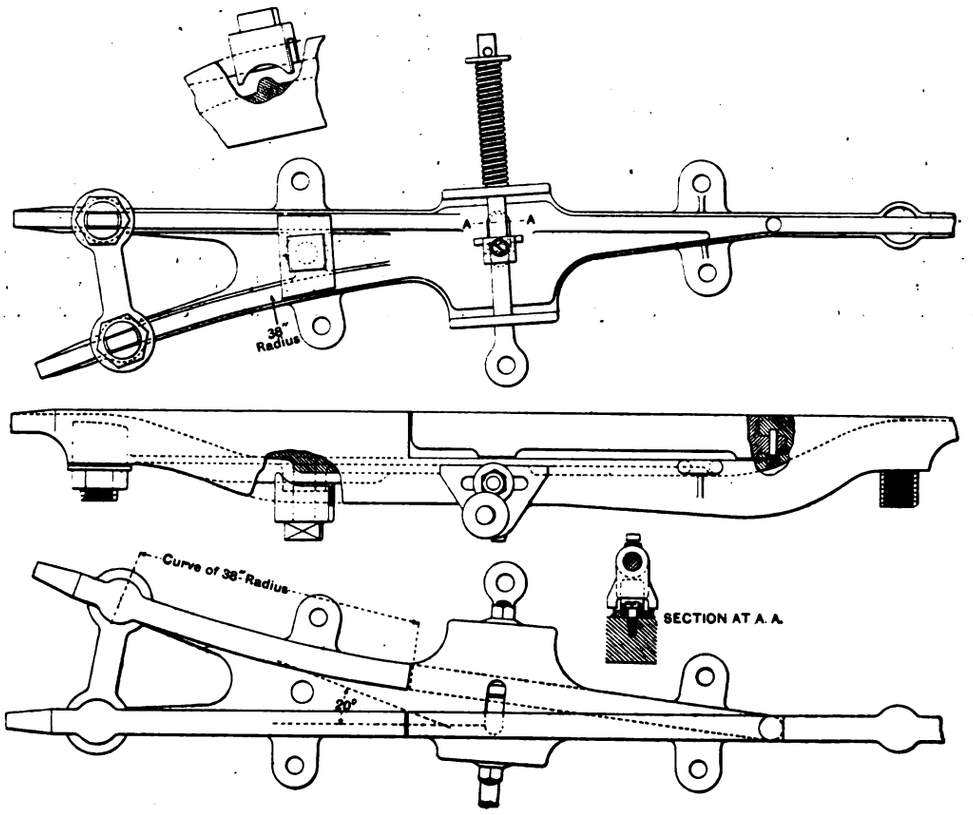


FIG. 5.—MECHANICAL FROG (⅛th full size).

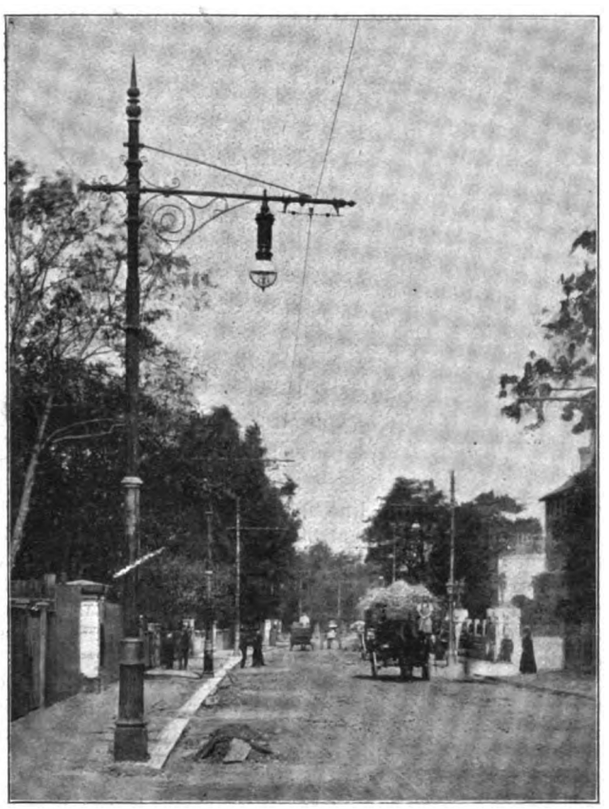

FIG. 6.—TYPICAL VIEW OF OVERHEAD CONSTRUCTION.

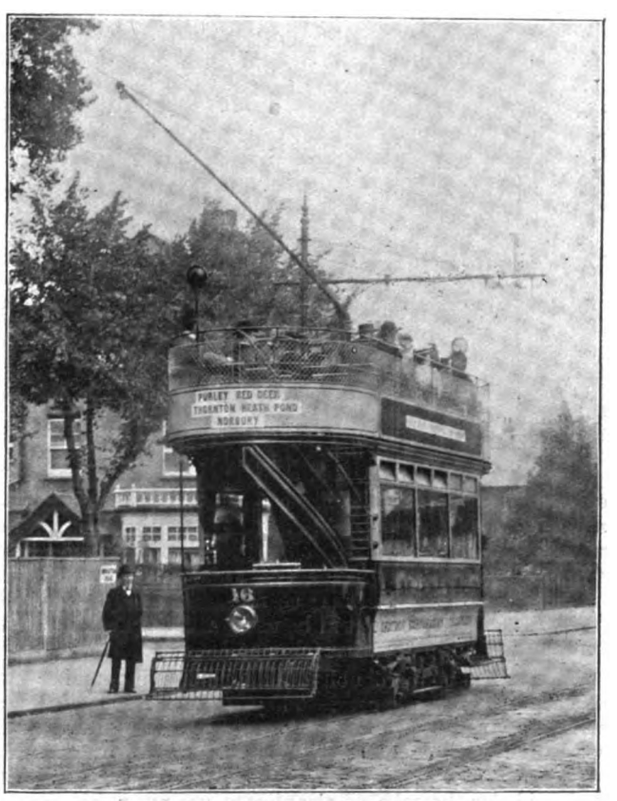

FIG. 7.—VIEW SHOWING ELECTRIC CAR.

overhead construction may be gathered from Figs. 6 and 7. The system, when completed, will have four feeding points, the line feeders being 0·3, 0·3, 0·25 and 0·45 sq in. respec-

An interesting particular in connection with the Croydon tramways is ths use of the Quin system of protection, which is being installed throughout. The general arrangement of the



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circuits of a four-way positive and negative feeding point is shown in detail in Fig. 4, and the complete arrangement of pilot wires, sectional insulators, section pillars, Quin pillars, &c., is depicted in Fig. 2. It will be seen that the system primarily consists of an automatic maximum and minimum cutout in each section of the line. These sections are separated by insulators fitted in the overhead trolley wire, the driver, of course, having to cut off current as the trolley pole passes over the insulator. From the negative bus bar in the Quin pillar a shunt is taken to the far end of the trolley wire, and connected to it at the sectional insulator. The current through this shunt coil keeps the automatic switch closed, but should the trolley wire break or the current fail the switch which connects the feeder to the trolley wire opens, and the section is completely isolated. There is a further protection in case a telegraph or telephone wire comes in contact with the trolley wire. A hand-brake, and also an electric emergency brake; this latter will, when the cars are travelling at full speed, bring them to a standstill in about 18yds. on the level. The tramway committee has decided to have two kinds of stopping places, the one where all cars will stop and the other where cars will only stop if required to set down or take up passengers. The maximum distance to be walked will be about 150 yards. The fare for the whole distance from Norbury railway station to Purley has been fixed at 3d., and the cars are being run on a five-minute service.

Current is taken from the Corporation electricity supply works, which are under the management of Mr. T. H. Minshall, and two 300kw. Thomson-Houston dynamos coupled to Belliss engines have been installed for this purpose, whilst a third set of 600kw. is now on order. One of these 300kw. sets is clearly shown in Fig. 8. Two boosters have been fixed with their armature in series with the rail feeders and the fields in series

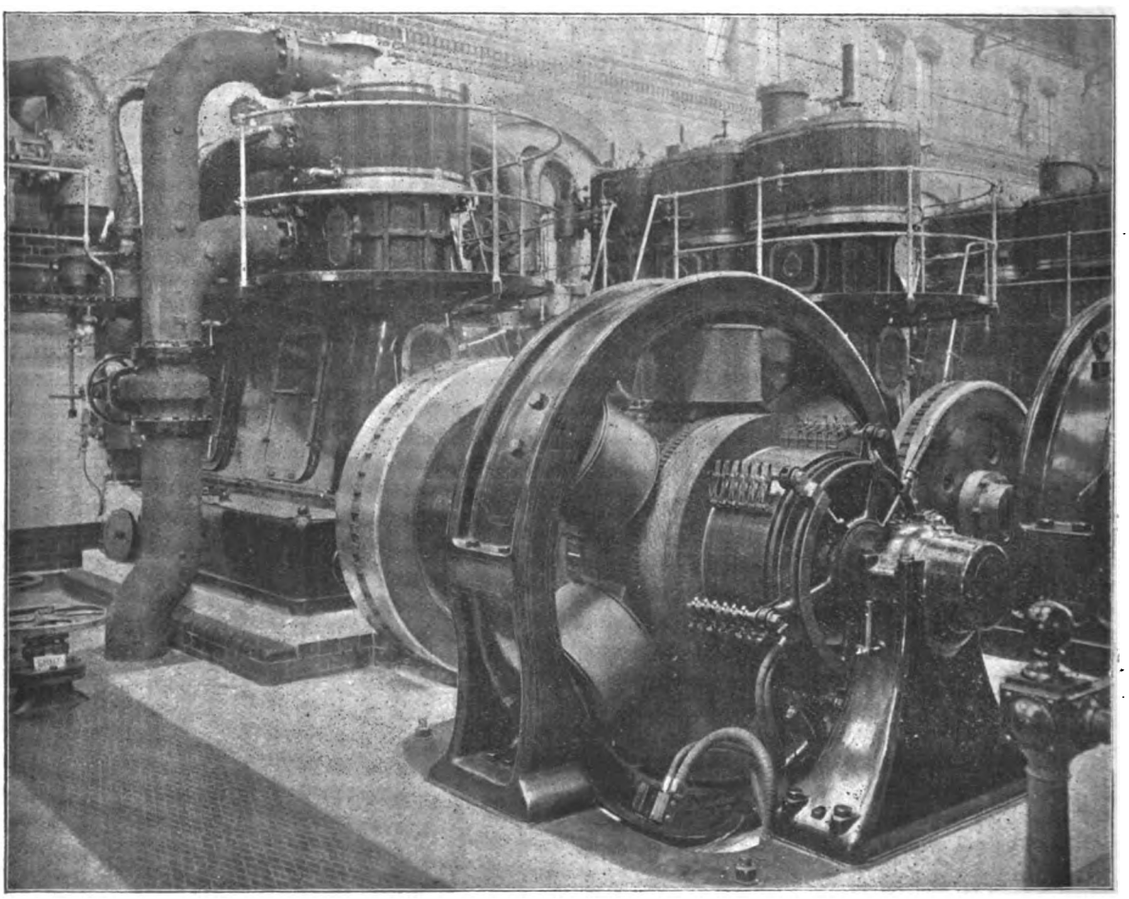

FIG. 8.—ONE OF THE 300KW. SETS.

series coil is placed between the feeder and the trolley wire, and this acts on the switch, disconnecting the circuit should an excess of current flow through it. Earthing plates are to be fitted at each feeding point, and an ammeter shunt will be in series with it. It has been settled to use portable recorders: two of these will be used, and they can be shifted from one feeding point to another as desired.

The cars are of the double-deck type—35 in number—and will each seat 52 passengers. They are fitted with staircases of the reversed pattern. The seats on the top are of the garden type with reversible backs, so that passengers can always sit looking forward. The seats inside are of perforated bent-wood, and, for the sake of cleanliness, are not upholstered in any way. There is a handle at the top of each staircase which rings the "signal bell." Every car is equipped with two electric motors of 35 H.P. each, and can be driven from either end. The cars are provided with two brakes—a powerful with the corresponding line feeders. The larger booster has an output of 450 amperes at 80 volts, and the smaller machine is capable of giving 550 amperes at 34 volts. Each is driven by a separate motor, and runs at 600 revs. per min. Rheostats are placed in parallel with the shunts of the generators, so that the pressure at the terminals can be reduced to half what it would be if no resistance were used.

In conclusion, we must thank Mr. F. S. Grogan, who has represented the British Thomson-Houston Co., for his courtesy in showing our representative over the system, and furnishing us with the necessary information to compile this article.

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**Telephone Cable from Ramsgate to Belgium.**—The laying of the submarine telephone cable between La Panne, in Belgium, and Ramsgate was commenced last Friday. The length of the line will be 57 miles.

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## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

(*Continued from page 863.*)

### MESSRS. LAHMEYER'S WORKS.

Although not one of the largest works visited by the Institution of Electrical Engineers in their tour of inspection in Germany, Messrs. Lahmeyer's works showed many points of interest. The firm was originally founded on the occasion of the Frankfort Exhibition of 1890 with a small staff and fewer workmen. The limited company, "Electricitäts-Aktien-Gesellschaft vormals W. Lahmeyer & Co.," was floated in 1898, and at present the share capital of the company is 10,000,000 marks with 5,000,000 marks debentures, and a staff of 756 and 2,100 workmen are employed. A general view of the works is given in Fig. 73. It is divided into two parts, one eastern and one western block, the former containing the head offices, two machine shops with galleries, stores, and the power station; and the western block, which was only completed this year, consisting of a main building four floors high, containing the mechanical workshops, pattern shops, &c., with two large machine shops adjoining it. The total space occupied by the two works is 32,600 square metres. The works are in connection with the railway, and, if required, trucks can be shunted right into the larger workshops. All the machinery is electrically driven, and the larger machines are fitted with their own motors. The yard, which is shown in Fig. 74, is very conveniently arranged, and at the time of our visit contained a large number of castings for the large machines to be delivered to the Charing Cross and Strand Co.; and these machines were very much in evidence in the workshops also. Fig. 75 shows a large facing lathe in which is the magnet wheel of one of these 1,600kw. 10,000 volt generators, and Fig. 76 shows the stator of a similar 1,600kw. machine being turned up in a large vertical lathe. General views of the two main fitting shops are given in Figs. 77 and 78. The first of these shops is chiefly occupied with machines of small to medium size and motor generators, the smaller work being done on the side galleries. The shop is spanned by two electrically-driven cranes of 10 and 20 tons capacity respectively, and these can be coupled together if required. Hand cranes and tackle are used in the side galleries.

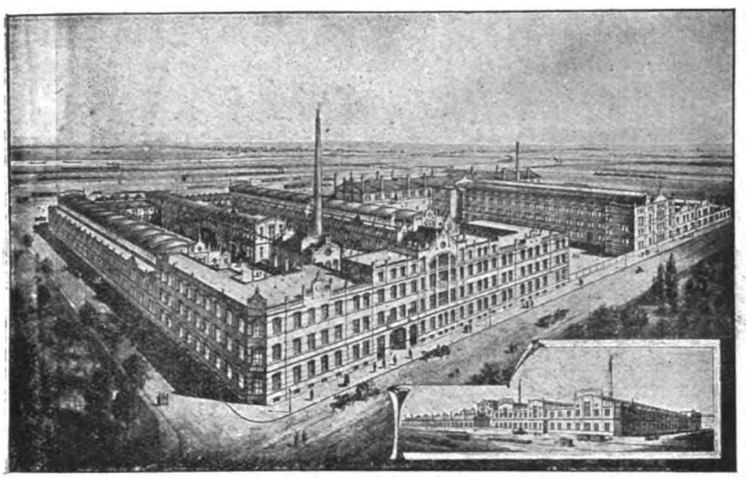

FIG. 73.—GENERAL VIEW OF MESSRS. LAHMEYER'S WORKS.

FIG. 74.—YARD OF MESSRS. LAHMEYER'S WORKS.

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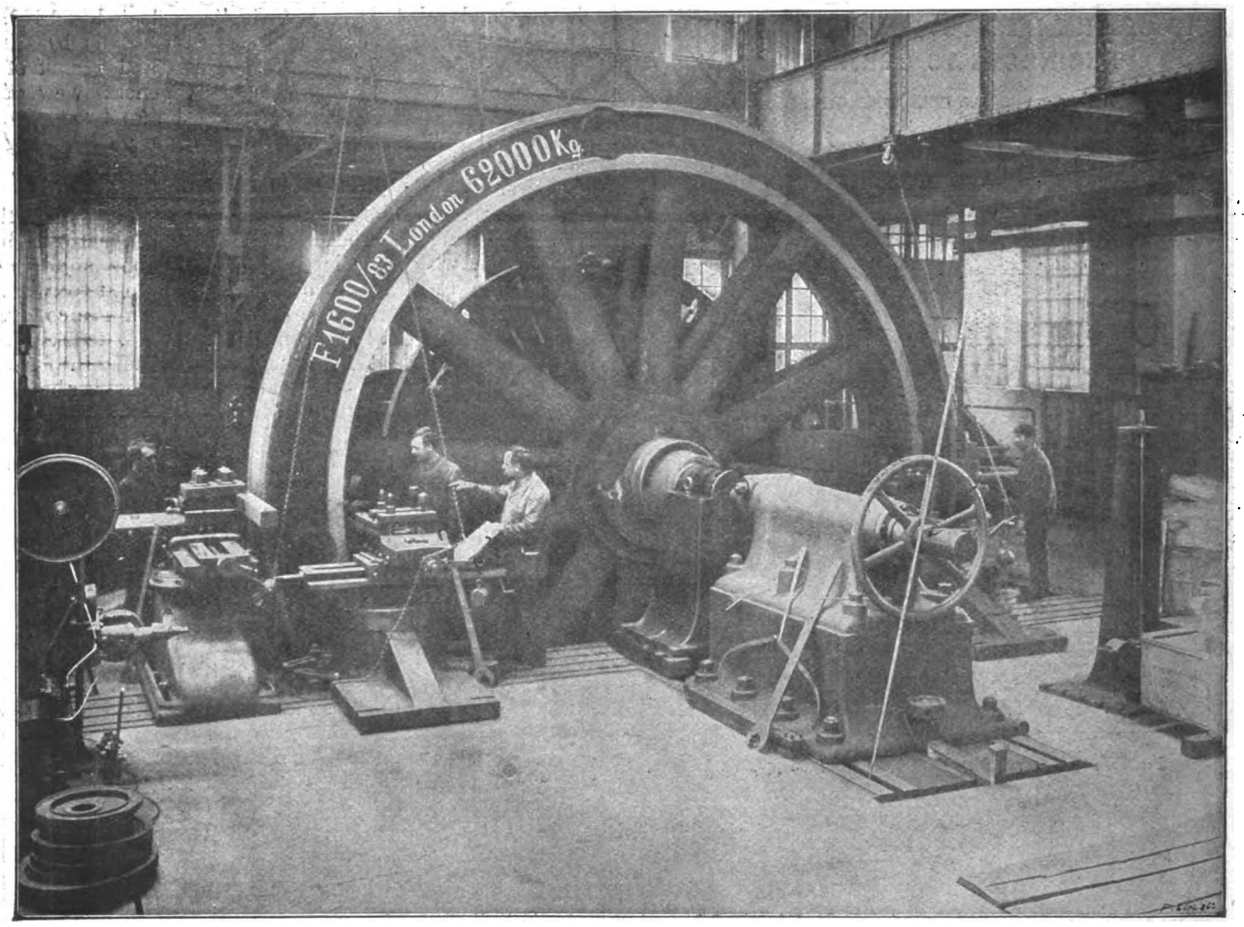


FIG. 75.—LARGE FACING LATHE.

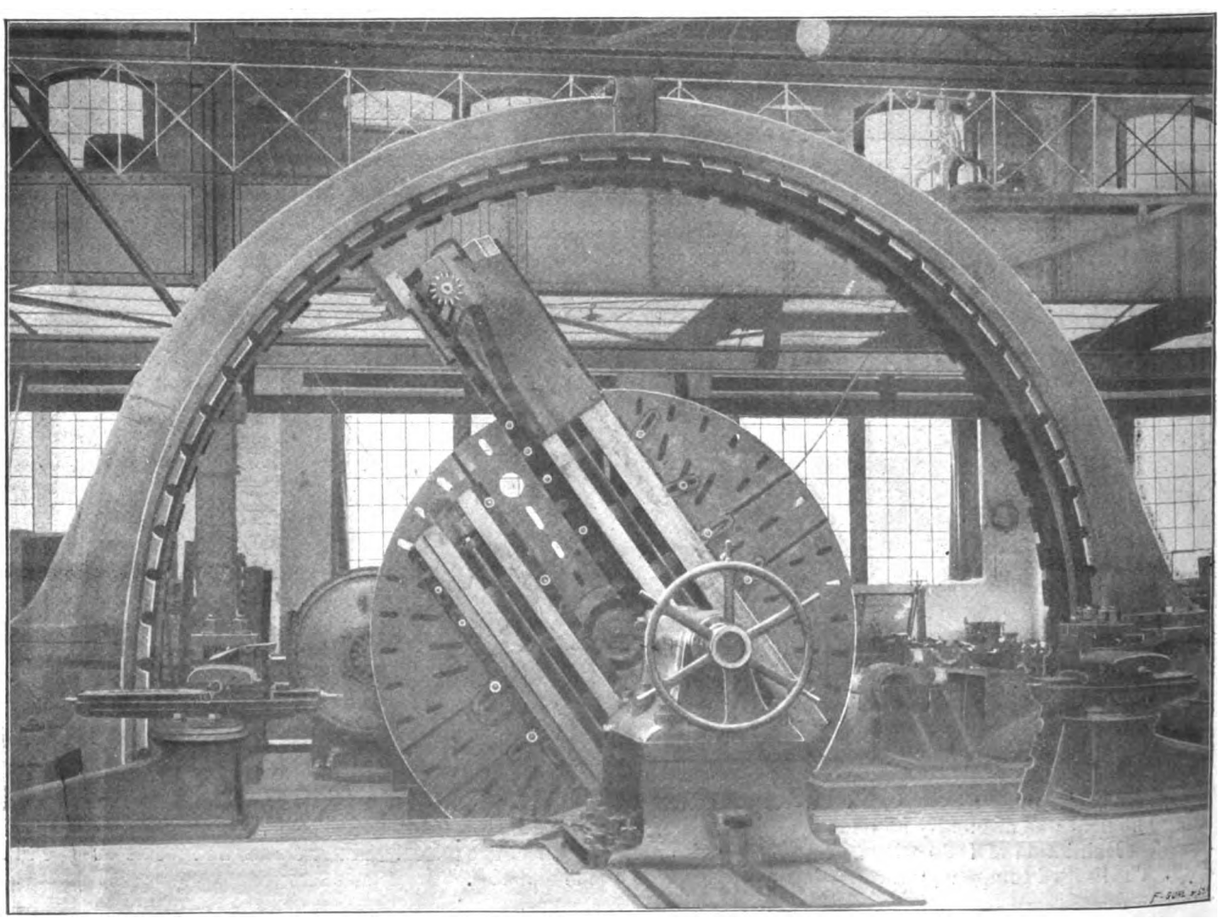

FIG. 76.—STATOR OF 1,600KW. MACHINE IN LARGE VERTICAL LATHE.

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FIG. 77.—ONE OF THE FITTING SHOPS.

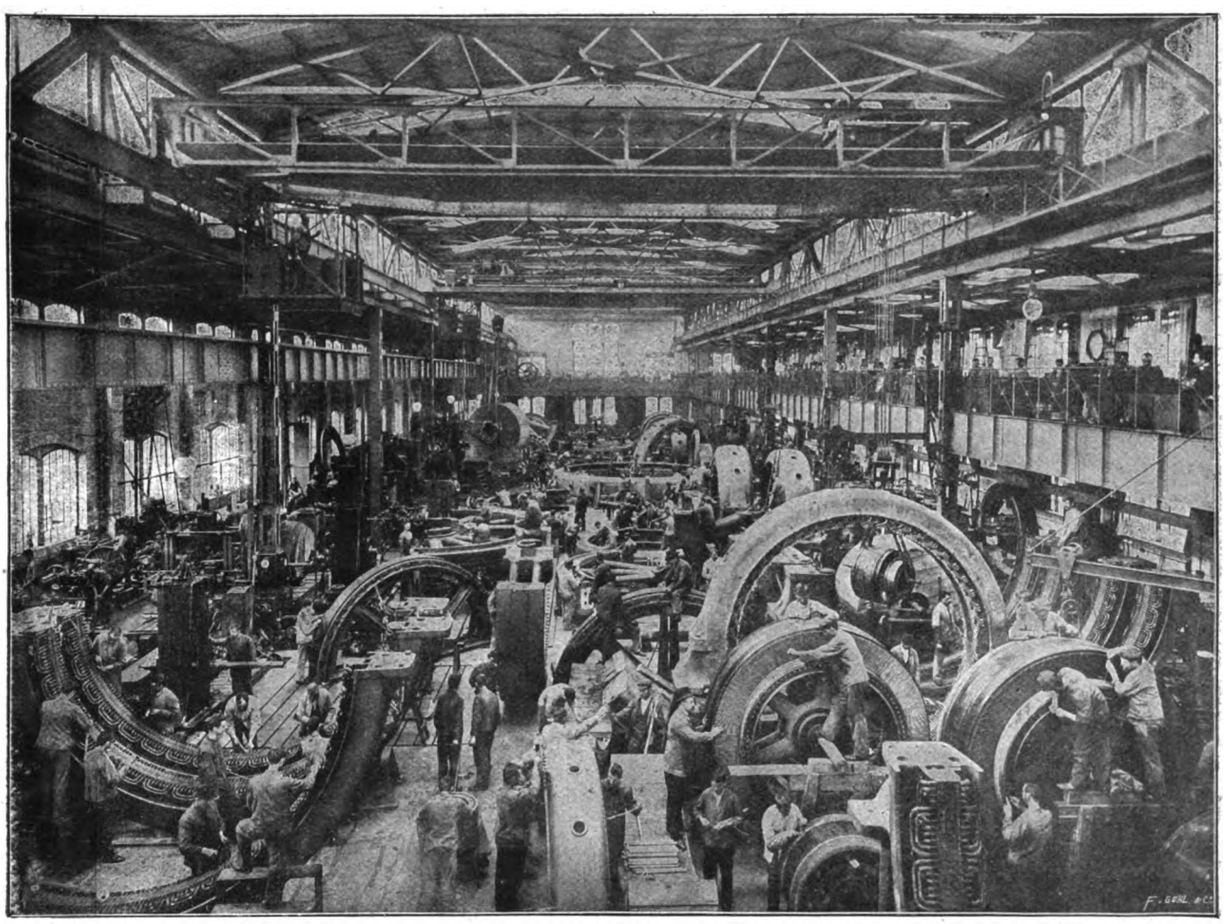

FIG. 78.—FITTING SHOP FOR LARGE WORK.

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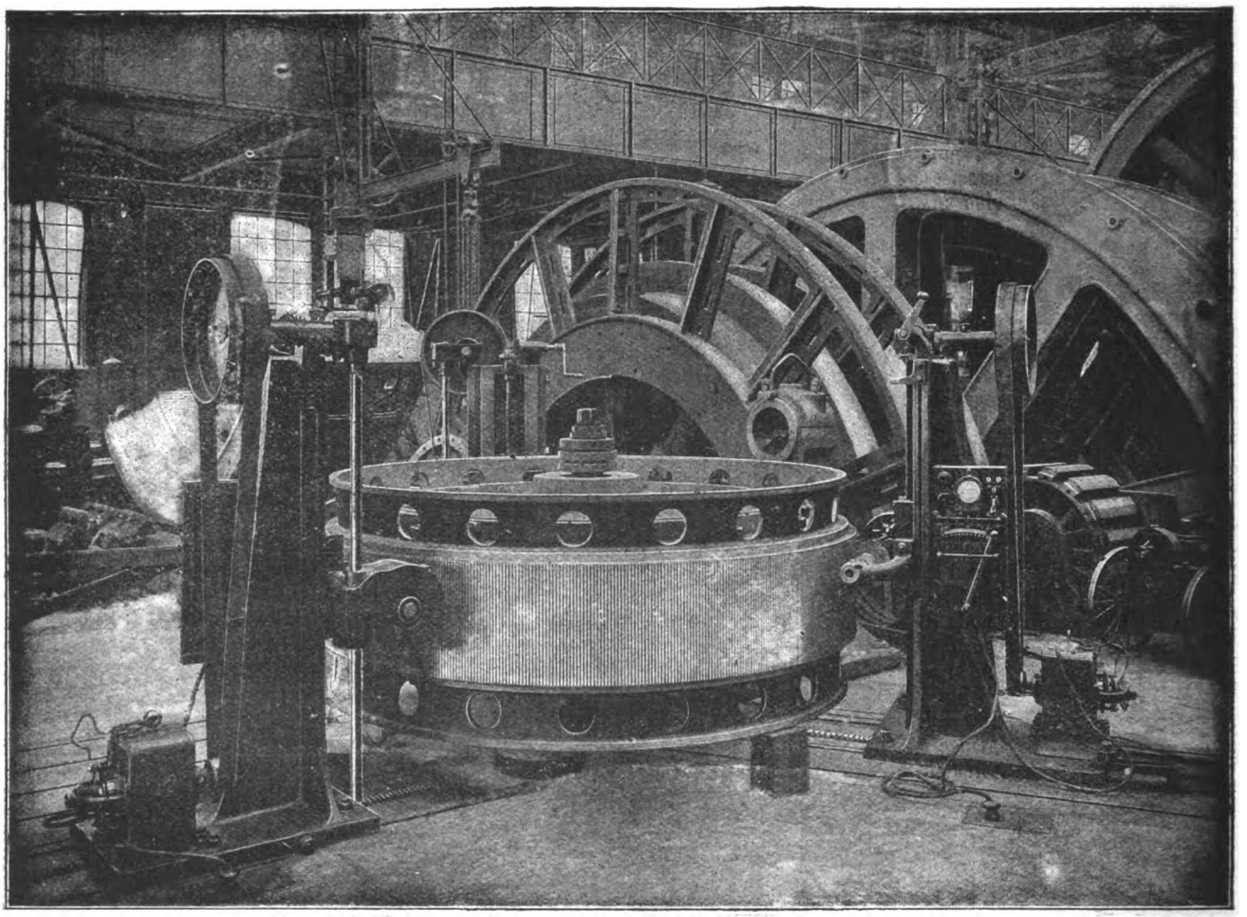

FIG. 79.—MILLING MACHINE FOR SLOTTING LARGE CONTINUOUS-CURRENT ARMATURES.

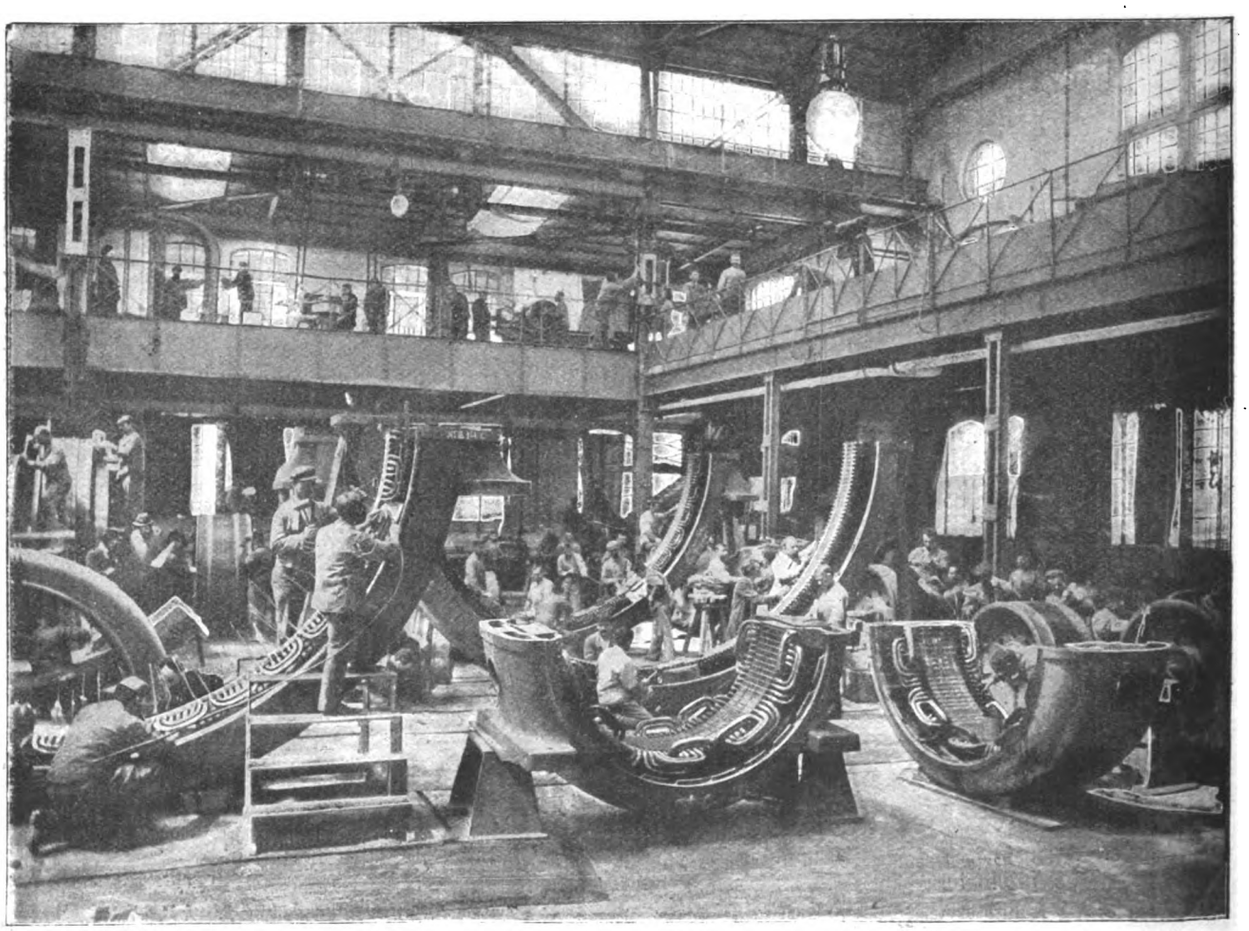

FIG. 80.—WINDING SHOP FOR LARGE MACHINES.

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Portable electrically-driven tools are largely used in this shop as well as in other departments of the works. Fig. 78 is the fitting shop in which all the larger work is done. In this shop are two 15-ton cranes, which can also be fitted together as in the preceding case for dealing with very heavy castings. Fig. 79 shows a large milling machine used for slotting large continuous-current armatures. By its means it is possible to work at the armature in three places at once, as is seen in the figure. Large continuous-current flywheel armatures are a particular speciality of this firm and a view of one of these is shown in Fig. 81. In fact, Messrs. Lahmeyer

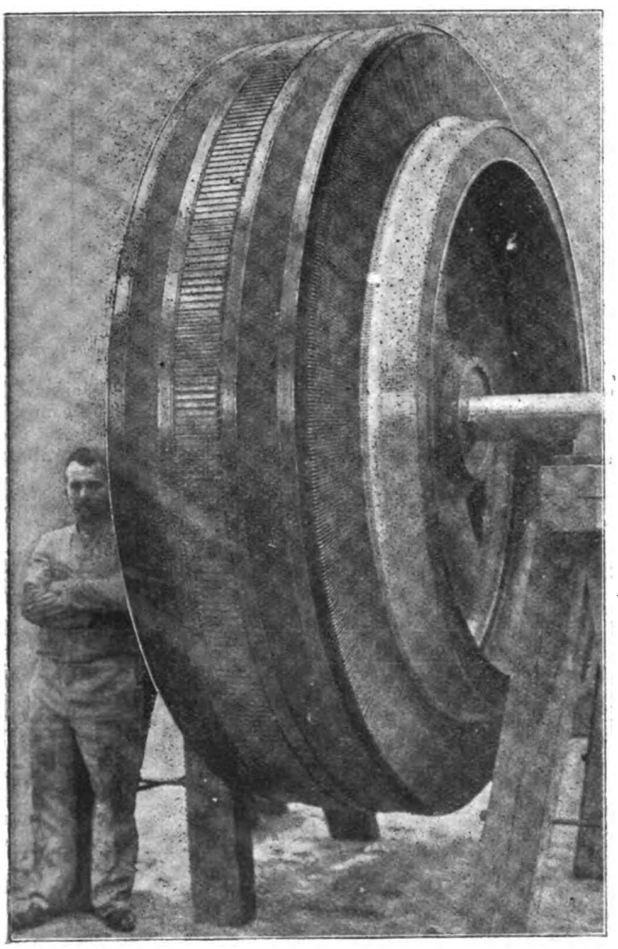

FIG. 81.—LARGE CONTINUOUS-CURRENT FLYWHEEL ARMATURE.

claim to have been the pioneers in the use of flywheel armature machines generally. The method of winding the alternator stators is seen in Fig. 80, which also affords a good general view of the winding shop for large machines.

[*Erratum.*—In the article on Messrs. Schuckert's works in our last issue, the name of the maker of the cell switch mentioned in the last paragraph should be that of Schuckert and not Siemens and Halske.]

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Physical Determination." By W. R. Kelsey. (London: Edward Arnold). 4s. 6d.

"Proceedings of the Royal Society." No. 450. Vol. LXVIII. (London: Harrison and Sons.) 1s. 6d.

"Jahrbuch der Elektrochemie." 1900. Edited by Dr. W. Nernst and Dr. W. Borchers. (Halle-a-S.: Wilhelm Knapp.) 24 marks.

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Strecker. No. 1. 1901. (Berlin; Julius Springer.)

Jahresbericht des Physikalischen Vereins zu Frankfurt-am-Main für das Rechnungejahr, 1899-1900. (Frankfort-on-the-Main: C. Naumann.)

## THE SPRAGUE MULTIPLE UNIT SYSTEM.*

BY FRANK J. SPRAGUE.

(*Concluded from page 867.*)

*The Apparatus.*—That shown in the accompanying photographs is for the handling of two motors of a nominal capacity of 150 H.P. each, sometimes taking as much as 700 amperes on a 500 volt circuit. The apparatus is so constructed that the main parts can be placed either inside or outside the car with perfect safety.

The master switch (Fig. 10) is of the cylinder type. Right and left movement of a single handle, normally latched in a central position, produces ahead and reverse movement, respectively, of the

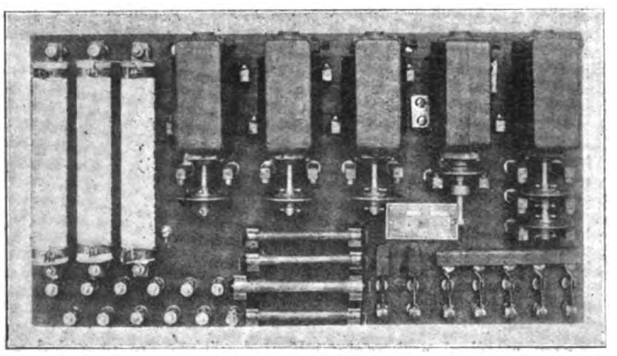

FIG. 6.—RELAY BOARD AND SWITCHES.

the car, and any desired variation of speed. The handle is readily detachable. Its movement is opposed by a spring which returns it to the central or "off" position when released, and automatically cuts off the main current. The cover is lined with mica, well lacquered, and is easily removable. The vulcabeston separators are hinged to facilitate inspection.

The relays, automatic stop and throttle (Fig. 6), are of similar construction. They are mounted vertically upon a slate support and thoroughly insulated, and the contacts are well separated and rigidly secured. The coils are held firmly in place, and the plungers

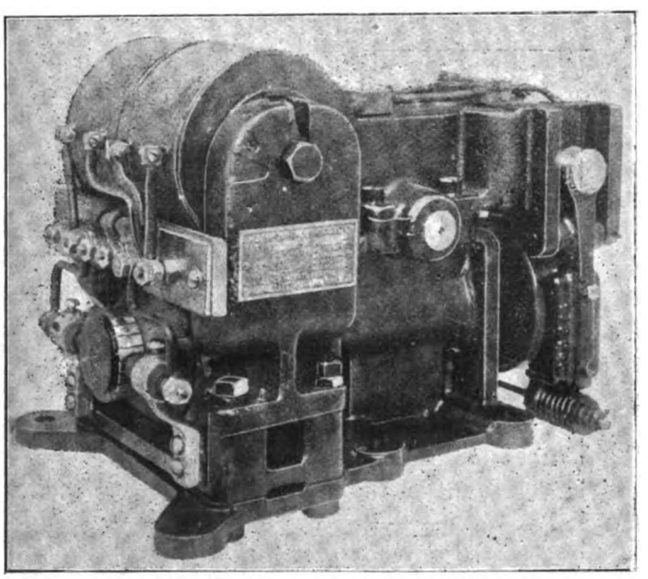

FIG. 7.—PILOT MOTOR.

are positively guided. Platinum or silver contacts are used for the throttle in order to require minimum attention, and to insure perfect contact. The protective fuses for the control circuits are carried by clips on the relay slate, which also carries for convenience the cutout switches and part of the adjusting resistances.

The main controller (Fig. 11), is of an "ironclad" type. All cables are led to bolted terminals similar to standard switchboard construction, and connections are made outside the controller. The

* From the *Street Railway Journal.*

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terminals are widely spaced, and mounted upon slate. The main contact segments on the cylinder are provided with removable tips, and are of the best quality of rolled copper. They are 1¼in. wide, and each carries only the current of one motor. The contact fingers

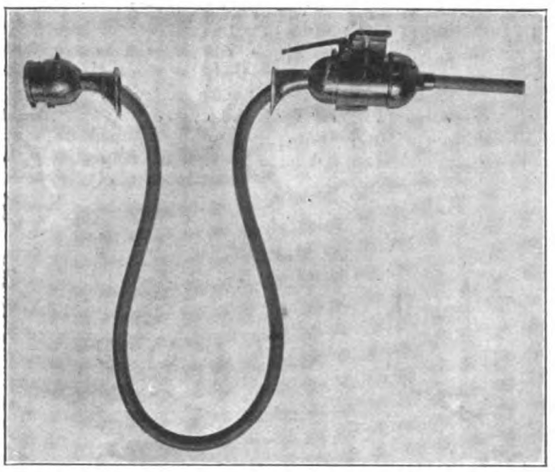

FIG. 8.—JUMPER AND COUPLER END.

are screw attached and screw adjusted. They are provided with springs reinforced by a shunt of leaf copper. The finger bases are cast solid with the terminal studs. The baffiers are of reconstructed granite. The control limit contacts and segments are completely isolated from the main contacts by a separating partition of vulcabeston insulation. All exposed metal surfaces not contact surfaces in the interior of the controller are thoroughly covered by asbestos strip and insulating varnish, and are finished hard and smooth. Means are provided for adequate ventilation of working contacts and blow-out coil. The insulations on the shaft are double-keyed to prevent possible loosening, and are thoroughly set under pressure.

The pilot motor, Fig. 7, is rigidly bolted to the controller base, and is readily removable as a whole, or the fields can be removed separately. It drives the controller by a stepped movement through a powerful spring and locking pawl. These ensure "quick make" of contacts and positive notching. The gears run in an oil chamber,

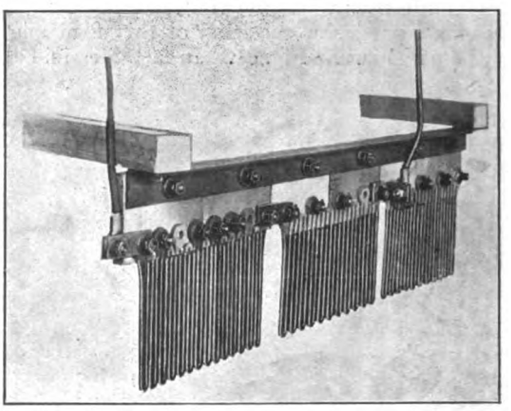

FIG. 9.—A SECTION OF THE GRID RESISTANCE.

thus securing efficient and continuous lubrication. The armature support and shaft are forged from one piece of steel. The commutator is made of the best drawn copper insulated with mica. The brushes are of carbon, and have automatic feed. All coil terminals

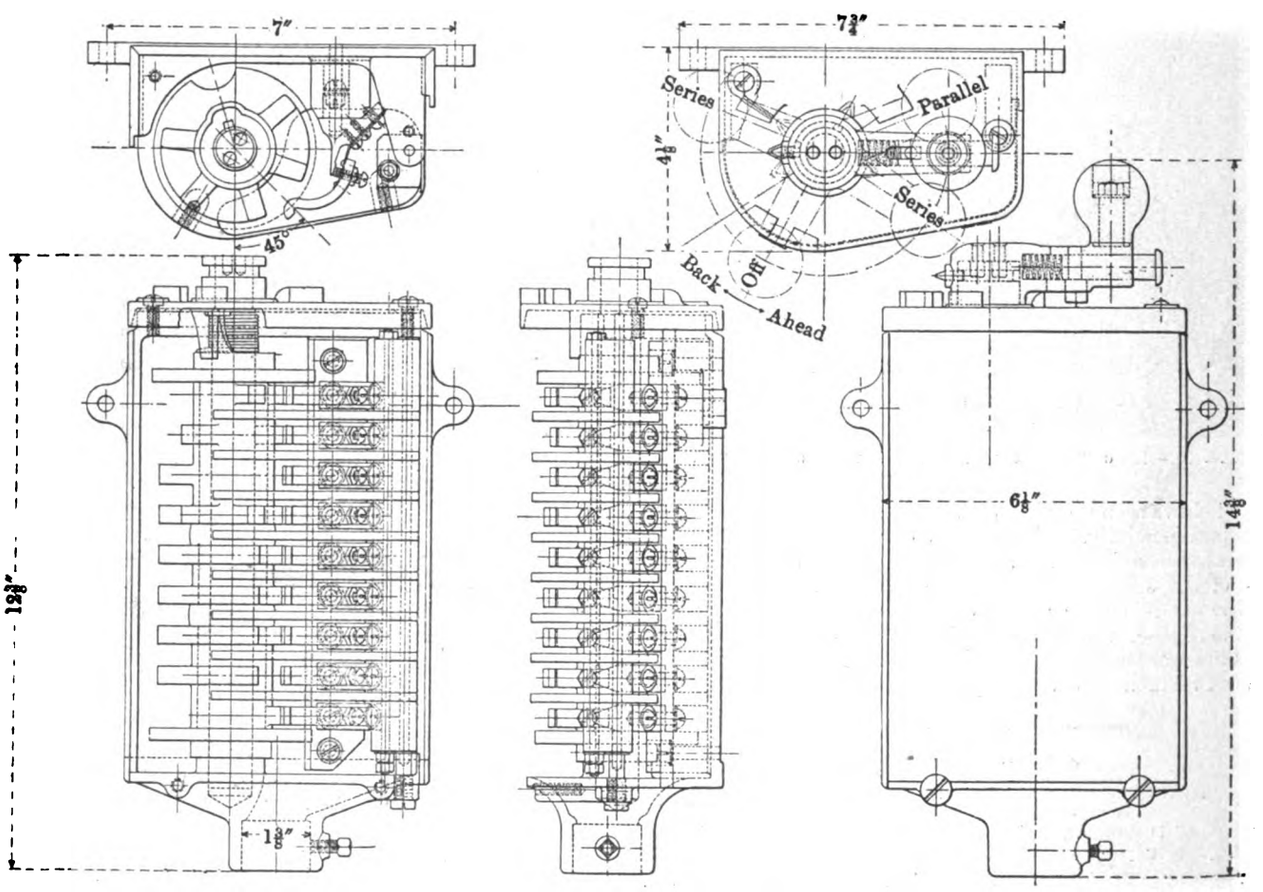


FIG. 10.—ASSEMBLY OF MASTER SWITCH.

are of heavy copper, securely fastened, with means for bolting the connecting wires.

The reverser, Fig. 12, is of the same "ironclad" type of construction as the controller. The contact-plates, fingers and finger bases, deflectors, bearings and blow-out coils are interchangeable

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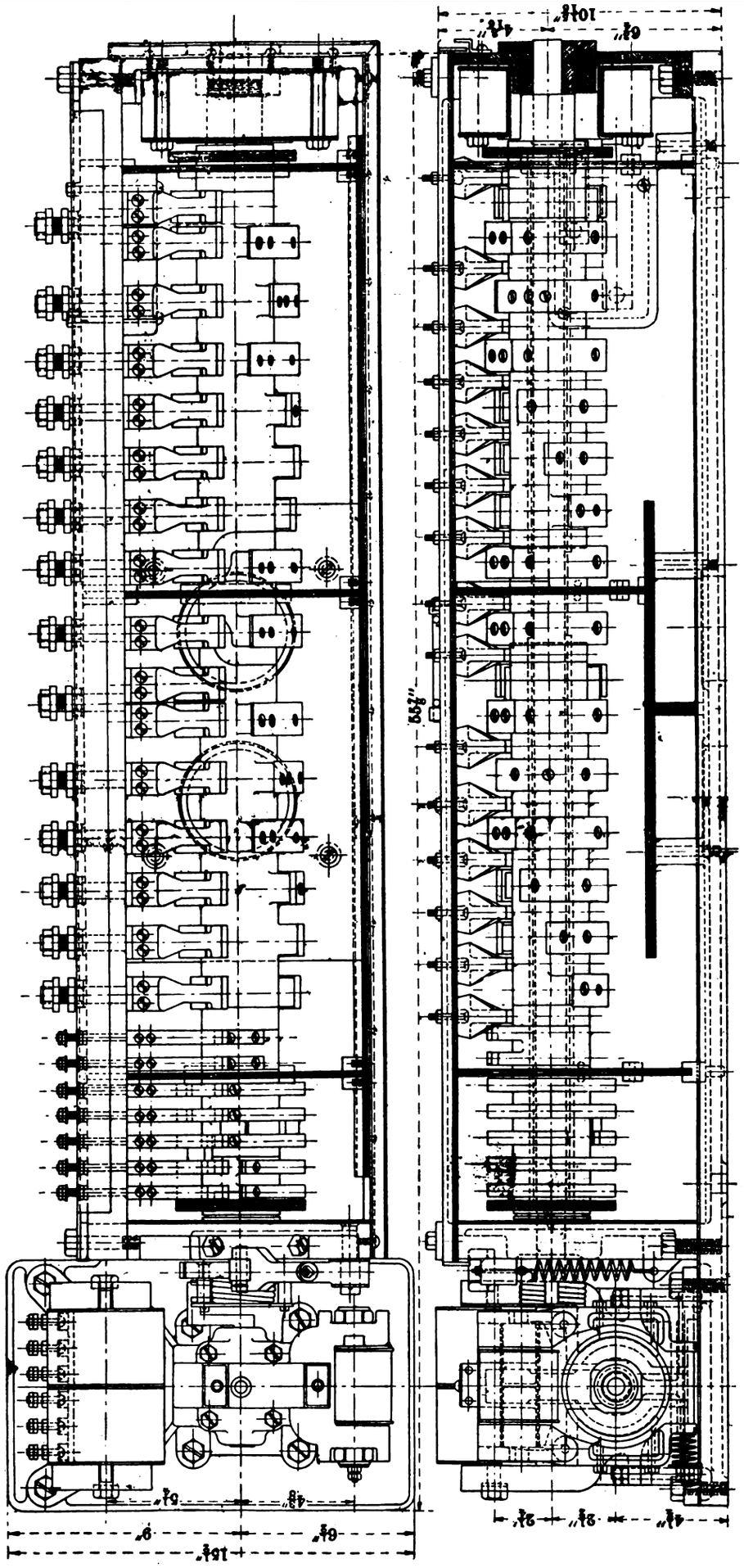
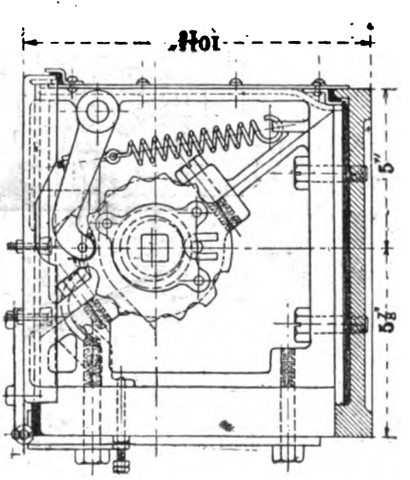



FIG. 11.—ASSEMBLY OF MAIN CONTROLLER.

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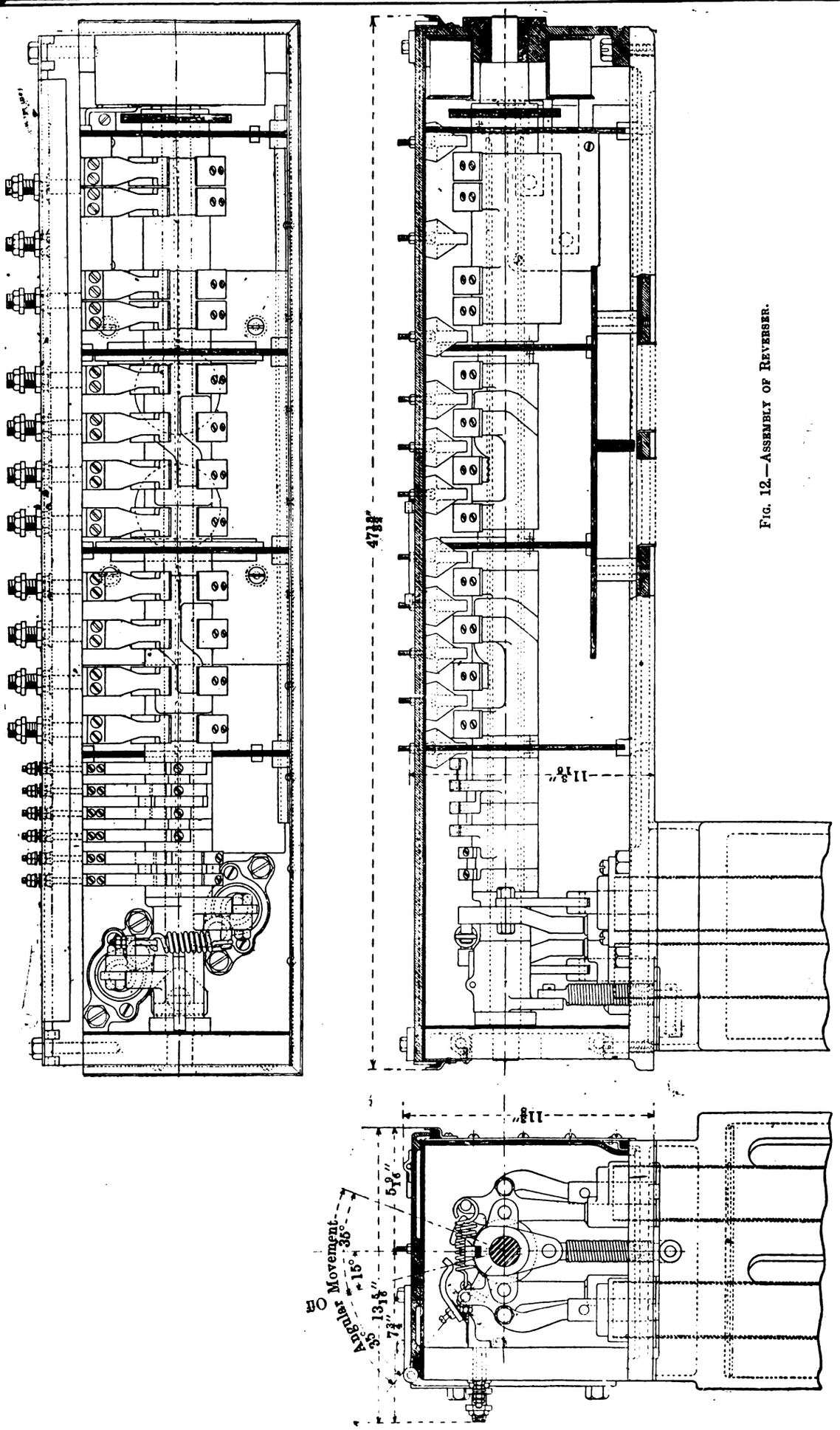


FIG. 12.—ASSEMBLY OF REVERSER.

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with those of the controller. In addition to the motor-reversing contacts, the reverser has a muffled double "line break." This is isolated by vulcabeston partitions from both the motor and the limit contacts. The plungers are kept central and guided by phosphor-bronze guides. The reverser is brought to "open" by a powerful eccentric spring connection, and the link connection to reverser cylinder is constructed so that the reverser is "dead beat" when opened. Provision is made for the release of the cylinder from the drive for the purpose of ready inspection.

The couplers, Fig. 8, are iron shells enclosing a block of insulating material which supports split-spring terminals of the train wires. They are connected to the train line at junction boxes. The terminals are separated by an insulating partition, and are well insulated. The couplers are shrouded, and are self-closing when not in use. The jumper, whose ends are constructed in a similar manner to the couplers and has complementary female contacts, is reversible. The connecting cable is made under rigid specifications to secure the highest insulation and the greatest durability. Both the jumper and couplers are connected to the cables permanently at the back and are filled with insulating compound. Each conductor is insulated with the best quality of rubber and protected with braid in varied colours to facilitate connections. The cable is sheathed with a heavy waterproof braid for mechanical protection. Only four connections are used for control where the coast relay is omitted, and provision is made for the pump governing line.

The grid resistances, Fig. 9, for the main motors are of a special cast material, and are of a form to insure flexibility. They are supported in longitudinal vertical planes by reconstructed granite insulations carried by angle irons for attachment to car.

The weights of equipment are as follows :—

| | Lb. |
|---|---|
| Two master controllers | 45 |
| One set relays, fuses, switches, &c. | 96 |
| One main controller and pilot motor | 520 |
| One reverser | 560 |
| Two junction boxes | 6 |
| Two couplers, with attached cables | 25 |
| One jumper | 10 |
| One set grid resistances | 660 |
| One set master switch and train-line cables | 50 |
| Total | 1,972 |

To complete the equipment of a motor car, there remain the main motors and their installation, and the necessary platform-switch and train cables, besides the provision for braking. "Train-line" cars have only the train-cable couplers and jumpers, unless it be desired to control an equipment from them, in which case master switches can be added.

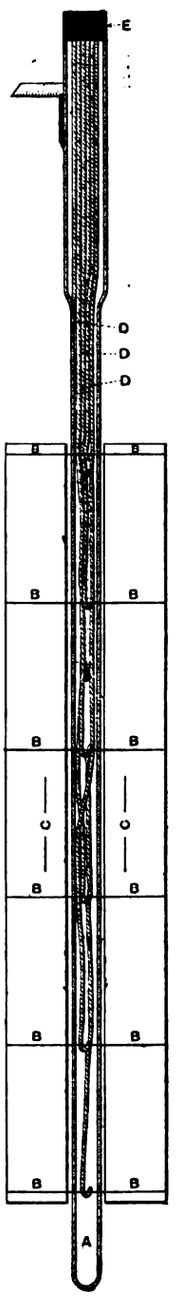
*General.*—Since the integrity of a train line, the vital part of a system, must be preserved, the number of wires is kept small in number, and the duty on a train line is kept a minimum. The current through any conductor or contact is kept at approximately 1 ampere or less, so that any arc or crossed circuit which may be established will be local to the conductors affected. The train line is made alive at the platform-switch only, and the other ends of the relay circuits are grounded. No ground conductor is permitted in the train line, as its presence could evidently be a source of trouble. When running at half or full speed, only one wire in the train line is energised, and only one magnet on each car. The line voltage is used, thus greatly reducing the liability of failure through poor contact, which has proved a notable objection to low-voltage controlling currents. All connections from train line to ground at the operating coils on each car are locally protected, so that any one cannot communicate failure to any other car of the train. This localisation of circuits must secure automatic cutting out of any affected car without complication of circuits on any other car.

The time from operation at the master switch to current admission is $\frac{2}{3}$th second, and to full multiple $2\frac{1}{2}$th seconds, unless restrained by the operation of the throttle or motorman. It can be made just as rapid as required.

Determinate acceleration is positively secured by the working of the throttle. This may be maximum allowable current input, but the operator may restrain at will by manipulating his master switch. That this method must secure greater economy than ordinary hand input must be obvious to anyone who has to deal with the average performance of large numbers of men. Furthermore, since the service on railways is becoming more severe, larger powers are being used, higher schedules made, more frequent signals and track complications are being introduced, it becomes essential to remove from a motorman the physical labour of operating controllers, and all thought as to the safety of operation, leaving him free to more safely pilot his train. All relay switches, being simple gravity solenoids, are not influenced by any wear of parts, pins or contacts, and thus no adjustment for wear is necessary. All operating coils are designed for satisfactory operation between 275 and 650 volts, and are subjected to a 4,000 volt insulation test.

## A NEW FORM OF PLATINUM ELECTRODE.

The electrolysis of chloride solutions upon a commercial scale has always been handicapped in the past by the difficulty of finding a durable and cheap form of anode. Gas carbon anodes are cheap but are not durable; platinum anodes are durable but are expensive. Nevertheless, blocks of gas carbon are being used as anodes in a large number of installations for the production of alkalies and chlorine products at the present moment, and the use of platinum is restricted to the factories where hypochlorites or chlorates are the final product of the electrolytic cell.



Vertical Section of the Heraeus Platinum Electrode.

Many attempts have been made to devise forms of platinum anode which shall give a large superficial area of anode surface per unit weight of metal employed. The well-known German firm, Heraeus, of Hanau-on-the-Maine, have brought out a new platinum electrode which successfully meets this requirement.

The accompanying figure shows a vertical section of this new electrode. A is a glass tube with the lower end closed by fusion. Into the walls of this tube a number of fine platinum wires, B, B, B, B, are fused, and to the projecting ends of these wires, strips of platinum foil, C, C, 0·8in. wide and only 0·0003in. in thickness, are attached by autogenous soldering.

The connection with the current supply is provided by an equal number of copper strips, D, D, D, D, which pass down the interior of the tube and are soldered to the portions of the platinum wires which pass through it. The upper ends of these strips are soldered on to a copper block, E, by which electrical connection with the main conductor is rendered simple. If this block E be made of suitable form, any number of these glass tube electrodes can be hung upon an insulated cross-bar carrying the current.

An electrode constructed in this way with an active surface area of 10·75 sq. ft. will only require 100grm. of platinum, and although the foil used is extremely thin, yet the cross pieces of platinum wire to which it is attached give to it considerable mechanical strength.

A further advantage offered by this form of electrode is that the loss of E.M.F. by internal resistance can be reduced to a minimum by using sufficiently thick copper wires to make the connections in the interior of the tube A, and that by increasing the thickness of these wires, and of the cross wires, the electrode can be adapted to currents of very high intensity.

The current density is also rendered fairly regular at all points upon the surface of the electrode owing to the numerous connections made between it and the main conductor, by the cross wires upon which the platinum foil is fixed.

If care be used in the construction of these electrodes, they stand well both in hot and cold electrolytes, and the glass tubes do not crack or break at the points where the platinum wires pass through them.

The inventor of this new form of electrode considers that it will now be possible to use platinum as electrode material in many electrolytic processes and manufactures, from which its high price has hitherto, excluded it, and that in this new form platinum can even compete in price with carbon.

**Wireless Telegraphy at Sea.**—The ss. "Lucania" reported, on her arrival at Liverpool last Saturday, that on the previous Wednesday she had been in communication at sea with the outward bound ss. "Campania." The two steamships were in communication by means of wireless telegraphy for two hours, and were 86 miles apart when the signalling was commenced. Neither ship sighted the other during the voyage.



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Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON

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## POPULAR SCIENCE.

The phrase "popular science" has so often been associated, in the truly scientific mind, with "science falsely so called," that there is danger of it being quite forgotten that popular science of pure and strictly orthodox character is not only possible but actually exists. The irresponsible imagination of untutored minds has so frequently found vent in the so-called science columns of newspapers and the science-made-easy articles of magazines, that the layman searching for scientific truth in intelligible language is often misguided and led astray from the narrow way wherein may be discovered the elementary knowledge which he seeks. Indeed, so rare is the genuine source of popular science, that some scientists have even thrown doubt on both its actual and its possible existence, asserting that the "esoteric" principles of science are comprehended only by the trained initiate and can never be clothed in such simple language as to become "exoteric" and understanded properly of the people. As regards the elementary principles of science this scepticism is not justified by facts; we go further, and assert that there is no inherent and insuperable difficulty in presenting, in clear and undistorted outline, even the most recondite of modern scientific theories, by such language and illustrative art as that they shall be intelligible to the average unscientific mind. But this is a task for the leaders of science, not for the rank and file; the successful popular science teacher is the man to whom the very vanguard of science looks for instruction. Numerous instances which serve to prove this may be cited: CLERK MAXWELL'S brilliant little treatise on "Matter and Motion," Prof. GEIKIE'S world-read primer on "Geology," THOMAS HUXLEY'S popular essays on biological science, Prof. PERRY on spinning tops, Mr. VERNON BOYS on soap bubbles—all these are works in which the true inwardness of science is made intelligible to the lay mind. True popular science, as illustrated by these and kindred examples, is seen to consist essentially in the presentment of necessary outline and the omission of minor detail, as opposed to the caricature which wrongly so-called popular science presents.

An apt illustration of the successful manner in which a master mind may sketch in popular outline the form of a recondite aspect of modern scientific speculation and theory

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is to be found in a recent article on "Cathode Rays," by Prof. J. J. THOMSON, in *Harper's Monthly Magazine*. We wish that every science article in magazines of this class were as sound in its facts and as intelligibly explicit in its language as the article now before us. The article is described as being written "with special reference to recent investigations by the author." It states that at the outset that these have "a very direct bearing on our ideas of matter and electricity," and thus it secures at once the keen interest of every reader who is not a dolt. In what simple yet effective language is the production of cathode rays next described:—

When a current of electricity is sent between two wires fused in a glass tube from which the air has been exhausted until the air pressure is only an exceedingly small fraction, say $\frac{1}{10000}$th, of the atmospheric pressure, the tube presents a very striking and varied appearance, of which the general nature may be gathered from Figs. 1 and 2. Confining our attention to the neighbourhood of the wire by which the current leaves the tube (this wire is called the cathode; it is the one marked – in the figure), we find (see Fig. 2) a velvety glow spreading over the surface of the wire; next to this comes a space called the dark space, which is almost dark, and whose boundaries run parallel to the surface of the wire forming the cathode; outside the dark space the gas is luminous for some distance, this luminous portion forming what is known as the negative glow. So far we have been describing the appearance of the gas left in the tube, but the gas is not the only source of light, for the glass in the part of the tube near the cathode glows with a vivid phosphorescence, the colour of which depends upon the kind of glass of which the tube is made. If the glass is soda glass, the light given out is a bright yellowish-green, while with lead glass the light is blue. It is to the cause of this phosphorescence that we wish to call attention in this article.

Using phraseology not less intelligible, Prof. THOMSON next takes his reader through the history of the researches on cathode rays and introduces him to the corpuscular theory of electricity and its bearing on the constitution of matter. After reviewing the work of CROOKES and others, he describes HERTZ's discovery of the transmissibility of cathode rays through gold leaf and the production of Lenard rays: "LENARD was thus the first physicist to cross the Rubicon between the inside and the outside of the tube." The divergence of Continental and English views having been explained, the reader is gradually prepared to accept the evidence of LENARD'S and PERRIN'S researches as to the corpuscular nature of the rays. The size and velocities of these corpuscles are next discussed in popular language, and the wonderful substance, radium, discovered by Prof. and Madame CURIE, is described:—

We may suppose that it [the corpuscle] forms a part of all kinds of matter in the normal state, and that the heat and light which have to be applied to metals are only required to get the corpuscles out of the metal, and that in the metal itself, even under normal conditions, there are corpuscles moving freely about, and able to carry heat as well as electricity from one part of the metal to another. There are some substances which are perpetually emitting cathode rays without the need of any stimulus from heat or light. This, as has been shown by BECQUEREL, is the case with uranium and its compounds; the property is, however, possessed to an enormously greater extent by a new substance discovered by Prof. and Madame CURIE, and called by them radium, which is obtained from the mineral pitchblende. Its preparation is very difficult and laborious, as from several tons of pitchblende only a few grammes of radium can be obtained. This substance has been shown by its discoverers to emit corpuscles, and it is very remarkable that the velocity with which the corpuscles are emitted is about two-thirds of that of light, which is double the highest velocity we have hitherto been able to give (even with the most powerful induction coils) to the corpuscles in an exhausted tube. It is one of the romances of science that a harmless-looking white powder like radium should be perpetually bombarding its neighbours with projectiles of this velocity—a bombardment which is not always harmless, as I believe there are instances of sores being caused by too lavish an exposure to the radium attack.

Naturally, the hypothesis is touched upon that cathode rays are projected from the sun upon the earth, and the probable relation of this bombardment to the phenomenon of the aurora is suggested. Finally, the author observes that "it is a striking instance of the unity of physical phenomena on the smallest and largest scale that an occurrence apparently so exceptional as the glowing of the glass in a small tube should be closely connected with some of the most widespread phenomena in nature, and give the clue to their explanation."

We have sought in the foregoing abstract of Prof. J. J. THOMSON'S article to indicate the manner in which he has handled the difficult task of popularising a recondite subject, rather than to review the article from the scientific point of view. Much is lost by not reproducing the article as a whole, and we recommend our readers to peruse it. Reverting now to the original subject of the popularising of science through the medium of general periodical literature, we venture to hope that the proprietors of magazines, and even of the daily press, will follow the example before them, and invoke the aid of the leaders of science in presenting the facts and theories of science before the world in popular form. Though this course would rob such publications of their spuriously sensational character, the apparent loss would be a real gain, for the information conveyed would be of permanent value and utility; while, as regards sensations, what can be more healthily sensational than the romance of real science?

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Zeeman Effect.*—Reese has shown that the separation of the external components of the regular Zeeman triplet or quadruplet, as seen perpendicular to the lines of force, does not vary proportionally with the strength of the magnetic field in which the luminous source is placed. This fact was established for various zinc and cadmium lines up to a field of about 26,000 units. N. A. Kent has extended these researches to fields of 33,000 units, using a Rowland grating of 13ft. radius. The results show that the separation of the outer components of the zinc lines 4,680·38, 4,722·26, 4,810·71 is not proportional to the strength of the field. For iron lines chosen somewhat at random the same is true, and the lines which, in the ordinary iron spectrum, are "nebulous" in character show the least increase in Zeeman separation as the field is increased in strength. In other words, the curve plotted between the strength of field H and the resulting separation $\Delta\lambda$ shows the greatest droop. Preston's law that $\frac{\Delta\lambda}{\lambda^2 H}$ is a constant for homogeneous lines, holds not only for zinc, cadmium and magnesium, but also for mercury and cadmium. [N. A. KENT, *Phil. Mag.*, September, 1901.]

*Simultaneous Multiplex and Ordinary Telegraphy.*—The simultaneous transmission of telegraphic and telephonic messages over the same wire is rendered possible by the difference in the effects produced by continuous and oscillating currents respectively. It follows that any system of telegraphy which employs oscillating currents offers the possibility of a simultaneous transmission of continuous and oscillatory messages. Such a system is that of E. Mercadier, who operates with electric tuning-forks. He has tested the possibility above indicated in a practical manner and on a large scale, and has succeeded in completely establishing it. The line worked with was that between Paris and Bordeaux. Among the various forms of auxiliary apparatus devised by Van Rysselberghe, Maiche, Cailho, Picard, &c., that of Cailho was chosen, and 12 simultaneous messages were transmitted by Mercadier's system, together with signals, with the Morse, Hughes, or Bandot transmitter. Since messages can be sent in both directions, this means that one wire can carry 25 messages at a time, together with extra messages between intermediate stations. This means a conveying capacity of some 1,300 telegrams of 20 words per hour, and a page of *The Times* could be transmitted from London to Dublin in half an hour.

[E. MERCADIER, *Comptes Rendus*, September 16, 1901.]

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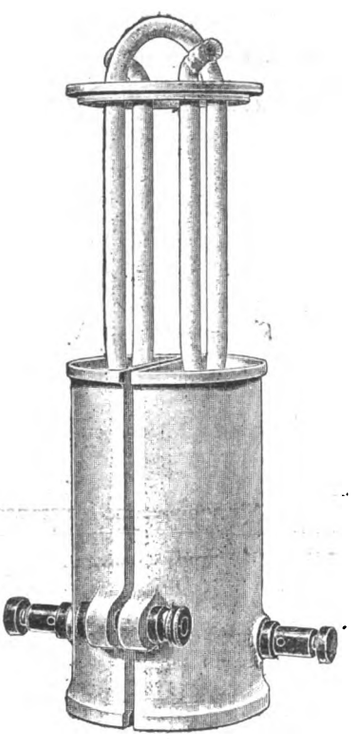
*Energy of Röntgen Rays.*—Measurements of the energy of Röntgen rays have been made by Dorn, Schoeps and Rutherford, who found an average quantity of 0·0002 gramme-calories per interruption. This result, fairly concordant as it is among the three independent observers, is doubted by F. Leininger, who also uses a bolometer method, but has not succeeded in obtaining any bolometer deflection at all, though a comparison between the sensitiveness of Rutherford's bolometer and his own shows that he had a right to expect a deflection of 19 scale divisions. Since one of the tubes used had an adjustable vacuum and could be studied both in a very hard and a very soft condition, the negative result cannot be attributed to the hardness of the tubes. That the tube was highly efficient could be proved by its powerful fluorescence effects. The author cannot account for this discrepancy. It suggests the desirability of further independent investigations.

[F. Leininger, *Physikal. Zeitschr.*, August 31, 1901.]

*Disc Interrupter for Alternate Currents.*—E. Ruhmer reports some further improvements in the liquid interrupter with exchangeable perforated plates. The electrodes are introduced through the sides, thus obviating gliding sparks which might lead to explosions. By making one electrode of lead



and the other of aluminium the author has succeeded in producing an apparatus which only interrupts the alternating current in one direction. This is of special utility in Röntgen-ray work. The life of an aluminium electrode is about 500 hours.

[E. Ruhmer, *Physikal. Zeitschr.*, September 21, 1901.]

*Luminous Effects on Wires.*—Bare wires appear surrounded by a luminous halo when they are connected with the secondary of an induction coil, and the circuit is either open or closed by means of a Crookes tube. Besides the halo bright stars appear on the wires at nearly equal intervals. To study this phenomenon in greater detail, J. Borgmann examined the behaviour of such wires in tubes containing gas at various pressures. An essential difference was produced in the phenomena observed by inserting a spark-gap of less than 3mm. in parallel with the induction coil. Without such a spark-gap there is no difference produced by a change of pole. As the exhaustion increases the stars become brighter, and are the centre of discs at right angles to the wire. They also increase in number, until finally they coalesce to a slightly stratified light column. On introducing the spark-gap, a decided difference is produced by connecting the tube with the positive or the negative pole of the induction coil respectively. The difference becomes the more marked the higher the vacuum. The stars only appear on connecting with the positive pole. On connecting with the negative pole a continuous halo surrounds the wire, which leaves the wire on further exhaustion and travels outwards. When the pressure is only a few tenths of a millimetre, a series of dark green rings are seen on the wall of the tube, which revolve round the wire and travel along the tube. The approach of a conductor widens the interval between them, but a magnet produces no effect.

[J. Borgmann, *Physikal. Zeitschr.*, August 17, 1901.]

## NOTES ON ROTARY CONVERTERS AND PHASE-SWINGING.

W. M. Thornton, M.Sc., M.I.E.E.

(*Concluded from page 872.*)

*Energy Dissipated in Core.*—Heaviside has shown how the energy supplied to a metallic core by an alternating current circulating round it is dissipated. The Paper on "The Induction of Currents in Cores," Vol. I. "Electrical Papers," p. 353, contains a complete statement of the various physical transformations.

Referring to §13 of the Paper—that on "Heat in Core and in Coil"—and using his notation, the heat per second dissipated in the core is seen to be by equation (33),

$$w = \frac{\pi\rho l}{(4\pi)^2} \cdot (A^2 + B^2) \int_0^c (M'^2 + N'^2) r \cdot dr \text{ ergs.}$$

the integration being from centre to circumference of the core. Here $\rho$ is the specific resistance of the material of the core, and $l$ is the length of the core in centimetres.

A and B are "constants" depending on the electrical constants of the core. M′ and N′ are oscillating functions involving the nature of the material of the core and its dimensions. Thus

$A = 4\pi e P/(P^2 + Q^2)$, $B = 4\pi \cdot eQ/(P^2 + Q^2)$, from equation (40)

(One N occurring in Heaviside's equations is the number of turns in the coil supplying the alternating current. In the case of the damping coil this is unity.) $e$ is the voltage in the coil, and in (4) above this is found in terms of the armature current and phase and the reluctance of one pole circuit.

Also, $P = rM + \frac{\rho L}{2\pi\mu c} \cdot M'$, $Q = rN + \frac{\rho L}{2\pi\mu c} \cdot N'$.

Here $\mu$ is the permeability of the core, $c$ the radius of the curved surface, L the inductance of the damping coil, M and N functions given below.

$$M = 1 - \frac{x^2 r^4}{2^2 4^2} + \frac{x^4 r^8}{2^2 4^2 6^2 8^2} - \frac{x^6 r^{12}}{2^2 \ldots 12^2} + \frac{x^8 r^{16}}{2^2 \ldots 16^2} - \ldots$$

$$N = \frac{xr^2}{2^2} - \frac{x^3 r^6}{2^2 4^2 6^2} + \frac{x^5 r^{10}}{2^2 \ldots 10^2} - \frac{x^7 r^{14}}{2^2 \ldots 14^2} + \ldots$$

M′ and N′ are the differential coefficients of these with regard to $r$, viz.:

$$M' = -\frac{x^2 r^3}{4^2} + \frac{x^4 r^7}{2^2 4^2 6^2 8^2} - \frac{x^6 r^{11}}{2^2 4^2 6^2 8^2 10^2 12} + \ldots$$

$$N' = \frac{xr}{2} - \frac{x^3 r^5}{2^2 4^2 6} + \frac{x^5 r^9}{2^2 4^2 6^2 8^2 10} - \ldots$$

In the above, $x = 8\pi^2 n\mu/\rho$. $n$ is the frequency of the alternating current supplied to the core, that is the frequency of phase-swinging, and since $a' = 21{\cdot}1$ and $n = a'/2\pi$ it may be taken as 3. Thus, taking $\mu = 100$ for the flux densities worked at, $\rho = 10{,}000$, a high value, but in the right direction, for the heat varies inversely with this, $x = 2{\cdot}4$; and $r$ may be taken as 10cm., $l$ as 20 cm. Substituting these values in the above series

| | |
|---|---|
| M = − 29,600. | $M^2 = 8{\cdot}76 \times 10^8$. |
| N = − 26,490. | $N^2 = 7{\cdot}01 \times 10^8$. |
| M′ = + 34,000. | $M'^2 = 11{\cdot}56 \times 10^8$. |
| N′ = − 45,250. | $N'^2 = 20{\cdot}5 \times 10^8$. |

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Performing the integrations, the heat may be written

$$w = \pi\rho l c e^2 \frac{(MM' + NN')}{P^2 + Q^2},$$

$$w = \pi\rho l c e^2 \left\{ \frac{MM' + NN'}{r^2(M^2 + N^2) + \left(\frac{\rho L}{2\pi\mu c}\right)^2 (M'^2 + N'^2) + \frac{r\rho L}{\pi\mu c}(MM' + NN')} \right\}$$

Thus, using the values of M, N, M', N' given above,

$$w = \frac{1{\cdot}145 e^2}{10^4} \text{ ergs per second.}$$

Now $e = k i_1 (1 + 2q\phi)\frac{d\phi}{dt}$.

Thus $w = \frac{1{\cdot}145 \times 0{\cdot}737}{10^4}(k i_1)^2(1 + 2q\phi)^2 \cdot \left(\frac{d\phi}{dt}\right)^2$ ft. lb. a second, (18)

and $k = 4{\cdot}64 \times 10^4$, $i_1 = 100$.

Therefore, $w = 181(1 + 2q\phi)^2\left(\frac{d\phi}{dt}\right)^2$ ft. lb. a second.

The torque $= \frac{w}{2\pi n}$, and $i$ thus $= 2{\cdot}9(1 + 2q\phi)\left(\frac{d\phi}{dt}\right)^2$ ft. lb. (19)

When $d\phi/dt = 1$, this term is to be added to that already found by considering the heat in the coil alone.

Thus the effect is to increase the numerical coefficient A by 2·9, and the expression for the damping constant $\gamma$ is greater in the ratio $(A + 2{\cdot}9)/A$.

Now $A = 0{\cdot}4$ so that $\gamma$ is increased in the ratio $3{\cdot}3/0{\cdot}4 = 8{\cdot}25$, or the rate of damping of the phase-swinging due to one coil and core together is greater in this ratio than with the coil alone.

The motion is reduced in the ratio 1/2·7 in 1·175 seconds when all eight coils and cores are acting. That is, not more than one or two beats are heard, and the adjustment of current in the alternating circuit is not disturbed by pulsations from the converter.

The above time, compared with the former value given for the coil alone, shows that the absorption of energy and its dissipation as heat is very considerably increased by the presence of a low-resistance coil, placed so as to surround the core, and that this is sufficient to account for the damping as observed in practice.

The rate at which damping varies with the resistance of the coil may be seen by writing $\gamma = a/r + b/(cr^2 + dr + e)$, $r$ being the resistance of the coil and the other letters constants for the particular machine discussed. In this case $a = 1{\cdot}25 \times 10^4$, $b = 3{\cdot}07 \times 10^{11}$, $c = 15{\cdot}76$, $d = 7{\cdot}9 \times 10^3$, $e = 5{\cdot}1 \times 10^4$, $r$ being expressed in candle-power units. The first term, due to the coil alone, represents a rectangular hyperbola, the second due to the core is a curve of the third degree. Between the practical limits $r = 10^4$ and $r = 10^6$, the second curve is real and positive, and the two curves together resemble the lower half of a hard steel hysteresis loop.

Writing $\gamma = \gamma_1 + \gamma_2$, the values may be compared from the following:

| $r$ | $\gamma_1$ | $\gamma_2$ | $\gamma$ |
|---|---|---|---|
| $10^4$ | 1·25 | 192 | 193·25 |
| $10^5$ | 0·125 | 1·9 | 2·025 |
| $10^6$ | 0·0125 | 0·019 | 0·03 |

Thus the advantage of reducing the resistance is seen to be very great at low values, and by increasing the cross-sectional area of the coils their number may be reduced.

To compare these results with those obtained when the damping coil is omitted, it is sufficient to substitute for the resistance of the damping coil that of the constant magnetising circuit, which, being ten thousand times greater, correspondingly diminishes the boundary current and intensity of waves sent radially into the core.

The current in the damping coil is not in phase with the voltage due to the change of flux. The inductance of the coil $= 4\pi/R$, where R is the reluctance of one-pole magnetic circuit, *i.e.*, half a complete circuit. In the case quoted $R = 0{\cdot}00097$. Hence $L = 4\pi/0{\cdot}00097 = 1{\cdot}288 \times 10^{-5}$ henrys, the resistance $r = 0{\cdot}00006$ ohms. Thus $L/r = 1{\cdot}288/0{\cdot}00006 \times 10^5 = 0{\cdot}214''$, the "time-constant.

The tangent of the angle of lag $= 2\pi n L/r = 4$. Thus the angle = 76deg.

When the time constant is above a certain critical value the current in the damping coil is increased by the effect of the eddy currents in the core, and below this value decreased. In order, then, to obtain the best result in practice with minimum material the resistance must be made not greater than the critical resistance given by

$$\frac{L}{r} = \frac{\pi\mu c^2}{\rho} \cdot \frac{Y y}{1 - Y_3}, \quad \ldots \quad (52)^*$$

where
$$Y_4 = \frac{1 + \frac{6y}{6^2 8^2} + \frac{80y^2}{6^2 8^2 10^2 12^2} + - \ldots}{1 + \frac{2y}{2^2 4^2} + \frac{6y}{2^2 4^2 6^2 8^2} + \ldots},$$

and
$$Y_3 = \frac{1 + \frac{3y}{4^2 6^2} + \frac{3 \times 3\frac{1}{3}y^2}{4^2 6^2 8^2 10^2} + \ldots}{1 + \frac{2y}{2^2 4^2} + \frac{6y^2}{2^2 4^2 6^2 8^2} + \ldots},$$

in which
$$y = x^2 c^4.$$

Thus
$$r = L\rho(1 - Y_3)/\pi\mu c^2 Y_4 \quad \ldots \quad (20)$$

Using the same values of $x$ and $c$ as before $Y_4 = 0{\cdot}0242$, $Y_3 = 0{\cdot}0723$. Therefore $r = 0{\cdot}00016$ ohms. With any resistance less than this the waves of magnetic force will be strengthened and the damping increased; above this it will be diminished.

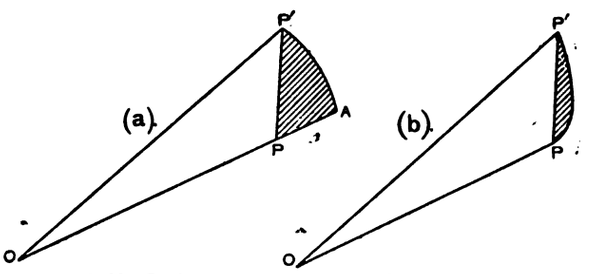


FIG. 5.

The cross-sectional area of the damping coil should be greater than $\rho' l'/r$, where $\rho'$ is the specific resistance of the material of the coil and $l$ the perimeter of the pole core, allowing for the thickness of the coil frame, $r$ being found by equation (20).

In the expression for $\gamma$, equation (15), the quantity $q$ is not constant, but varies with the load, being zero at the point of breaking step and a maximum at no load. The quantity B depends on the magnitude of the load thrown off or on, since the initial amplitude of oscillation depends on the work done on the armature during the change of position. $a'$ also is greater for light loads than for heavy, and this agrees with the observation that the beats are stronger and diminish more rapidly than for corresponding changes at full load.

The effect of heavy impedance on the *continuous* side of the converter would be to prolong the time of impact of the load and to diminish the impulsive change of armature momentum. The result is shown at (*b*) Fig. 5.

In the second case the effect is to diminish the work

$$\int_{\phi_1}^{\phi_2} (F_2 - F_1)\frac{r}{p} \cdot d\phi,$$

and thus to dimish the initial amplitude of the swing. It also diminishes the damping, but it is of more importance to keep down the initial disturbance, phase-swinging of small amplitude not being of consequenc. Coils placed around the poles, or copper rods arranged in a manner equivalent to these, are, without doubt, the best way of checking slow pulsations of current in converters or synchronous motors. Rapid pulsations may be kept down by the use of suitable choking coils on the alternating side. Synchronous motor-generators run more smoothly than converters on account of the separation

* "Electrical Papers," p. 371.

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of the magnetic circuits, a disturbance on one side only affecting the other mechanically, through the shaft. The inertia of the moving parts is also greater in the first, diminishing the initial amplitude of swing.

*Effect on Generator.*—The immediate effect of phase-swinging on the generator is to vary periodically the retarding torque. If the disturbances are synchronous with the fluctuations of crank effort there is a cumulative oscillation imparted to the magnet wheel which aggravates the current fluctuations in the circuit and may in time lead to one or all of the converters breaking step.

A somewhat sluggish governor is thus an advantage, for the electric disturbances are rapid impulses rather than sustained loads.

Flywheel design for synchronous motor driving is really a question, in the first place, of motor design, so that the moving parts may not be subjected to synchronous oscillations of load between generator and motor. There will, however, be a minimum weight of wheel for each motor or converter on the circuit. This will depend on the variations of engine power, and on the mechanical disturbances experienced during the phase-swinging of the rotaries, though these may not be synchronous.

The variation of current for any one converter swinging within given phase limits is found from the current curve of Fig. 1. Thus 2deg. change at normal load causes 11 amperes variation above and below the normal working current of

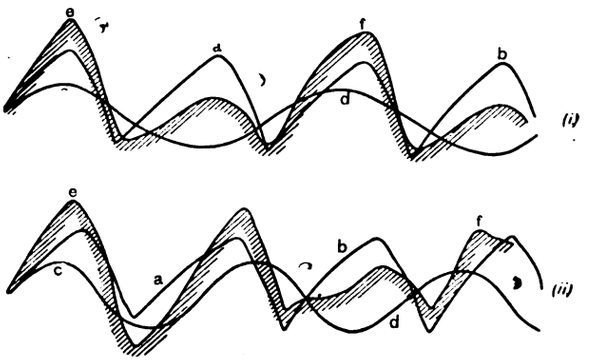


FIG. 6.—Resultant Variation of Crank Effort during Phase-swinging.

100 amperes. The resisting torque in the generator will vary accordingly. (A calculation made of the effect of the field variations in the generator on the torque shows that these are too small to measurably affect the pressures on the crank pin.)

Let I be the moment of inertia of the generator magnet wheel, $w$ its angular velocity in radians a second. The kinetic energy of the wheel is $\frac{1}{2}Iw^2$, and for any change

$$\frac{d}{dw}(\text{KE}) = Iw,$$

or

$$I = \frac{\delta(\text{KE})}{\delta w} \cdot \frac{1}{w} \quad \ldots \ldots \quad (21)$$

I is to be the minimum moment of inertia, hence $\delta w$ is the maximum allowable change of angular velocity and $\delta$(KE) the corresponding change in its kinetic energy, or of the work done on the wheel.

Consider a system of one motor and one generator. A variation of 11 amperes in the armature will cause a change of 120lb. in the mechanical force on the wheel periphery. This reduced to the crank pin in the ratio 3·25 is 390lb.

Let the curve ($ab$) (Fig. 6) represent the top of a crank effort diagram of a two-crank engine. On this must be superposed a periodic curve $cd$ which may be taken as a simple harmonic of amplitude 390lb. The maximum amplitude of the crank effort curve at 100kw. is 780lb. Thus the phase-swinging currents in this case cause a disturbance of half the normal variation of crank effort. Assuming a frequency of 180 for the phase-swinging and 90 for the engine speed, the first curve is obtained $ef$; choosing any smaller value of phase frequency, the general effect is shown by (ii.).

Let $\delta$(KE) be the maximum shaded area above the mean line, $\delta w$ the change of angular velocity and $\delta\phi$ the corresponding change of phase position.

Then $$\delta w = \frac{1}{p}\frac{\delta\phi}{\delta t},$$

where $p$ is the number of pairs of poles on generator.

From equation (21) $$I = \frac{p\delta(\text{KE})}{w\left(\frac{\delta\phi}{\delta t}\right)},$$

$$W = \frac{gp\delta(\text{KE})}{k^2 2\pi n\left(\frac{\delta\phi}{\delta t}\right)} \text{ lbs.},$$

where $n$ is the revolutions per second. Writing $\delta(\text{KE}) = c\text{E}$, where E is the work done per stroke of engine and $c$ is the ratio of the maximum shaded area above the mean line to the work done in one stroke, then

$$W = \frac{gpc\text{E}}{2\pi nk^2\left(\frac{\delta\phi}{\delta t}\right)}.$$

In an actual case $c = 0{\cdot}06$, $p = 12$, E = 24,500 foot pounds, $n = 1\frac{1}{2}$ revs. per sec., $\delta\phi/\delta t = 0{\cdot}05$ radian per sec., $k = 0{\cdot}85$ radius of periphery.

The weight of the rim of a 14ft. wheel per 100kw. converter is then 8,500lb., or nearly 4 tons. Thus a 1,000kw. generator supplying five sub-stations of 200kw., each would require a wheel-weight, including generator moving parts, of 40 tons to ensure smooth running.

## ELECTRICITY WORKS ACCOUNTS.

**The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—**

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Sept. 17, 1901 | Kingston-upon-Hull (Mun.) | July 13, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Bath (Municipal) | April 20, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bedford (Municipal) | Aug. 3, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Birmingham (Company) | Sept. 15, 1899 | Leith (Municipal) | May 17, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Blackpool (Municipal) | Oct. 5, 1900 | Liverpool (Municipal) | Mar. 22, 1901 |
| Bournemouth (Company) | May 3, 1901 | London (Company) | July 26, 1901 |
| Bolton (Municipal) | Nov. 30, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bradford (Municipal) | July 12, 1901 | Manchester (Municipal) | Sept. 13, 1901 |
| Brighton (Municipal) | May 10, 1901 | Morley (Municipal) | June 14, 1901 |
| Bristol (Municipal) | Aug. 30, 1901 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Norwich (Company) | Dec. 28, 1900 |
| Bury (Municipal) | Aug. 9, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Cambridge (Company) | April 12, 1901 | Nottingham (Municipal) | Sept. 21, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Oldham (Municipal) | Feb. 1, 1901 |
| Cardiff (Municipal) | Jan. 11, 1901 | Oxford (Company) | April 12, 1901 |
| Charing Cross (Company) | Mar. 15, 1901 | Pontypool (Company) | May 3, 1901 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Prescot (Company) | Dec. 8, 1899 |
| Chester (Municipal) | Aug. 16, 1901 | Preston (Company) | Dec. 14, 1900 |
| City of London (Company) | July 26, 1901 | Reading (Company) | Dec. 21, 1900 |
| Clerkenwell (Company) | April 19, 1901 | Richmond (Company) | June 29, 1900 |
| Coventry (Municipal) | Feb. 23, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| Croydon (Municipal) | July 20, 1900 | Scarborough (Company) | July 13, 1900 |
| Crystal Palace District (Co.) | Sept. 13, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Derby (Municipal) | Jan. 26, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | St. Pancras (Municipal) | July 5, 1901 |
| Dover (Company) | April 26, 1901 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Eastbourne (Company) | May 4, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South London (Company) | May 31, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | South Shields (Municipal) | Sept. 20, 1901 |
| Folkestone (Company) | April 26, 1901 | Southampton (Municipal) | Feb. 8, 1901 |
| Glasgow (Municipal) | Sept. 27, 1901 | Southport (Municipal) | July 7, 1899 |
| Gloucester (Municipal) | Aug. 30, 1901 | Stafford (Municipal) | Aug. 16, 1901 |
| Great Yarmouth (Mun.) | Dec. 28, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Greenock (Municipal) | Aug. 30, 1901 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | April 19, 1901 |
| Hanley (Municipal) | Aug. 9, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | May 17, 1901 |
| Hast'gs & St. Leonards (Mun.) | July 12, 1901 | Windsor and Eton (Co.) | July 19, 1901 |
| Hove (Company) | May 10, 1901 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Hull (Municipal) | Sept. 20, 1901 | Woolwich (Company) | May 31, 1901 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | July 19, 1901 |
| Kensington & Knightsbr'(Co.) | Mar. 16, 1900 | | |

### Blackpool Municipal Electric Supply Works and Tramways.

It will be seen from our first table that the electricity supply department at Blackpool has suffered severely from the increased price of coal. The fuel item shows a rise from

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## BLACKPOOL.

*Undertaking Worked by* ..... Blackpool Corporation.
*Date of Commencement of Supply* ..... October, 1893.
*System of Supply* ..... [con.-curr. for tramw'y supply
*Chief Engineer* ..... Alt.-curr. trans. sub-stations for lighting and Robert C. Quin.

| YEAR ENDED | MAR. 31, 1900. | MAR. 31, 1901. |
|---|---|---|
| **QUANTITIES—** | | |
| Units generated | 1,427,607 | 1,760,459 |
| „ **SOLD (TOTAL)** | 1,148,564[a] | 1,515,363[g] |
| „ sold to consumers | 955,511[a] | 1,250,612[g] |
| „ sold for public lighting, &c. | 193,053 | 264,754 |
| „ used on works | 24,906 | 28,573 |
| **UNITS SOLD per 8 c.p. LAMP CAPACITY** | 15·3 | 20·2 |
| Maximum supply demanded | 1,300 kilowatts | 1,460 kilowatts |
| Number of public lamps | 200 arc, 264 glow | 240 arc, 290 (8 c.p.) glow |
| Number of consumers | 900 | 910 |
| Connections to mains in 8-c.p. lamps | 78,000 | 82,204 |
| **CAPACITY OF PLANT IN 8-c.p. LAMPS** | 75,000 | 75,000 |
| **CAPACITY OF PLANT IN KILOWATTS** | 2,400 | 2,400 |

| CAPITAL— | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|
| **AUTHORISED (TOTAL)** | £162,515 | £67·7 | £162,515 | £67·7 |
| Share | — | — | — | — |
| Loan (including Debenture charges) | 162,515 | 67·7 | 162,515 | 67·7 |
| **RECEIVED (TOTAL)** | — | — | 145,094 | 60·4 |
| Share | — | — | — | — |
| Loan (including Debenture charges) | — | — | 145,094 | 60·4 |
| **AUTHORISED, NOT RECEIVED (TOTAL)** | — | — | 17,421 | 7·26 |
| Share (unissued) | — | — | — | — |
| Share (uncalled) | — | — | — | — |
| Loan (including Debentures) | — | — | 17,421 | 7·26 |
| **REPAID (TOTAL)** | 1,181 | 0·492 | 2,344 | 0·977 |
| **RESERVE OR SINKING FUND** | 9,460 | 3·94 | 11,845 | 4·94 |
| **DEPRECIATION FUND** | 678 | 0·282 | 700[m] | 0·293 |
| **EXPENDED (TOTAL)** | 118,535 | 49·4 | 145,094 | 60·4 |
| Lands and buildings | 12,041 | 5·02 | 18,301 | 7·63 |
| Plant | 72,663[b] | 30·3 | 88,869 | 37·0 |
| Mains | 31,613 | 13·2 | 35,704 | 14·9 |
| Miscellaneous | 2,218 | 0·924 | 2,218 | 0·924 |
| **BALANCE OF CAPITAL ACCOUNT** | — | — | — | — |

| REVENUE— | Total. | Per unit sold | Total. | Per unit sold |
|---|---|---|---|---|
| **TOTAL** | £18,465 | 3·858d. | £23,523 | 3·725d. |
| Revenue from supply | 14,612[c] | 3·053d. | 17,778[h] | 2·815d. |
| „ meters, &c. | — | — | — | — |
| „ public lighting | 3,792[d] | 0·793d. | 5,656[j] | 0·896d. |
| „ sale of lamps, &c. | 24 | 0·005d. | 17 | 0·003d. |
| „ miscellaneous sources | 37 | 0·008d. | 72 | 0·011d. |
| **EXPENDITURE—** | | | | |
| **TOTAL COSTS** | £10,501 | 2·194d. | £16,016 | 2·536d. |
| **WORKS COSTS** | 8,501 | 1·776d. | 14,147 | 2·241d. |
| *Generation of Electricity—* | *7,141* | *1·492d.* | *11,970* | *1·895d.* |
| Fuel (including cartage, &c.) | 3,354 | 0·701d. | 7,697[k] | 1·219d. |
| Oil, waste, water, stores | 845 | 0·177d. | 980 | 0·155d. |
| Wages at station | 1,775 | 0·371d. | 1,870 | 0·296d. |
| Repairs & maintenance at Station | 1,124 | 0·235d. | 1,423 | 0·225d. |
| *Distribution of Electricity* | *572* | *0·120d.* | *756* | *0·120d.* |
| Wages, &c. | 572 | 0·120d. | 756 | 0·120d. |
| Repairs, renewals of mains, &c. | | | | |
| *Public Lighting* | *788* | *0·165d.* | *1,421* | *0·225d.* |
| Attendance | 310 | 0·065d. | 434 | 0·069d. |
| Renewals | 478 | 0·100d. | 987[l] | 0·156d. |
| **MANAGEMENT CHARGES, &c.** | 2,000 | 0·418d. | 1,869 | 0·296d. |
| *Royalties* | — | — | — | — |
| *Rent, rates, taxes* | *576* | *0·120d.* | *512* | *0·081d.* |
| *Management* | *1,424* | *0·298d.* | *1,357* | *0·215d.* |
| Salaries | 974 | 0·204d. | 926 | 0·147d. |
| Stationery, &c. | 169 | 0·035d. | 104 | 0·016d. |
| Establishment charges | 156 | 0·033d. | 327 | 0·052d. |
| Law charges, &c. | 125 | 0·026d. | | |

| FINANCIAL RESULTS— | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
|---|---|---|---|---|
| **WORKING PROFIT FOR YEAR** | £7,963 | 7·22% | £7,507 | 5·70% |
| Carried to Depreciation Fund | — | — | 163 | 0·124% |
| Carried to Res. or Sinking Fund | | | | |
| Net int. on loans (incl. Deb. charges) | 6,787 | 6·15% | 7,550 | 5·73% |
| **BALANCE FROM LAST ACCOUNT** | — | — | — | — |
| **Do. AVAILABLE for DISTRIBUTION, &c** | 1,176 | 1·07% | — | — |
| *Deficit* | — | — | *205* | *0·156%* |
| **ORDINARY DIVIDEND PAID** | — | — | — | — |
| **% of TOTAL COSTS to GROSS REVENUE** | 56·9% | | 68·1% | |
| Expenditure per kilowatt capacity | £4. 7s. 6d. | | £6. 13s. 6d. | |
| **REVENUE PER KILOWATT CAPACITY** | **£7. 13s. 10d.** | | **£9. 16s. 0d.** | |
| Expenditure per 8-c.p. lamp capacity | 2s. 9½d. | | 4s. 3½d. | |
| **REVENUE PER 8-C.P. CAPACITY** | **4s. 11d.** | | **6s. 3½d.** | |
| **REVENUE PER 8-C.P. CONNECTED** | **4s. 8½d.** | | **4s. 8½d.** | |
| Price charged for lighting, per unit | 7d. (1 hr.) to 2d.[e] | | 7d. (1 hr.) to 2d.[e] | |
| „ for power, per unit | 2½d. and 2d.[f] | | 2½d.[i] | |
| „ for public lighting | 7d. (1 hr.) to 2d.[e] | | 7d. (1 hr.) to 2d.[e] | |

BLACKPOOL.—REMARKS—*a* Includes 228,651 to tramways. *b* £10,906 on public arc lamps, posts, switches and erecting. *c* Includes £1,905 from tramways for 228,651 units at 2d. *d* Includes £2,443 for current at 8d., 7d. and 2d. per unit, £788 for attendance, repairs, maintenance and carbons and £560 interest and sinking fund charges on capital cost of public lamps. *e* Maximum demand system. *f* 2½d. for private motors and 2d. traction supply. *g* Includes 392,197 to tramways. *h* Inclusive of £3,120 from tramways. *i* For traction 2d. per unit up to 250,000 units, 1½d. after. *j* £3,409 for current, £1,421 for attendance, carbons and maintenance and £827 interest and sinking fund on outlay on public lamps. *k* Of which £7,286 was cost of coal and coke the balance being cost of unloading, shunting and terminal charges. *l* Of which carbons and their carriage was £361. *m* The suspense account established.

## BLACKPOOL CORPORATION TRAMS.

*Worked by* ..... Blackpool Corporation. [1899.
*Date of Commencement of Work'ng* ..... Conduit system, 1885. Trolley system, July,
*System* ..... Overhead trolley at 500 volts.
*Tramway Manager* ..... J. Lancaster.
*Engineer* ..... Robert C. Quin.

| YEAR ENDED | MAR. 31, 1900. | MAR. 31, 1901. |
|---|---|---|
| QUANTITIES. | | |
| *Car mileage* | *318,885* | *483,796* |
| **Passengers Carried** | 3,421,736 | 4,828,010 |
| **Total Length of Single Track** | 1·325 miles | 1·0 mile |
| „ „ Double „ | 1·788 miles | 2·75 miles |
| **Total Equivalent Length of Single Track Worked** | 4·901 miles | 6·5 miles |
| Rolling stock, No. of motor cars | 16 | 41 |
| „ No. of trailers | nil | nil |
| **Total Capital Expenditure** | £100,744 | £156,180 |
| On Promenade line | 37,878[a] | 37,878[a] |
| On Lytham-road line | 17,662 | 17,695 |
| On Station-road (south shore) line | 5,362 | 5,362 |
| On Promenade Extension line | 151 | 151 |
| On Dickson-road line | 9,873 | 9,873 |
| On Central Drive and Marton line | — | 35,692 |
| On Springfield-road to Gynn line | 1,030 | 11,923 |
| On cars | 6,864 | 11,943 |
| On plant at electricity works | 3,894 | 3,994 |
| On car sheds | 5,302 | 10,305 |
| On conversion from conduit to overhead trolley system | 12,724 | 11,359 |

| REVENUE. | Total. | Per car mile. | Total. | Per car mile. |
|---|---|---|---|---|
| **Total** | £22,611 | 17·02d. | £30,683 | 15·23d. |
| Passenger traffic | 22,285 | 16·78d. | 30,300 | 15·04d. |
| Advertising | 326 | 0·245d. | 383 | 0·190d. |
| EXPENDITURE. | | | | |
| **Total** | 13,742 | 10·34d. | 17,203 | 8·540d. |
| **Total Working Expenses** | 11,642 | 8·765d. | 14,363 | 7·130d. |
| *At Station* | *402* | *0·303d.* | *505* | *0·251d.* |
| Wages | 78 | 0·059d. | 126 | 0·063d. |
| Cleaning and repairs | 120 | 0·090d. | 126 | 0·063d. |
| Electric lighting | 130 | 0·098d. | 235 | 0·117d. |
| Coal, coke, water and gas | 60 | 0·045d. | | |
| *On Road* | *11,240* | *8·465d.* | *13,858* | *6·883d.* |
| Wages | 4,113 | 3·096d. | 5,811 | 2·883d. |
| Electric power for traction and lighting | 1,905 | 1·434d. | 3,483 | 1·728d. |
| Cleaning centre channel and rails | 165 | 0·124d. | 149 | 0·074d. |
| Repairs and maintenance— | | | | |
| Roadway and rails | 1,884[b] | 1·419d. | 1,151 | 0·571d. |
| Centre channel | 200[b] | 0·151d. | nil | — |
| Motors and gearing | 660[b] | 0·501d. | 398 | 0·198d. |
| Cars and wheels | 1,370 | 1·031d. | 1,419 | 0·705d. |
| Overhead system | 650 | 0·489d. | 989 | 0·491d. |
| Oil, waste, &c., for cars, motors and gearing | 69 | 0·052d. | 107 | 0·053d. |
| Lamps for car lighting | 54 | 0·041d. | — | — |
| Uniforms, badges and bell punches | 170 | 0·128d. | 352 | 0·175d. |
| **Management & General Ch'rg's** | 2,100 | 1·580d. | 2,842 | 1·411d. |
| *Rent, rates and taxes* | *991* | *0·746d.* | *1,354* | *0·672d.* |
| *Management* | *958* | *0·721d.* | *1,253* | *0·622d.* |
| Salaries | 796 | 0·599d. | 1,032 | 0·512d. |
| Printing and stationery | 160 | 0·120d. | 221 | 0·110d. |
| *General charges* | *151* | *0·114d.* | *235* | *0·117d.* |

| FINANCIAL RESULTS. | Total. | Per cent. to mean capital expended. | Total. | Per cent. to mean capital expended. |
|---|---|---|---|---|
| **Working Profit** | £7,466[c] | 7·80% | £12,076[c] | 9·40% |
| Carried to tramway reserve fund | 2,000[d] | 2·09% | — | — |
| Interest and sinking fund | 3,819 | 3·99% | 4,642 | 3·61% |
| Balance from last account | 1,758 | 1·84% | — | — |
| **Balance** | 3,405[e] | 3·55% | 7,434[e] | 5·79% |
| Percentage of total expenditure to revenue | 60·8% | — | 56·0% | — |
| **Revenue per Mile of Track** | £4.613 | — | £4.720 | — |
| Expenditure per mile of track | 2,805 | — | 2,645 | — |
| **Revenue per Mile of Route** | 7.265 | — | 8,185 | — |
| Expenditure per mile of route | 4,416 | — | 4,588 | — |
| **Revenue per Passenger from Fares** | 1·56d. | — | 1·51d. | — |
| Total revenue per Passenger | 1·59d. | — | 1·53d. | — |

BLACKPOOL CORPORATION TRAMWAYS.—REMARKS—*a* Includes £15,587 total cost of purchase of works, plant, &c., from Blackpool Electric Tramway Co. (Ltd.) and expenses of purchase and £9,125 repairing and reconstructing centre channel, plant, machinery, &c., in 1891. *b* After crediting £869 loss on sale of centre channel stock (see *d*). *c* After deducting £1,403 part of special expenditure in doubling line at places. *d* After adding loss on sale of centre channel stock, £809 (see *b*). *e* Transferred to aid the rates.

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0·7d. to 1·2d. per unit—nearly 0·52d. It is owing to substantial economies in other expenses that the aggregate generating costs have risen no more than about 0·4d. and the total costs 0·34d. Yet we must say that, with the exception of wages at the station, the several items of works costs displayed in our column for 1900-1 are disappointing, although on the whole they are an improvement on the preceding year's figures. The load factor last year having risen to 11·86 per cent. was much more favourable than in 1899-1900, while the output upon which the results were obtained was 32 per cent. higher. The management and property charges at barely 0·3d. is a most satisfactory result. Very little progress appears to have been made in the acquisition of new business. During the year only 10 new consumers were obtained and the lamp connections were increased by only 5·4 per cent.

In 1896 there was established a suspense account to provide for the replacement of rubber-insulated cables by lead-covered ones. The total net cost of the substitution was £13,169. This amount has now been wholly paid off by instalments from the general district rate during the last four years.

The tramways accounts summarised in our second table show greatly improved results. As against a total expenditure of 10·34d. per car mile in 1899-1900, we find 8·54d. last year. It will be noticed that the chief economy effected was in the repairs and maintenance expenses on the roads.

The number of passengers carried last year was nearly 42 per cent., and the car miles run nearly 52 per cent. above those in 1899-1900. We find that the average number of cars running daily was 16·8, and with a daily average of 13,227 the highest number of passengers carried in any one day was 45,537.

## ON THE RESISTANCE AND E.M.F.s OF THE ELECTRIC ARC.*

BY W. DUDDELL.

The discrimination between resistances and E.M.F.s in conductors or apparatus in which both of these quantities are functions of the current is considered, and it is pointed out that whether such an apparatus may be said to possess a resistance, or an E.M.F., or both, depends to a large extent on the nature of the definition of these quantities, and a definition of these quantities is adopted. The essential stipulation is made that whatever means be used to measure the resistance and E.M.F.s of the arc, the conditions of the arc must not be in any way changed by the test. It is considered that the main phenomena of the arc depend on the exact thermal conditions of its different parts, and on the distribution of the heated gaseous and other particles, so that it is necessary to maintain these constant during the test. This leads to the condition that not only must the testing current used be very small, but also that the test must be completed in an exceedingly short time after applying the same. As illustrating how very short a time may be allowed to elapse, it was found than an appreciable change in the thermal conditions of an arc had taken place in $\frac{1}{10000}$th sec. after changing the arc current by as little as 3 per cent.

*Historical.*—A brief historical *résumé* is given showing that previous experimenters have not succeeded in measuring the true resistance and back E.M.F. of the arc, due to their not having realised the importance of completing the test before the conditions of the arc have had time to be altered by the testing current. Those methods, similar to the Kohlrausch method of measuring the resistance of an electrolyte, in which an alternating testing current is superposed on the direct current, such as that employed by Messrs. Frith and Rodgers, who found that what they measured as the resistance of the arc had in some cases a negative value, are shown to have failed owing to the frequency of the alternating testing current not being high enough. This frequency should be, instead of a few hundred periods per second, as used by previous observers, many thousand periods per second, in order that the conditions of the arc may not vary and the true resistance may be obtained.

*Preliminary Experiments.*—In the preliminary experiments the oscillatory discharge of a condenser was superposed on the main direct current through the arc, and was used as the testing current, the wave-forms of the superposed oscillatory P.D. and current being recorded by means of an oscillograph. If the arc behaved as a non-inductive resistance, the waves of P.D. and current should be similar curves and in phase. This is found *not* to be the case with frequencies up to 5,000 periods per sec. The author concludes from these experiments that, each increase made in the frequency of the superposed alternating testing current has led to the arc conditions being less affected by it, and, in consequence, to the arc behaving more and more like an ordinary non-inductive resistance, and, therefore, that much higher frequencies are required to obtain the true resistance. In fact, frequencies up to 120,000 periods per sec. were finally used. Owing to experimental difficulties in employing the above method with much higher frequencies, a fresh method was adopted.

*Basis of Method Adopted.*—An apparatus A is considered which has resistance and E.M.F., but no self-induction or capacity, and through which a steady current is flowing. There is mixed with the steady current an alternating testing current. It is shown that if the apparatus A possess a true resistance, and if the frequency of the testing current be such that *the conditions of the apparatus are not in any way changed by it*, then the resistance of A will be a constant over the range of variation of the current, and equal to the impedance of A to the superposed alternating current. A criterion that the apparatus A has a constant resistance is that the power-factor of A with respect to the alternating testing current must be unity. It is concluded that in order to prove that the arc has a true resistance and to find its value it is necessary to show :—First, that it is possible to find a value of the frequency of the testing current for which the power-factor of the arc with respect to this current is unity; second, that the power-factor remains unity and the impedance constant, even when the frequency is greatly increased above this value; thirdly, to determine the value of the impedance of the arc under these conditions, which will be its true resistance.

*Method of Measuring the Impedance and Power-Factor.*—Owing to the high frequency of the testing current finally used—viz., 120,000 periods per sec., it was difficult to devise a satisfactory method of measuring the impedance and power-factor; wattmeters and dynamometers could not be used, as at these high frequencies their windings behaved more like insulators than conductors, owing to their self-induction. The method finally adopted was the well-known three-voltmeter method, for which three pieces of special apparatus were used—

1. An alternator to produce the high-frequency currents.
2. A new measuring instrument called a "thermo-galvanometer" to measure the three voltages.
3. A standard resistance with which the impedance of the arc was compared, which had a time constant of only $2{\cdot}7 \times 10^{-7}$ seconds.

*The High-frequency Alternator.*—The alternator is of the inductor type; it was belt-driven from two discs by means of a figure of 8 drive, each disc being separately belted to the source of power so as to balance, as far as possible, the pull on the alternator spindle due to the driving belt. The speed of the alternator was 35,400 revs. per min., and the highest frequency 120,000 periods per sec. To give an idea of how very high this frequency is, it is mentioned that if a frequency of 100 periods per sec. be represented by 10in., a very ordinary scale in plotting curves, then the squared paper that would be required to plot the curve between impedance and frequency for the solid arc, which extends over the range from 250 to 120,000 periods per sec., would be 1,000ft., or about $\frac{1}{5}$th mile long. It was found that the spindle alone of the alternator without the inductor could be driven at 60,000 revs. per min., or 1,000 revs. per sec. A table of high-frequency alternators shows that this alternator gives a frequency seven or eight times as high as the highest value previously attained.

*The Thermo-galvanometer.*—The principle of this new instrument consists in causing the current to be measured to flow through a very fine wire, the heat radiated by the wire being measured by a modified Boys' radiomicrometer. The instrument is practically non-inductive, and may be used equally well for direct or alternating currents. The actual instrument used has a resistance of about 18 ohms, and gives a deflection of 500 scale divisions at a scale distance of 2,000 divisions (1 scale division = $\frac{1}{40}$th in.) for a current of about $9 \times 10^{-4}$ ampere. Telephone and microphone currents can be easily measured with this instrument.

*Results Obtained by Varying the Frequency.*—This, the fundamental investigation of this communication, consists in varying the frequency of the superposed alternating testing current to see whether, at a sufficiently high frequency, the conditions of the arc remain constant. The criterion that the conditions of the arc remain unchanged has been shown to be that the power factor, as measured with the superposed alternating current, is unity. Under these circumstances the true resistance will be equal to the impedance. It is experimentally found by sufficiently increasing the frequency, that the power factor approximates asymptotically to +1, and that for the highest frequencies used, it is +1 to within the limits of experimental error, therefore at these frequencies the variations of the P.D. and current obey Ohm's law, and the impedance of the arc is equal to its true resistance. With *solid* carbons the power factor at 250 periods per sec. is −0·91, on increasing the frequency it decreases numerically until it vanishes at 1,950 periods per sec., with further increase of frequency the power factor increases rapidly at

* Abstract of a Paper read before the Royal Society.

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first, then more slowly becoming asymptotic to +1, and finally practically attains this value at 90,000 periods per sec.; above this frequency the power factor is within the limits of experimental error +1 up to the highest frequency used, viz., 120,000 periods per sec. The impedance of the *solid* arc increases with increase of frequency from 0 97 ohm at 250 periods per sec. to 3·8 ohm at 90,000 periods per sec., above which it remains practically constant. *The true resistance of the above arc 3mm. long between 11mm. solid "Conradty Noris" carbons, and through which a current of 9·91 amperes is flowing, is found to be 3·81 ohms.* The P.D. accounted for by ohmic drop is therefore 37·8 volts out of an observed P.D. arc of 49·8 volts, so that *there appears to be a real back E.M.F. opposing the flow of the current in this arc of 12 volts.* With *cored* carbons the power factor at 250 periods per sec. is + 0·67, and it increases until it is practically + 1 at 15,000 periods per sec., and remains unity within the limits of experimental error up to the highest frequency tried of 50,000 periods per sec., the impedance becoming practically constant as with solid carbons. *The true resistance of the above arc 3mm. long between 11mm. cored "Conradty Noris" carbons, and through which a current of 10 amperes is flowing, is found to be 2·54 ohms and the back E.M.F. 16 9 volts.* The fact that the solid arc has, at low frequencies, a negative power factor, indicates that the arc is supplying power to the alternator: this is shown to be the case by means of a wattmeter. This is not, of course, at variance with the principle of conservation of energy, as the alternating energy given out by the arc is derived from the direct current energy supplied to it. This fact that the solid arc is capable of transforming, under suitable conditions, direct current into alternating current is the basis of the "Musical Arc" recently shown, for the first time, at the Institution of Electrical Engineers.

*Effect of varying the Direct Current.*—Having found that it is possible to measure the true resistance and back E.M.F. of the arc, the effect of changing the direct current, the arc having a constant length of 3mm., is examined. The resistance of both the *solid* and the *cored* arcs is found to increase with decrease of the current through the arc, apparently tending to become infinite for current O. The back E.M.F. of the *solid* arc first decreases with increase of current and then increases again, having a minimum value of 11·3 volts at about 6 amperes. With *cored* carbons the back E.M.F. increases with increase of current from 12·2 volts at 1 ampere to 18·5 volts at 20·8 amperes. The high P.D.s required to maintain small current arcs are shown to be due to the high resistance of these arcs. The connection between the resistance $r$ and the current A for the *cored* arc, length 3mm. between 11mm., "Conradty Noris" carbons, can be approximately expressed over the range 1·5 to 20 amperes by $(r+0{\cdot}25)A=29$. For the *solid* arc, length 3mm. between the same size and make of carbons, and over the range 1·5 to 11 amperes, the relation is $r=33{\cdot}5/A+42/A^2$.

*Effect of Varying the Arc Length.*—The direct current through the arc being kept constant, the change in resistance and back E.M.F. due to change of arc length is examined. It is found that both for *solid* and for *cored* arcs increasing the length increases the resistance, the curves between resistance and length being very similar to those between P.D. arc and length. This latter curve is generally assumed to be a straight line for *solid* arcs, but such was not the case over the wide range of length, 1mm. to 30mm., used for these experiments.

*Effect of Varying the Nature of the Electrodes.*—Both the resistance and the back E.M.F. are found to depend greatly on the composition of the electrodes; thus simply soaking a pair of solid carbons in potassium carbonate reduced the resistance of the arc between them from 3·81 to 2 92 ohms, and increased its back E.M.F. from 12 to 15·6 volts, the arc length and direct current being kept constant. Similar results were produced by introducing other impurities. The author is of the opinion that the resistance of an arc between *perfectly pure carbon* electrodes would be very high, so high that it might be impossible to maintain a true arc, and that traces of impurities are essential to provide the carriers of the electric charges in the vapour column.

*Seat of the Back E.M.F.*—In order to determine whether the back E.M.F. and resistance are localised at the electrodes, or are distributed along the vapour column, a search carbon was introduced into an arc 6mm. long between *solid* "Conradty Noris" carbons, 11mm. diameter, current 9 91 amperes. The impedance to the high frequency testing current, of that part of the arc between the search carbon and each of the main carbons, was measured for three different positions of the search carbon. From these tests it is deduced that the resistance of the above arc, as a whole, consists of three parts—a resistance at or near the contact of the positive electrode and the vapour column of about 1·61 ohms; the resistance of the vapour column, about 2 5 ohms; and a resistance at or near the contact between the vapour column and the negative electrode of about 1·18 ohms. The back E.M.F. consists of two parts located at or near the contact between the electrodes and the vapour column. That at the *positive* electrode, about 17 volts, *opposes* the flow of the direct current while that at the *negative* electrode, about 6 volts, *helps* the flow of the direct current, *i.e.*, is a *forward* E.M.F.

*Conclusion.*—The author considers that the new facts given in the Paper assist in formulating a consistent explanation of the resistance and back E.M.F. of the arc. The values found for the resistance of the vapour column and for the contacts between it and the electrodes offer no serious difficulties. The greater part of the two E.M.F.s are considered as being most probably due to thermo-electric forces, and experiments in support of this view are described, in which it was found possible to obtain a P.D. of 0·6 volts by unequally heating two *solid* carbon electrodes with a blow-pipe flame, the voltmeter indicating that the hotter carbon was positive to the cooler. By using *cored* carbons and adding potassium salts, this P.D. was increased to 1·5 *volts.* It is pointed out that the differences of temperature existing in the arc must be many times as great as those which it is possible to produce with the blow-pipe, as the cooler electrode must be red hot, or else it does not seem to make contact with the surrounding flame.

*On the Resistance of an Electrolyte.*—In measuring the resistance of an electrolyte by the Kohlrausch method, it is often assumed that the errors due to polarisation are avoided if the frequency of the alternating or interrupted current used is as high as a few hundred periods per second. To investigate the accuracy of this assumption the arc was replaced by a cell containing sulphuric acid, density 1·20 (temperature 20°C.), as the electrolyte, and its impedance and power factor tested exactly the same way as those of the arc. It is found with this cell that it was not until the frequency exceeded 10,000 periods per sec. that the electrolyte behaved as a non-inductive resistance, and the errors due to the polarisation were avoided. If the resistance of this cell were tested in the ordinary way at a frequency of 100 periods *per sec.*, the value obtained would be over *twice* its true resistance. It is concluded that unless other methods are adopted to eliminate the effects of polarisation, *it must not be assumed that the use of alternating currents of ordinary frequencies of a few hundred periods per second, eliminates the possibility of errors due to polarisation.*

## SOME EXPERIENCES AND RESULTS DERIVED FROM THE USE OF HIGHLY SUPERHEATED STEAM IN ENGINES.*

BY R. LENKE.

In no branch of heat engine building has such an amount of study been spent as in steam engines from Watt's time up to to-day. The economy of the steam engine is, in spite of all efforts, not the best, and the steam engine in its highest perfection attainable at present cannot claim the first place in comparison with other heat engines. And so the problem of generating and using superheated steam has become a question, from the solution of which a considerable stride in improving economy has been expected and really made. Superheated steam is generated by the addition of heat to saturated steam. The behaviour of superheated steam is similar to that of gases; it is a very bad conductor of heat, and has the special peculiarity of being able to lose a certain amount of heat without becoming saturated or wet steam. The thermal capacity of steam is only 0·48, therefore very little heat is required to superheat steam; but as the steam loses the heat as quickly as it acquires it, every passage conveying superheated steam must be well covered with non-conducting material. Although there are some losses when using superheated steam on account of the heat radiation, they are very much smaller, because the loss of heat from superheated steam has lower calorific value than the latent heat of saturated steam. Superheated steam has a greater volume per unit of weight than saturated steam at the same pressure, hence one advantage, and the higher the temperature the greater this advantage. At various pressures and temperatures the increase of volume may be taken from the following Table I.:—

**Table I.**

| Pressure. | 390°F. | 570°F. | 750°F. |
|---|---|---|---|
| 70 | 1·1 | 1·33 | 1·57 |
| 115 | 1·06 | 1·29 | 1·52 |
| 170 | 1·02 | 1·24 | 1·46 |

Table I. shows that the higher the pressure is the smaller the increase of volume; and it is proved from practice that the advantage with lower pressure is indeed greater in proportion than with higher pressures. The question may arise whether the increase of volume does not require more additional heat than the benefit derived from it is worth. To show this clearly Table II. has been prepared expressing how many B.T.U. less are required to produce 1 cubic ft. of superheated steam than of saturated steam at the same

* Paper read before Section III. (Mechanical) of the International Engineering Congress at Glasgow.



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pressure. For various pressures and temperatures the total heat per cubic foot is as follows :—

**Table II.**

| Pressure. | Saturated. | 390°F. | 570°F. | 750°F. |
|---|---|---|---|---|
| 70 | 233 | 219 | 192 | 175 |
| 115 | 350 | 337 | 297 | 267 |
| 170 | 492 | 485 | 432 | 398 |

*i.e.*, to produce, for example, 1 cubic ft. of steam at 115lb. pressure and a temperature of 570°F.,

$$\frac{350-297}{350}=15\text{ per cent},$$

less heat is required than to produce 1 cubic ft. of saturated steam at the same pressure. With saturated steam engines, 20 to 25 per cent. of admitted steam is condensed during the admission period, consequently the practical steam consumption is very much in excess of the theoretical. Superheated steam does not condense during this period if sufficiently superheated, hence another advantage.

The economy effected by using superheated steam in engines is very remarkable, and, acknowledging this fact, a great number of steam users all over the world superheat the steam, although in many cases only a few degrees, yet a considerable saving in steam and coal is always the result. To obtain the full benefit, the required temperature of steam is 660°F. to 700°F., and to stand this temperature the engines must be specially designed. It is not sufficient to use mineral oil with a very high flash point, and anyone who tries to supply an existing engine of any kind with steam at that temperature will have a very unpleasant experience, even when using the above-mentioned oil.

The introduction of superheated steam into engines largely influences the expansion of the heated parts. Engines always gave great trouble when the distribution of metal in the cylinders was not uniform, as parts with more metal expanded most, and forced the cylinder walls towards the inside and made the cylinder out of shape. When using liners in the cylinders, they were squeezed in at the ends, decreasing the diameter, and jamming the piston body if sufficient clearance was not provided. With steam jackets heated with steam of 500°F., the lubrication ceased as the cylinder walls became too much heated, consequently it was found necessary to do away with jackets, or if jackets were already provided, not to pass steam through them. Pistons constructed on the Ramsbottom type always worked satisfactorily—except in the case of pistons fitted with steel springs—when they were in contact with highly superheated steam. Any kind of gunmetal gets brittle after a very short time, therefore valves, seats and all parts in direct contact with superheated steam, must be made of cast-iron or other suitable mixture. Copper also loses about 40 per cent. of its strength at that temperature, consequently copper bends in pipes are not practicable. The best material for piping has proved to be wrought-iron and steel, each pipe being as long as possible, to have the least number of flanges. For long, straight-pipe connections, provision must be made to meet the expansion, which is, at 700°F., 0·0037 of the length, so that, for example, 100ft. of pipe extends 0·37 of a foot, or nearly 4½in. Glands and stuffing boxes at first frightened users, so the engines were constructed single-acting to avoid the use of glands, but no serious difficulties have arisen on that account. It is advisable to place the stuffing box as far as possible from the cylinder end to keep it well away from the hottest parts, and to allow of as much radiation as possible. Sufficient clearance in the neck bush should be made to allow for the expansion of piston rod, and no metal with a melting temperature below that of the steam should be used. Valves and valve gears are influenced in the same way by superheated steam. Valves containing many ribs or different thicknesses of metal (in section), such as plain slide-valves or Corliss valves of the usual construction, are not suitable for high temperatures. A Corliss valve of medium size will stand 480°F. to 500°F., but no more, and the latter temperature very seldom. The smaller the plain slide-valves are the higher temperature they will stand; large slide-valves will hardly stand even slightly superheated steam if no provision is made for forced lubrication of the valve face.

Piston-valves have proved to be most suitable for the highest temperature, owing to their uniform distribution of metal, but even with this sort of valve certain experience is necessary to get them in good working order. With ground valves, the ribs holding the boss for the valve spindle must not begin within the working surface of the valve, but have to be placed beyond that, because they expand and make the valve polygonal. The valves must be ground in other liners to those in which they are to work in the engine; the former liners have to be smaller in diameter to secure more clearance to provide for the expansion of the valves; all ribs must be placed beyond the working surfaces of the valve. The cylinder expands in length more or less than the steam-chest, causing thereby deformation of the latter, which must be carefully considered in design. It is best to work the valves in liners fixed in the cylinder and with a small clearance, sufficient to allow for the deformation of the steam chest. With this construction it is, of course, necessary to make steam-tight joints between the several ports, and this is best done by stepping the liners and seats and using narrow asbestos rings for each step. The liner is then forced on to the small seats by set screws in the cover, these asbestos rings making a lasting joint. Long valves cast in one piece become scored, whether they are cooled from inside with exhaust steam or not; consequently, all valves should be made as short as possible. Rings and springs in valves cannot be recommended, as the steam comes behind the rings and increases the pressure, causing friction and, therefore, increased oil consumption. As it is impossible to rely on tightness of piston valves they must be made as small in diameter as possible. It may be stated here that superheated steam can travel at 30 to 40 per cent. higher speed through steam ports than saturated steam, and this fact has to be considered during construction. Two piston valves working one in the other, as the Rider or Meyer valves, are impracticable for superheated steam. If engines of that type are intended to be worked with superheated steam, each valve must work in a separate chamber. Double-beat valves can also be recommended as being safe, but they require a special arrangement, which is not always obtainable with every gear. Very often it happens when warming up the engines that the valve spindles get hotter than the gland boxes, and on starting the engine, the friction between spindle and stuffing box is greater than the power of the spring, and if the valves are not positively driven they remain open during the full stroke.

An engine constructed in accordance with the principles just explained, is as safe with superheated steam as any other engine with saturated steam. From the experience over several years, it is not necessary to be bound to single-acting engines.

Besides the economy, the use of highly superheated steam has some other advantages which are also important. It makes the steam consumption nearly independent of the size of engine, as a small engine has about the same steam consumption as a large one, as for example, an 80 H.P. compound condensing engine uses 10·45lb. of steam at 160lb. pressure, and a 1,000 H.P. engine uses 9lb. of steam per I.H.P. per hour. The use of highly superheated steam does not require high boiler pressures, 160lb. is the highest to be recommended, as no advantage can be derived by exceeding this. As the amount of heat transmitted from the steam to cylinder walls, and vice versa, is much lower with superheated steam than with saturated steam, the whole range of temperature from boiler pressure to vacuum can take place in one or two cylinders, so that the use of a triple expansion engine does not make the slightest improvement in economy. It is not intended to be understood that the author proposes to do away with all triple-expansion engines for very large plants; their use will be necessary for constructive reasons.

With regard to economy obtained from engines working with superheated steam, the gain is derived from the larger volumes of the steam and the doing away with initial condensation. Generally, the steam consumption of modern engines working under good conditions may be taken as follows :—Single-cylinder condensing engines with saturated steam and a pressure of 90—100lb. per square inch use 19—25lb. of steam per I.H.P. per hour, corresponding to 373—490 B.T.U. per minute. The great difference in temperature between admission and exhaust steam causes much waste by initial condensation, and consequently this type of engine especially favours the use of superheated steam. With superheated steam the consumption has been lowered to 13½—15lb., corresponding to 290—335 B.T.U. Non condensing single cylinder engines gave consumptions of 15—18lb. of steam per I.H.P. per hour, which is about the same consumption as an average compound condensing engine with saturated steam. The non-condensing compound engine decreases the consumption to 14—16lb. per I.H.P. per hour. The compound condensing engine is the most economical, and the economy obtained can hardly be reached by a quadruple expansion engine working at a pressure of 300lb. The steam consumption of such an engine either compoand or tandem, at 140lb. pressure only, never exceeds 10lb. per I.H.P. per hour and usually remains below, many tests having proved 8·5lb. and 8·8lb. consumption per I.H.P. To utilise better these temperatures and to work with various loads with safety and nearly uniform economy, Mr. Schmidt has introduced the receiver heater with automatic valve. The idea is to keep a steady mean temperature of cylinder walls not higher than will make the lubrication unreliable for different rates of expansion.

A few words may be said with regard to the cost of a superheated plant. Superheated steam engines use on an average 30 to 40 per cent. less steam than saturated steam engines of the same type. Consequently boilers can be made 30 per cent. smaller, and the difference in price will nearly cover the cost of the superheater. For the same steam consumption the superheated steam engine is cheaper, as it may be worked with a lower boiler pressure, and it is simpler, *i.e.*, instead of a compound engine with saturated steam, a single cylinder engine with superheated steam may be used, giving the same or better results than the former.

With regard to oil consumption, it was found not to be more than that of an ordinary saturated steam engine. For example: A

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20 I.H.P. engine used in 24 hours 4lb. of oil, and a 300 I.H P. Corliss ompound engine 2·2lb. in 10 hours for both cylinders.

In view of the great advantages of steam superheating, and the great number of engines running at present satisfactorily, it is astonishing that a few failures have caused prejudices amongst some engineers, who make the general introduction of the use of superheated steam very difficult. It will be worth mentioning that the result of a great number of trials have always proved a great saving in steam and coal, and even with small plants and simple piston-valve engines, almost the same good economy is obtainable as with large engines with most exact valve-gears. It is therefore recommended that superheated steam should be used in connection with *all* engines; the only question to be settled is the degree of superheat, which largely depends on local circumstances and the construction of the engine, and this matter should be left to the judgment of an experienced engineer.

## LEGAL INTELLIGENCE.

### Cardwell v. New Rottingdean Electric Lighting Co.

At Brighton County Court, last week, Messrs. Cardwell, Boorman and Ford-Lloyd (Ltd.), London, sued defendant company for £17. 8s. 4d., the price of two electricity meters.

Mr. P. COOTE, electrical engineer, said the two meters the subject of dispute had been supplied to the company in a hurry, and were returned on the plea that they were more costly than the meters ordered, were not for the right voltage, and that the makers' voltage marks on the meters had been altered.

Mr. S. READ, managing director of defendant company, said that he ordered two Ferranti meters from plaintiffs' Brighton agent, Mr. Eagles, who could not obtain them, and then agreed that he should supply two "similar meters" at the same price. The meters supplied, however, were considerably more costly than Ferranti's, and after they had been tested by the company's engineer they were found to be unsuitable. Two Ferranti meters were subsequently purchased at a cost of only £8. 14s.

ALFRED JUPP, foreman of the electric lighting works at Rottingdean, said one of the meters was marked 110 volts when it was delivered.

Mr. HUMPHRYS, for defendants, contended that plaintiffs had not fulfilled their contract. He suggested that the voltage figures on one of the meters had been altered from 110 to 100.

Mr. R. B. POPE, for plaintiffs, said there was not the slightest evidence in support of so serious an allegation.

The JUDGE, having examined the figures under a magnifying glass, said he could see no trace of their having been altered. The imputation, however, was a most serious one. He found that the 100 volt meter was in accordance with defendants' order. The other meter was much higher in price than a Ferranti meter, and he had some doubt about that part of the case, but it was a matter of urgency, and he held that plaintiffs' agent acted for the best in supplying it. There would be judgment for plaintiffs for the amount claimed and costs.

### Hampstead Electric Supply Co. (Ltd).

In the Vacation Court on Wednesday the Lord Chief Justice heard an application on behalf of debenture holders for the appointment of a receiver and manager of this undertaking. The company consented, and the order was granted, with leave for the manager to act for three months.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The Tramways department of the Liverpool Corporation require a superintendent for their electric tramcar construction and repairing department. Some particulars are set out in an advertisement. The commencing salary is £300 per annum, subject to certain conditions. Applications to the town clerk (Mr. E. R. Pickmere), Municipal Offices, Dale-street, Liverpool, by first post, Saturday, Oct. 12.

Bootle Corporation require a resident electrical engineer. An advertisement contains further particulars. Application to the town clerk (Mr. J. Hy. Farmer) by 10 a.m. Oct. 14.

A junior shift engineer is required at the Perth electricity works. Application to burgh electrical engineer (Mr. John Lambert) by Oct. 12. See advertisement.

Manchester Tramways committee require a number of trolley linesmen. Applications to the general manager (Mr. J. McElroy), 55, Piccadilly, Manchester. See advertisement.

Two assistant electricians are required for a large cable factory near London. See advertisement.

East Ham Council require a works foreman for construction of the permanent way of electric tramways. Applications by Oct. 9.

A lecturer and demonstrator in electrical engineering and general physical laboratory work, with a knowledge of machine construction and mechanical drawing, is required for the City of Norwich Technical Institute. Applications to the principal, Mr. W. Gannon, M.A. See advertisement.

Mr. J. W. Woods, telegraph engineer for the Birmingham district' and Mr. T. Harrison, assistant superintendent in London, have been appointed superintending engineers of the postal telegraphs of the metropolis.

Mr. L. de R. Du Verge has been appointed an assistant engineer at the Bristol electricity works.

Mr. R. M. Carr, chief assistant at Bexhill, has been appointed mains superintendent at Maidstone.

Mr. McEwen, formerly demonstrator at the Royal College of Science, has been appointed assistant in the electrical department of the Central Technical College, Exhibition-road, S.W.

Mr. R. W. L. Phillips, deputy city electrical engineer at Bristol has been appointed chief electrical engineer to the borough of Bedford.

### EDUCATIONAL NOTICES.

Mr. Mervyn O'Gorman will deliver a special course of six evening lectures on Insulation at the City and Guilds Technical College, Finsbury, beginning on Thursday, Oct. 10, at 8 p.m. See advertisement.

A course of 12 lectures, with laboratory instruction, on electro-chemisty, will be given at the East London Technical School by Prof. Lehfeldt, D.Sc., commencing on Friday, Oct. 11. See advertisement.

In the recent award of the scholarships presented by the Saddlers' Company, of Londou, the first three boys on the list hailed from St. Thomas Charterhouse Schools, London, E.C., and two of these (Henry J. Herink and Harold Howe) have secured scholarships of the value of £120 each.

**Aberdeen**.—Increased borrowing powers, to the extent of £200,000, for the electric lighting and gas departments have been applied for.

**Archangel (Russia)**.—As far back as 1897 a concession for electric lighting and electric tramways was granted, and a contract for the construction and equipment of the works was signed, but since that date no progress has been made with the schemes.

**Barnstaple**.—An inquiry was held here last week into the application of the Council to borrow £27,000 for electricity supply. The town clerk (Mr. James Bosson) said the Corporation spent £1,100 a year in lighting, and he estimated £700 of that was for the compulsory area. The scheme of the consulting engineer (Mr. W. H. Trentham) was adopted by the Council without opposition. It was proposed to erect the generating station in Castle-street on municipal property. The borough surveyor (Mr. A. Thorne) gave evidence as to the value and position of the proposed site for the station, and Mr. Trentham supplied technical details. He said the continuous-current three-wire system would be employed; current would be supplied at 6d. per unit. He estimated that incandescent electric lamps could now be fitted into houses at about the same rate as gas jets. The present price of gas in Barnstaple was 3s. 9d. per 1,000. £21,450 of the proposed expenditure related to the compulsory area. As to the remainder of the town, he did not propose to extend public lighting, except where mains were laid for private consumers. He anticipated a demand for 5,000 to 6,000 8 c.p. lamps. At Torquay, where he had been responsible for the installation, there had been a supply for 3½ years, and a profit of £620 was made last year. There had been a loss at the start of £830 at Torquay, but such enterprises were not expected to pay until the third year. The high-tension alternating current system of supply was not, he considered, so economical as the low-pressure system. Opposition evidence from ratepayers was then taken, but it was shown that four of the opponents were shareholders in the local gas company, two of them being directors.

**Bath**.—The Electric Lighting committee have considered a proposal to extend the electric lighting mains to Weston and Combe Park, outside the borough, at an estimated outlay of £750. Promises have been received equivalent to 500 8 c.p. lamps, and it is believed that when the mains are laid 2,000 8 c.p. lamps will be taken. The clerk has warned the committee that the Local Government Board will not sanction a loan for laying cables outside the borough. The committee reply that they can incur the outlay out of revenue, and the proposal has been agreed to.

**Battersea (London)**.—The electricity works of the Borough Council were formerly opened by the chairman of the London County Council (Mr. A. M. Torrance) on Saturday. A description of these works appeared in our issue of the 27th ult.

**Birkenhead**.—The permanent way of the Oxton electric tramway route was inspected on Friday last, and the cars started running the same day.

**Bristol**.—Sanction has been obtained to a further loan of £1,004 for additional land for the Avonbank electricity works.

The acquisition of the tramway undertaking of the Bristol Tramways and Carriage Co. is being discussed in local circles, and at the next meeting the Council will be invited to appoint a special committee to report on the matter.

**British Electrical Manufactures in Russia**.—A report recently received at the Foreign Office is to the effect that articles of British manufacture in which an increased business could be done in Russia

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include electric plant, machinery, apparatus and accessories, and machine tools.

**Carnarvon.**—The Council have reiterated their determination to apply for a provisional order, and Mr. Peterson's application will be opposed.

**City of London.**—We dealt in our last issue (p. 884) with the progress of the dispute between the City of London Corporation and the City of London Electric Lighting Co., and referred to the spirit of compromise prevailing in regard to this matter. At the meeting of the Common Council last Thursday

Mr. W. O. CLOUGH called attention to certain correspondence on the subject which has appeared. He asked if was the intention of the Streets committee to advise an appeal against the latest judgment given by the Courts as to the electric lighting contracts?

Mr. PAINTER (chairman of the committee) said the question of appeal was still under consideration.

The TOWN CLERK then read the letter from the City of London Company (particulars of which appeared in our last issue), offering to continue the public lighting in the western and central districts at the same price and subject to the same conditions as heretofore, provided arrangements as to public lighting in all the three districts which are now supplied with current for public lighting by the company was fixed until 1914, the earliest date provided for the Corporation's power of purchase to occur.

Mr. PAINTER moved reference of this letter to the Streets committee for consideration and report.

Mr. CLOUGH asked that the report on the matter by the committee be expedited. He thought the committee should speedily come to a decision on the subject of appeal against the judgments of the High Courts, and should report as to the desire or otherwise of the Corporation to purchase the company's undertaking.

Mr. ALPHEUS CLEOPHAS MORTON hoped the Court would reject the amendment, which was introduced solely with the view to force the hands of the committee and of compelling the Corporation to buy up the company and undertaking at its own price. The company no doubt were under the impression they had a monopoly of electricity supply and could charge the maximum price. But the Board of Trade stepped in and allowed competition. A provisional order was granted to a rival company, thus protecting the citizens of the City of London from 40 years of plundering. The question of buying out the company need not be considered for many years, but in the meantime millions of money had been saved to the citizens.

Mr. PAINTER, in reply, said it could not be denied that they were under obligations to the company, though they might have been working on a fraudulent basis. If it were possible for him before he left office this year to make some progress in the matter, he would be glad. The amendment was rejected, and the letter referred to the committee.

**Cleckheaton.**—The District Council have obtained sanction to a loan of £25,000 for electricity supply and have let the contracts for plant, particulars of which are given in another column.

**Derby.**—At Wednesday's meeting of the Council it was announced that there had been a loss on the year's working of the electricity undertaking of about £2,800, attributable mainly to the high price of coal. The discussion on the minutes of the Electric Lighting committee was postponed.

**Dover.**—Being anxious to acquire the undertaking of the Dover Electricity Supply Co., the Council invited the directors to submit terms. The directors, however, declined, but were willing to consider any offer from the Council. Mr. E. Manville's report on the subject has also been considered, but at the last meeting of the Council the question was adjourned, as the company's terms were not deemed sufficiently moderate to justify negotiations.

The Council propose to extend their electric tramway to Kearnsey and River.

**Darlington.**—The General Purposes committee have decided to start work on the construction of four lines of electric tramway.

**Dingwall.**—Among projects before the Council is one for the erection of electricity works and utilising water power in the generation of current.

**Dunstable.**—The Council have received Mr. A. T. Snell's report on electricity supply. Mr. Snell recommends that powers be obtained for a lighting scheme combined with an electric tramway or light railway connecting the town with Luton.

**Electricity in Mining.**—The annual report of the general manager and secretary of the South Staffordshire Mines Drainage Commission (Mr. E. Howl) states that the Midland Electric Corporation for Power Distribution have almost finished the erection of their power station at Ocker Hill, and are busily occupied in laying cables in several parts of the district. There is every prospect of electric current being available early next year for working the proposed centrifugal pumps to drain the low-lying areas.

**Felixstowe.**—The Council have resolved to dispose of their provisional electric lighting order, and tenders are to be invited.

**Glasgow.**—In our issue of 20th ult. we referred to a strange departmental dispute as to the laying of underground telephone cables. On Thursday a joint meeting of the Fire Brigade sub-committee and the Telephone committee was held to discuss the conduct of Firemaster Paterson, when, by his instructions, employés of the B.I.W. Co., who were opening Ingram-street to lay telephone wires into the central station of the Fire Brigade, were drenched with water by the apparatus of the fire department. A letter of apology was submitted by Mr. Paterson, and the affair was allowed to drop.

The Alexandra-parade electric tramway route was opened for traffic on Tuesday.

**Greenock.**—The inspection of the electrical equipment of the tramway between Rue End-street, Greenock, and Ashton took place on Wednesday and the line was opened for traffic yesterday.

**Hampstead (London).**—Loans of £7,078 for electric lighting extensions (for 42 years) and £2,545 for meters (for 10 years) have been obtained from the London County Council, and in regard to the first loan the Borough Council have agreed that the cost of all plant and machinery which it may be necessary to renew or replace during the currency of the loan shall be defrayed out of a sinking fund or out of maintenance account.

**Hull.**—The Electric Lighting committee have considered a report of the city electrical engineer (Mr. A. S. Barnard) recommending the supply of electric current in Hessle (4 miles from Hull) and the matter has been referred to the Hessle authority. The committee have approved plans for the extension of the generating station, &c., at an estimated cost of £42,000, including buildings (£8,300), boiler-house plant (£3,720), engine-house plant (£18,450), sub-stations (£1,750), mains (£9,210) and contingencies (£570). It has been decided to apply for borrowing powers for carrying out this work.

**Leigh.**—Col. Durnford held an enquiry yesterday into the Council's application to borrow £11,250 for electricity supply extensions. Although supply has only been given for about 18 months, the heavy demand for current for both lighting and power will necessitate further considerable extensions in the immediate future.

**Leyton.**—The Council are taking steps to acquire the lines of the North Metropolitan Tramways Co. in the district.

**Light Railways.**—The Light Railway Commissioners opened an inquiry at Halifax on Friday into the application for powers to construct light electric railways from Holmfield to Southowram and from Elland to Southowram at a cost of £82,889, towards which the Southowram Council propose to contribute £5,000. For the promoters it was stated that the scheme presented engineering difficulties, the highest point of Southowram being 850ft. above sea level, or 600ft. above Holmfield. The scheme comprised three lines, and the western section would join the Lancashire and Yorkshire Railway, while the other extreme would touch the joint line of that company and the Great Northern Railway. The scheme was opposed by the Great Northern Railway Co. and others. After evidence had been taken, Earl Jersey said the Commisioners were not satisfied with the engineering details. The country presented many difficult features, which had not been sufficiently taken into account, and the cost of safety sidings and accommodation works required more attention. The promoters then asked for an adjournment to enable them to amend the engineering particulars. If the Commissioners decided to allow the opposition scheme at Holmfield to proceed, it would seriously handicap them in bringing forward fresh proposals. Earl Jersey having declined to limit the rival scheme, or to grant any adjournment, the case for the Holmfield line was opened. It was stated that it would be about 4¼ miles in length, with a number of branch sidings. The cost, including a bridge at Godley, was estimated at £63,618. A section of the line having been abandoned, the Lancashire and Yorkshire Railway Co. opposed the remainder of the scheme because they believed it would divert from them to the Great Northern Railway certain traffic. After evidence had been tendered, the Commissioners said they would give their decision in a few days.

The Board of Trade have confirmed the Welshpool and Llanfair light railway (amendment) order, and the Bury and Diss light railway order, the latter in a modified form.

Following upon the rejection of the British Electric Traction Co.'s scheme for a light railway, Crewe Council announce that they will themselves again apply for powers. It is proposed to follow the routes indicated in the company's project, but two short lengths of line will probably be added.

**Maidstone.**—Last week the Council debated the question of obtaining powers to construct electric tramways. The Council were recommended to rescind the resolution passed on May 1 to promote a bill and, instead, to apply to the Light Railway Commissioners for an order to construct light electric railways. This resolution was eventually passed, but not by a two-thirds majority as required. A loan of £1,500 is sought for wiring and fitting the public buildings in the borough for the electric light.

**Manchester.**—The City Council have instructed Prof. A. B. W. Kennedy to prepare specifications and plans for the installation of two 6,000 H.P. sets at the Stuart-street station, and for buildings and plant for 10 sub-stations in connection therewith, at an estimated cost of £350,000. On Wednesday

The Chairman of the Electricity committee (Dr. Bishop) explained that under Prof. Kennedy's proposals it was intended to instal two 6,000 H.P. engines at the Stuart-street works and to provide buildings and plant for 10 sub-stations at an estimated cost of £350,000. The whole of the Dickinson-street and Bloom-street works being fully occupied in meeting

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existing and probable future demands for current for lighting and traction, it had become imperatively necessary to prepare for the future by installing additional plant at Stuart-street. At Dickinson-street it was proposed to replace at least four of the 400 H.P. engines by two turbo-generators of 3,000 H.P. each. These two additions would ultimately replace the 11 400 H.P. sets now installed, and thereby a saving of £3,000 a year would be effected in coal, oil and wages. These alterations would cost £30,000. It was also proposed to borrow £82,000 for completing Dr. Kennedy's scheme, and to ask for £15,000 to cover the cost of laying cables to Denton sub-station. The committee were anxious to take on fresh customers, and realised the inconvenience which would-be customers were suffering, but it would be a suicidal policy to undertake more responsibilities than they could reasonably hope to meet. No fewer than 85,000 8 c.p. lamps were awaiting connection, and the new Midland hotel proprietors had guaranteed to take not less than half a million units per annum. A warehouse in Portland-street wanted 1,200 lights, and Messrs. Beyer and Peacock asked for a further 500 H.P. of power (making 1,500 H.P.) for their works. The cost of connecting the Stuart-street works with the railway would be £8,800. The motion was adopted.

The electric tramway from Deansgate to Hightown was opened on Monday.

**Mexborough.**—The charges for electric current have been fixed at 5d. per unit for private lighting and 3d. for power. The destructor and electricity works and also the market and Council offices are to be wired.

**Municipal Telephony.**—The Tunbridge municipal telephone has, it is stated, 650 subscribers. The village of Uckfield has petitioned the Corporation for inclusion in the telephone area.

A conference of local authorities in the Oldham district will shortly be held to consider the question of a municipal telephone service. Already the districts of Saddleworth, Middleton, Springhead, Lees, Royton, Chadderton and Crompton have expressed themselves in favour of the project.

**Nelson.**—A sub-committee has been authorised to arrange for the construction and working of the proposed light electric railway through Barrowford.

**Northampton.**—The Council decided on Monday to purchase the undertaking of the Northampton Tramway Co. for £37,500. The Council intend to obtain powers to electrically equip and extend the system.

**Nottingham.**—On Monday the Council will discuss a report recommending the promotion of a bill for powers to construct additional tramways.

The Electricity committee will also recommend the raising of further capital for carrying out extensions of the electricity supply undertaking. The total capital authorised to be raised amounts to £235,000. £233,682 has been expended, and the balance will only suffice for extensions of mains in hand. The electrical engineer (Mr. H. Talbot) has prepared an estimate of the amount required for the next five years as follows:—St. Ann's power station: Additional boilers and machinery to complete the equipment of the first section of the station, £38,750; meters, house connections, &c., £16,250; extensions of mains, £30,000; total, £85,000. Eastcroft power station: Generating station in connection with destructors proposed to be erected in Eastcroft, £2,000; machinery, plant, cables, mains, switch gear and battery, £13,500; total, £15,500; or £100,500 for the two stations. The committee recommend that powers be obtained next session to raise this sum as it may be required In order to carry on the work of extending the mains, and to provide for a supply of current to new customers until parliamentary powers have been obtained, the committee recommend that application be made to borrow £15,000 for extensions of mains, house connections and meters.

**Pembroke (Dublin).**—The charge for electric current to private consumers has been reduced from 6d. to 4½d. per unit.

**Personal.**—Messrs. William McLean & Co., electrical installation contractors and supplies dealers, of Flinders-lane, Melbourne, and of New Zealand and Fiji, notify us that their manager, Mr. O. L. Remington, is about to make a tour of the electrical and manufacturing industries of Europe and America. While in London Mr. Remington's headquarters will be the Hotel St. James, Regent-street, W., where he arrives about the 5th or 6th inst.

Mr. Sidney H. Short, of the English Electric Mfg. Co., left for New York on the "Oceanic" on Oct. 2 to attend the annual Tramway Convention to be held in that city on Oct. 9.

**Presentation.**—To celebrate the marriage of Mr. O. H. Ellis, chief assistant engineer of the Glasgow Corporation Telephone department, a presentation of a marble clock to Mr. Ellis and a silver tea service to Mrs. Ellis was made on the 25th ult. Mr. J. L. Chambers, chief engineer, made the presentation, and those present included the local staff of the B.I.W. Co., who had previously presented Mr. and Mrs. Ellis with a set of silver dessert knives and forks.

**Railway Station Lighting.**—Edinburgh Electric Light committee have made an agreement with the directors of the North British Railway Co. for the supply of electric current for lighting Waverley station and other works for another five years at a special rate. The directors were considering the question of putting down independent plant for generating their own current, but favourable terms have now been obtained from the Corporation.

**Reading.**—The Corporation took over the local tramways on the 1st inst. The lines are being converted to overhead electric traction.

**Salford.**—The Corporation during the last week have successfully run a tramcar along Irwell-road, and the consulting engineers (Messrs Lacey, Clirehugh and Sillar) expect to have the whole equipment ready shortly.

The electrical equipment of the Higher Broughton electric tram route was inspected by Mr. A. P. Trotter on Monday. As soon as official sanction is given, the line will be opened for traffic.

**Seaham Harbour.**—The receipt of a request for consent to a provisional order has induced the Council to instruct the surveyor to report upon electricity supply.

**Southampton.**—At last week's meeting of the Council it was decided that the report prepared by Messrs. Kincaid, Waller and Manville on the working of the electricity department, with special reference to the Corporation's tramway undertaking, be printed and distributed amongst the members, together with Mr. Chaplin's reply thereto, and Messrs. Kincaid, Waller and Manville's comments upon this reply.

**Southwark (London).**—The Council are recommended to retain Messrs. Kincaid, Waller and Manville in connection with the application for the extension of the Newington electric lighting order.

**Stockton.**—Applications for consent to provisional orders have been received from several companies, and as some of the councillors favour the Council's retention of electric lighting powers, it has been decided to engage an electrical engineer, at a fee of 50 guineas, to report upon electricity supply.

**Stockport.**—Cheadle Council have been asked to grant a lease for working an electric tramway from the new borough boundary at Cheadle Heath to Cheadle and Gatley.

**Stoke-on-Trent.**—The North Staffordshire Railway Co. have intimated to the Council that they are unable to supply electricity in bulk to the Corporation. The Potteries Electric Traction Co. have also declined to submit any proposal for the supply of current, but offer certain conditional terms, on the basis of a transfer of the Corporation's provisional order. The Council have decided not to entertain the question of transfer.

**Telegraphic Communication between Belle Isle and Canada.**—The Canadian journals announce that the subaqueous telegraph cable between Chateau Bay, Labrador, and Belle Isle, has been successfully laid, establishing direct connection between the Straits of Belle Isle and the telegraph system of Canada. This connection will prove of great benefit to shipping. The number of shipwrecks in this part of the Canadian waters has been increasing of late, and the establishment of direct telegraph communication will be a boon.

**Tramway Strike.**—The conductors on the Hartlepool electric tramways have struck work, demanding the dismissal of one of the company's inspectors.

**Walthamstow.**—The Council have unanimously resolved to apply to the Light Railway Commissioners for powers to construct electric tramways.

**Waterford.**—The consulting engineers (Messrs. Lacey, Clirehugh and Sillar) have presented their report on electric lighting to the Corporation.

**Water-Power in Spain.**—A water-power supply station has been completed at Viguera, Lagrono, from which current will be supplied to Viguera, Alberite, Villamediana, Nalda, Istallana and Albelda. The plant comprises a 110 H.P. horizontal turbine and a 55kw. two-phase alternator.

**West Bromwich.**—The Electric Lighting committee recommend the Council to adopt the following scale of charges for electricity supply:—4½d. per unit for one hour's use per day, 3d. for two hours, 2½d. for three hours, 2½d. for four hours, 2d. for five hours, or 4½d. per unit for 91 hours' maximum demand per quarter and 1½d. after. For churches and chapels a flat rate of 3½d. per unit is recommended, and for power a uniform rate of 1d. per unit. In moving the adoption of the report, at the Council meeting on Wednesday, the chairman (Ald. Pitt) said they did not expect to make a profit the first year or two. Although their charges were about the lowest in the kingdom, yet they believed when they had the trams running their undertaking would pay. The tramway company would take about 600,000 units annually, and in order to supply that quantity the present plant would have to be extended at an estimated cost of £1,494. The revenue from the company would be about £4,000 per annum. The mayor considered the electric lighting station had been erected 18 months too soon. To reduce the price of current by 25 per cent. was, he urged, a grave mistake. The report was, however, adopted.

**West Ham.**—In a recent discussion at a Council meeting light was thrown upon the position of the borough electrical engineer and his relations with certain members of the Council. The Lighting and Tramways committee reported that they had considered a com-

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munication from Mr. J. K. Bock to the mayor, stating that from several recent discussions in the Council he had felt doubtful as to the wishes of the Council regarding his position, and he had applied for and been appointed borough electrical engineer at Bedford. Mr. Bock further stated that he only desired to meet the wishes of the committee, and that if he felt assured of their confidence he was quite prepared to decline the appointment. The committee having considered the matter and had an interview with Mr. Bock, that gentleman decided to decline the appointment at Bedford and remain at West Ham, whereupon the committee passed a resolution of continued confidence in Mr. Bock. Ald. Kidd said, as a matter of fact, like many other officials, Mr. Bock had been browbeaten by the Council on many occasions; on several occasions he had heard things said about him to which he had had no opportunity to reply. He therefore assumed the Council desired to dispense with his services, or that some of its members wished to drive him out. He had made several applications for positions, and was chosen by seven different towns. Bedford wished him to commence his duties at once. Ald. Kidd said Mr. Bock had now decided to remain at West Ham. The report was adopted.

**Witham.**—Messrs. Crompton & Co. have notified the Council that the cost of erecting electricity works would be £2,400, and the annual cost of maintenance, interest, &c., £349, against £220, the present cost of gas lighting.

**Wood Green (London).**—A special meeting of the Council has been called for the 30th inst. to authorise application for a provisional electric lighting order.

**Worcester.**—The Council on Tuesday accepted a number of tenders for electrical plant. It was resolved to expend £27,461 in the erection and equipment of a supplemental electricity generating station in the city in view of the conversion of the city tramways and light railways in the immediate district to electric traction. Of this sum £7,180 was for buildings and £20,281 for plant.

**York.**—The Electric Lighting committee report that the demand for electric current is so great that further extensions must be made to meet the anticipated demand for 1902-3. Supply was commenced in April, 1900, with plant of a capacity of 320 H.P., and in Dec., 1900, a 360 H.P. unit was added, and with the extensions now in hand current will be available equal to 21,000 8 c.p. lamps. There are, however, already connected or on order 32,500 lamps, and the city electrical engineer (Mr. C. A. Midgley) estimated the cost of the extensions, including buildings, at £50,000, as follows:—Two engines, £9,000; two dynamos, £5,000; four boilers, £6,000; four sets stokers, shafting, &c., £1,000; steam, feed and exhaust pipes, valves, tank, two steam pumps, £4,300; condenser, £1,100; economiser and motors, £3,200; switchboard and connections, £1,200; 20-ton crane, £500; buildings, including coal bunkers and sidings, £7,500; works wiring, £150; clerk of works, £120; draughtsman, £130; contingencies, £800; allowance for coal-conveying machinery, fitting up of the stores, a new workshop, also to provide for minor mains extensions, £10,000. The committee have adopted Mr. Midgley's recommendations, and on Monday the Council will consider a resolution to apply for sanction to borrow £50,000 for carrying out the work under the supervision of Mr. Midgley, who will receive £200 extra as remuneration.

**Electro-Harmonic Society.**—The sixteenth season of this society opens on Friday evening, Oct. 11, when a smoking concert will be held in the banqueting hall of St. James's Hall, London, W., at 8 p.m. The society now numbers 350 members, 35 nominations having been received during the last few weeks. An excellent and varied programme has been prepared for the opening night. Mr. W. E. Lane, A.M.I.E.E, the hon. sec., 14, Durley-road, Stamford-hill, N., will be pleased to receive nominations for new members.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

### TENDERS INVITED.

The directors of the *Great Western Railway* require tenders for the supply of the stores set out in an advertisement elsewhere from Dec. 1, 1901, to Nov. 30, 1902. These requirements include telegraph instruments and apparatus, telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, copper and gutta-percha wires and copper tubes, indiarubber goods, brass work, telegraph poles and yellow pine, &c. Samples and patterns can be seen at Swindon from 8th to 17th inst. at the office of the stores superintendent, where specifications, &c., can be obtained. Tenders to the secretary (Mr. G. K. Mills), Paddington Station, London, W., by 21st inst.

*London County Council* require tenders for track and slot rails and fastenings, tie-bars, &c.; also roadwork and platelaying required for reconstruction on the conduit system of the tramway routes between Westminster, Blackfriars, and Waterloo respectively and Tooting; also for electric lifts, pumps, fans, &c., for electrical equipment of the Greenwich footway tunnel and approaches; and for generating plant, rails, &c., for tramways. Tenders by Oct. 8.

The directors of the *Lancashire and Yorkshire Railway* invite tenders for twelve months' supplies of various articles, including iron castings, copper, ironmongery, rails, sundry tools, oils, &c. Forms of tender, &c., from the stores department, Osborne-street, Manchester, where samples can be examined. Tenders to secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. Oct. 7.

*Newport* (Mon.) Corporation invite tenders for winches for steel chimney shaft, outside coal handling, piping, switchboard, cables, cable-ways, overhead construction, complete electric motor car and repair shop equipment. Tenders to town clerk by 5 p.m. Oct. 21.

*British Electric Traction Co*, Donington House, Norfolk-street, London, W.C, invite tenders for construction of about 2½ miles of tramway in Stourbridge and about 8 miles of tramway in Wolverhampton and Darlaston. Tenders by 18th inst.

*Stepney* (London) Electrical committee require tenders for arc lamp columns, lamps, fittings, &c., and switchboard. Tenders to Chairman by noon Oct. 17.

*Wakefield* Electricity committee invite tenders for a 550 B.H.P. high-speed enclosed engine and a 400kw. two-phase alternator. Tenders to Chairman by Oct. 15.

*Manchester* Electricity committee invite tenders for the supply, delivery and laying of cables of an approximate length of 147¾ miles. Tenders to Chairman by noon Oct. 9.

*Glasgow* Tramways committee are prepared to consider designs for mechanical point-shifting appliances, and inventors are invited to communicate with the general manager, Mr. John Young.

*Glasgow* Corporation invite tenders for 2 miles of 2in. pipes for the electricity department. Tenders by Oct. 8.

*Blackpool* Corporation invite tenders for poles, plinths, cables, &c., overhead materials, trolley wire and bonds and 20 electric car equipments. Tenders to Chairman Tramways committee by noon Oct. 21.

The Guardians of the *Greenwich* Union invite tenders for electric lighting installations at their new Homes for Children. Tenders to the Union Offices, East Greenwich, S.E., before Oct. 10.

*Batley* Corporation invite tenders for boilers, economiser, feed pumps, condensers, pipework and accessories, and travelling crane. Tenders by 18th inst.

*Leeds* Lighting committee require a main switchboard. Tenders to town clerk by Oct. 8.

*Leeds* Corporation require tenders for 50 electric motor-cars. Tenders by noon Oct. 15.

*Kirkcaldy* Corporation invite tenders for a main switchboard. Tenders to town clerk by 10 a.m. Oct. 24.

*Bournemouth* Town Council invite tenders for concrete foundations to tramcar sheds. Tenders by Oct. 15.

Tenders are required for wiring the *Luton* school board offices, &c. Tenders to clerk by 15th inst.

The municipal authorities of *Villar del Arzorispo* (Valencia, Spain) require tenders for the concession for electric lighting for eight years. Tenders by 12th inst.

The *Spanish* Ministry of Public Works require tenders for the construction and working of an electrical tramway between Linares and Las Minas. Tenders by 17th inst.

**Army Contract Notice.**—The Secretary of State for War gives notice that tenders for specific quantities of various articles, set out in an advertisement elsewhere, will probably be invited from time time during the next twelve months. Included in the list are electrical instruments, acids, indiarubber goods, lamps and lanterns, metals, oils, telegraph cable, timber, wire, &c. Manufacturers who wish to be applied to when tenders are required should communicate with the Director of Army Contracts (Mr. A. Major), War Office, Pall Mall, London, S.W.

### TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by Bournemouth Corporation for work, plant and equipment of the electric tramways. Mr. F. W. Lacey, M.I.C.E., is borough and tramway engineer, and the consulting engineers for the works are Messrs. Lacey, Clirehugh and Sillar:—

*Contract No. 3 (Boilers, &c.).*

| | | | |
|---|---|---|---|
| E. Danks & Co. (*accepted*) ... | £9,400 | Tinkers Limited ..... | £12 793 |
| J. Thompson ..... | 18,000 | Yates and Thom ..... | 11,877 |
| Fraser & Son ..... | 13,339 | Babcock and Wilcox, incomplete. | |

*Contract No. 4 (Water Cooler).*

| | | | |
|---|---|---|---|
| Klein Eng. Co. (*accepted*)* ... | £859 | Doherty and Donat..... | £380 |
| W. Watson ..... | 3,570 | Couper, Schwarz & Co.† ..... | 773 |
| Wheeler Condenser Co. ..... | 1,721 | A. Koppel‡ ..... | 750 |

* Cooling surface, 106,000 sq. ft. † Cooling surface, 26,000 sq. ft.
‡ Cooling surface, 36,432 sq. ft.

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*Contract No. 5 (Travelling Crane).*

| | | | |
|---|---|---|---|
| J. Carrick & Son (*accepted*)... | £326 | Chatteris Eng. Works Co. ... | £363 |
| Herbert Morris and Bastert | 1,450 | J. Spencer & Co. ..... | 350 |
| Carrick and Ritchie..... | 365 | J. Hitchen & Sons ..... | 285 |

*Contract No. 10 (Permanent Way Construction, Trolley System).*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| J. G. White & Co. (*accepted*) ..... | £93,721 | 3 | 3 | B. Cooke & Co. .....£108,300 | 0 | 0 | |
| G. Law ..... | 128,987 | 12 | 0 | E. Nuttall ..... | 99,758 | 11 | 1 |
| W. M. Murphy ..... | 124,953 | 0 | 0 | Macartney, McElroy & Co. ..... | 98,040 | 19 | 0 |
| Dick, Kerr & Co. ... | 113,188 | 19 | 7 | W. Griffiths & Co.... | 93,837 | 14 | 7 |

*Contract No. 11 (Electric Conduit System).*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| J. G. White & Co. (*accepted*) ..... | £58,152 | 0 | 0 | Dick, Kerr & Co. ... | £63,657 | 5 | 0 |
| British Thomson-Houston Co. ..... | 67,709 | 0 | 0 | W. Griffiths & Co.... | 60,306 | 0 | 0 |
| | | | | British Westing-house Co. ..... | 59,116 | 4 | 5 |

Worcester Corporation have accepted the following tenders for generating plant:—

*Boilers.*

Babcock and Wilcox ..... £5,597

10 tenders were received, ranging from £6,750 to £5,275.

*Engines and Dynamos.*

D. Bruce Peebles & Co. (Belliss engine) ..... £9,769

64 tenders were received, ran ging from £11,415 to £4,817.

*Condensing Plant.*

Sir Hiram Maxim Engineering Co. ..... £1,649

19 tenders were received ranging from £2,127. 10s. to £1,556.

*Switchboard.*

Ferranti Limited ..... £1,490

28 tenders were received, ranging from £2,040 to £695.

*Overhead Travelling Crane.*

Herbert Morris and Bastert ..... £174

12 tenders were received, ranging from £700 to £178.

*Accumulators.*

Ashmore, Benson, Pease & Co. ..... £1,317. 10s.

14 tenders were received, ranging from £2,849 to £1,317. 10s.

Cleckheaton District Council have accepted the following tenders in connection with their electricity supply and refuse destructor works:—

Meldrum Bros., refuse destructor plant; Bellies and Morcom, steam engines; Johnson-Lundell Electric Traction Co., dynamos; Phœnix Dynamo Manufacturing Co., balancer and booster sets; Electrical Power Storage Co., accumulators; Jas. Spencer & Co., travelling crane; B.I.W. Co., cables; Dorman and Smith, main switchboard.

King's Lynn Corporation have accepted the tender of the British Insulated Wire Co. (Ltd.) for the supply of 920yds. of 0·3 sq. in. concentric cable, insulated and lead-covered, with earthenware troughing, joint boxes, &c., for £412. 1s. 2d.

Wigan Electric Light and Tramways committee have accepted the tender of Back and Manson for copper wire, and that of John Spencer (Ltd.) for 100 tramway poles.

Hull Corporation have accepted the tender of Messrs. Clayton, Son & Co. for four boilers at £2,492. 10s. 2d., and that of Thomas Parker (Ltd.) for two dynamos at £3,951.

Hull Sanitary committee have accepted the tender of Mr. T. W. Broadbent for wiring and fitting the new destructor buildings for electric light at £330.

Blackburn Electricity committee have accepted the tender of Messrs. Dick, Kerr & Co. for three 850kw. steam dynamo sets, with Belliss engines.

Deptford (London) Borough Council have accepted the tender of the Hart Accumulator Co. for the supply of 45 of their standard lighting type cells at the public baths, Laurie-grove.

Bristol Corporation have accepted the tender of Buchanan and Curwen for wiring the Avonbank electricity works.

In regard to the tenders recently advertised for six new cells to the refuse destructor at Blackpool, six tenders were received for the complete plant and 13 for portions of the work. These tenders are under consideration.

Blackpool Corporation have accepted the tender of Mr. Thomas Dryden for 40 arc lamp canopies.

## BUSINESS NOTICES.

Messrs. Isidor Frankenburg (Ltd.) notify the removal of their London depôt for electric light cables and wires from 128A, Queen Victoria-street, to 26, Shaftesbury-avenue, London, W., where a large stock of cables and wires will be kept by their agents, the Accessories Manufacturing Co.

Mr. W. Stamm, 25, College-hill, London, E.C., informs us that he has been appointed sole agent for the United Kingdom for Mr. Ernest Schiess, of Duesseldorf-Oberbilk, manufacturer of machine tools of all kinds, especially for heavy work.

Mr. Justus Eck informs us he has severed his connection with Messrs. Geipel and Lange and has transferred his private consulting business in order to take up the appointment of technical manager and adviser to the Union Electric Co. (Ltd.).

Communications for the Cardiff Electric Lighting and Tramways departments should in future be addressed to the Central Offices, The Hayes, Cardiff.

Messrs. F. and A. H. Hodgson (trading as Fredk. Hodgson & Co), electrical engineers, 11, Poultry-chambers, E.C., 54, Church-street, Kensington, W., 249, Victoria Dock-road, E., and 45, Montpelier-vale, Blackheath, S.E., London, have dissolved partnership.

Messrs. W. W. Green and S. Boulding (trading as Green and Boulding), electrical and mechanical engineers, 105, Bunhill-row, London, E.C., have dissolved partnership. Debts by Mr. Boulding, who continues.

## BANKRUPTCIES.

J. A. M. Collier, electrical engineer, Claremont-grove, Gateshead, has been adjudicated bankrupt. The first meeting of creditors will take place on Oct. 4 at 30, Mosley-street, and the public examination on Oct. 10 at the Court House, Newcastle-on-Tyne.

The trustee (Mr. G. W. Chapman, Bankruptcy-buildings, London) in the failure of T. W. Greaves and W. G. Randall (lately trading as T. W. Greaves & Co.), electrical engineers, &c., 230, East India Dock-road, E., and 6, Nelson-street, Greenwich, has been released.

The trustee (Mr. J. F. Dyson, Central Buildings, Huddersfield) in the bankruptcy of Edwin Moorhouse, electrician, 203, Hyde Park-road, and 40, New Briggate, Leeds, has been released.

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**Traction Supplies List.**—A well-illustrated price list of electric traction supplies is issued by the General Electric Co., in which special attention is called to trolley heads, standards, and fittings made under Wood's patent. Carbon brushes and gears, standardised to suit the chief makes of traction motors, and motor parts and tools, are also listed.

**Electrical Fixtures and Glassware.**—The General Electric Co. have issued a new catalogue of electric light fittings and glassware of a very exhaustive character. We have only room in this issue to say that the catalogue consists of nearly 280 pp., closely packed with illustrations of all kinds of fittings and glassware for electric lighting, and forms a very comprehensive list of this class of goods.

**Iron and Steel Tubes.**—Messrs. John Spencer (Ltd.) have ready the 21st edition of their catalogue of iron and steel tubes and fittings for all purposes, special attention being given to electric light, telegraph and telephone poles, overhead electric tramway poles, wire and cable tubes, oil pipe lines, tramway bracket arms, bases and fittings, high-pressure steam mains for electric light and power installations, &c., &c. The catalogue is very compact, and can be slipped into the pocket.

**Johnson-Lundell Electric Plant.**—Several excellent additions to the Johnson-Lundell Co.'s system of electric traction plant and equipment are described in pamphlets Nos. 51, 101, and 151, treating of "traction motors, controllers and regenerative breaking," "automobiles and launch and motor controllers," and "surface contact electric traction" respectively. Each pamphlet is well illustrated.

**Siemens' Solid System.**—A useful and instructive pamphlet describing the solid system of laying underground mains for electric lighting and power work owned by Messrs. Siemens Bros. & Co., 12, Queen Anne's-gate, London, S.W., is just issued, and contains, in addition to the text describing the chief features of the system, a series of illustrations showing the mains in actual course of laying, as well as a couple of illustrations showing examples of the hard salt-glazed stoneware troughs into which the cables and protecting compound are filled. The troughs are made up in lengths of about 2ft, fitting well together to resist lateral displacement. A spigot piece is provided which forms a bridge for the cable, obviating the necessity for using pieces of wood or other material for this purpose. No cement or other jointing material is required. Where a number of mains are laid side by side in separate troughs, these troughs, having no external jointing pieces, occupy the minimum of ground space and effect a considerable saving in trench work. Where branch connections are required the mains can be so spaced to admit the service joint box at any point. A simple arrangement for providing consumers' connections is a stoneware box with a T-branch for the service line which can be readily substituted for a length of the trough. Any type of main can be used in conjunction with this system.

**Accumulator List.**—A new edition of the catalogue of the stationary type of Pritchett accumulators, manufactured by Messrs. Pritchetts and Gold, Feltham, Middlesex, is now ready, and includes particulars of the class of Pritchett cells suited for yacht and launch work. Accumulator accessories are also listed.

**Electrotypograph.**—The Nürnberg firm of Electricitäts Aktiengesellschaft vormals Schuckert & Co. are credited with being about to place upon the market an electrical type-setting machine which has been christened the "Electrotypograph."

**Lightning Arresters List.**—The International Electric Co., 55, Redcross-street, London, E.C., issue a sheet circular illustrating

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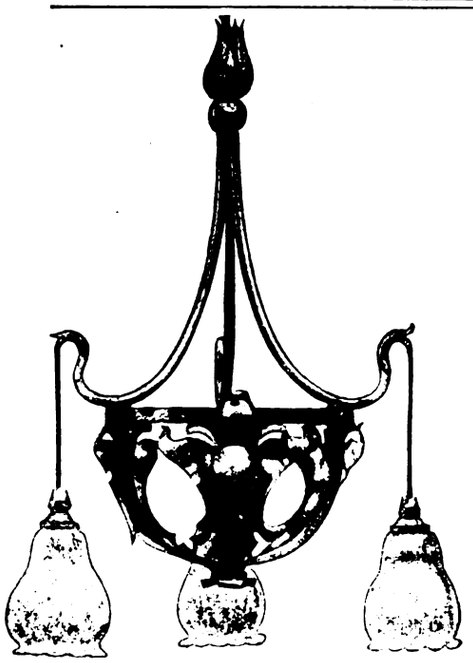
the lightning arresters with H.V. guards and patent alarm signal supplied to the Corporation exchanges at Glasgow, Tunbridge Wells, &c. Apparatus for both switch-room work and subscribers' instruments are illustrated.

**The Artistic Fittings Industry.**—Makers of fittings for electric lighting have not been slow to take advantage of the distinct improvement in public taste in regard to these goods. This improvement was undoubtedly in the main brought about by the enterprise shown by leading makers in establishing separate showrooms for their fittings, which gave the long-required opportunity to contractors to provide their clients with fittings best adapted to their special requirements after ocular demonstration of their suitability. We recently visited the premises at 162, Shaftesbury-avenue, London, W.C., which have been specially adapted by the Electrical Co. for the display of the infinite variety of artistic fittings for which they have a large and increasing demand. These fittings are manufactured partly in this country and partly on the Continent, and are shown in oxidised silver, bronze, lacquered and burnished brass, iron and other metals. In armoured bright iron these fittings have a finish in imitation of old armour, and some of the examples are especially fine and will well repay a visit both from the utilitarian and antiquarian aspect. Entering the showrooms from the first floor we are introduced to the goods finished in oxidised silver, and notice especially catalogue Nos. 6578 and 6827 (which we illustrate), hall light fittings of excellent design, No. 6792, a dining-room fitting of neat appearance, and Nos. 8331A, 8332 and 8332A, each in their way perfect examples of this class of fitting. The display is well set off by a tasteful selection of shades in silk and other material, and the addition of a number of classic figures in single, double and three-light groups is most attractive. The next room is devoted to bronzes, and here again the show is of a most complete and artistic character. The well-selected display of dining-room counterweight fittings, with shades en suite, embraces a large range of subjects and designs suited to all tastes. In room No. 3 is grouped a good selection of hammered iron-work fittings, a special feature of which, as above mentioned, is the work in armoured bright iron. Several examples of these fittings are of more than passing interest. We are able to illustrate in Nos. 6885, 8150A, a few items of this special class of work. The next room in the group is devoted to artistic fittings in all the leading Louis, Adams and Empire styles. Two of these are shown in 8028 and 8371A. Here a feature of the display is the adaptation of onyx to the different styles and classes of fittings. This material has come



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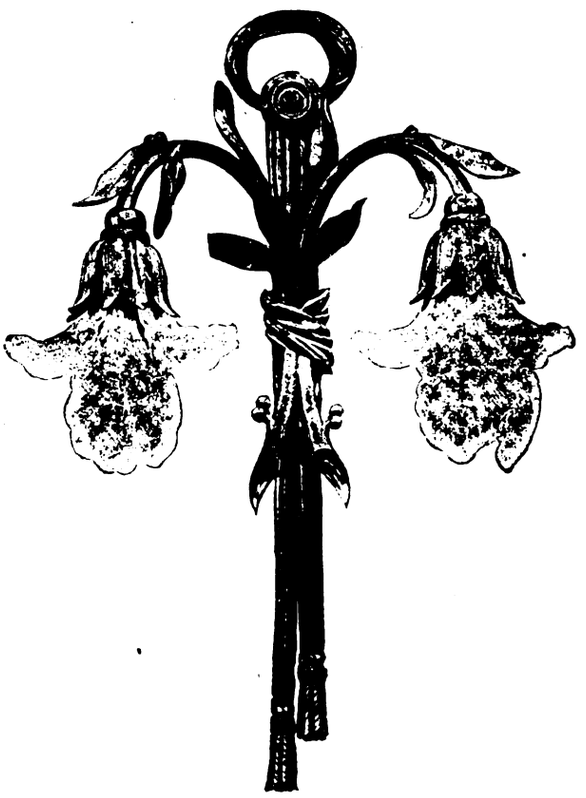

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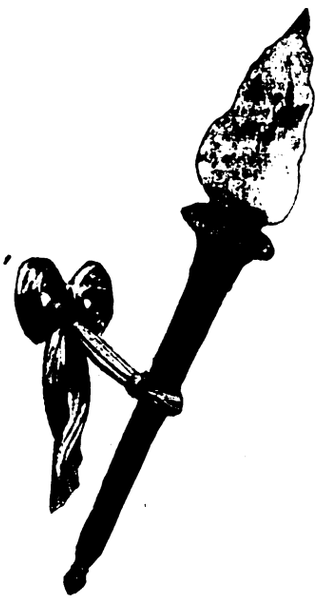

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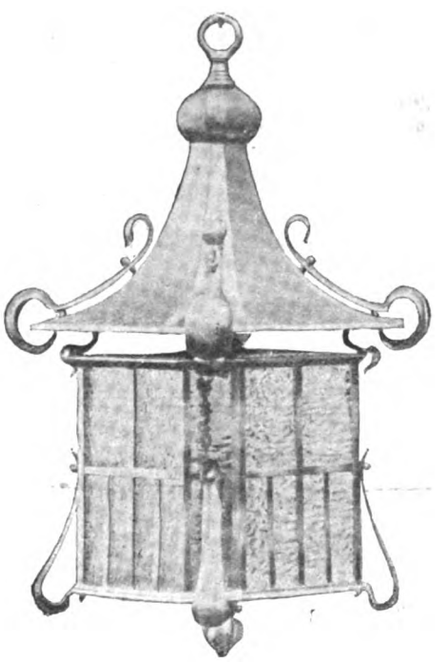

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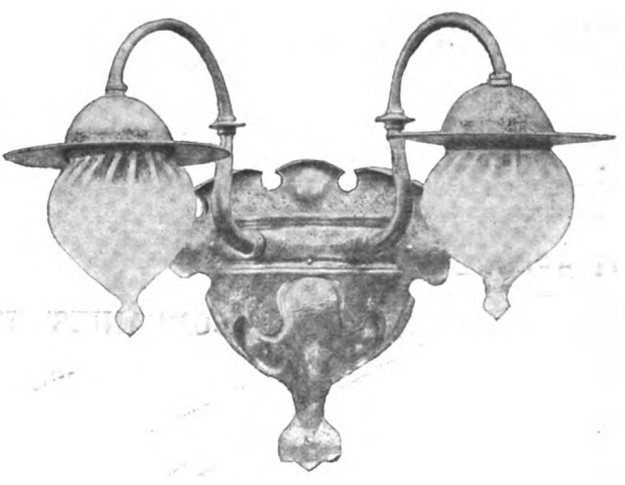

No. 8150A.

No. 6885.

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into favour, and as there are 24 different colours of onyx from which selection can be made in the making-up, a very attractive set of fittings is at the command of those whose tastes are in this direction. In this room there are a number of examples of the one, two and three-light fittings with glass iris shades which have become so popular recently. No. 8371A is an example of this class. The advantage of these shades is that they not only shade the light but are a particularly attractive ornament, and being made up in several detachable pieces are not so liable to be broken off either by accident or carelessness as are the fixed glass shades. Large numbers of these iris lights are sold, as may be said of many of the examples in this particular room. The next room is devoted to what may be termed fittings of general utility. Here there is a varied assortment of goods for every class of illumination. A noticeable feature is the improvement in style and in the materials used in making up these fittings. There can be no doubt that the demand for a much better class of fitting now prevails, and especially is this the case in what are called drop-light fittings. This improvement has been brought about without any material increase in the price of the goods. Owing to the greatly increased demand makers are now able to dispose of large numbers of fittings of similar design as well as to add to their range of subjects, classical and otherwise, and the original cost is thus spread over a larger area. For restaurant and hotel illumination, for mansion lighting, and for the decoration, occasional or permanent, of special styles of rooms in private residences, the display at the Electrical Co.'s showrooms is excellent. We should, in conclusion, mention that special attention has been given to the introduction of counter-weight bedroom lights, in which the most varied tastes are shown. Panels throughout the showrooms are devoted to the showing off of these lights. The catalogue which the Electrical Co. have prepared for the use of contractors and trade buyers is very complete, and has been got up regardless of expense. Nearly 100 pages are devoted to a varied assortment of fittings for all requirements, and the whole of the illustrations are, we are assured, direct photos from actual fittings. The showrooms are well worthy a visit, and their excellent arrangement reflects much credit upon the managers of this branch of the Electrical Co.'s operations.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Sept. 25 to Oct. 1, with the ports of destination :—

*Africa*—Alexandria, £1,280; Cape Town, £361 (including £200 telegraph material); Delagoa Bay, £132; Durban, £139; East London, £344; Zanzibar, £22. *Argentina*—Buenos Ayres, £55. *Australasia*—Adelaide, £538 (including £239 telegraph material); Brisbane, £1,444 (telegraph material); Fremantle, £114; Melbourne, £768 (including £224 telegraph wire); Sydney, £1,987; Townsville, £1,420 (telegraph material). *Belgium*—Ostend, £70. *Canada*—Halifax, £600 (telegraph material). *Ceylon*—Colombo, £75 (including £25 telegraph material). *China*—Shanghai, £75. *Denmark*—Copenhagen, £153 (telegraph material); Korsor, £4,950 (telegraph cable). *Germany*—Hamburg, £120. *Gibraltar*, £19. *Holland*—Amsterdam, £60; Rotterdam, £96 (telegraph material). *Hong Kong*, £9. *India*—Bombay, £78 (including £32 telegraph material); Calcutta, £653 (including £136 telegraph material); Madras, £112. *Japan*—Kobe, £65 (telegraph cable). *Malta*, £74 (telegraph cable). *Siam*—Bangkok, £84. *Spain*—Barcelona, £1,571. *Straits Settlements*—Singapore, £243. *Sweden*—Stockholm, £126 (telegraph material). Total £17,815, against £57,254 for the corresponding week last year (Sept. 26 to Oct. 2).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

June 1, 1901.

11,248. G. A. LEWES. London. An improvement in the form of glass chimneys and globes for incandescent gas and electric lighting.

11,253. THE BRITISH ELECTRIC PLANT CO. (LTD.), and W. L. SPENCE. Glasgow. Improvements in or connected with the application of electric motors to the driving of machine tools.

11,254. C. M. STEAD. Leeds. Improvements in incandescent light fitting, more particularly applicable to electric incandescent lights.

11,257. J. R. QUAIN and T. T. TURNBULL. London. Improvements in and relating to electrolytic incandescence lamps.

11,277. R. W. BOYD. London. An improved apparatus for utilising electric lamps in the heating of plates and other domestic utensils, and in the boiling of water and other liquids.*

11,280. C. DE KANDÓ. London. Improvements in electrical reversing switches and in mechanism for operating them.*

11,290. THE PICK MOTOR CO. (LTD.) and J. H. PICK. London. Improvements in electric contact makers and breakers.

JUNE 3, 1901.

11,307. R. H. WILKINSON. Liverpool. Improvements in overhead trolleys or collectors for electric tramway or railway vehicles.

11,308. J. HOLMES. Bradford. Improvements in and relating to joints for conducting cables.

11,315. D. MACKAY and H. SOLATER. Leith. The "Sparkless" Regulator for electric motors.

11,327. S. MUSITO, R. H. DE SZENT GYÖRGY, and E. HAGYI-RISTOC. London. Improvements in and relating to the electrical transmission of signs or sounds.*

11,348. O. J. LODGE and A. MUIRHEAD. London. Improvements in syntonic space telegraphy.

June 4, 1901.

11,371 F. J. HEWITT and W. G. DUNNING. Liverpool. An improved guard for the prevention of the fouling of overhead wires by a trolley or trolley arm used in the overhead rolling-contact system of electric traction.

11,408. THE BRITISH THOMSON-HOUSTON CO. (LTD.) London. Improvements in electric railways. (S. B. Stewart, United States.)

11,409. A. ANDERSON and J. M. ANDERSON. London. Improvements in insulating supports or "insulators" for electric conductors.*

11,450. W. H. STEWART. Liverpool. Improvements in appliances for high-tensional electrical conductors for ensuring safety in case of fracture.

11,470. R. A. FOWDEN. London. Improvements in printing telegraphs.*

June 5, 1901.

11,500. A. SANSONE. Manchester. Improvements in the manufacture of chlorine and chlorides and in the production of electric energy therewith.

11,524. G. E. B. EYRE, W. H. SPOTTISWOODE, C. A. SPOTTISWOODE, and J. E. LEWIS. London. Improvements in electrotyping.

11,529. W. BOEHM. London. Improved manufacture of electric lighting, heating and resistance bodies.*

11,530. W. BOEHM. London. Improvements in or relating to electric glow lamps or devices.*

11,537. C. A. JENSEN. London. Improvements in electric alarm apparatus. (Carrado Zanotta, Italy.)*

June 6, 1901.

11,545. W. A. HEYES and L. O. HEYES. Wigan. An improved method of fixing and connecting up guard wires for the protection of overhead trolley wires used for electric traction, and means for automatically disconnecting the current supplied to the trolley wires.

11,552. A. HUDSON. Great Lever. An improved automatic self-locking life-guard for electric-propelled cars or other vehicles.

## SPECIFICATIONS PUBLISHED.

NOTE.—**All Specifications can now be obtained at the uniform price of 8d. each.**

1901.

3,823. AMES. Conduits for electric wires and cables.

9,676. BRITISH ALUMINIUM CO. (LTD.) (Cowles). Electric smelting process and apparatus to be used therein.

9,769. LAKE (McElroy-Grunow Electric Railway System). Current collectors or contact shoes for electric railways.

9,883. FOX. Controllers for electric motors.

9,919. STONE. Wire cables, lightning rods, and the like.

10,733. BRITISH THOMSON-HOUSTON CO. (LTD.) (Emmet and Hewlett). High potential electric switches.

10,737. BRITISH THOMSON-HOUSTON CO. (LTD.) (Stewart). Electric circuit breakers.

10,848. TOMKINS. Apparatus for winding coils for continuous-current dynamo and motor electric machines.

# COMPANIES' MEETINGS AND REPORTS.

## Willans and Robinson (Ltd.).

The ordinary general meeting was held on Wednesday, under the presidency of Mr. Mark Robinson, M.Inst.C.E.

The SECRETARY (Mr. C. S. Essex) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen: We are able to congratulate ourselves again upon a successful half-year. The profit is not quite so large as for the previous half year, though a little greater than for the corresponding half of 1900. But it has often been pointed out that our system of balancing the accounts half-yearly, instead of yearly, as in so many companies, though an excellent system, has the drawback that each set of accounts covers too short a period for the law of averages to take effect: one is liable to fluctuations from merely accidental causes. For some reason, the second half of each year is usually better than the first, and we hope it will be so this year. The fluctuation is hardly great enough to call for detailed consideration, but one obvious cause, it need hardly be said, is the recent high price of materials. Apart from the profitableness or otherwise of our work, we are of necessity passing through a relatively lean time. The extensions at Rugby are coming gradually into use, but the capital they represent did nothing towards earning the dividend which it now receives. At the Queensferry boiler works we had £92,141 invested

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in buildings, plant, &c., at the end of June, and this is wholly unproductive, and must be so for some time to come. So we may congratulate ourselves that we have a 10 per cent. dividend, with the usual large amount carried to reserve. At Queensferry the buildings are practically complete, except the power house, but we still wait for a good deal of the machinery. One department, however, is complete—viz., the steel-making plant—and we hope to start steel-making in a week or two. I am sometimes asked if we have orders in hand for boilers to ensure business for the new works. Certainly not; nor do we seek for them. The orders will come fast enough when we can show the world that we can execute them within a short time. Two important inquiries even reached us last week. All we have ever said of the Niclausse boiler and its merits we would repeat now with added force, and the works will be worthy of the boiler. Let me repeat, as emphatically as ever, that even if the Admiralty failed in the end to acknowledge the enormous advantages of the Niclausse boiler, even if the fanatics who are trying to put back the clock and restore the old shell boilers in the Navy were to succeed, the success of our boiler-making business at Queensferry would still, in our opinion, be assured. We have never taken the Navy work into account in our calculations, but land work only, for on land the best boiler will win, with little reference to prejudice, and with none at all to politics. Of the general progress of the company it is unnecessary to say much. The shops are full of work, and there seems to be plenty more before us. The authorised issue of capital was carried out with complete success in the spring, though it cannot be denied that the time was and is an unfavourable one for financial operations. The amount and the disposal of the share premiums so far received upon this issue is fully stated in the report. After the legal opinions obtained upon the subject last year it is not necessary to say much in justification of the action taken. We have often been urged to write off the goodwill, and the present occasion has given the desired opportunity. As regards writing off the value of patents, that was definitely proposed to the shareholders two years ago and was approved by them. The amount (£3,335) almost wholly represents the Niclausse boiler licence. We have still to receive about £36,000 in premiums on the late issues, so there will be no difficulty in making the invested reserve fund up to an amount beyond the £100,000 of which we have spoken on former occasions—independently of the debenture redemption fund. These are results of which a company eight years old may be proud. Turning to the details of the accounts, there are certain increases of expenses, such as "Advertising," which has risen by £202, but the total sum is still, I have little doubt, much below that spent by most firms working under like conditions. "Books, stationery and printing" is bound to increase with a developing business. "Travelling and general expenses" include the expenses of a representative sent to Japan, whence some good orders have come to us, while others are hoped for. We subscribe £350 to the Volunteer Corps, which is practically the amount we had promised to contribute to provide the works corps with a machine gun and carriage, but which it became necessary to apply, in part, to more urgent needs for clothing, &c., due, it seems to us, to the unwise stinginess of the War Office in such matters. Our volunteer company is strong in numbers, and no less than 86 went into camp for training this year. Of our reservists who went to the front I deeply regret to say two have been killed. Five of our men are still on duty, and three have returned safe. "Interest on investments, &c.," is less than last half year.

Sir R. Sankey, who is retiring, has brought to our counsels the support not only of a distinguished name, but of a ripe wisdom and experience gained in high administrative positions both at home and abroad. Sir Richard has been responsible for great engineering works, and though these were rather in the domain of civil than of mechanical engineering, this fact has but added weight to his views as an independent critic of the work carried on by the company. We all share his regret at parting. We desire to take the present opportunity to strengthen the board, not in the sense of replacing Sir Richard by a better man, which would be impossible. but by a man who can give his whole time to the business, and allow his whole future to be dependent upon its success. I would roughly describe the board at present as consisting of two working managers and three independent advisers and critics, who, not being always present, are perhaps the more useful as critics, but are not available for dealing with the many knotty points of daily administrative work. With a third working manager we shall be strengthened where strength is wanting, and we shall still have two directors whose special function will be to watch over the interests of our sleeping partners, the shareholders. Mr. Arthur Lazenby, whom we recommend for the appointment, took honours in the mathematical tripos at Cambridge in 1887, served his time as an engineer with Messrs. Simpson & Co., Pimlico, and went to Australia in connection with some important pumping machinery sent out by that firm. In 1890 he came to us at Thames Ditton as one of the assistants to the late Mr. Willans in carrying out the long series of steam-engine trials which afterwards became so celebrated, and later became my own assistant. He has for some years had charge of the foreign branch of the business. Mr. Arthur Lazenby is a considerable shareholder in the company, as he was in the old company. I now propose that the report and accounts be adopted.

Mr. A. R. HOLLAND (a shareholder) seconded the motion.

A short discussion followed, and satisfaction was generally expressed at the results shown.

The CHAIRMAN, in reply to questions, said that a large proportion of the reserve fund was invested in Consols, and it was all in trustee investments. They hoped to be able to be turning out Niclausse boilers from the works in 12 months—not making them, but supplying them.

The motion was carried unanimously.

Dividends for the half-year ended June 29 last at the rates of 6 per cent. per annum on the preference and of 10 per cent. per annum on the ordinary shares were then approved.

Lieut.-Gen. Sir RICHARD H. SANKEY, K.C.B., R.E., afterwards addressed the meeting.

The CHAIRMAN then proposed the election of Mr. Arthur Lazenby as a director, which was seconded by Mr. A. H. COUSINS (a shareholder), and warmly supported by Lieut.-Gen. Sir R. H. Sankey, and carried unanimously.

A vote of thanks to the chairman and directors terminated the proceedings.

## Johnson-Lundell Electric Traction Co. (Ltd.)

The annual general meeting of this Company was held on Wednesday under the presidency of Mr. L. W. HOLMES.

Mr. A. TILLEY (Secretary) having read the notice convening the meeting,

The CHAIRMAN formally moved the adoption of the report and accounts.

Mr. G. B. HUNTER seconded the motion, and said that as a member of the board he was disappointed they had not made further progress. The Directors had, however, attended very steadily and energetically to the Company's business, and while he felt that a somewhat longer time had being taken than was expected in placing the Company's manufactures before the public at home and abroad, progress had been made, and he felt hopeful that when the Directors next meet the shareholders a better report would be presented.

Mr. REGNART asked whether the best thing to be done would not be to wind up and divide what there was amongst the shareholders.

Mr. HENDERSON said that, looking at the accounts, it appeared that nearly £12,000 of calls were in arrear to April 30 last, and he would like to know what progress had been made in the collection of this amount. There was also a sum of £10,000 paid in advance of calls, and he wished to know whether that sum had been paid by outside shareholders or by shareholders who were connected with the promotion of the Company. There was also an item showing Directors' fees £1,526, besides which, amongst sundry creditors, the Directors were down for a further £1,470, which seemed to require explanation. It would appear that the Directors' fees amounted to five times the total year's income of the Company. There was also £2,419 for salaries, of which he would like an explanation. On the credit side there was £596 received as royalties, and he wished to know from whom this sum was received. There were also certain statements made by the Chairman at their statutory meeting in August last year, as to the manufacture of their motors by Messrs. J. H. Holmes & Co., of Newcastle, which seemed to require some explanation. They had been led to believe that the Company was in a satisfactory condition as to putting its manufactures on the market, while they were actually face to face with the fact that the total income earned was under £600. There was apparently not £15,000 now available for the uses of the Company, and he would like to know if the Directors considered they could proceed with the business without making further calls. It appeared to him that the Company had been put before the public 12 or 15 months at least before it should have been floated. With regard to the association of Mr. Holmes with the Company he wished to know what share of the price of their motors did Mr. Leonard Holmes or his firm receive—in shares or in cash—and what holding had Mr. Holmes in the Company.

Mr. SHEPHERD asked what part of the whole amount of the issued capital of the Company the public had applied for?

The CHAIRMAN: With regard to the calls in default, we have naturally hesitated to take legal proceedings against the shareholders who assisted in the underwriting of the Company's capital, especially as we really did not require the money at the moment. We did, however, a month ago, give notice to each of the defaulting underwriters that unless their calls were paid within 30 days writs would issue. This notice expired yesterday, and we are taking proceedings. The £10,000 advanced calls referred to represented the shares held by the Electrical Vehicle Syndicate, the bulk of whose assets we bought out. As to the Directors appearing as creditors, we have not taken our fees, and if we had, we should not appear on the other side of the account. With regard to the amount of the Directors fees, if the Company had earned a good dividend nothing would have been said about these; but the shareholders must remember that the Directors had been put to a great deal of trouble and work, and although there was nothing to show for it there would be in the future, and the Directors had well earned their fees. But they were willing, if the shareholders wished it, to forego their fees for this year. The Company had had to face the strike in America, when the Sprague Company's shops were closed for months, and they had had Mr. Johnson, a Director, to whom they looked on the technical side, at death's door. As to the salaries, these represented the sums paid to Mr. Johnson, under his agreement with the Company, and the salaries of the office staff, which had been hardly worked during the period under review. The drawing office in America also had to be provided for, as all their dynamos had to be standardised, and their motors not only standardised but drawn down from the very initial stages. That had been done in America, but was now being done on this side, and their whole staff was now in this country. The £596 from royalties represented only a small amount of what was owing to the Company under this head. As to proceeding with the work of the Company, the Directors considered that this could be proceeded with without making further calls for some time to come. The German patents, he hoped, would be shortly sold. With regard to the capital question, if they sold their foreign patents they would have plenty of money for building works, and this was their original intention. They had not proceeded with this building because the cost of building was very high. He held the view that there was an enormous amount of money being invested in this country in the building of electrical works which he was certain could not be kept going, and when their Company required works he thought they would be able to get them very cheap. He

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believed the Directors were right in the course they had taken in regard to this and other matters. As to the share that Messrs. J. H. Holmes & Co. had in the promotion of the Company, and their present holding, he did not think it was his place to say. This he would say, however, that Messrs. J. H. Holmes & Co. were by far the largest shareholders in the Company, as they held 6,009 shares, as well as being very large holders in the Electric Vehicle Syndicate. The public subscribed only about 7 per cent. of their paid-up capital. He had personally no reason to doubt the future success of the Company, and nothing had shaken his faith in it. He had been disappointed at the slow progress, but there was good reason for this, and he asked the shareholders to give the Directors another year of office. They were just about entering upon a strong campaign, they would probably have sold their foreign patents by that time, and Mr. Johnson was going to the Continent to work up a foreign business.

In reference to a question as to the Company's patents, the Chairman asked Mr. Webb to reply.

Mr. WEBB: So far as I can gauge, our dynamo patent was thoroughly assured and practically perfect. I personally thought when the patents were purchased that we not only bought the patent rights but all the drawings and everything ready to go on with the manufacture of the machinery; but it turned out that the American drawings and other things are so different that everything connected with the dynamos has had to be re-cast and re-drawn. To my mind the most valuable part of the patents is the motor control, for which I can see an enormous demand in the future. I thought the Johnson-Lundell Co. were in a position with their patent rights to get the Sprague Company or some other American firm to flood the English market with these motors, but such was not the case. The motor was right in design and theory, but for all the various sizes the whole thing had to be drawn out, models had to be made, and the motor constructed and tested before it was put upon the market. These tests so far as they had been made in America had proved perfectly satisfactory, and there is to be a test in Blackburn, I understand, during the month of October current. The Company has a valuable patent in the stud system of surface contact for traction which I think is going to be a great success, and will get rid of the unsightly trolley. Until the tests I have referred to are made the sale of the German patents is delayed, as it is a condition precedent that the machinery made under these patents shall fulfil all the conditions that the Johnson-Lundell Electric Traction Co. averred they would.

Mr. HENDERSON said Mr. Webb's explanation was satisfactory as far as it went. It appeared to him (Mr. Henderson) that the Germans had been much more wide awake than had the Directors of the Johnson-Lundell company.

Mr. HUNTER wished to explain that the sum of £1,400 in the accounts was not due to the Directors in addition to the £1,500 which appeared in the profit and loss account as fees; it was the same amount, only somewhat varied, and represented the liability of the company for Directors' fees. With regard to their patents no question has arisen as to their validity, nor was it a question of the patents fulfilling the conditions stated in the Company's prospectus. The Germans, however, wanted a great deal more, and asked for severe tests. They, in fact, asked for a greater percentage of saving than the Company had pledged themselves to, and there were other conditions in the German agreement which were not quite satisfactory to the Directors.

The CHAIRMAN then put the resolution to the meeting for the adoption of the report and accounts, which was carried.

Mr. E. H. Johnson, Mr. Henry Webb and Mr. A. Mackay, the retiring Directors, were re-elected, as were the Auditors, and a vote of thanks to the Chairman terminated the proceedings.

## Chloride Electrical Storage Syndicate (Ltd.).

The ordinary general meeting of this company was held at the offices, Clifton Junction, near Manchester, on Friday last. The directors' report for the year ended June 30 stated that the output of the works had been maintained during the year. Although somewhat better prices had been obtained the profits had increased to but a small extent owing to the high price of raw materials. There was now, however, a tendency to fall. The negotiations respecting additional land adjoining the syndicate's property had been concluded, and land had been acquired on long lease sufficient to provide for any further extensions that might be necessary for some considerable time to come. The syndicate's exhibit at the Paris Exhibition had been awarded the gold medal, the highest class of award made to any storage battery.

An agreement had recently been entered into for the supply of batteries for special purposes which the directors anticipated would lead to considerable increase in the syndicate's business. The directors had also secured control of the patent rights protecting an improved method of using storage batteries in connection with supply stations for power and lighting which would greatly increase the efficiency and utility of the batteries so used.

The profit for the year amounted to £9,660. 17s. 1d. After providing £853. 6s. 4d. for debenture interest and writing off £4,555. 17s. 8d. there remained £4,251. 13s. 1d., to which was added £10,429. 4s. 9d. from last account, less directors' fees, income tax and audit fee (£855. 19s.), leaving £14,680. 17s. 10d., which the directors recommended should be carried forward, as the money was needed in the business. Further capital was required for the extension of the syndicate's operations and for the release of profits earned for the payment of dividends, but the directors had not concluded any arrangements, as circumstances had not been favourable for raising additional capital on satisfactory terms.

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The following report of the proceedings at the meeting on Friday last have been courteously supplied to us:—

The CHAIRMAN (Dr. F. H. Bowman), in proposing the adoption of the report, said the works had been fully employed during the year, and had they been larger they could have been kept fully going. The demand for storage batteries, which had really only just begun and was rapidly increasing, had to be met, and it was necessary, therefore, that their works should be extended. Additional adjoining land had been obtained on a 999 years' lease, so that this extension could be carried out. Although the company was making good profits year after year, dividends could not be paid because it was impossible for the directors to deplete the capital necessary for keeping the concern in full efficiency, and the fall in values in industrial concerns, and even in the best classes of securities, had not made it desirable for the moment to endeavour to raise fresh capital. He concluded by foreshadowing a coming reconstruction of the company.

Dr. E. HOPKINSON reviewed the accounts, and explained that before the present board took over the company a large sum had been paid for patents which had proved to be not of the value they were supposed to have been. This was represented on the credit side of the balance-sheet by upwards of £170,000, and on the other side by paper shares. He thought it would be of great benefit to the company that the items on both sides should be wiped out one against the other, and some fresh capital introduced, so that the balance-sheet could be put upon a business-like basis, and the annual amounts earned be paid to shareholders, instead of being used to wipe off the old incubus and to provide the necessary working capital. Looking at the past year as a normal one, he thought they could look forward to the continuance of the profits which had been realised in the past, and that they should be in a position to pay a reasonable dividend upon the cash capital of the business, seeing that they had solid assets and a flourishing business.

A SHAREHOLDER said that it was rather hard on shareholders that, when enough money had been earned to pay an 18 per cent. dividend on the actual cash capital of the company, they should go empty away.

Mr. BANNISTER, a director, pointed out that he held about 10,000 shares, and it would suit him very well indeed to get a dividend; but as a trustee of the company, representing the interest of the shareholders, he would not be faithful to that trust if he was a party to paying away money in dividends. The past policy of conserving the profits had been the syndicate's salvation, the actual cash paid to the company on which to work having been only about £53,000.

A vote of thanks to the chairman, directors, manager and staff terminated the proceedings.

## Brockie-Pell Arc Lamp (Ltd.).

The first annual report, for the period ended June 30, states that, after writing off £435. 17s. 11d. for depreciation on plant there remains a net profit of £2,465. 8s. 7d. The increase in business during the year has been most encouraging, the orders received for lamps being greatly in excess of those in previous years. At present 1,000 lamps are in course of construction, over 800 of which are for orders already received. The company was entrusted with the lighting of the buildings and grounds of the Glasgow Exhibition with Brockie-Pell arc lamps, and the directors are informed that these lamps have given every satisfaction, and their superiority has been acknowledged by those interested in electric lighting who have visited the exhibition. Nearly 1,100 lamps are in use nightly, and form the largest installation of arc lamps in the United Kingdom. The report states that the directors have demonstrated that a substantial profit can be made, and under ordinary circumstances a dividend could be paid, but it is impossible to do this out of this year's profits and leave sufficient working capital for the increased needs of the company. They are therefore unable to recommend the payment of a dividend, and propose that the whole amount be carried forward; and shareholders are asked to acquiesce in an arrangement which will enable the company to extend their trade so that the fixed charges will bear a smaller proportion to the gross profits than has hitherto been the case. In order to attain this result the directors find it necessary to call up the balance of capital. A call of only 6d. per share is to be made at present, the remaining 6d. to be called up at the expiration of three months. The directors refer with regret to the death of their late managing director (Mr. W. Shrimpton). Mr. W. J. G. FitzGibbon has been appointed to the post of manager in addition to his former work as secretary.

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**CAPE ELECTRIC TRAMWAYS (LTD.)**—The directors' report for the year ended June 30 states that after provision for debenture interest there is a net balance of £75,922. 2s. 9d., which, added to £11,319. 11s. 2d. from last year, makes £87,241. 13s. 11d., out of which the directors have paid 12 per cent. (represented by two interim dividends of 6 per cent. each in February and August). £8,000 has been placed to reserve, and £12,000 to special reserve, leaving a balance profit of £16,841. 13s. 11d., which has been carried forward. During the year the Cape Town electric tramway system carried 13,056,965 passengers, against 11,332,627 in the preceding year. The Port Elizabeth system carried 3,253,656 passengers, against 2,967,420. The arrangements for enlarging the power station in Cape Town and increasing the rolling stock have been checked, owing to the great but unavoidable delay experienced in landing plant. Efforts are, however, being made to hasten the completion of the work. Extensions of the company's system have been authorised, and are in progress.

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**CHILIAN ELECTRIC TRAMWAY AND LIGHT CO. (LTD.)**—The directors' report for the year to Dec. 31 last gives the credit balance on the year's operations as £3,514. 2s. 9d., or with balance forward £6,444. 18s. 5d. This is to be carried forward. During the year the conversion of the tramways to electric traction has been pushed on, and a large portion of the service in Santiago is being worked electrically. During the year the company's cars carried 42,071,049 passengers, earning $1,830,268.08, against 41,743,687 passengers and $1,819,143.16 in 1899. Good progress has also been made in extending the installation of electric lighting in the city of Santiago, for which the

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company holds the exclusive monopoly. The people of Santiago are gradually appreciating the advantages of electric lighting and every confidence is felt that this branch of the business will realise expectations. The work of reconstructing the tramways and the installation of the electric lighting is being carried out by the Allgemeine Elektricitäts-Gesellschaft, Berlin. The directors have decided not to continue at present the experimental work of proving the possibility of utilising the waters of the river Maipo as a generator of power, the steam power already provided being sufficient for all present requirements.

**DIRECT WEST INDIA CABLE CO. (LTD.)**—The directors' report to June 30 states that the net result of the year's working is a profit of £5,236. 10s. 3d., compared with £5,455. 18s. 3d. for the previous year. An interim dividend of 3 per cent. has already been paid, and (after providing £591. 2s. for depreciation of spare cable and other stores) a further equal payment, tax free, is now declared, leaving £2,796. 13s. 3d. to be carried forward. The credit to revenue account is now £27,943. 8s. 4d. The company's cables continue to work with complete efficiency. At last Thursday's meeting the report was adopted.

**ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS (LTD).**—At the meeting last week the chairman (Mr. G. Richardson) said the net profit for the past year was £21,200, and after adding £3,900 forward from last year £25,100 remained to be dealt with. The expenses referred to in the previous report (£7,342) had been written off. The payment of a dividend of 8 per cent., less tax, absorbed £12,000, and £3,778 was carried forward. The company had worked on rather short capital, on account of the increase of business and on account of delays in getting payments from corporations. They proposed to issue 5 per cent. debentures to the amount of £50,000, shareholders having the preference in subscribing. All the money would be employed practically as working capital.

**ELECTROLYTIC ALKALI CO. (LTD.)**—The directors' report to Aug. 31 states that all the patents referred to in the prospectus have been transferred to the company, and the consideration (£25,000 in cash and £75,000 in fully-paid ordinary shares) has been paid. Boring operations were started in Feb., 1900, and brine of excellent quality was found. Subsequent operations convinced the directors that the supply is practically inexhaustible. The commencement of production was greatly delayed owing to failure in obtaining completion of buildings and delivery of machinery according to contract, and it was not until the beginning of April last that a start could be made. The process worked perfectly from the first, the products are of the highest quality, and the anticipated results have been fully realised. The demand for the company's products is greatly in excess of the capacity of the present plant, which is only applied to the production of bleaching powder and soda crystals. The directors are so satisfied with the results that they strongly recommend the immediate extension of the plant, and for this they propose to make a further issue of shares. The directors consider that the profit (£1,242) earned by the working of an average of 36 cells during about 4½ months is satisfactory, and recommend that this amount be carried forward.

**HALIFAX AND BERMUDAS CABLE CO. (LTD.)**—The directors' report to June 30 states that the year's working shows a profit of £4,904. 14s. 7d., compared with £3,795. 7s. 9d. to June, 1900. An interim dividend of 2½ per cent. has already been paid, and (after providing £258. 8s. 6d. for depreciation of spare cable and other stores) a further equal dividend of 2½ per cent., tax free, which will leave £2,078. 11s. 11d. to be carried forward, and increasing the amount to credit of revenue to £15,171. 0s. 2d. The company's cable continues to work with complete efficiency. At the meeting of shareholders on Thursday last the report was adopted.

**LEAMINGTON AND WARWICK TRAMWAY CO. (LTD.).**—At a meeting this week the chairman (Ald. Mann) said everything was now in order for conversion of the line to electric traction, and next year they expected electric cars would be running between Warwick and Leamington. Mr. J. A. Lycett said he was hopeful of the financial results under electric equipment. The cost of horse trams had been about 1s. per tram mile, and the receipts 1s. 2d., whereas electric traction would not cost more than half that sum. He believed that the right to supply electric current for light and power would be a source of revenue to the company.

**NEW ST. HELENS AND DISTRICT TRAMWAYS CO. (LTD.)**—The directors' report for the year ended June 30 states that the negotiations with the Corporation for a modification of the terms of the lease were not concluded until 4th ult., when the concessions recommended by the Electric Supply and Tramways committee were rejected by the Council. The lease, however, provides for a revision in five years from the date of its commencement. The accounts do not admit of payment of any dividend on the preference shares for the six months. The net profit was £272. 17s. 5d. after paying preference dividend and interest upon calls paid in advance. Of a total of £26,301. 2s. 4d. from traffic receipts, £15,368. 7s. 6d. had to be paid to the Corporation, equal to 5·01d. per car mile. Substantial reductions in the cost of working will be effected by curtailing the frequency of the service and otherwise.

**STIRLING AND BRIDGE OF ALLAN TRAMWAYS CO. (LTD.)**—The directors' report states that under the provisional agreement with the British Electric Traction Co. negotiations were still pending with the local authorities. In February Stirling Council gave notice of intention to purchase the line from King-street, Stirling, to the bridge over the Forth, but that notice had not yet been followed up.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26$\frac{13}{16}$d. per oz. (Oct. 3). Consols (2½ per cent.) 93$\frac{5}{8}$—93$\frac{1}{2}$ for money, 93$\frac{5}{16}$—93$\frac{7}{16}$ for account; 2½ per cent. 94$\frac{1}{4}$—94$\frac{3}{4}$ (Oct. 3). Consols Pay Day, Nov. 6; Stocks and Shares Continuation Days, Oct. 9 and 23; Ticket Days, Oct. 10 and 24; Pay Days, Oct. 11 and 25; Mining Share Carry-over Days, Oct. 8 and 22.

**ANGLO-AMERICAN TELEGRAPH CO. (LTD.)**—After placing £6,000 to credit of renewal fund, the directors have declared an interim dividend for the quarter ended Sept. 30 of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, less tax, payable on Nov. 1.

**CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)**—An interim ordinary dividend at the rate of 6 per cent. has been declared.

**ELECTRIC LIGHTING BOARDS (BRITISH MANUFACTURING CO.) LTD.**—Sir James W. Szlumper, J.P., M.I.C.E., mayor of Richmond, has been elected a director of this company.

**ELEKTRICITATS AKTIENGSSELLSCHAFT VORMALS SCHUCKERT & CO. (NURNBERG)**—It is stated that this company has sold its Bosnian works at Jaice, and that the Vienna house has been given up, as a contribution to the policy of the directors in bringing about an equilibrium in the finances of the company.

**PERTH ELECTRIC TRAMWAYS (LTD.)**—This company are offering £150,000 5 per cent. first mortgage debenture stock at 97½ per cent. The stock is redeemable by means of a sinking fund calculated by annual drawings at 107½ per cent. to last for 30 years.

**PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BUENOS AYRES (LTD.)**—The scrip, or allotment letters with bankers' receipts attached, of the 4 per cent. first debentures of this company can be exchanged for definitive bonds at the London offices, Basildon House, Moorgate-street, E.C.

**STOCK EXCHANGE NOTICES.**—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the £1 shares of the *Sir Hiram Maxim Electrical and Engineering Co. (Ltd.)* and 30,000 5 per cent. cumulative preference and 30,000 ordinary shares of £5 each of the *Urban Electric Supply Co. (Ltd.)*, and also to allow the further issues of 37,926 £10 ordinary fully-paid shares and 10,000 £10 fully-paid 6 per cent. cumulative preference shares of the *British Electric Traction Co. (Ltd.)*, 15,731 £2 fully-paid ordinary shares and 60,000 £2 fully-paid 6 per cent. cumulative preference shares of the *Brush Electrical Engineering Co. (Ltd.)*, and £95,000 4½ per cent. debenture stock of the *Potteries Electric Traction Co. (Ltd.)* to be quoted in the official list.

**THE PARSONS TURBINE IN GERMANY.**—A company, entitled the Turbinia Deutsche Parsons-Marine Aktien Gesellschaft, has been formed at Berlin. Messrs. Brown, Boveri & Co. are largely interested in the new company, which has been formed to construct vessels equipped with steam turbines on the Parsons system and for dealing in turbines generally. The board includes Messrs. W. Boveri and C. E. L. Brown, F. Barker (Parsons' Foreign Patent Co.), and C. J. Leyland (Parsons' Marine Steam Turbine Co.).

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Sept. 28 | 850 | + 49 | 17 | 14,775 | + 1,563 |
| *Birmingham Tramways. | ,, 28 | 5,305 | + 404 | 12 | 58,379 | + 4,233 |
| *Blackburn Corporation.. | ,, 27 | 582 | + 126 | 39 | 19,565 | + 2,010 |
| Blackpool Corporation... | ,, 26 | 1,543 | + 509 | †26 | 32,599 | + 8,127 |
| Blackpool and Fleetwood | ,, 28 | 923 | + 155 | 13 | 17,877 | + 214 |
| Bolton Corporation ..... | ,, 29 | 1,568 | + 280 | 26 | 40,138 | + 4,529 |
| Bradford Corporation... | ,, 29 | 1,358 | + 786 | 26 | 29,117 | +15,627 |
| Brisbane Trams ..... | Aug. 14 | 1,932 | - 432 | 33 | 67,291 | + 8,068 |
| *Bristol Trams & Carriage | Sept. 27 | 4,123 | + 720 | 12 | 49,705 | + 6,655 |
| *Buenos Ayres & Belgrano | ,, 1 | 2,709 | + 624 | 9 | 23,481 | + 4,335 |
| Calcutta Trams. Co. ... | ,, 28 | R21,015 | +R 231 | 13 | R167,026 | +R14,690 |
| Carlisle Trams. Co. ..... | ,, 28 | 192 | + 3 | 13 | 2,735 | + 85 |
| Central London Railway | ,, 28 | 5,902 | + 694 | 13 | 73,993 | ... |
| City & South London Ry. | ,, 29 | 1,938 | + 364 | 13 | 24,207 | + 4,587 |
| Cork Elec. Trams ..... | ,, 26 | 488 | + 44 | 38 | 18,338 | + 2,171 |
| Dover Corporation ..... | ,, 28 | 268 | + 13 | 26 | 6,671 | + 306 |
| Dublin & Lucan Rly. ... | ,, 29 | 101 | + 6 | 13 | 1,789 | + 257 |
| Dublin United ..... | ,, 27 | 3,529 | - 150 | ‡13 | 51,221 | + 1,125 |
| Dublin Southern Dist.... | ,, 27 | 803 | - 51 | ‡13 | 14,449 | |
| *Dundee Corporation ... | ,, 25 | 693 | + 204 | 13 | 9,231 | + 3,056 |
| *Glasgow Corporation ... | ,, 28 | 14,278 | +4,530 | 16 | 200,212 | +49,513 |
| Halifax Corporation..... | ¶ ,, 29 | 2,307 | + 655 | 24 | 30,843 | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation..... | ,, 28 | 1,702 | + 425 | 13 | 22,439 | + 5,205 |
| Liverpool Corporation... | ,, 21 | 9,576 | - 260 | 38 | 339,900 | +42,646 |
| *Liverpool Overhead Rly. | ,, 29 | 1,589 | - 96 | 13 | 22,120 | - 560 |
| *Manchester Corporation | ,, 28 | 2,291 | ... | §16 | 32,354 | + 163 |
| Perth (W.A.) Elec. Trams | ,, 27 | 800 | + 407 | ‡13 | 11,173 | + 6,346 |
| Portsmouth Corporation | ,, 28 | 1,284 | + 389 | ... | ... | ... |
| *Sheffield Corporation ... | ,, 29 | 3,862 | +1,348 | 13 | 49,268 | +15,555 |
| Southampton Corporat'n | ,, 25 | 969 | + 234 | 13 | 13,041 | + 3,845 |
| Southend Corporation... | ,, 28 | 290 | ... | 10 | 3,302 | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Fortnight.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 25. | Price Wednesday, Oct. 2. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 2. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅝ ⅝ | ⅝ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 39/4½ | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) xd | 97 102 | 95 100 | ... | ... | 100 | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 13 | 12 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ 10½ | 9½ 10½ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 6 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ 8½ | 7⅞ 8¼ | 4 4 10 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¼ 8¾ | 8¼ 8½ | 4 0 0 | March and September | 8½ | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅛ 8 | 7⅛ 8 | 2 3 9 | ... | 8⅛ | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 5 0 | February and August | 9⅜ | 9½ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ 5½ | 5¼ 5½ | 3 18 3 | ,, ,, | ... | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 103 105 | 104 106 | 3 16 4½ | ... | 105½ | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 5¼ 5⅜ | 5¼ 5⅜ | 4 15 8 | March | 5¼ | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 1 4 | June and December | ... | ... |
| 70,579 | 10 | ... | City of London Electric Lighting Ord. | 8 9 | 8½ 9½ | ... | February and August | 8⅜ | 8 1/16 |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11½ 12½ | 11½ 12½ | 4 16 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 121 124 | 122 127 | 3 19 6 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 103 | 101 104 | 4 8 4 | ... | 102 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 9 | 8½ 9½ | 4 4 3 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 13 | 12 13 | 4 12 4 | March and September | ... | ... |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 103 106 | 104 107 | 4 5 4 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5½ 5¾ | 5⅝ 5¾ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7½ 8½ | 7½ 8½ | 2 10 0 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 12 | 11 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ 7 | 6½ 7 | 4 5 9 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 104 | 101 104 | 3 17 6 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Kngtbg. Co. & Notting Hill Co. (J't. St'n.) 4% xd | 103 105 | 101 104 | 3 16 11 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ 1⅝ | 1½ 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | ... | Do. 6 per Cent. Preference | 4 5 | 4 5 | ... | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 100 | 96 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 98,767 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 14 | 13 14 | 4 5 9 | April and October | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 115 | 112 115 | 3 18 8 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 100 | 97 100 | 3 10 3 | ... | 98½ | 97½ |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15½ 16½ | 15⅞ 16⅞ | 4 4 10 | March | 16⅛ | 15⅝ |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5¾ 6¼ | 5¾ 6¼ | 3 16 11 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 102 | 99 102 | 3 19 0 | ... | ... | ... |
| 300,000 | 1 | ... | Rand Electric | 1 7/16 1 9/16 | ⅞ ⅞ | ... | ... | ... | ... |
| £135,000 | Stock | ... | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 60 70 | 60 70 | ... | January and July | ... | ... |
| £107,800 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs. xd | 102 104 | 100 102 | 4 8 3 | April and October | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 16 | 15 16 | 4 10 8 | February and August | 15⅝ | 15 7/16 |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 100 | 97 100 | 3 10 6 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 9 8 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2 3 | 2 3 | ... | ... | ... | ... |
| 109,518 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 13 | 11½ 12½ | 4 4 0 | March and September | 12½ | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) xd | 4⅛ 4⅜ | 4 4½ | 4 14 1 | April and October | 4 1/16 | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 125 128 | 125 123 | 4 14 10 | ... | ... | ... |
| 20,000 | 10 | ... | Barcelona Tramways Ordinary | 8 9 | 8 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 96 101 | 96 101 | 4 19 9 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 6 | ... | ... | ... |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 13 14 | 13 14 | 4 12 10 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams, Investment Ord. | 2 3 | 2¼ 2¾ | ... | ... | 2⅜ | 2¼ |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ 5 | 4⅝ 5 | ... | ... | 4⅜ | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 103 105 | 103 105 | 4 6 7 | ... | 103½ | ... |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary | 21½ 22½ | 21½ 22½ | 3 13 4 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ 10⅝ | 10⅜ 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 115 | 112 115 | 3 10 2 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 6½ | 6 6½ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9½ 9¾ | 9½ 9¾ | 5 2 7 | May and November | ... | ... |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 101% 103% | 101% 103% | 4 9 1 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 14 15 | 14 15 | 6 0 0 | ... | 14⅜ | 14½ |
| 90,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11¾ 12½ | 11¾ 12½ | 4 18 0 | February and August | 12½ | 12 1/16 |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures xd | 123 124 | 121 124 | 4 0 8 | ... | 123 | 121½ |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅝ 2 | 1⅝ 2⅛ | ... | ... | 1 15/16 | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. xd | 5½ 5¾ | 5½ 5¾ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 3/0 | Do. "B" (ex 3/0 on a/c of arrears) | 5½ 5¾ | 5½ 5¾ | 2 3 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 107 | 104 107 | 4 14 7 | ... | 104½ | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 98 101 | 98 101 | 5 0 2 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11½ 12½ | 11½ 12½ | 2 8 0 | ... | ... | ... |
| £350,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 105 107 | 105 108 | 4 4 6 | ... | 106½ | ... |
| 400,000 | 1 | 1½% | Cape Electric Tramways Shares | 1⅞ 2⅛ | 1⅞ 2⅛ | 2 16 6 | ... | 2 | ... |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock | 102 105 | 101 104 | 3 2 6 | June and December | 103 | 102⅝ |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 105 108 | 104 107 | 3 15 2 | ... | ... | ... |
| £440,100 | Stock | ... | Do. Deferred Stock | 98 101 | 98 101 | ... | ... | ... | ... |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 118 | 113 118 | 3 8 3 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams, Co. 5% Cum. Pref. | 5¼ 5½ | 5¼ 5½ | 4 6 11 | ... | 5⅝ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 103 105 | 103 106 | 3 16 11 | ... | ... | ... |
| £855,000 | Stock | 1¾% | City and South London Railway Con. Ordinary | 51 54 | 51 54 | 2 15 7 | February and August | 53 | 51 |
| 47,500 | 10 | 2/0·84 | Do. Ordinary (Nos. 22,501 to 70,000) xd | 5 5½ | 5 5½ | 3 15 9 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 134 | 129 134 | 3 15 2 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 123 127 | 123 127 | 3 19 2 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 118 | 113 118 | 3 8 6 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 12 13 | 12 13 | 3 16 11 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 14½ 15½ | 15 16 | 3 15 0 | ... | 15 13/16 | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) xd | 97 100 | 97 100 | 3 10 0 | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ 5 | 4½ 5 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ 22½ | 21½ 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ 15 | 14½ 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 113 | 111 113 | 4 0 6 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 6¾ 7 | 6¾ 7 | 3 13 7 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference xd | 12¾ 13 | 13 13⅛ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 104 | 103 104 | 3 17 8 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 107 | 105 107 | 3 15 6 | ... | 106½ | 10 1/2 |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 114 | 110 114 | 4 8 6 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 100 102 | 100 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 100 102 | 100 102 | 4 8 11 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 3 3½ | 2½ 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ 5 | 4 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11½ 12½ | 11½ 12½ | 1 12 0 | ... | ... | ... |
| 10,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9½ 10½ | 9½ 10½ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 106 109 | 106 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 91 94 | 91 94 | 3 3 10 | June and December | ... | ... |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Sept. 25. | Price Wednesday, Oct. 2. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 2. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 19 0 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ 4⅛ | 3⅜ 4⅛ | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | ... | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 56 | 53 56 | 5 11 9 | Feb., May, Aug., Nov. | 54 | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 100 | 98 100 | 6 1 3 | ,, ,, | 99½ | 98½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10½ 10⅝ | 10⅛ 11 | 2 5 6 | ,, ,, | 10 1/8 | 10⅛ |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock xd | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock xd | 101 103 | 100 102 | 3 18 5 | ,, ,, | 102 | 101 |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 6 | 5 6 | 7 10 0 | February and August | 5 | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 13½ 14½ | 13½ 14½ | 6 17 11 | ,, ,, | ... | ... |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary xd | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference xd | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ 104⅞ | 100⅞ 104⅞ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10½ 11⅛ | 10⅜ 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | ... | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. ) | 100 103 | 100 103 | 4 8 4 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Eastern Ordinary [to 1,200) (red.) | 142 147 | 141 146 | 4 15 11 | Jan., Apr., July, Oct. | 144 | 142 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 96 99 | 93 99 | 3 11 0 | ,, ,, | ... | ... |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 116 | 113 116 | 3 10 0 | May and November | 115½ | 114 |
| 300,000 | 10 | 2/6 | Eastern Extension | 14 14½ | 14 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14½ | 14½ |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 114 119 | 114 119 | 3 7 6 | February and August | 114½ | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 103 | 100 103 | 3 18 1 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101% 104% | 101% 104% | 3 18 3 | May and November | ... | ... |
| 159,000 | 10 | 5/0 | Great Northern of Copenhagen | 30 32 | 30 32 | 4 13 9 | January and July | ... | ... |
| 78,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos | 100 103 | 100 103 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red.) | 41 45 | 41 45 | 5 11 1 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 102 105 | 102 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 5 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 99 102 | 99 102 | 4 17 10 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 100 103 | 3 18 5 | January and July | ... | ... |
| 88,321 | 10 | ... | West India and Panama | ½ ¾ | ½ ¾ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 6 | 5 6 | ... | ,, ,, | ... | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 17 4 | January and July | ... | ... |
| 20,930 | 10 | 3/0 | Western Telegraph (late Brazil'n Submarine) | 14½ 14¾ | 14½ 14¾ | 4 14 11 | Mar., June, Oct., Dec. | 14⅛ | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 106 | 103 1 6 | 4 15 6 | June and December | ... | ... |
| £348,777 | Stock | 4% | * Do. 4 per Cent. Deb. Stock (red.) | 103 103 | 103 106 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 5 0 | Chili Telephone (fully paid) | 3½ 4 | 3½ 4 | 6 5 0 | August | ... | ... |
| 224,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | 2/6 | 2/0 2/6 | 6 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¼ ⅜ | ¼ ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3⅜ 4⅛ | 3⅜ 4⅛ | 6 1 3 | February and August | 4⅛ | 3 1/8 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | 12 | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ 5 | 4¾ 5 | 5 0 0 | ,, ,, | 4⅞ | 4 7/8 |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 98 | 90 90 | 3 11 5 | June and December | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 6 | ... | 96½ | 95 |
| 171,504 | 1 | 0/8½ | Oriental | ⅞ 1 | ⅞ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5⅛ | 5 5⅛ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ 5⅛ | 4¾ 5⅛ | 4 15 3 | June and December | ... | ... |
| £ 79,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 16 5 | June and December | 103½ | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 1/16 1/8 | 1/16 1/8 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ ½ | ⅜ ½ | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 8 9 | 8 9 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ 5¾ | 5½ 5¾ | 5 4 4 | January and July | 5½ | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ 5¼ | 4¾ 5¼ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ 1⅝ | 1⅜ 1⅝ | 5 14 3 | September | 1⅝ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 2¼ | 2 2¼ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 102 105 | 102 105 | 4 5 9 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 9 1 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 16 | 15 16 | 4 13 9 | ,, ,, | 15½ | 15½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ 6¼ | 5⅜ 6¼ | 4 0 0 | ,, ,, | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 114 | 110 114 | 3 19 6 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 95 | 92 95 | 4 15 6 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary xd | ¾ 1 | ¾ 1 | 8 0 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference xd | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2 8½ | Crompton and Co. (Nos. 1 to 54,000) | 3⅜ 3¾ | 3⅜ 3¾ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 105 | 100 105 | 4 15 8 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ¼ ½ | ¼ ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1⅜ 2⅜ | 1⅜ 2⅜ | | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 85 | 4 15 3 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) xd | 85 90 | 84 89 | 5 12 4 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5⅜ 6¼ | 5¼ 6¼ | 5 12 0 | Half-yearly | 6 | ... |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5⅜ 6 | 5⅜ 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 104 107 | 105 103 | 4 4 6 | ... | 10 3/4 | ... |
| 112,100 | 2 | 1/3½ | Electric Construction Co. | 1⅜ 2⅛ | 1⅜ 2⅛ | 5 6 8 | January and July | ... | ... |
| 31,390 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅜ 2⅝ | 2⅜ 2⅝ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 102 | 98 102 | 3 18 10 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅜ 10⅛ | 9⅜ 10⅛ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 4% | Do. 4% 1st Mortgage Debentures xd | 99 102 | 97 100 | 4 0 0 | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary | 16½ 17½ | 16½ 17½ | 6 11 5 | February and August | 17½ | 17 |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅜ 6 | 5⅜ 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 110 114 | 110 114 | 3 19 3 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 22 23 | 22 23 | 4 6 11 | ,, ,, | 22 1/16 | 22½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) xd | 100 103 | 100 103 | 3 17 7 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 38 42 | 38 42 | 5 0 0 | March and July | 38½ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 106 | 104 1 6 | 3 16 2 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ 11⅛ | 10⅜ 11⅛ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ 6⅛ | 5⅜ 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | 10⅜ | 1⅛ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | 7 | ... |
| £ 00,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 7 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 6 | 5 6 | 5 0 0 | ... | ... | ... |
| 180,227 | 10 | 4 6 | Globe Telegraph and Trust | 11 11½ | 11 11½ | 4 11 4 | Jan., Apr., July, Oct. | 11½ | 11½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ 15½ | 14½ 15½ | 3 18 8 | ,, ,, | 15½ | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 127 132 | 127 132 | 4 12 6 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,221. [No. 25. Vol. XLVII.] FRIDAY, OCTOBER 11, 1901. PRICE SIXPENCE (by post, 6d.). Abroad, 8d., or 15 cents. or 80c., or 70pf


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## NOTES.

THE supplement which Mr. A. G. HANSARD contributes to our issue this week will, we are sure, receive a cordial welcome from electric tramway engineers in this country and abroad. It supplies them with a comprehensive series of simple curves or diagrams, by means of which accurate estimating of traction power quantities can be effected without calculation. Without such aid the engineer must choose between a rough-and-ready approximation as to the power to be allowed for each car, and a series of elaborate calculations that must occupy considerable time. There is nothing of rough approximation in Mr. HANSARD'S diagram; within the limits of practical requirements, the results obtainable are as accurate and useful as those obtained by direct calculation. By adopting the logarithmic system of division and scaling, Mr. HANSARD has secured an uniform percentage accuracy throughout the range of the curves, and has also given the curves the simple and convenient shape of straight lines. For further particulars as to the use of these curves we refer our readers to Mr. HANSARD'S article on page 937.

FROM London to Brighton has long been an exceptionally favourable route for a direct high-speed railway, and in recent years there have been several schemes set on foot; but nothing has yet advanced to a definite Parliamentary stage. During the past few days the public has been startled by the announcement of a project to construct an electric railway capable of covering the distance of 47 miles in 32 minutes, or an average speed of about 90 miles an hour. The engineer to this scheme is Mr. F. H. CHEESEWRIGHT, and we understand that it is intended to apply for Parliamentary powers next month. There are to be no intermediate stations; the route is to be as straight as possible, with tunnels in preference to long gradients or curved diversions; and, it is said, the monorail system will not be adopted. Of the desirability for an electric express railway between London and Brighton there can be no question; but, until the details are published, it is impossible to decide whether Mr. CHEESEWRIGHT'S project meets the case. It is said that the L. B. and S. C. Railway intend to fight if the project is taken to Parliament; they might find it advantageous to initiate a similar scheme of their own, for such an express service as that promised would relieve them of a burden which has long been too heavy for them to bear on their existing lines.

EVERY storm such as that of last Sunday does damage to numbers of land-lines and causes congestion of the telegraphic and telephonic traffic all over the country, and it is evident that the Post Office will have to give more serious attention than heretofore to the laying of long underground lines. The so-called experimental underground line from London to Birmingham was unnecessary to demonstrate the feasibility of a long-distance underground connection for telegraphic purposes; nor was it necessary to spend years over the laying of a trial line in order to determine the question of cost—a very good estimate could have been made beforehand with existing data. The telegraph department has now, however, no longer any excuse for delay, and should make up its mind with energy and determination to lose no more time in laying cables to assist the existing land-lines on the most important telegraphic routes.

IN the case of long-distance telephone lines a technical difficulty is, of course, introduced, owing to the fact that the electrostatic capacity of the wires in an underground cable is greater than that of the corresponding wires erected on poles. Any practical suggestion, therefore, for an improvement in the design of telephone cables is welcome. Mr. J. H. WEST, in an article which we print in another column of this issue, takes up the question of "cross-talk" in the case of a telephone cable laid up in fours and discusses how it might possibly be obviated. At the outset, however, we must disagree with

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Mr. WEST as to the advantages of this cable over the paired cable as regards capacity. Taking the capacity between each pair of wires, irrespectively of the remainder, that of the two diagonal wires would theoretically be the smaller, as the paired wires are closer together; but in considering the capacity of a wire we must assume as the second plate of the condenser not only the other wire of the loop, but also all the other wires in the cable and its lead sheathing. Then in practice it is found that the capacity of the cable for the same number and size of conductors and thickness of insulation is slightly greater instead of slightly less for a cable laid up in fours than a cable laid up in pairs. The cost of the former, however, being less, Mr. WEST's investigation has still an object.

COMING now to the question of cause and remedy. The cause of the cross-talk as Mr. WEST explains with great clearness in his diagrams, is the want of symmetry of the wires, and this is occasioned by an incident in manufacture—viz., that some of the bobbins on the stranding machine have a tighter strain on them than others. This might be overcome in a measure by mounting the bobbins so that they rotate very easily, and then applying to each an accurately graded brake. But even then the strain on the wires would be continually varying, for it is essential in the case of dry-core cable that it be loosely stranded, and the least chance will, therefore, cause this variation. For the same reason the three methods of reversing the wires suggested by Mr. WEST could hardly be relied upon sufficiently to eliminate the fault which is inherent in cable laid up in fours, and hence we come back to the former position of telephone cable makers and users, which Mr. WEST's investigation is useful in strengthening—namely, that the saving in using this class of cable instead of paired cable is not worth the extra precautions and risks of failure.

THE fall in value of calcium carbide consequent upon over-production in Europe and America, has caused those interested in electro-metallurgical works to give their attention to the possibilities offered by the manufacture of other electric furnace products. In various localities in France, Switzerland and the States, plants intended for carbide manufacture are now being utilised for the production of several alloys of the ferro-chrome type, and this new field of usefulness for the electric furnace promises to be highly remunerative to those who first enter it. Carbide works have, however, been erected in such numbers and can be so easily adapted to the smelting of refractory ores, that it is to be feared the over-production which has caused the slump in carbide values will soon become characteristic of these new industries. For the moment, however, the production of ferro-chrome, ferro-silicon, and ferro-titanium is not overdone, and the works which manufacture these alloys are few in number.

THE issue of the *Electrical Review* of New York for September 7th contains some interesting details relating to the manufacture of ferro-chrome at Great Kanawha Falls, 36 miles above Charleston, W. Va. At this spot a natural fall, 26ft. in height exists, and by the erection of a dam and canal 8,000 H.P. has been rendered available for industrial purposes. The Wilson Aluminium Co. have installed generating machinery equal to 8,000 H.P. at this place, and this power is now being used to manufacture ferro-chrome of high purity. The chrome ore used in the electric furnaces is imported from Australia and Asia Minor, and an alloy containing up to 70 per cent. chromium is produced. The entire output of the plant at present is sold under contract to the Carnegie and Bethlehem Steel Companies, and is used for hardening the armour plates now being made by these two companies for the United States Navy.

APART altogether from motor car questions, the efforts of motor car engineers to devise a simple and effective spirit engine has its interest for electrical engineers, who are constantly feeling the need for a cheap and compact engine for driving small dynamos in out-of-the-way circumstances. The *Engineer* discusses the suitability of methylated spirit for this class of engine. It seems there are several advantages in this form of alcohol over petroleum spirit, not the least being the less stringent regulations for storing it, owing to the smaller risk of explosion. In an internal combustion engine, alcohol explodes more gradually than benzene or low-flash petroleum spirit does, thus producing an indicator diagram showing more favourably as regards freedom from vibration and shock. On the other hand, the delayed combustion does not point to an improvement in the efficiency. Users of small motive power for sundry electrical purposes might well consider the merits of methylated spirit as a fuel for internal combustion engines.

IN an article on the annual conversazione of the American Institute of Electrical Engineers which appeared in our issue of May 3rd last, we gave a short description of the Cooper-Hewitt vapour lamp. This lamp attracted a great deal of attention at the conversazione, and through the courtesy of the *Electrical World* of New York we are enabled to give a more complete account of it. There seems no doubt that this type of lamp has a marvellous efficiency—the example exhibited at the conversazione had an efficiency represented by only 0·32 watt per candle—but the difficulties in manufacturing a practical lamp would appear to be enormous, and we do not gather that they have so far been successfully overcome. It is to be noted that the current through the lamp, as patented, would depend on the temperature of the room, but we have no particulars as to how this current would vary with changes of temperature, and until these particulars are obtainable it will be impossible to say whether a practical vapour lamp has been invented.

THERE is a decided tone of panic in the article we reprint this week from the editorial columns of the leading gas journal. Our esteemed contemporary, reflecting on past years of contest with electric lighting, feels that the time has come when it should ask itself "how the case stands" at the present time. It discovers at once "a grave situation." "Gas investments," it lamentably admits, "are not held in the estimation they should command, primarily because electric lighting has made inroads upon the preserves of some big undertakings. On the other hand, gas has not yet in a single

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instance definitely stopped the career of an electric light undertaking." War to the knife is called for—"let but a single electric lighting company be killed" and, as if by magic, "the gloomy finance that threatens" will "brighten up." Our contemporary advocates, indeed, desperate measures: "the only way, at present, to carry the war into the enemy's camp," it declares, is for gas companies to undertake public lighting "at cost price." Great must be its faith if it believes that gas companies will be induced to do anything of the sort. What inducement is there to shareholders to lock up capital in gasworks philanthropically supplying the public with street lighting without profit? Better far that they should invest in "electric lights."

**Electricity Meters.**—The Long-Schattner prepayment electricity meter has been officially approved by the Board of Trade. This is the first prepayment meter which has obtained such official approval.

**Opening of the Vizzola Electricity Works.**—The electricity works at Vizzola, near Callarate, Italy, about which so much has been written lately, were formally opened by the King and Queen of Italy on Wednesday.

**Incandescent Gas Mantles.**—The *Journal of Gas Lighting*, referring to the fragility of incandescent gas mantles, says "they can never be made strong enough to endure the tender mercies of the average domestic servant."

**Electric Tramways in Berlin.**—The German Emperor has objected to one of the electric tramway lines proposed by the municipality of Berlin. This line was to have crossed the thoroughfare Unter den Linden, and it was to this that the Emperor took exception. If the Unter den Linden had to be crossed he suggested that a tunnel and lifts should be employed.

**Explosion on Ludgate Hill.**—On Wednesday night an explosion occurred in one of the surface boxes on Ludgate-hill (London) belonging to the Post Office telegraph service. The explosion was evidently due to an accumulation of gas in the pipes or surface box, and was probably ignited by a jointer's lamp, as two men were executing repairs in the box at the time. The two men were badly burnt, their clothes having caught fire.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 ... | — |
| Pará—Maranham | Mar. 2, 1900 ... | — |
| Cadiz—Teneriffe | Aug. 6, 1901 ... | Oct. 9, 1901 |
| Bolama—Bissao | Aug. 16, 1901 ... | — |
| Curaçoa—Vela de Coro | Sept. 11, 1901 ... | Oct. 4, 1901 |
| Bolama | Sept. 12, 1901 ... | — |
| Gibraltar—Tangiers | Sept. 13, 1901 ... | Oct. 5, 1901 |
| Zanzibar—Mombasa | Sept. 27, 1901 ... | — |

**The Use of 200-volt Incandescent Lamps in the United States.**—In an editorial note on this subject the *Electrical World* of New York writes as follows:—

> There can be no question of the advantage and economy of using the higher pressure lamp (200 volt) in new direct-current three-wire systems, with overhead transmission wires, supplying a scattered suburban area. In large cities, however, in which direct-current three-wire systems of 120 volts pressure on a side have come into long established use, the cost of changing lamps, fixtures and apparatus from 120 to 240 volts is so considerable, that it is doubtful if the high-pressure lamp can gain entrance.

**Cape-Australian Cable.**—As already announced, the c.s. "Anglia" has accomplished her task of laying the Rodrigues section of the Cape-Australian cable. The c.s. "Scotia" has also completed her work to Cocos, and is now engaged in laying the cable from Cocos to Fremantle (Perth), which work is expected to be completed about the end of the current month. The "Anglia" is now on her way home, and will befollowed by the "Scotia," to ship and lay the cable from Fremantle to Adelaide, and so complete this important work.

**New York Underground Rapid Transit Co.**—A large contract for electric railway power plant has just been awarded by the New York Underground Rapid Transit Co. to the Westinghouse Electric and Manufacturing Co. The plant will comprise six alternators of 5,000kw. capacity each, three exciters of 250kw. each, 26 rotary converters of 1,500kw. each and 78 transformers each of 550kw. capacity. At the present time the work of building the tunnels is in progress. There will be in all some 21 miles of track and 48 stations. The lines will be operated by direct-current, fed to the train motors by a third rail.

**Battery Car Sickness.**—The Paris correspondent of the *Daily Mail* states that on Tuesday last, while about a dozen passengers in an electric tramcar were nearing the Hôtel de Ville, Vincennes, they were seized with pains in the stomach, fainting fits, and spitting of blood. When the alarming symptoms manifested themselves the tramcar was stopped and the unfortunate passengers were treated at a chemist's shop. One little girl, five years of age, remained more than an hour unconscious. The indisposition of the travellers is said to have been due to the action of poisonous fumes arising from the accumulators.

**The Export of Electrical Apparatus from New York.**—We see from *Electricity*, of New York, that the Treasury department has instructed the collector of customs at New York to allow, on the exportation of certain electrical apparatus, such as generators, motors, alternators, commutators, armatures and rheostats, in the manufacture of which no other than imported unmanufactured or rough-trimmed mica has been used for insulating purposes; also on the exportation of mica manufactured into sheets, plates or other forms, wholly from the same description of imported mica, for use in foreign countries as electrical supplies, a rebate equal in amount to the duty paid on such imported material used, less the legal deduction of 1 per cent.

**Paris Exhibition Literature.**—The eighth part issued of MM. Hospitalier and Montpellier's "L'Electricité à l'Exposition de 1900" (Vve. Ch. Dunod, Paris), is on "Canalisation et Appareillage," and is from the pen of M. Hospitalier. Only 12 pages are devoted to conductors, insulators, cables and their accessories, but the "appareillage" is more fully dealt with, descriptions and illustrations being given of typical switches, cutouts, &c. Some of these are of especial interest for the fact that they have preserved their original form although designed years ago, while on the other hand others, whatever else may be said against them, have the redeeming feature of novelty. Several new and serviceable pieces of apparatus are described, however, and taken as a whole the present number of this valuable publication falls little short of the high standard of excellence attained by some of its predecessors.

**The Boston Elevated Railway.**—Mr. Louis Bell, in a recent number of the *Electrical Review* of New York, writes a critical article on the *raison d'être* of the elevated railway at Boston. After praising the line as an engineering success, the author mentions that it has very little real value as an addition to the general transit facilities of Boston. The structure is singularly resonant, so that the noise of the trains is very much in evidence. In the author's judgment the Boston line is quite the noisest of its kind, far more troublesome in this respect than the New York "L" with its locomotives. How far this resonance is due to the design of the structure and how far to the high speed, quick acceleration, and multiplicity of driving wheels could hardly be told without an experimental study of the case. There has been much complaint of injury and annoyance from minute particles of steel detached from the third rail and dropped into the street below. It is only necessary to look at the contact shoes, when the trains are under way, in order fully to realise the cause of the trouble and its probable serious magnitude.

**"Rapid Transit" in London.**—At the recent meeting of the County Council, the chairman made the following remarks on the transportation facilities of London:—

> The Highways committee had vast schemes in progress and under consideration. It aimed at revolution; it would not rest content until every district in London was properly served with tramways. It was convinced that horse traction was doomed, that electricity must be the future power, and that the conduit system must be adopted. He would give one illustration, of a personal character, showing how the individual was served who



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wished to travel in London. To return last Saturday week from the ceremony of opening the new electric generating station at Lombard-road, Battersea, the following appeared to be the quickest route—a car from the station a certain distance, another to Chelsea Bridge, an omnibus to Victoria Station, train to Mansion House, omnibus to Broad-street, train to Mildmay Park, and then car to Highbury, or seven conveyances to go about 9 miles. The working men of London were handicapped by such a monstrous want of system more severely than in any other city. Surely that state of things needed alteration.

Monstrous, indeed; but no one has helped to perpetuate it more than the London County Council, whose opposition to electric traction in the past has placed London in the very rear of progress in such matters.

**Electrical Equipment of Railway Workshops.**—A recent number of the *Western Electrician* describes the electrical equipment of the Burlington railway shops, at Hannibal, Mo. In the machine shop 40 tools are driven by 29 motors, aggregating 172 H.P., the greatest number of machines being driven by one motor being three. The boiler shop has eight machines, operated by seven motors, with a total of about 100 H.P. With a total rated capacity of 696 H.P. in motors connected, which includes all of the machine tools (582 H.P.), a transfer table (50 H.P.), a travelling crane (44 H.P.), a turntable (4 H.P.), two elevators (15 H P.), and the small hot water service pump (1 H.P.)—that is, with the whole electrical equipment in service, excepting the 50 H.P. motor for the shavings exhaust, not yet installed, the 70 H.P. in motors for heating, and the lighting load, none of which has been required during working hours since the plant went into operation—the maximum switchboard load, which includes the motor and wiring losses, has not exceeded 200 H.P., or 29 per cent. of the connected load, although piecework is well established. With the motors, which have not yet been placed in service, and with the lighting the total connected load will be 941 H.P. (816 H.P. for the total of 76 motors), and the switchboard load about 400 H.P., or 42½ per cent.

**Post Office Telephone Appointments.** — Two important appointments have been made at the Post Office in connection with the telephone department. Mr. A. M. J. Ogilvie has been appointed head of the department, and Mr. G. F. Preston general manager. Mr. Ogilvie entered the Post Office service in 1881 as an upper division clerk, and rose to the rank of first-class clerk in the secretary's office. For several successive years he was one of the private secretaries to the Postmaster-General. He is Major in the 24th Middlesex (Post Office) Rifle Volunteers, and is one of the most popular men in the Post Office service. Mr. G. F. Preston comes from the National Telephone Co., having been for the last few years superintendent of their southern division. He has had 20 years' experience in telephone work both in the engineering and managerial departments. He started his career with the Metropolitan Brush Electric Lighting Co. in the early eighties, and soon after joined the London and Globe Telephone Co. He subsequently occupied positions with the United Telephone Co. and the Northern District Telephone Co., and became an official of the National Telephone Co. when the Northern District Company was absorbed by the latter concern. Mr. Preston is a Member of the Institution of Electrical Engineers. We wish him every success in his new capacity.

**Wireless Telegraphy.**—An important agreement has just been concluded between Marconi's International Marine Communication Co. (Ltd.) and Lloyd's, by which the latter agrees to employ no other system of wireless telegraphy than the Marconi system for the period of 14 years. The agreement also provides for the immediate equipment of 10 Lloyd's signalling stations, one of which is to be on the Fastnet Rock and two on the Red Sea coast, together with the taking over of some of the existing British stations, of which there are at present eight in number that could be rendered serviceable to Lloyd's for mercantile signalling.——We are also informed that the Marconi International Company has received an order to equip, by the 2nd prox., the liner "Savoie," belonging to the Compagnie Transatlantique. This vessel sails between Havre and New York, and is the first of the company's fleet to be equipped with wireless telegraph apparatus. On this liner, as on all the liners and land stations worked commercially by the Marconi companies, the charge for commercial messages between any ship and land or between ship and ship is 6d. per word. For communications to be transmitted over land lines, the land charges are, of course, additional. In the case of a message transmitted from an outgoing ship to an inward bound vessel, to be transmitted over land lines, the charge is 1s. per word plus the land charges.

**The Electrolysis of Fused Salts.**—In a recent issue of the *Zeitschrift für Elektrochemie*, Lorenz gives details of experiments carried out at the Zurich Polytechnic relating to the electrolysis of fused lead chloride. In a previous research it had been proved that the disagreement with Faraday's law observed in the yield of metal at the cathode, was due to the diffusion of a fine metallic cloud or mist through the fused electrolyte. This cloud passes gradually from the cathode to the anode, and when it reaches the latter the metal combines with the free chlorine to form the corresponding chloride. The union with chlorine occurs most readily at the surface of a carbon anode, and a fall in the E.M.F. of the cell results. The metallic cloud thus acts as a strong depolariser when it reaches the anode. Measurements of the chlorine liberated at the anode of a cell containing fused lead chloride have also been made, and have proved that a further loss of chlorine occurs in addition to that accounted for by the re-formation of lead chloride. This is due to absorption of chlorine gas by the carbon of the anode, and with new anodes it may amount to 25 per cent. of that theoretically liberated. As the anodes become saturated this loss gradually diminishes, and after a certain time the deficiency under this head falls to nil. The earlier and later investigations therefore prove, that the various polarisation values obtained at the anode and cathode during the electrolysis of fused salts are due to actual losses of material, and are not due to the formation of $PbCl_4$ or similar compounds. Further experiments are to be carried out, but those already completed have proved that 1·2 V. is the normal discharge potential of $PbCl_2$ at 600°C., and that only at this voltage is correspondence with Faraday's law obtained.

**Development of the Nernst Lamp in America.**—Under the above title Mr. A. J. Wurts read a Paper at the annual convention of the American Institute of Electrical Engineers at Buffalo. In the case of the Nernst lamp used in the United States the standard 220 volt glower is about 25mm. long and 0·63mm. diameter. The steadying resistance is made of iron wire, which is used on account of its high temperature correction. This wire is mounted in a small glass tube filled with an inert gas. Difficulty has been experienced owing to the porcelain disc above the heater becoming coated with a thin layer of platinum black. This decreases the illuminating power, and if not removed in time causes a current leakage. The best method, so far, of removing this difficulty has been found by coating the surface of the porcelain with a thin layer of white paste, which may be removed from time to time with a stiff brush. Should the platinum black be allowed to accumulate, all danger of leakage currents is avoided by surrounding the holes through which the lead wires pass by small annular rings or grooves, it having been discovered that the platinum black will not deposit in these small spaces; the continuity of the platinum black surface between the lead wires is thereby interrupted. A 220 volt glower operating at its normal current of 0·4 of an ampere requires 20 volts more in the open air than when burning with five other glowers in a 3in. globe. The efficiency of the 6-glower lamp with clear heater case, but without the dome shade, is 1·2 watts measured in the direction of greatest intensity. Tests taken with a 6-glower lamp show that the mean spherical candle-power in Hefner units was 149 with opal outer globe, the lamp taking 2·35 amperes at 220 volts. In the lower hemisphere the mean intensity was 240 candles, or with shade 279 candles. Seventeen 6-glower lamps have been running at East Pittsburg for more than a year, and are now showing an average life of 800 hours per glower. With 2·4 amperes and 220 volts an increase of 14 per cent. in voltage causes a 10 per cent. increase in current. It is probable that the 6-glower lamp will be sold at from 14 to 15 dollars.

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## TRAMWAY POWER CALCULATIONS.

[WITH SUPPLEMENT.]

BY ARNOLD G. HANSARD, B.A.

Although for very rough purposes it may sometimes suffice to allow, after roughly considering the conditions, a certain number of amperes per car in order to estimate the total power required by a tramway system, if accurate results are desired it is necessary to make a detailed calculation of the power required to move the car at the scheduled speed at different points on the route. As these calculations become rather laborious when frequently repeated the diagram which is issued as a supplement to *The Electrician* this week has been prepared to facilitate such work. Novelty is not, of course, claimed for this type of diagram, but it is believed that the particular form adopted, and especially the use of logarithmic scales in its preparation, will be found to render it exceptionally handy, covering, as it does, a large range without making the diagram cramped.

The diagram is, of course, equally available for determining the maximum output the motors must be specified to be able to provide, and for predicting the maximum speed that motors, whose characteristics are known, can be expected to attain on any portion of the track.

Given the gradient and the weight of the car, it is evident the H.P. required on the car axle is determined for each speed, except so far as it is affected by air friction and the friction of the track and of the axle journals. For the present purpose this has been taken as constant and together equal to 30lb. per ton weight of the car. This may be thought by some to be rather high, but in practice the condition of the rails, presence of curves, &c., will cause this figure to be sometimes exceeded, and the writer believes that the figure adopted will be found not far from the minimum that should be provided for in making calculations.

The diagram allows the following information to be obtained by inspection:—

1. Given the weight of the car and the gradient, the "drawbar pull" is shown.

2. Taking into account the speed, the brake horse-power required to drive the car may be found.

3. If the efficiency of the electrical equipment is known, the kilowatts to be supplied to the motors are shown, the column for which is also scaled in "Amperes at 500 volts."

The diagram is almost self-explanatory, but an example will make its use quite clear. The horizontal scale marked "Tons weight of car" gives the total loaded weight of the car. Suppose this to be 13 tons. The sloping lines on the right correspond to different gradients; they are drawn for gradients measured in the usual English way—viz., 1 in 500, 1 in 125, 1 in 50, &c.; but alongside these figures are also given the scale of gradients on the percentage system—viz., 0·2, to 0·8 per cent., &c. Suppose the gradient to be 1 in 125; follow up the vertical line from 13 tons till it cuts the sloping line corresponding to this gradient; on carrying the eye horizontally to the left from this point the column headed "Tractive effort in lbs." is reached between 600 and 650lb., showing that about 625lb. will be needed to move the car at a uniform speed on this gradient.

The sloping lines on the left-hand (upper part) correspond to different speeds. Say that 8 miles an hour is here required. Following along horizontally from the point on the tractive effort column just mentioned—viz., 625lb.—till the line marked 8 miles per hour is reached, on dropping down vertically the horizontal scale is met at a point about a quarter of the way between 13 and 14 B.H.P., so that, say, 13¼ B.H.P. is required.

The lower set of sloping lines correspond to different efficiencies of the electrical equipment, allowing for all losses in the motors, gearing, and rheostats. If this may be taken at 80 per cent., we find on following down from 13¼ B.H.P. to the 80 per cent. line, and then moving horizontally to the right, that the power taken from the line would be a little over 12kw., or a little less than 25 amperes at 500 volts.

It is often necessary to allow for accelerating a car on a gradient. In order to estimate the tractive effort and power for this it is only to be remembered that an acceleration of 1ft. per second per second requires about the same effort as an additional 3 per cent. gradient (more exactly 3·1 per cent.). Thus, if, in the example taken, an acceleration of 0·5ft. per second per second is wanted, we have only to add 1·5 per cent. to the 0·8 per cent. (which is the equivalent given of 1 in 125), making 2·3 per cent. in all; this is at once seen to be a line lying between the 1 in 40 and 1 in 45 lines, but nearer to the latter, making the tractive effort about 1,050lb., and taking about 23 B.H.P. at 8 miles per hour. In this connection it is convenient to remember that an acceleration of 1ft. per second per second produces a speed of 10 miles an hour in approximately a quarter of a minute.

It will be noted that, as all the scales are logarithmically divided, any errors in reading the result are proportional to the total, so that the same percentage accuracy is attainable throughout.

## ELECTROMAGNETIC THEORY.—CXXV.*

BY OLIVER HEAVISIDE.

*(Continued from page 606.)*

§ 496. The displacement components $D_h$ perpendicular to, and $D_z$ along the axis are found by

$$D_h = -\frac{dZ}{dz}, \qquad D_z = \frac{1}{h}\frac{d}{dh}Zh. \tag{76}$$

Applying these to (70) and (75), we obtain

$$D_h = \frac{Cl}{2\pi uh\sqrt{l^2-h^2}}, \qquad D_z = -\frac{C\cot\theta}{2\pi u\sqrt{l^2-h^2}}, \tag{77}$$

which apply inside the cone, and

$$\begin{aligned} D_h &= -\frac{C}{4\pi h}\left\{\frac{h^2t}{R^3} - \frac{z}{Ru} - \frac{l}{u\sqrt{l^2-h^2}}\right\}, \\ D_z &= -\frac{C}{4\pi h}\left\{\frac{hzt}{R^3} + \frac{h}{Ru} + \frac{h\cot\theta}{u\sqrt{l^2-h^2}}\right\}, \end{aligned} \tag{78}$$

inside the sphere. These are exhibited in a form admitting of a ready interpretation.

According to (77), and as previously seen, the displacement in the cone starts from the axis, to the amount $C/u$ per unit length, spreads uniformly all round, perpendicularly to the axis at first, and then turns round in hyperbolic curves, ultimately tending to parallelism with the conical wave front. This displacement, of total amount $C/u$ multiplied by the distance of the apex from the sphere, all reaches the sphere, and enters it.

Now the terms at the end of (78), containing $l$, are of the same nature as those in (77). Therefore this part of D in the sphere represents the continuation of the process just described, originating along the axis all the way from the right to the left side of the sphere, but weakened, as if the electrification density were $\frac{1}{2}C/u$.

Next, the middle terms in (78) represent displacement in semi-circles centred at O, the centre of the sphere. Consider a spherical shell of radius $R=(h^2+z^2)^{\frac{1}{2}}$ and of unit depth, centred at O. Then $\frac{1}{2}C/u$ of displacement starts from the pole of this shell on the axis on the right side, spreads out uniformly in the shell, follows the lines of longtitude all round, and terminates at the pole on the axis on the left side. (Both poles here are really unit lines). This distribution of displacement, combined with the former, makes the linear density of electrification be fully $C/u$ on the right side of O, and zero on the left side.

Finally, the terms containing $t$ in (78) represent a radial distribution of displacement such as is due to the charge of amount $-Ct$ situated at the origin, and $+Ct$ upon the surface of the sphere of radius $vt$. The charge at the origin is the necessary complement to the charge along the axis (real or fictive as the case may be). The apparent charge $+Ct$ on the sphere does not exist, for the displacement has no divergence there.

To examine the state of things on the spherical surface. The radial component of D, say $D_R$, anywhere in the sphere is

$$D_R = \frac{hD_h + zD_z}{R} = -\frac{C}{4\pi}\left\{\frac{t}{R^2} - \frac{1}{Ru}\frac{l - z\cot\theta}{\sqrt{l^2-h^2}}\right\}. \tag{79}$$

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Now, when $R = vt$, we have $l = l_2$, and

$$l^2 - h^2 = (Ru/v - z)^2 \tan^2\theta - h^2 = (R\tan\theta - z\sec\theta)^2$$

and $$l - z\cot\theta = \frac{R\tan\theta - z\sec\theta}{\sin\theta}.$$

So, taking the + value of the radical in both cases, we get $D_R = 0$ on the left side of the circle of contact with the cone, and

$$D_R = -\frac{Ct}{2\pi R^2} \qquad (80)$$

on the right side. This formula (80) also represents $D_R$ in the cone, according to (77), at $R = vt$, and completes the verification.

It should be noticed, because it is rather remarkable, that the displacement in the cone reaches the sphere everywhere at the proper angle to make the normal component the same. That is, the displacement enters the sphere equably all over that portion which is to the right of the circle of contact. Multiply (80) by the area $2\pi R^2(1 - v/u)$, and we get $Ct(1 - v/u)$, which is the charge upon the portion of the axis outside the sphere. The rest of the axial charge is joined to the charge at the origin by tubes of displacement entirely inside the sphere, of course.

Although the formulæ are necessary for precision, yet the general nature of things may be easily seen without them, guided by the radial displacement just round O, and the hyperbolic in the cone, and the fact that the wave front is the outermost sheet of displacement. The hyperbolic tubes of displacement, as soon as they enter the sphere, begin to be deflected towards the axis. They all converge to the centre ultimately, though the outer ones only do so by making a wide sweep round the other side of O.

Using the two potentials $A_0$ and $P_0$ in the sphere, defining $P_0$ by

$$P_0 = -\frac{Ct}{4\pi Rc} + \frac{v^2}{u}A_0 \qquad (81)$$

we may write the electric force thus

$$\mathbf{E} = -\dot{\mathbf{A}}_0 - \nabla P_0, \qquad (82)$$

as may be verified. Knowing already that curl $\mathbf{A}_0 = \mu\mathbf{H}_0$, the form of expression has become quite antiquarian, or at least classical. $P_0$ is the potential of the electrification within range of the point considered. Now the direction of $\mathbf{A}_0$ is that of the impressed current, which happens to be all the same way. Hence the appearance of $A_0$ in $P_0$, equation (81). In general, $P_0$ and $A_0$ have no simple connection.

§ 497. The passage from the above theory of a moving line of electrification to that of a moving point-charge is tolerably obvious. First, it is easy to construct the formulæ for a short piece of electrified line moving in its own line. For imagine at the moment $t = 0$ electric separation to begin at O, the negative electrification remaining there, whilst the positive is moved along the axis so as to constitute the linear current. The resulting **E** and **H** are completely known by the above. Next, at the moment $t = \tau$, stop the electric separation, without other change. Then we have a line charge of amount $C\tau$ moving in its own line at speed $u$, running away from a fixed charge $-C\tau$ at the origin. The results are also completely known, because the stoppage of the first supply is equivalent to the superposition upon the first supply (without stopping it) of a new supply, the negative of the first, only differing in starting at the moment $t = \tau$. So the results for **E** and **H** are, after the moment $t = \tau$, the same as before in a certain forward region, and behind it the results are the difference of two similar states of **E** and **H** which overlap. If $\tau$ is very small, we have two nearly coincident cones and spheres. In the region common to both is a differential state of affairs, though in the space between the cones is the original state, and at the rear the hinder part of the sphere shows the negative of the original state. The previous formulæ make the state of **E**, **H** and electric current intelligible everywhere.

Now shorten the interval $\tau$ to 0, and at the same time magnify $\sigma$ in proportion. In the limit we come to this problem. At the moment $t = 0$, a finite charge $\rho$ is projected from the origin at speed $u$, leaving behind the compensating charge $-\rho$. The solutions for **E** and **H** are obtained by differentiating the previous solutions for a line charge with respect to the time, with alteration of the constant factor.

Thus, in the sphere, if we put $\rho u = C$, so that C is the moment of the impressed electric current, we shall have

$$A_0 = \frac{\mu C\tan\theta}{4\pi(l^2 - h^2)^{\frac{1}{2}}}; \qquad (83)$$

or, expanding $l$,

$$A_0 = \frac{\mu C}{4\pi\{(ut - z)^2 + h^2(1 - u^2/v^2)\}^{\frac{1}{2}}}, \qquad (84)$$

and the corresponding magnetic force is

$$H_0 = \frac{-Ch\tan\theta}{4\pi(l^2 - h^2)^{\frac{1}{2}}}, \qquad (85)$$

or, expanded,

$$H_0 = \frac{C}{4\pi}\frac{(1 - u^2/v^2)h}{\{(ut - z)^2 + h^2(1 - u^2/v^2)\}^{\frac{1}{2}}}. \qquad (86)$$

Again, inside the cone, but outside the sphere,

$$A = \frac{\mu C\tan\theta}{2\pi(l^2 - h^2)^{\frac{1}{2}}}, \qquad H = \frac{-Ch\tan\theta}{2\pi(l^2 - h^2)^{\frac{1}{2}}}. \qquad (87)$$

These are entirely residual formulæ due to the near coincidence of similar opposite states. Thus (86) holds good only up to the inside of the spherical surface, $R = vt$, and (87) holds good from the axis up to the inside of the conical surface, and the outside of the sphere. The conical and spherical sheets require separate consideration.

The magnetic force is now negative in both the cone and the sphere (when the cone exists, that is to say) or in the contrary direction to the natural magnetic force of the impressed current under usual circumstances. Its intensity just outside the spherical shell is double that just inside. But this is no guide to the magnetic force of the shell itself. This shell is bounded by sheets of oppositely directed electric current. But the shell is really an electromagnetic pulse, consisting of tangential **E** and **H**, to be presently noticed. The conical surface is also the seat of a sheet of displacement and magnetic force, and their directions are unreversed, that is, **D** is from the apex of the cone, and **H** is as usual. But just underneath it **D** and **H** are reversed—viz., at the boundary of the internal conical region.

The complicated distribution of electric current in the previous line-problem is now replaced by a similar distribution of displacement, also obtained by time-differentiation. The results are

$$D_r = -\frac{\rho}{4\pi}\left\{\frac{h}{R^3} + \frac{h\tan\theta}{(l^2 - h^2)^{\frac{1}{2}}}\right\},$$
$$D_z = -\frac{\rho}{4\pi}\left\{\frac{z}{R^3} - \frac{l}{(l^2 - h^2)^{\frac{1}{2}}}\right\}, \qquad (88)$$

in the sphere. Similar to (59), (60), in fact.

Here the first part represents the radial displacement due to the charge $-\rho$ at the origin, but extending only as far as $R = vt$. The rest represents displacement directed towards the apex of the cone. Calling this part d, its components are

$$d_h = -\frac{d}{dh}\frac{\rho}{4\pi}\frac{\tan\theta}{(l^2 - h^2)^{\frac{1}{2}}}, \qquad d_z = \cot^2\theta\frac{d}{dz}\frac{\rho}{4\pi}\frac{\tan\theta}{(l^2 - h^2)^{\frac{1}{2}}}. \qquad (89)$$

This exhibits the displacement d in the sphere derived in eolotropic manner from the scalar potential used in previous investigations of steadily travelling states. This derivation (89) is valid whether $u <$ or $> v$. But should the cone be non-existent ($u < v$), then the moving charge $\rho$ is inside the sphere, and the displacement is in its natural direction, away from $\rho$. The complete displacement is then the sum of two radial distributions—one isotropic, centred at the fixed charge, the other eolotropic, centred at the moving charge. They do not cancel at the spherical sheet unassisted, but by leakage from the sheet.

The cone formulæ for the displacement are

$$D_r = -\frac{d}{dh}\frac{\rho}{2\pi}\frac{\tan\theta}{(l^2 - h^2)^{\frac{1}{2}}}, \qquad D_z = \cot^2\theta\frac{d}{dz}\frac{\rho}{2\pi}\frac{\tan\theta}{(l^2 - h^2)^{\frac{1}{2}}}, \qquad (90)$$

similar to (89), but doubled. The apex is the point of convergence, as before, so there is no change in direction of the displacement.

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The complete course of the displacement is thus: First the conical sheet of displacement from the apex. When this reaches the circle of contact it divides right and left in the spherical shell. Now the conical sheet carries an infinite amount of displacement. So the amount entering at the circle of contact is also infinite. But the leakage from the shell is also infinite close up to the circle of contact, and this forms the reversed flux of displacement before mentioned just under the real conical wave front. The rest of the displacement entering at the circle of contact makes a spherical shell of finite intensity, with finite leakage. Continuity is made between the displacement in the sphere and in the cone by the leakage from the spherical shell. It is defined by

$$\bar{H}_0 = cv\bar{D}_0 = \frac{\rho}{4\pi R}\,\frac{u\sin\beta}{1-(u/v)\cos\beta}, \qquad (91)$$

$\bar{H}_0$ and $\bar{D}_0$ mean the product of H and D in the shell and its depth, and $\beta$ is the polar angle of the sphere, radius $R = vt$. The proof is that this formula for $\bar{D}_0$ harmonises the displacement in the sphere and cone according to (88) and (90). Full details were given of the continuity of the current in the line-problem. The details are exactly the same here as regards the displacement, so they need not be repeated in the new application.

§ 498. To treat the case of $u<v$, we have merely to omit the cone formulæ. The rest remain valid, including the spherical pulse. I pointed out in the line-problem that the state of things in the cone was established instantly. The same is true in this point-problem in a more complicated manner. But even when $u<v$, there is a similar instantaneous establishment of the steady state understood in a particular way. Thus, let there be no compensating charge at the origin. The problem is then this: The charge $\rho$, initially at rest at the origin, is suddenly projected along the axis at speed $u$, leaving nothing behind. No change is made in the magnetic force, or in the spherical pulse. To find the change in the displacement, we have merely to superimpose upon the previous D the polar displacement of $\rho$ in its initial position. The new displacement is therefore the d of equations (89) inside the sphere. Outside the sphere is the remains of the initial polar displacement in any case, and the cone displacement in addition when $u>v$.

Now let the charge be inside the sphere. As it changes its position, and the sphere expands, there is a variable state of things. But if we travel with the charge and keep near it, there is no change at all. That is, the steady state is established instantly at the charge itself, when its motion is altered. It is the spherical pulse alone that does all the work of establishing E and H, or else the spherical and conical pulses together. The initial act of changing the motion generates the pulse. The external work is, if $u<v$, done momentarily too. It is easily seen that the distribution of displacement round the charge is then symmetrical and involves no inertial resisting force. But if $u>v$, continuous working is needed to maintain the velocity, because the cone is being constantly regenerated at the apex.

But the finite point-charge must not be taken literally. Even in electrostatics it is a make-believe, because its energy is infinite. In its motion there is a higher degree of make-believe, and infinities of less easy interpretation. We should spread out the charge to finitize results. In special cases of plane and line distributions the energetic relations becomes quite plain and in accordance with Newtonian dynamics.

The apparent inertia of a charge due to electromagnetic causes arises from the lag involving bending of the displacement just round it when its velocity changes. There is no bending there when $u$ becomes constant. It is then further away, being propagated outward. But this apparent inertia is not a constant. It is a function of $u$. The continuous working required when $u<v$ is something like frictional resistance. Change of velocity should be understood in Newton's sense. Thus an electron revolving at constant speed in a circular orbit wastes energy continuously on account of the curvature.

On the question of inertial resistance to change of motion I take the opportunity of making a correction to the Note, App. G., vol. 2., p. 533. That Note agrees generally with the investigations of this volume, but the paragraph on p. 534, beginning "Where does the energy come from?" requires some emendation, to be made in the sense of the present section. Mr. G. F. C. Searle called in question my statement that the force on a charged body set moving, whilst tending to vanish when $u<v$, does not when $u=v$. He said it did tend to vanish. I agreed. But he said further that the force vanished because it varied as $t^{-1}$. On consideration I differed, and said only the initial impulse was wanted after all. I go further, and say the same is the case at any speed not exceeding $u=v$.

As regards the force on a distribution of electrification or a "collocation of electrons," imagine it held together like a rigid body, and to be initially at rest, and then to be set in steady rectilinear motion ($u<v$) without rotation. The steady state of D is fully assumed close round the electrification in a time interval equal to the greatest diameter of the region occupied divided by $v$. The spherical pulses are then fully clear of the electrification.

*(To be continued.)*

## VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO GERMANY.

(BY OUR SPECIAL CORRESPONDENT.)

*(Continued from page 907.)*

### THE ESSEN POWER STATION.

This works is situated at a central point of the Rhenish-Westphalian coal and iron district, and supplies power to a large number of mines besides a lighting load. Some 800 motors aggregating 4,000 H.P. are connected to its mains, and about 30,000 lamps. As is seen, the average size of motor works out to 13 H.P., there being several motors with large outputs. Thus one sheet-iron rolling mills alone uses 500 H.P. through the medium of 19 motors; another ironworks has six motors, aggregating 100 H.P.; and one of the large mechanical engineering works is furnished with power and light from 41 motors totalling 600 H.P. and six transformers of 600kw. The largest lighting consumer is the Government railway administration, which takes current for lighting its stations at a wide radius from the works. Following the usual Continental practice in such cases, Messrs. Lahmeyer & Co., who erected the works, adopted a three-phase system throughout, supplying three-phase motors and also three-phase lamp circuits; in fact, three wires are led in to all the consumers' premises except the very smallest.

The engine-room now contains four generating sets, two of 1,000kw. and two of 500kw., two more of the larger size being also on order. All the machines generate three-phase current at 5,000 volts and 50 ~ per sec., and are driven at 94 revs. per min. by vertical cross-compound engines. Fig. 88 is a general view of the engine-room taken just before the second large set was erected. The roominess of the engine room is a common feature of all the German generating stations except those within Berlin. The larger machines are in every respect similar to the one exhibited by Messrs. Lahmeyer in Paris last year; in fact, this very machine now occupies the large vacant space seen in the illustration. Particulars of the design of this large alternator were published, with an elevation and section of the machine, in *The Electrician*, Vol. XLV., p. 768. Provision is made for coupling, subsequently, a continuous-current machine on to the same engine which drives one of the larger sets, should this be required for tramways or the town load.

The larger machines have each a 7 H.P. continuous-current motor for barring, this being driven by cells charged by a small rotatory converter. This rotatory converter furnishes current to a 220 volt circuit on which the pump and economiser motors are connected as well as the barring motors. Three-phase current is used for the motors of the large engine room travelling crane, however. The crane is rated at 40 tons and is provided with a 20 H.P. motor for lifting and 5 H.P. motors for the longitudinal and cross traverse.



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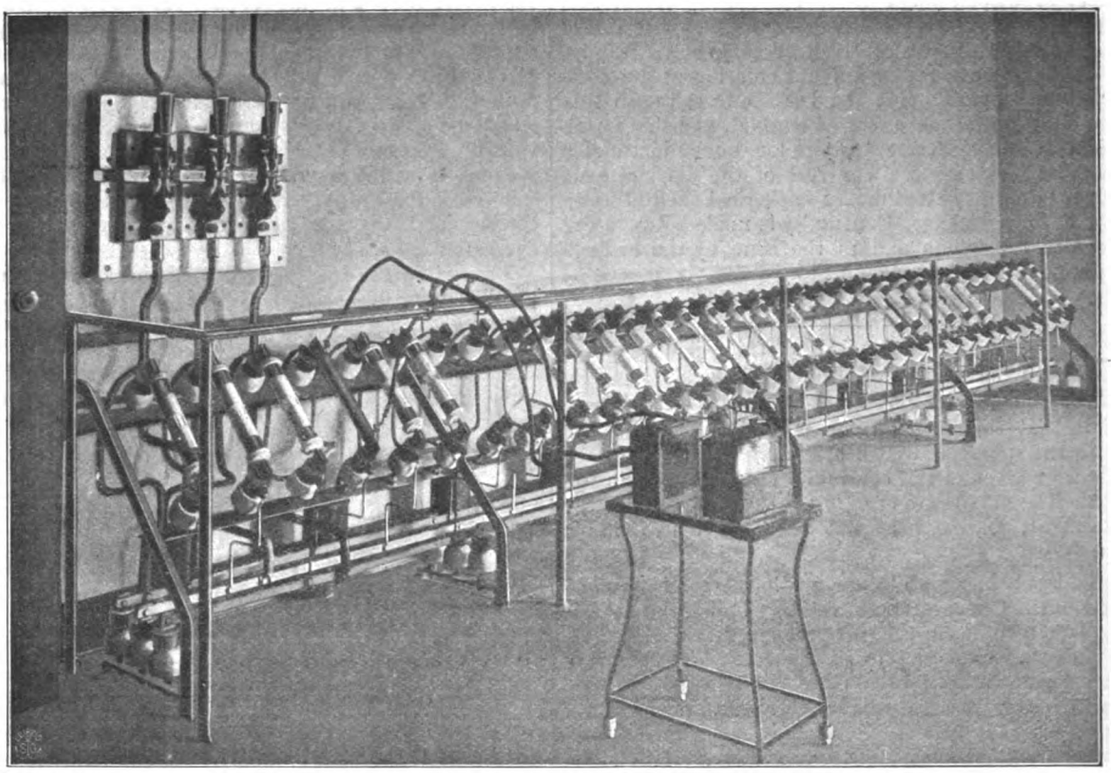

FIG. 82.—FEEDER FUSE ROOM.

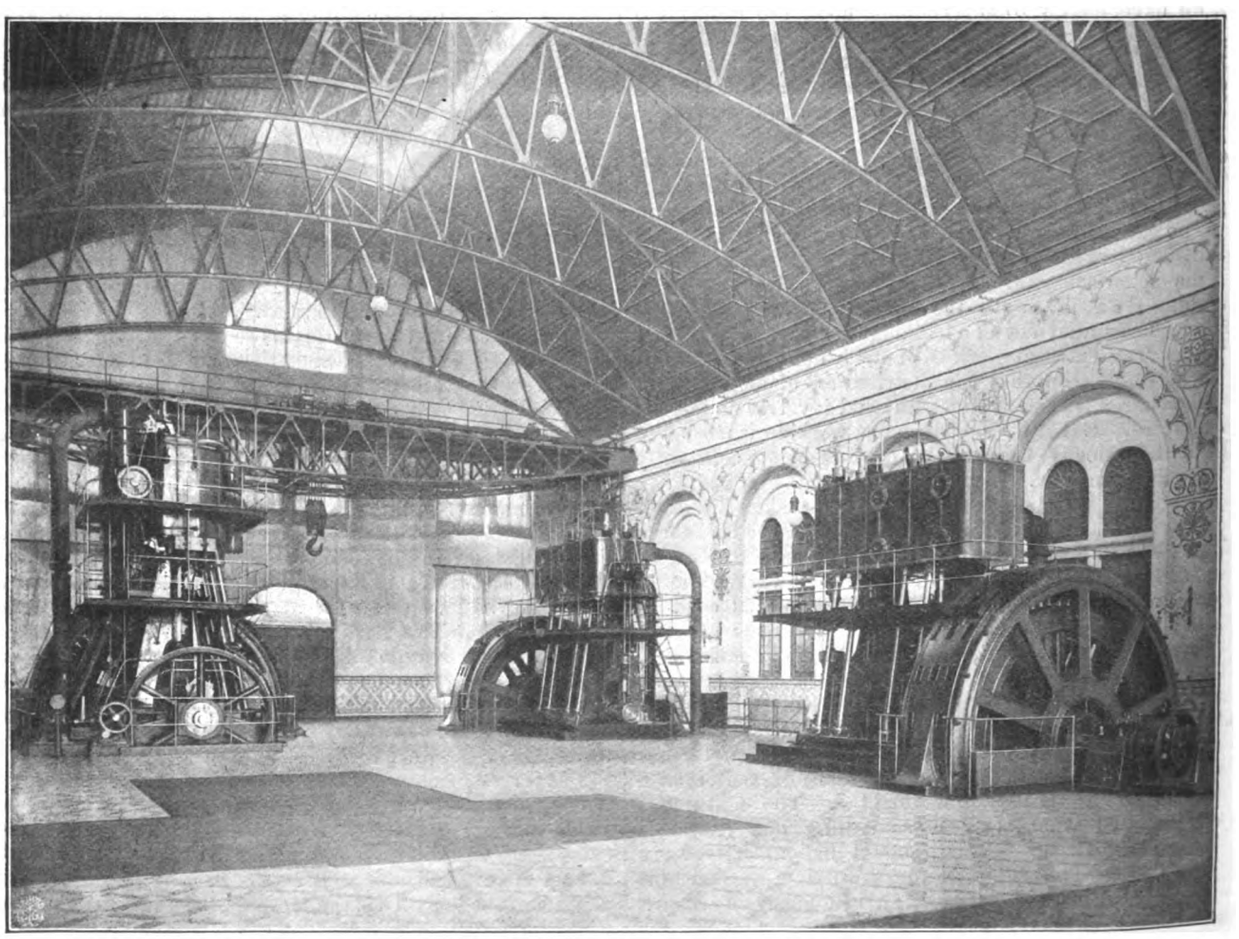

FIG. 83.—ENGINE ROOM IN THE ESSEN ELECTRICITY WORKS.

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Figs. 82, 84, and 85 show the switching arrangements. These have the advantage of simplicity; in fact, they are almost too simple for British tastes. The feeders are led into

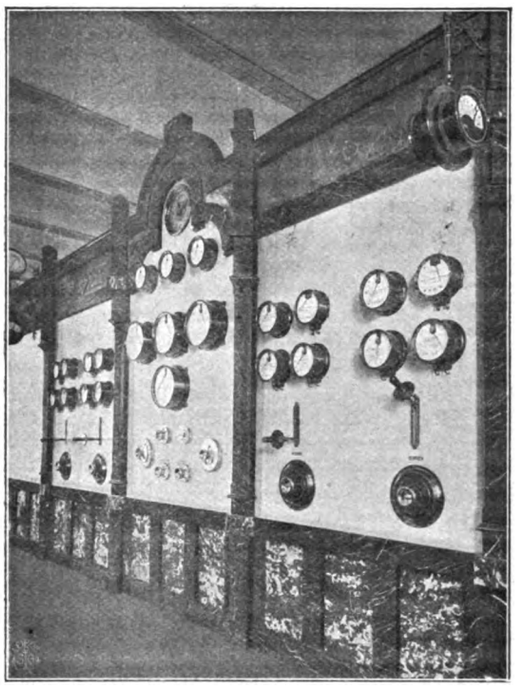

FIG. 84.—FRONT OF SWITCHBOARD.

over the engine room. Fig. 82 shows one side only of the feeder fuse room; there is a similar row of fuses on the other side. If a feeder is to be switched out independently of the others connected to the 'bus bar, it is necessary to do this by removing the fuse. The three fuses of each set of feeders are side by side, without shields between, and the 'bus bars are fixed on insulators below, as clearly seen in the figure. The main switchboard (Figs. 84 and 85) has thus only generator and no feeder panels, and is still further simplified by having the contacts of the switches behind the board. Pilot wires are brought back from two points on the secondary network, which is a closed one, and the switchboard is also fitted with voltmeters to afford an indication of the insulation of the cables.

Another interesting feature of the works is that, although the boilers are hand fired at present, arrangements are being put in for utilising in their furnaces the waste gases from some coke ovens in connection with a coal mine close to the works.

## UNDERGROUND PUMPING PLANT IN THE ZOLLVEREIN MINE.

The electrically-driven pumping plant put down by Messrs. Lahmeyer in the Zollverein coal mine, at Caternberg, near Essen, is over 400 metres below the surface, and has to perform the duty of lifting 8 cubic metres of water (specific gravity 1·02) per minute to this height. As the pump is a duplex differential pump running at the slow speed of 62 revs. per min., and is directly coupled to the motor, the design of the latter is interesting. The diameter of the pump plungers are 127 and 180mm., and the stroke is 1 metre. Fig. 86 shows the motor in elevation and section. It is a three-phase induction motor rated at 350 H.P., and receiving current at

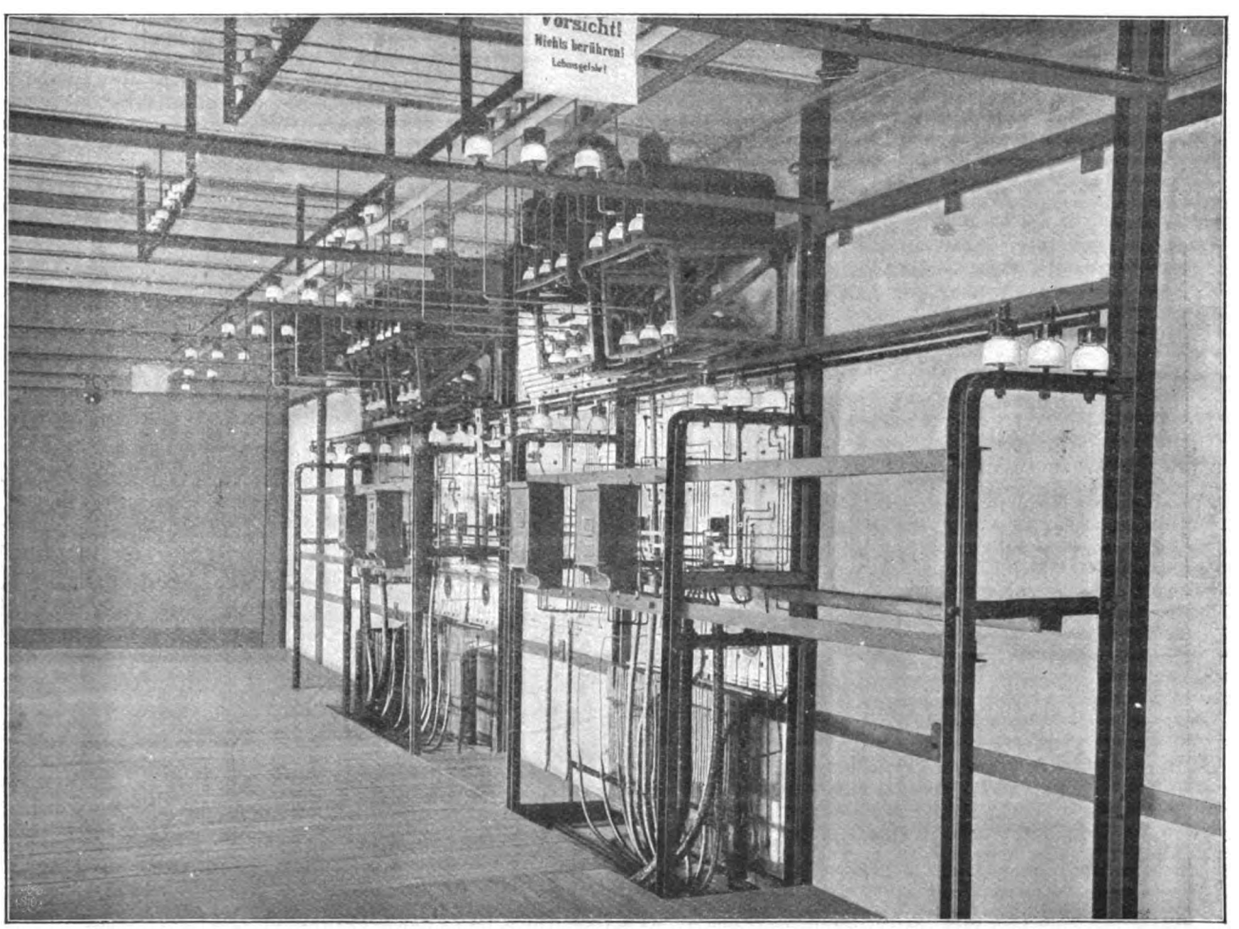


FIG. 85.—BACK OF SWITCHBOARD.

a special room (Fig. 82). Here they are connected by glass tube fuses, but not switches, to 'bus bars, which in their turn are connected to 'bus bars on the switchboard in the gallery

1,000 volts pressure and 25 ~ per sec. The motor weighs about 30 tons (not including the weight of the pump) and the diameter of the stator is 4½ metres, so that the work of taking

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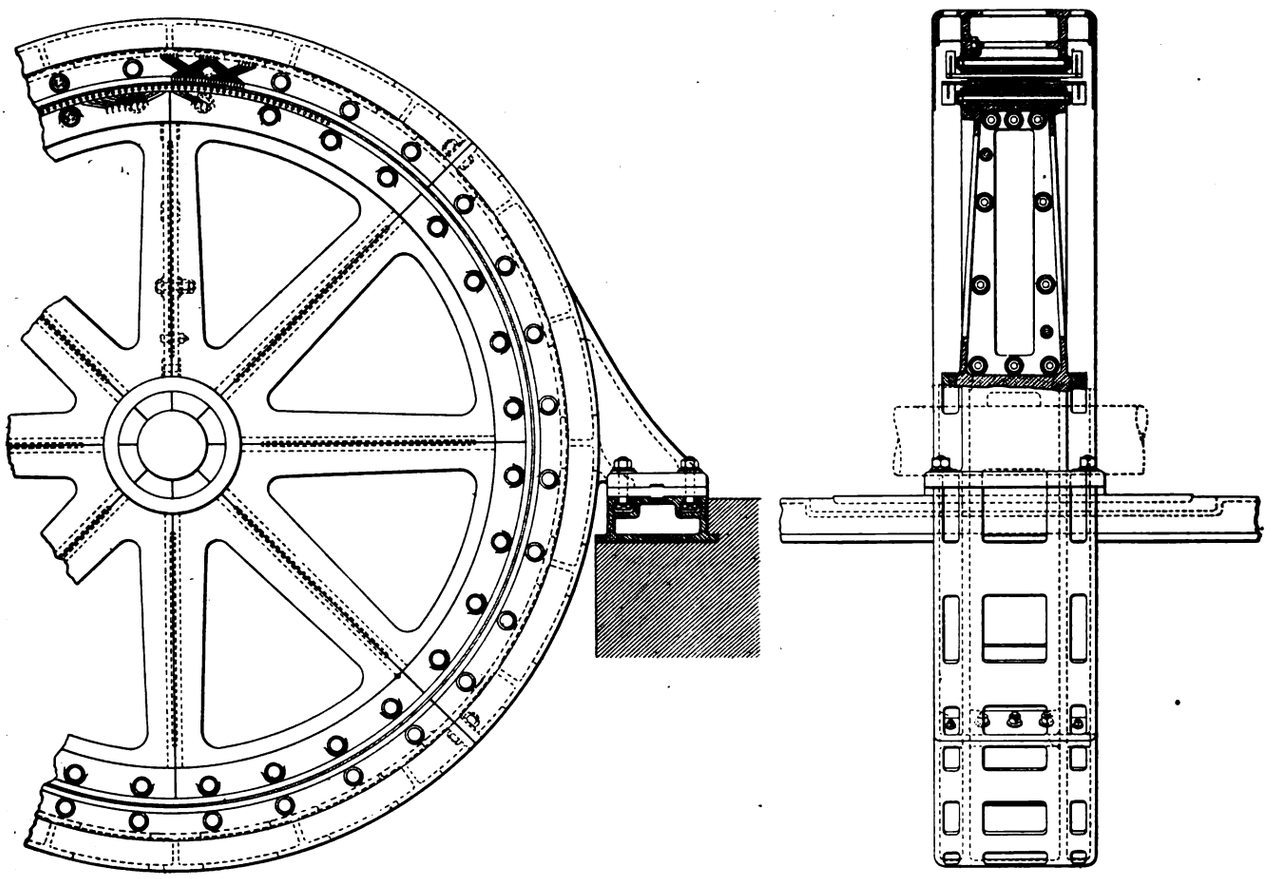

FIG. 86.—SLOW-SPEED THREE-PHASE INDUCTION PUMP MOTOR. Scale—1:40.

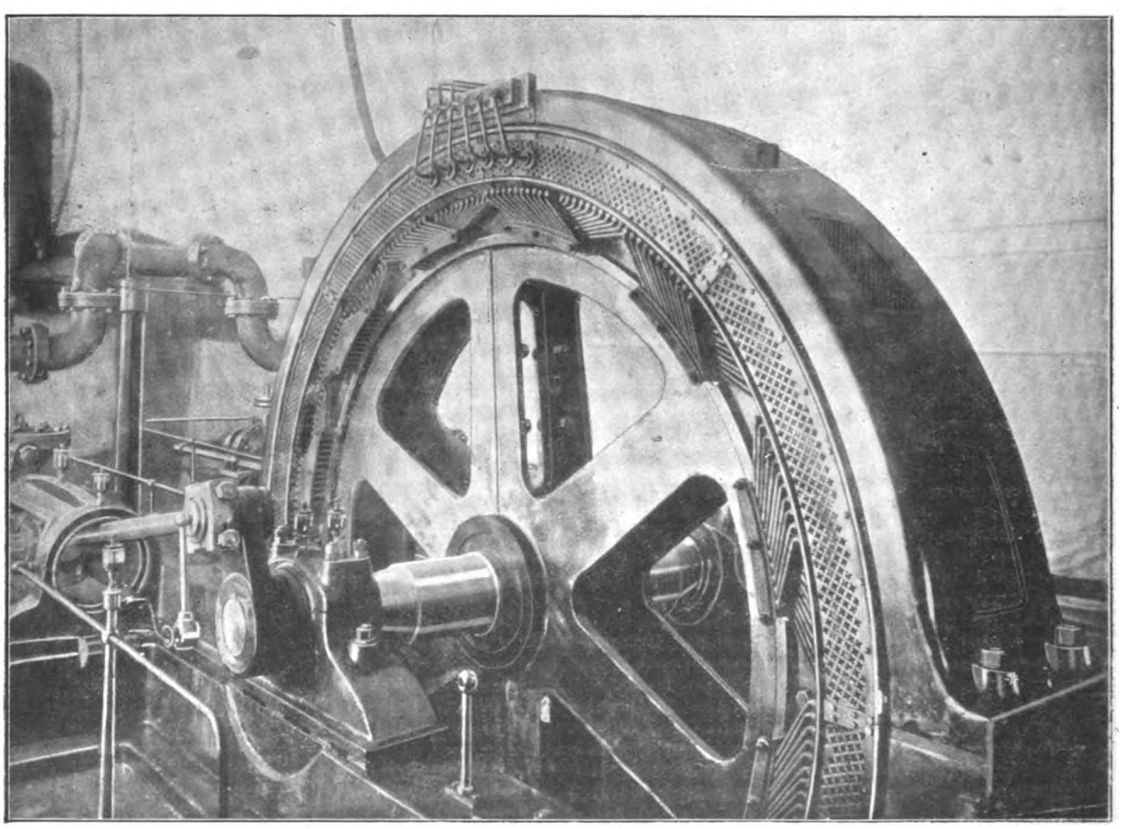

FIG. 87.—GENERAL VIEW OF SLOW-SPEED THREE-PHASE INDUCTION PUMP MOTOR.

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it down the shaft and erecting it was by no means easy. The rotor was taken down in eight pieces and the stator in four pieces, the heaviest piece weighing 8 or 4 tons. As is seen in Fig. 86, and also in Fig. 87, which is from a photograph of a similar motor and shows the arrangement of the rotor windings better than was possible in a photograph taken in the Zollverein mine itself, the rotor is held on a heavy flywheel which is to compensate the inequality of the power required by the pump during each revolution. No starting resistance is used, and therefore the motor has no brushes. As a steam-driven generator is provided in the power house on the surface solely for driving the motor, the motor is switched on before the machine is started, and runs up to speed with the generator. Thus, besides the motor, there are no electrical apparatus below except an ammeter and a three-pole switch for use on emergency.

The power house contains a vertical tandem compound engine, directly coupled to a three-phase 800kw. flywheel alternator, which furnishes current to the motor. The exciter is on the dynamo shaft, between the generator and the out-board bearing, but an additional separately-driven exciter is provided to excite the alternator while it is running up to speed, and until its own exciter has acquired the necessary voltage.

Two concentric cables lead down the shaft. Each is of 70 sq. mm. section, insulated with vulcanised rubber, and not lead-covered but armoured with galvanised iron wires, which are in their turn covered with compounded jute. The cables are fastened every 4 metres with wood-lined iron cleats.

In conclusion it may be added that the motor has been in use for 8 years, during which time it has always been working satisfactorily, and that Messrs. Lahmeyer have put over a dozen motors of a similar kind, and ranging up to 500 H.P., in various mines in the Essen and neighbouring districts.

## TESTING LARGE TRANSFORMERS.*

BY JOHN S. PECK.

The distinction of being the "largest in the world" belongs at the present time to seven Westinghouse 2,250kw. (3,000 H.P.) transformers recently installed by the Cataract Power and Conduit Co., of Buffalo, N.Y. The transformers are arranged for delta connection on both high-tension and low-tension windings, forming two groups of three each, one transformer being held as a reserve unit. The transformers are placed in a sub-station near Buffalo, for reducing the voltage of the Niagara Falls transmission circuit from 22,000 to 11,000 volts, for distribution through and about the city, as the use of 22,000 volts on the underground system in Buffalo is not considered feasible. The winding is made up of a number of thin coils, which are placed side by side, the primary and secondary being frequently interlaced in order to insure close regulation with loads of all power factors. Numerous ducts are provided between the coils, permitting a free circulation of oil through all parts of the winding, and precluding the chance of any local heating. The iron laminations lie in a horizontal plane, and are also provided at frequent intervals with ventilating ducts.

The case is of riveted boiler iron, with all seams and rivet heads thoroughly caulked. The case rests upon a cast-iron base, and is provided at the top with a cast-iron cover. Two large manholes in the cover permit an easy inspection of the interior of the transformer and admit of ready access to the terminal blocks. For cooling the oil, water is circulated through four spirals of brass tubing, which are placed inside the case below the surface of the oil. The four spirals are connected in parallel so that in case one should become disabled it may be cut out. For indicating the temperature of the transformer, a "Standard" thermometer is fastened in the side of the case so that the end of the thermometer is immersed in the oil. This arrangement not only affords a means of determining the temperature of the oil at all times, but is so arranged that should the temperature at any time exceed a certain predetermined value, a battery circuit will be closed by the thermometer and a gong sounded, thus immediately attracting the notice of the attendant. An oil gauge is also provided to show the height of the oil in the case, and a large valve is placed at the lower end of the case so that the oil may be quickly withdrawn. The terminals from the different coils are carried to marble terminal blocks placed above the transformer, but below the surface of the oil. The line leads are carried in at the top of the case through suitable bushings to the proper contacts on the terminal boards.

* From the *Electrical World* of New York.

Although these transformers are intended primarily for use in lowering from 22,000 volts, three-phase, to 11,000 volts, three-phase, they are so arranged that they may be connected for a number of other voltages; thus, the low-tension winding is arranged for either 2,200 or 11,000 volts and the high-tension winding for either 11,000 or 22,000 volts. The windings are so arranged that the transformers may be used for the Scott two-phase—three-phase connection, or for three-phase to three-phase transformation with delta connection. A number of taps are brought out from the windings, so that voltages approximately 5 per cent. higher or lower than those given above may be obtained. As the E.M.F. of the generators at Niagara Falls is 2,200 volts two-phase, the transformers can be used at the power houses as raising transformers, stepping up from 2,200 volts two-phase to 11,000 or 22,000 volts three-phase, or they may be used as reducing transformers at any point on the line for lowering from 11,000 or 22,000 volts, three-phase, to 2,200 volts, two-phase or three-phase. These different combinations of voltages and phases are easily made by simple changes on the terminal blocks of the transformers.

The high guarantees of performance under which these transformers were made were shown by actual tests to have been fulfilled,

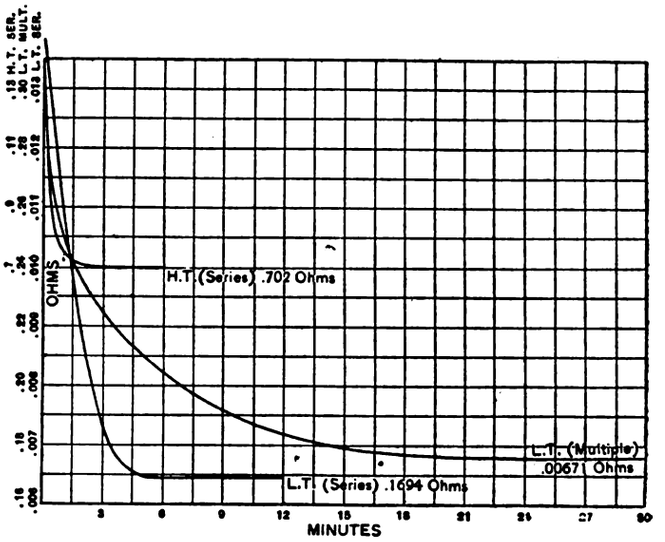


FIG. 1.—Curves.

with very comfortable margins. The table below gives the guaranteed performances, also the values which were actually obtained. In all cases the average obtained from the seven transformers is given :—

| Efficiency. | Full load. Per cent. | ¾ load. Per cent. | ½ load. Per cent. | ¼ load. Per cent. |
|---|---|---|---|---|
| Actual | 98·65 | 98·58 | 98·33 | 97·2 |
| Guaranteed | 98 40 | 98·40 | 98·20 | 97·0 |

| Regulation. | Non-inductive load. | Load having 80 per cent. power factor. |
|---|---|---|
| Actual | 0·76 | 1·8 |
| Guaranteed | 1·10 | 3·0 |

Temperature.—*Rise of Coils as Measured by Increase in Resistance.*

| | |
|---|---|
| Actual | 28·7 per cent. |
| Guaranteed | 40·0 per cent. |

All transformers stood the following tests :—

(*a*) 45,000 volts applied for one minute between high-tension and low-tension windings and between high-tension winding and core.

(*b*) 22,500 volts applied for one minute between low-tension winding and core.

(*c*) Two and one-fourth times normal voltage applied to the low-tension winding for 30 minutes, giving a maximun of 49,400 volts on the high-tension winding.

In making the resistance measurements of the windings some interesting phenomena were observed. When these measurements are made it is necessary, for reasons which will be explained later, to short circuit one winding while the other is being measured. It was found that resistance measurements taken at different times did not check with each other. This phenomena had been previously observed on large transformers, but never before to such a degree. On one transformer, after the measurements had been completed and it had been standing for several minutes entirely disconnected from the circuit, the testers were greatly surprised to draw a heavy arc upon breaking the short-circuiting connection. A consideration of the actions which occur in the transformers under the conditions of measurement, will make clear the reason for these peculiarities. The resistance was measured by the drop-in-potential method. A direct current was passed through the winding and the drop taken with a voltmeter. From the current and voltage readings the resis-

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tance was calculated. A 110 volt storage battery circuit was used, the current in all cases being approximately 6 amperes. With this current the drop through the windings was in most cases considerably less than 1 volt, so that it was necessary to insert a high-resistance in series with the winding.

When a direct current is sent through a transformer winding a magnetic field is induced in the iron. Slight variations in current will cause variations in the strength of the magnetic field, which may in turn induce high E.M.F.s in the transformer winding, and endanger the instruments in this circuit. It is chiefly for obviating this danger that one winding is short-circuited, for if there is a sudden change in the magnetic field a current will be induced in the short-circuited winding, which will in turn oppose the change in the strength of field. The short-circuited winding thus acts as a damper to choke out any sudden variations in magnetic field, with the accompanying high-induced voltage. When the direct current is passed through the winding, the magnetic field which is induced would reach very quickly its maximum value were it not dampened by the short-circuited winding; but on account of this winding the

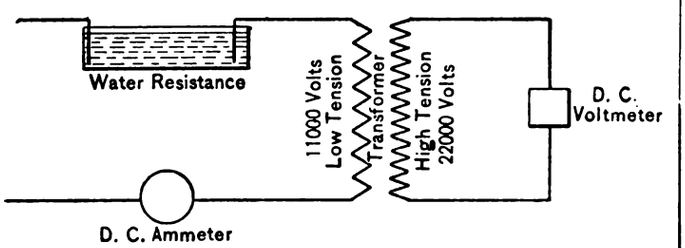


FIG. 2.—Diagram of Connections..

increase in the magnetic field is slow, and a considerable length of time is required for the field to reach its maximum value. While the field is thus building up, an E.M.F. is generated in the transformer windings, which E.M.F. is in such a direction that it is added to the E.M.F. due to the resistance of the winding, and the voltmeter reading is higher than it should be on account of the resistance of the winding alone, and the true resistance drop will be obtained only after the field has become stationary.

Fig. 1 shows three curves giving the relation between the apparent resistance of the windings and the time from the instant that the current was sent through the winding. One curve shows the high-tension winding all in series, another the low-tension winding all in series, while a third shows the low-tension winding in multiple.

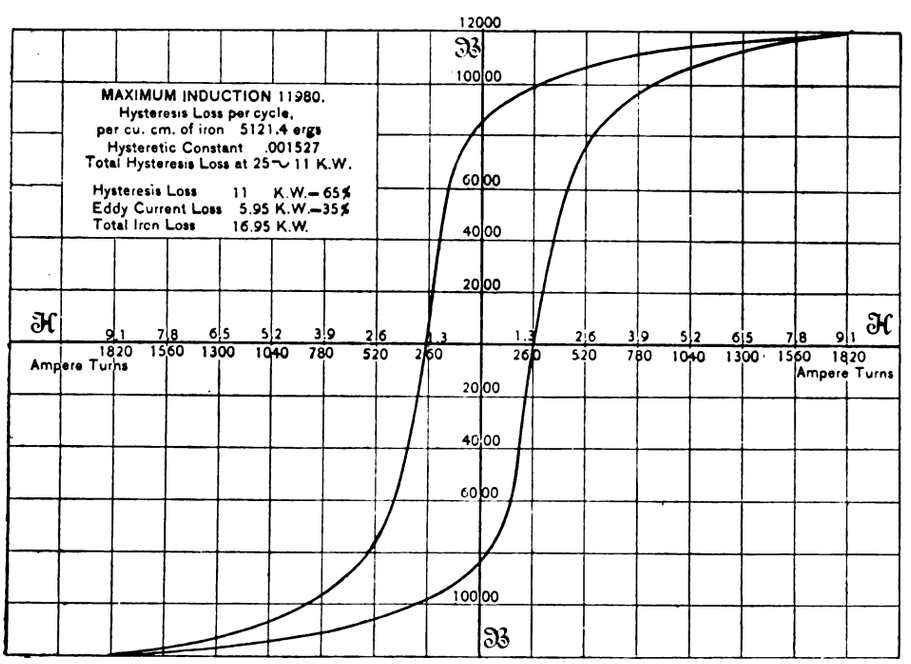


FIG. 4.—Hysteresis Curve.

It will be noted that approximately 30 minutes are required before the resistance, with all low-tension coils in multiple, reaches a stationary and true value. With the high-tension coils all in series the resistance reaches a stationary value in approximately three minutes. This difference in time depends upon the difference in magnetising force. With the high-tension coils all in series there are 10 times as many turns as with the low-tension coils all in multiple, and since the same current is used in each case, the amperes-turns are 10 times as great in the first case as in the second, and the iron is more quickly brought to a stationary value. If the winding is not short-circuited it is found that the resistance becomes stationary almost immediately; but in addition to endangering the instruments there is often great difficulty in reading the voltmeter on account of the rapid variations in voltage due to small though sudden changes in magnetic field. It is, however, possible to open the

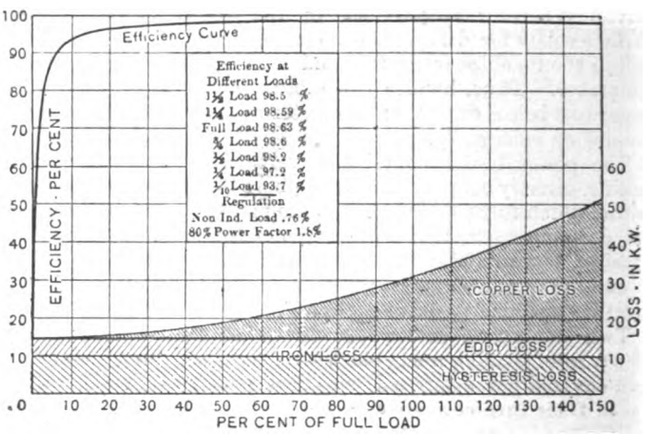


FIG. 3.—Efficiency Curve.

short-circuited winding for a short time until the magnetic field becomes constant, then to short-circuit it and so choke out the rapid oscillations. From the above it is evident that in measuring the resistance of the transformer care should be taken to ascertain that a constant resistance has been reached. When the direct-current circuit is opened the field would fall almost instantly to a minimum value were it not checked by the short-circuiting winding, but the current induced in this winding by the dying field prolongs the life of the field so that several minutes are required before it disappears entirely. It was while the field was dying out that the short-circuited connection was opened and the arc drawn.

The iron losses of the transformers were measured by means of a wattmeter in the usual manner. This method of measuring, however, gives the total iron loss and does not separate the hysteresis from the eddy current loss. On account of the large size of these transformers it was desired to separate the iron losses in order to determine whether the ratio which is found to exist between hysteresis and eddy current loss in small test samples is maintained in a large transformer. In order to make this separation the hysteresis loss was determined by a method devised by Mr. C. F. Scott for measuring the permeability and hysteresis loss on the field ring of one of the 5,000 H.P. Niagara generators. This was, however, the first time the method had been applied to the measurement of the hysteresis loss of transformers. The connections and instruments used for making the measurements are shown in Fig. 2. In the 11,000 volt winding is shown a direct-current ammeter and a water rheostat, the latter being so arranged that very close adjustments of resistance can be made over a wide range. Across the 22,000 volt terminals is a direct-current voltmeter.

If a direct current is sent through the low-tension winding, a magnetic field is induced in the iron. If the current is gradually increased or decreased, the magnetic field will also be increased or decreased. This changing field induces an E.M.F. in the transformer winding which may be measured by the voltmeter across the high tension winding. If the rate of change in the magnetic field is uniform, there will be a constant E.M.F. generated in the winding, and the voltmeter needle will remain stationary. It was found that a rate of change of approximately six C.G.S. lines per square centi-

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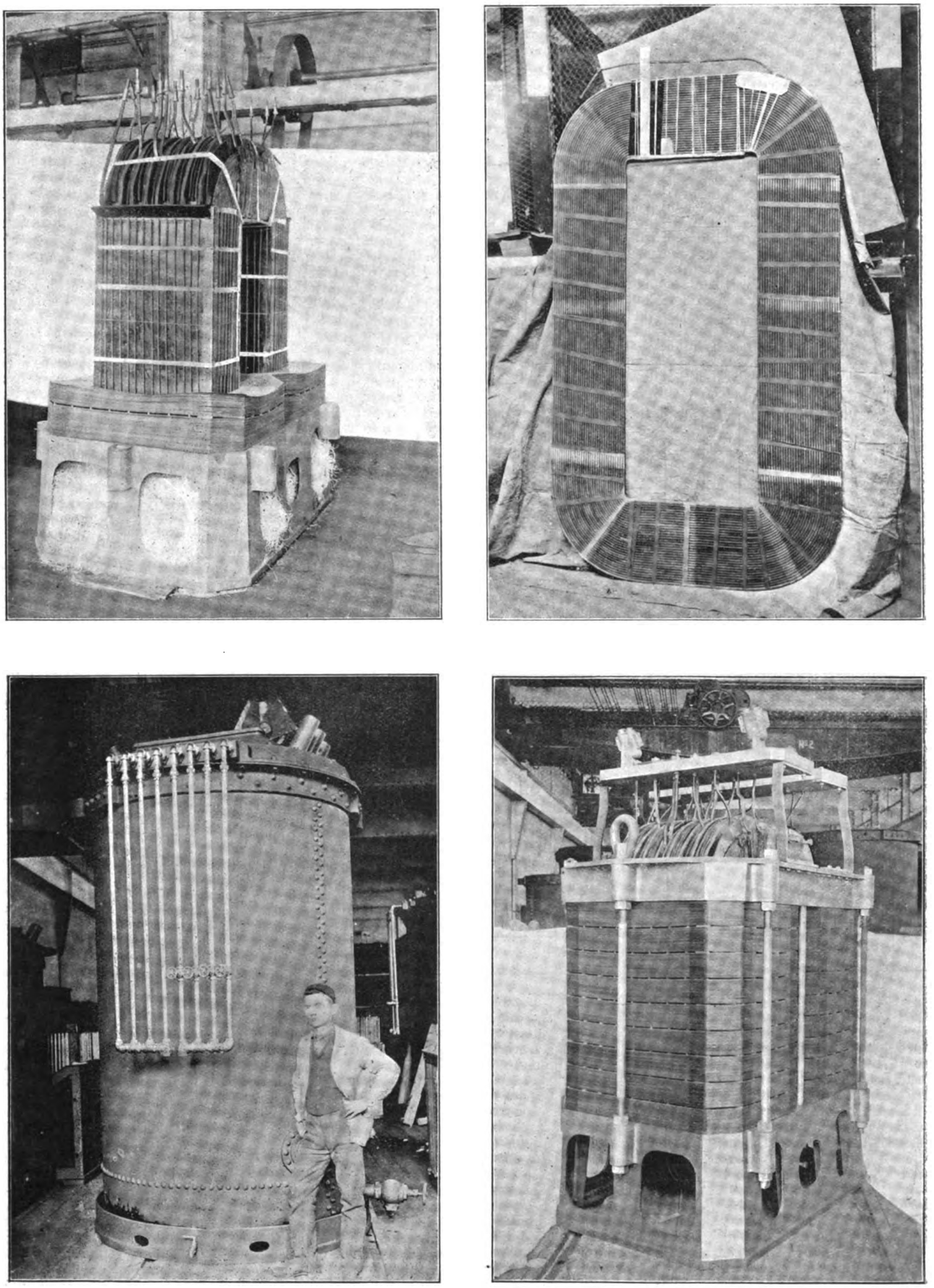

FIG. 5.—Views showing Transformers in Different Stages of Assembling.

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metre per second would give a reading of 0·1 volt on the voltmeter. By watching closely the voltmeter needle the resistance could be so changed as to give a constant reading of 0·1 volt. Starting with the iron demagnetised, at the end of one second the induction would be six lines per square centimetre, at the end of two seconds 12 lines, at the end of three seconds 18 lines, &c.; so that the time from the start gave a measure of the induction in the iron. The method used in taking the curves was as follows:—

Starting with zero current the resistance was cut out at such a rate as to give a steady deflection on the voltmeter. When the maximum desired induction was reached the voltmeter was reversed and the current gradually decreased to zero, then the current was reversed and gradually increased to a negative maximum, then the voltmeter again reversed and the current decreased to zero, thus completing the cycle. Readings were taken of current every five seconds, so that with a deflection of 0·1 volt the points came very close together on the curve. The instruments were so arranged that a comple cycle could be carried through without a moment's stop at any point. In taking the readings four men are desirable—one to vary the resistance and so hold the voltmeter constant, one for calling off the time intervals for readings, one for reading the ammeter and one for taking down the readings. In order to get the iron "into step," the transformer was run through the complete cycle several times before any readings were taken. With this method it was, of course, necessary to locate the horizontal axis after the curve was plotted, but this could be done without difficulty as the loops closed on themselves accurately and were found to be almost perfectly symmetrical about the two axes.

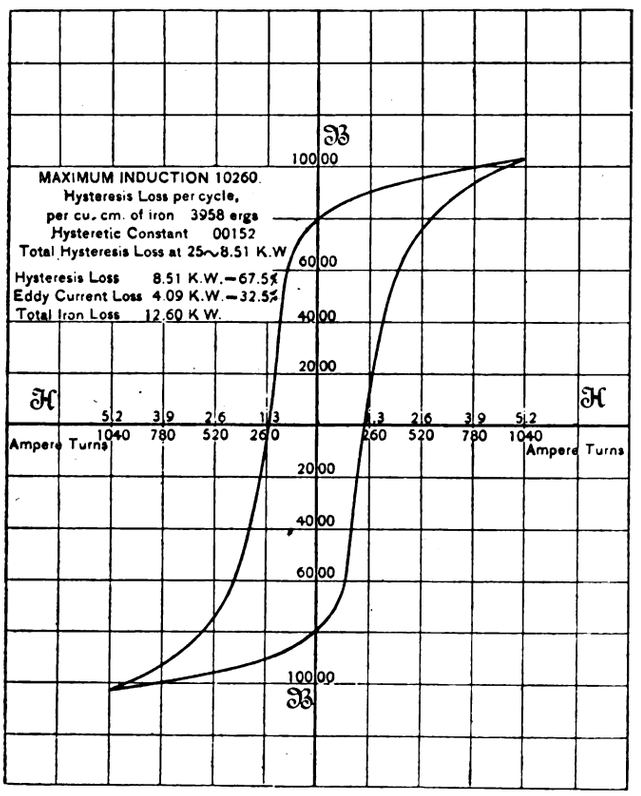


FIG. 6.—Hysteresis Curve.

The hysteresis loss per cycle is represented by the area of the loop, and was found to be 3,958 ergs per cycle at 10,260 gausses, and 5,121 ergs per cycle at 11,980 gausses. Using the equation $L = K\mathfrak{B}^{1.6}$ where L = hysteresis loss in ergs per cycle and $\mathfrak{B}$ = maximum induction, it is found that K = 0·00152 for a maximum induction of 10,260 gausses, and K = 0·001527 for a maximum induction of 11,980 gausses. Considering the fact that the magnetic circuit is rather wide and that the induction cannot be equally distributed over this section, the hysteresis constant is quite small and lower than is often obtained on small samples of transformer iron. The eddy current loss is found by deducting the hysteresis loss from the total iron loss. At an induction of 10,260 gausses the eddy current loss is 4·09kw. per transformer and 5·95kw. at 11,980 gausses. Assuming that this loss varies as the square of the induction, and that it is 4·09kw. at 10,260, it should be $4{\cdot}09 \times (11{,}980)^2/(10{,}260)^2 = 5{\cdot}56$kw. at 11,980. The measured value 5·9 is approximately 7·5 per cent. higher, but this difference may be accounted for by the unequal distribution of the flux in different parts of the circuit. The simplicity of this method of measuring the hysteresis loss of transformers is apparent. Its chief interest, however, lies in the fact that it is the only practical method yet devised for measuring this loss on a completed transformer

## THE COOPER-HEWITT VAPOUR LAMP.*

At the conversazione of the American Institute of Electrical Engineers last spring the exhibit which attracted the greatest attention was undoubtedly the mercury vapour lamp of Peter Cooper-Hewitt. An extended account of this lamp appeared shortly after in an article contributed to our columns by Mr. Cooper-Hewitt, but all of its features were not disclosed in the article, owing to patents pending. We are now enabled to present a more complete account of the lamp through the issue last week of a series of 10 patents, which together appear to cover quite all of the details. Seven of the patents are based on applications filed April 5, 1900, and three on applications filed January 25, 1901. The titles of the first-mentioned patents are as follows:—Electric lamp, method of operating electric lamps, starting apparatus and circuit for electric lamps, electric gas or vapour lamp and electrode therefor, enclosing case for electric lamps and method of manufacturing vapour or gas lamps. The titles of the three patents latest in date of application are: Method of controlling gas or vapour electric lamps, method of producing light by electricity, and apparatus for producing electric light. It has been previously proposed to pass electric currents through two electrodes consisting of bodies of mercury contained in hermetically-closed tubes, and to obtain light from the electric arc between the two mercury electrodes; but the inventor states that prior to his invention no such devices, so far as he is aware, have been produced which are suitable for commercial use. They have usually been started by bringing the two bodies of mercury constituting the electrode into actual contact with each other and then separating them, the electric current then being caused to arc across from one electrode to the other. Such method of starting has been found impracticable for any extended use, and requires the presence of a considerable outside resistance to prevent an excessive current-flow when the bodies of mercury are in contact, and even when started they have been incapable of commercial operation with efficiency or for any considerable period of time. Some materials when in a gaseous or vaporised state possess the capacity of emitting light under the influence of electric currents in a much higher degree than others. The vapour of mercury is efficient as a light-yielding material, and owing to its molecular weight and its low boiling or vaporising point, it is suitable. Moreover, it readily serves under the influence of the current to transfer the heat generated in the lamp to convenient points for radiation. Some of the materials normally existing in the form of gases may, however, be used—such, for instance, as nitrogen; but the amount of light which may be obtained from nitrogen per unit of length appears to be less than that which can be obtained from mercury vapours, other things being equal. The spectrum is also a matter to be considered in determining the material to be used. Mercury gives a light which is clear and white, but wanting in red rays, so that while useful for many purposes it may be undesirable for others. Lithium and similar materials yield spectra with red and other colours. Nitrogen and other gases develop red rays in abundance, and when combined with the mercury rays a beautiful result is obtained. The selection of the material for the vapour must be determined by the conditions and requirements. The lamp should be constructed to utilise, as far as possible, all the resistance of the lamp in the conversion of the electrical energy into light; but as there may be more or less heat developed the structure should be such as will radiate the heat at a suitable rate. Usually it is advantageous to employ a cooling chamber at some portion of the device outside the path of the current. In the case of mercury, for instance, an enlargement of the tube may project a distance beyond one of the electrodes, so that the excess of heat will be radiated. In some instances it is practicable to cause the radiation to take place through the walls of the tube surrounding the gas column at a sufficient rate to meet the requirements. If the temperature of the lamp is allowed to become too high, the lamp is liable to extinguish itself. When a fixed gas is used or vapours under such conditions that their densities cannot be unduly increased by heat in the tube, then the cooling chamber may be dispensed with. The lamp may be made of such a size as to render a special cooling chamber unnecessary.

The ability to start the lamp readily is of the utmost importance, and the inventor has found that certain materials added to the lamp before or while in the process of manufacture produce a condition which makes it possible to start a current under a moderate increase of electric pressure, and thereupon the continuous or an alternating current of low pressure readily traverses the lamp, producing an intense enduring light, one of the substances used being sulphur or its compounds. It has been found advantageous during the process of exhaustion to heat the tube by convenient means until a vacuum is formed and to then subject the contents of the tube to the action of an electric current at high voltage. It seems also desirable to free the tube as far as possible from certain foreign substances, and particularly from oxygen, and sometimes the

* From the *Electrical World* of New York.

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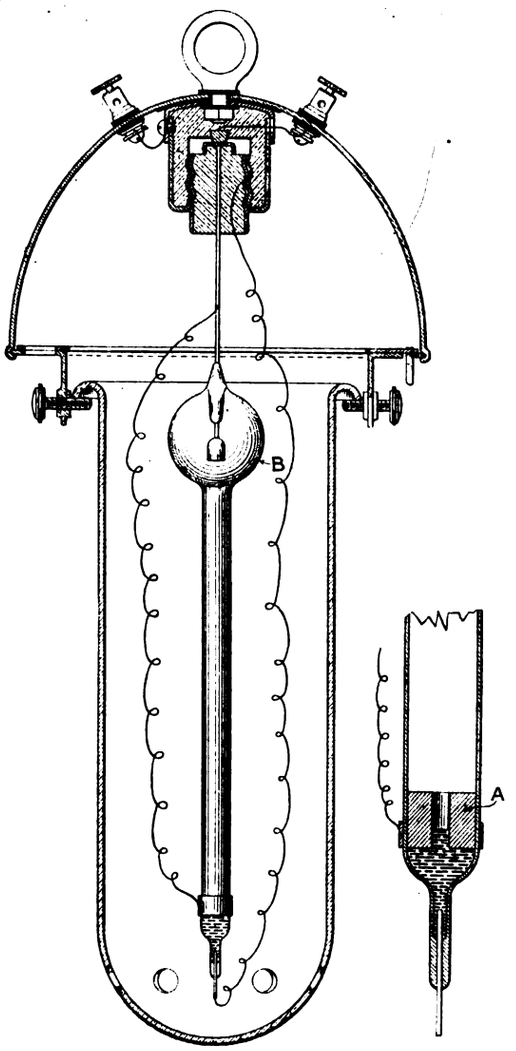
tube is treated with a bath of heated hydrogen before placing on the pump and also when the lamp is being exhausted. It is sometimes advantageous to use interrupted currents of high voltage flowing in a given direction and to first constitute one of the electrodes the anode and the other the cathode and then to reverse the direction of the currents. When no starting material is present in the lamp, it is possible to start by heating it by any convenient means—such, for instance, as a Bunsen burner or an electric heating-coil of any convenient construction—and simultaneously applying to the terminals a difference of potential substantially equivalent to that upon which the lamp is designed to operate and at the same time a boosted E.M.F. to enable the regular current to pass. When, however, the starting material is used, the lamp may be started without preliminary heating by means of electric currents at an E.M.F. usually higher than that upon which the lamp is normally intended to run.




THE COOPER-HEWITT VAPOUR LAMP.

This may be conveniently done by placing in the circuit leading to the lamp the secondary coil of a transformer, the primary of which is connected with the supply circuit through a suitable circuit interrupter, or an alternating current from a suitable tranefermer may be used.

It has been found advantageous when the lamp is to be started without heating and by means of moderately high voltage currents to surround the glass in the neighbourhood of one of the electrodes, or in the case of an alternating-current lamp each of the electrodes, by a band of conducting or semi-conducting material—such, for instance, as foil, which in turn is placed in electrical connection with the other electrode or grounded by means of a small conductor. This device appears to lessen or neutralise, to a certain extent at least, the static charge which gathers about the electrode during the application of the starting current, and it reduces the effective starting resistance of the lamp. A lamp which could be started only by extremely high potential currents, if at all, without this band may be started without difficulty when it is present.

Unless special means are provided to prevent it, a lamp of this character using mercury vapour is liable to have a more or less flickering effect, probably due to the shifting of the position at which the current enters the cathode. The inventor has succeeded in obviating such flickering in various ways. The tendency of the current seems to be to remain in the gas or vapour until it reaches the portion of the cathode most distant from the anode, and if a small body of mercury surrounds the cathode it will, unless means are provided to prevent it, wander over the surface of the mercury, and thus produce the flickering. By sufficiently obstructing the path beyond the portion of the cathode nearest the anode, the current will be forced to enter the cathode at a more or less fixed point, and thus become steady and obviate the flickering. A cylinder of porcelain or other suitable substance A, as shown in figure, may be placed in the mercury, leaving only a perforation through which the current must pass. Where the cathode is at the end of the tube, this difficulty may be overcome to a large extent by making it concave and arranging it so that the current will enter it on the concave surface. The condensing and impurity-containing chamber B, or its equivalent, performs an important function in the operation of the lamp. As the lamp commences to operate heat accumulates and the increasing temperature appears soon to result in increased resistance on the part of the vapour both. The chamber B is therefore constructed with sufficient radiating surface to get rid of the excess heat and keep the lamp in the proper condition. The chamber need not, however, necessarily surround the electrode; but it may be located elsewhere and be of other form, provided it is out of the vapour path. It may sometimes be desirable to insert a small balancing or steadying resistance in series with the lamp. This resistance is of importance mainly on starting certain kinds of lamps, which, when cold, owing to the starting material or other construction, would take too much current until they have acquired their working condition.

In constructing an electric vapour lamp, designed for service as an efficient light-giving medium the object should be to provide means for so controlling the effects of the current as to make the lamp self-regulating, so that the heat developed by the current shall vary the density of the vapour and incidentally the pressure, the whole being accomplished in such a manner that an increase of current-flow, and consequently of heat, shall produce an increased vapour resistance, thus cutting down the current and re-establishing normal conditions. This may be accomplished by properly selecting the conducting medium and the length and radius of its container, thus determining the normal pressure of the vapour, and by providing a suitable heat-radiating capacity for the lamp, not only through such careful selection of the length and radius of the container, but also through properly selecting the thickness of the walls and, in some instances, providing one or more special cooling chambers for assisting in the radiating of heat. Inasmuch as the radiation of heat takes place at the circumference, the temperature of a vapour through which an electric current is flowing must necessarily vary throughout from circumference to centre, being highest at the centre and lowest at the circumference. Accordingly, a vapour-carrying current will have a varying density, decreasing along the radius from the circumference to the centre. If, now, the density of the vapour in the container where no current is passing is at or below the density of maximum conductivity, the zone which nearest approaches the state of maximum conductivity when current is permitted to pass will be at the circumference, the vapour resistance increasing along the radius from the circumference to the centre inversely as the density due to the attenuation caused by heat from the current. When the density of the vapour in the container is greater than the density of maximum conductivity, the vapour resistance will decrease along the radius of the conducting column from the circumference to a point where the vapour is attenuated to the density of maximum conductivity, and from that point to the centre the density will be below the state of maximum conductivity, and consequently the vapour will be of greater resistance towards the centre. If such a density of the contained gas or vapour be adopted that the zone of maximum conductivity or the zone nearest approaching that state is at the circumference of the vapour, the danger is run of exposing the substance of the container to injury from the effects of the current; but with a vapour whose total normal density when no current is passing is at or below the condition of maximum conductivity, a radius can be selected sufficiently large to cause the accumulated vapour at the circumference, due to the heat developed when the current begins to flow, to have a resistance greater than that of maximum conductivity, whereby the condition mentioned in the preceding paragraph is attained; or a radius can be selected large enough so that the heat generated by the current will not endanger the container. Thus it will be seen that the best available working condition for a lamp of this class is generally one in which the density is somewhat above the state of maximum conductivity. In this condition the zone of greatest conductivity is an annulus located along the radius between the centre of the contained tube or chamber and the inner wall thereof. Bearing in mind that the conductivity of the gas or vapour is greatest at a given density or attenuation, the fact noted indicates that the stratum of gas or vapour between the inner surface of the wall and the so-called "conducting zone" is of greater density than that of maximum conductivity.



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Several of the patents relate to the means employed for obtaining an approximately definite resistance of the vapour path. The inventor has found that under proper conditions a gas or vapour enclosed within a suitable vessel or container can be made to control the flow of current under the influence of a given difference of electrical potential through the medium of its resistance; also that the electrical resistance of a conducting gas or vapour bears a definite relation to the density of the gas or vapour; that it is possible so to control the density of an enclosed gas or vapour acted upon by an electric current as to maintain that density at a predetermined degree, rendering its conductivity sufficiently stable and suitable for service as a light-giving medium, its efficiency in that respect being exceedingly great. The principles laid down above are embodied in practical form in a lamp in which the container is of glass having a bore ¾in. in diameter, the length between the electrodes being 54in., and the chamber lying outside of the path of the current having a radiating surface equal to a spherical area 3in. in diameter. The positive electrode will be constructed of pure iron held in place by a supporting pillar of glass, through which the platinum leading-in wire passes. The negative electrode may be a puddle of mercury, as shown, and a platinum leading-in wire extending through the walls of the vessel will connect the mercury with the external circuit. Such a lamp will run on a current of approximately 120 volts and pass approximately 4 amperes when the surrounding temperature is that of an ordinary room—say, 75deg.

## THE ELECTRICAL EQUIPMENT OF THE INNER CIRCLE. (Arbitration.)

The Hon. Alfred Lyttelton, K.C., M.P., the arbitrator appointed by the Board of Trade in connection with the dispute between the Metropolitan District and Metropolitan Railway Companies as to the most suitable system of electric traction for their present steam lines, sat for the first time on Monday last. The counsel engaged on either side are Mr. Cripps, K.C., Mr. R. W. Wallace, K.C., and Mr. Thomas for the Metropolitan Co., and Mr. Fletcher Moulton, K.C., and Mr. Gordon, K.C., for the Metropolitan District Co.

Mr. CRIPPS, K.C., said that although the Metropolitan Co. was desirous that the arbitration should commence as early as possible, nevertheless he was not prepared to put his evidence forward until about the last week in October or the first week of November.

Mr. FLETCHER MOULTON, K.C., on the other hand, thought the matter should proceed at once. He was prepared to commence this week.

The Hon. ALFRED LYTTELTON, K.C., was of the opinion that the Metropolitan Co. were quite reasonable in asking for the postponement which they did, in view of the fact that the appointment of an arbitrator in this matter and the arrangement of the first sitting had been pushed forward with such great expedition since the expiration of the period specified by Parliament.

After a little further discussion it was eventually agreed to proceed with the case for the District Co. on Tuesday, October 29th.

## BOOKS RECEIVED.

(Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.)

"Transactions of the Canadian Institute for August, 1901." (Toronto: Murray Co.) $2.

"L'Electricité à l'Exposition de 1900." Edited by E. Hospitalier and J. A. Montpellier. No. 8. (Paris: Vve. Ch. Dunod.)

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## ELECTRICITY WORKS ACCOUNTS.

### Leeds Municipal Electric Supply Works.

While the Leeds accounts indicate a failure to maintain the low cost figures obtained in 1899-1900, yet the results of last year's operations are, considering the circumstances, but little, if any, inferior to those of the preceding year.

It will be noticed from our table that with a rise in the fuel item of 0·14d. per unit, the generating costs have increased barely 0·12d., the works costs 0·15d., and the total costs only 0·12d. In view of the already very low cost figures at this place the above results should be most gratifying.

Owing, of course, to the combined effect of a slight diminution in the total revenue and the increased costs, the ratio of the working profit to the capital has fallen from 9·78 to 8·85 per cent., and the surplus without any allocation for depreciation was £6,882.

The year's output marks an advance of 25·6 per cent, and the equivalent 8 c.p. lamp connection shows an increase of 24·5 per cent.

### Ayr Municipal Electric Supply Works and Tramways.

Another undertaking which has done well in the face of high coal prices is that at Ayr. Here we find an increase in the fuel item of nearly 0·25d. per unit, accompanied by a rise in the total costs of only 0·1d. In comparing the several cost figures of this undertaking with those of other places it is necessary to keep in mind the fact that at Ayr the load is peculiarly constituted. Of the total output sold, that for public lighting was last year 65·2 per cent., while the number of units sold to consumers was only 35 per cent.

This to some extent explains the high load-factor which obtains at this place—19 per cent. in 1899-1900 and 19·85 per cent. last year. Even making due allowance for the favourable load, we can only characterise the costs as being very creditable.

The average price received per unit for public lighting was 1·55d., and with the large proportion of the total so sold it is not surprising that the total revenue is comparatively very low, and that, notwithstanding the moderate expenditure, the net result of the year's operations is again a deficit, and, unfortunately, an increased one.

The output for the year was higher by 15·2 per cent., and the total lamp connection by 12·05 per cent. than in the preceding year.

Up to May 31st last the total amount borrowed and received as capital on accouut of the electric tramways under construction was £25,012. The expenditure up to the same date amounted to £8,598, distributed thus—on permanent way £6,271; on buildings, £587; on machinery and plant, £23, and on miscellaneous items, £1,717.

**The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—**

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Sept. 27, 1901 | Kingston-upon-Hull (Mun.) | July 13, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Bath (Municipal) | April 20, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bedford (Municipal) | Aug. 3, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Birmingham (Company) | Sept. 15, 1899 | Leith (Municipal) | May 17, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | Leyton (Municipal) | Jan. 13, 1901 |
| Blackpool (Municipal) | Oct. 4, 1901 | Liverpool (Municipal) | Mar. 22, 1901 |
| Bournemouth (Company) | May 3, 1901 | London (Company) | July 26, 1901 |
| Bolton (Municipal) | Nov. 30, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bradford (Municipal) | July 12, 1901 | Manchester (Municipal) | Sept. 13, 1901 |
| Brighton (Municipal) | May 10, 1901 | Morley (Municipal) | June 14, 1901 |
| Bristol (Municipal) | Aug. 30, 1901 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Norwich (Company) | Dec. 28, 1900 |
| Bury (Municipal) | Aug. 9, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Cambridge (Company) | April 12, 1901 | Nottingham (Municipal) | Sept. 21, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Oldham (Municipal) | Feb. 1, 1901 |
| Cardiff (Municipal) | Jan. 11, 1901 | Oxford (Company) | April 12, 1901 |
| Charing Cross (Company) | Mar. 15, 1901 | Pontypool (Company) | May 3, 1901 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Prescot (Company) | Dec. 8, 1899 |
| Chester (Municipal) | Aug. 16, 1901 | Preston (Company) | Dec. 14, 1900 |
| City of London (Company) | July 26, 1901 | Reading (Company) | Dec. 21, 1900 |
| Clerkenwell (Company) | April 19, 1901 | Richmond (Company) | June 29, 1900 |
| Coventry (Municipal) | Feb. 23, 1900 | Salford (Municipal) | Feb. 28, 1900 |
| Croydon (Municipal) | July 20, 1900 | Scarborough (Company) | July 13, 1900 |
| Crystal Palace District (Co.) | Sept. 13, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Derby (Municipal) | Jan. 26, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | St. Pancras (Municipal) | July 5, 1901 |
| Dover (Company) | April 26, 1901 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Eastbourne (Company) | May 4, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South London (Company) | May 31, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | South Shields (Municipal) | Sept. 26, 1901 |
| Folkestone (Company) | April 26, 1901 | Southampton (Municipal) | Feb. 8, 1901 |
| Glasgow (Municipal) | Sept. 27, 1901 | Southport (Municipal) | July 7, 1899 |
| Gloucester (Municipal) | Aug. 20, 1901 | Stafford (Municipal) | Aug. 16, 1901 |
| Great Yarmouth (Mun.) | Dec. 28, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Greenock (Municipal) | Aug. 30, 1901 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | April 19, 1901 |
| Hanley (Municipal) | Aug. 9, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | May 17, 1901 |
| Hast'gs & St. Leonards (Mun.) | July 12, 1901 | Windsor and Eton (Co.) | July 19, 1901 |
| Hove (Company) | May 10, 1901 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Hull (Municipal) | Sept. 20, 1901 | Woolwich (Company) | May 31, 1901 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | July 19, 1901 |
| Kensington & Knightsbr'(Co.) | Mar. 16, 1900 | | |

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| | LEEDS. | AYR. |
|---|---|---|
| *Undertaking Worked by* | Leeds Corporation. | Ayr Corporation. |
| *Date of Commencement of Supply* | May, 1893. | January, 1896. |
| *System of Supply* | Alternate-current transformers. | Alternate-current transformer sub-stations. |
| *Chief Engineer* | Harold Dickinson. | Arthur J. Fuller. |

| YEAR ENDED | MARCH 25, 1900. | MARCH 25, 1901. | MAY 15, 1900. | MAY 15, 1901. |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | — | — | 499,355 | 553,615 |
| „ **SOLD (TOTAL)** | 2,005,840 | 2,520,414 | 425,639 | 490,496 |
| „ sold to consumers | 2,004,840 | 2,519,414 | 168,039 | 170,736 |
| „ sold for public lighting, &c. | 1,000 | 1,000 | 257,600 | 319,760 |
| „ used on works | 47,239 | — | 12,000 | 12,000 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 21·1 | 20·05 | 21·8 | 25·1 |
| Maximum supply demanded | 3,426 kilowatts | 4,268 kilowatts | 256 kilowatts | 282 kilowatts |
| Number of public lamps | 1 arc | 1 arc | 82 arc, 117 (32 c.p.) glow | 85 arc, 146 glow |
| Number of consumers | 1,394 | 1,829 | 356 | 450 |
| Connections to mains in 8-c.p. lamps | 106,263 | 132,283 | 17,912 | 20,069 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 95,000 | 125,600 | 19,500 | 19,500 |
| **CAPACITY OF PLANT IN KILOWATTS** | 3,040 | 4,020 | 625 | 625 |

| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| **AUTHORISED (TOTAL)** | — | — | — | — | £50,000 | £80 | £70,000 | £112 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | — | — | — | — | 50,000 | 80 | 70,000 | 112 |
| **RECEIVED (TOTAL)** | £226,521 | £74·6 | £217,420 | £54·1 | 48,377 | 77·4 | 55,962 | 89·5 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 226,521 | 74·6 | 217,420 | 54·1 | 48,377 | 77·4 | 55,962 | 89·5 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | — | — | — | — | 1,623 | 2·60 | 14,038 | 22·5 |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | 1,623 | 2·60 | 14,038 | 22·5 |
| **REPAID (TOTAL)** | 9,101 | 2·99 | — | — | 2,000 | 3·20 | 2,000 | 3·20 |
| **RESERVE OR SINKING FUND** | — | — | 12,949 | 3·22 | 993 | 1·59 | 2,068 | 3·31 |
| **DEPRECIATION FUND** | — | — | —[e] | — | — | — | — | — |
| **EXPENDED (TOTAL)** | 307,522 | 101 | 368,098 | 91·6 | 46,865 | 75·0 | 56,158 | 89·8 |
| Lands and buildings | 70,337 | 23·1 | 76,350 | 19·0 | — | — | — | — |
| Plant | 129,267 | 42·7 | 154,787 | 38·5 | — | — | — | — |
| Mains | 95,254[a] | 31·3 | 133,856[f] | 33·3 | — | — | — | — |
| Miscellaneous | 12,665 | 4·17 | 3,105 | 0·773 | — | — | — | — |
| **BALANCE OF CAPITAL ACCOUNT** | −81,001[b] | −26·6 | −150,678[b] | −37·5 | 1,512 | 2·42 | −196[d] | −0·313 |

| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
|---|---|---|---|---|---|---|---|---|
| **TOTAL** | £36,221 | 4·335d. | £43,669 | 4·160d. | £5,200 | 2·933d. | £5,591 | 2·736d. |
| Revenue from supply | 34,066 | 4·080d. | 42,297 | 4·030d. | 3,123 | 1·762d. | 3,327 | 1·629d. |
| „ meters, &c. | 2,155 | 0·258d. | 1,328 | 0·126d. | — | — | — | — |
| „ public lighting | — | — | — | — | 1,933 | 1·091d. | 2,065 | 1·010d. |
| „ sale of lamps, &c. | — | — | — | — | — | — | — | — |
| „ miscellaneous sources | — | — | 45 | 0·004d. | 144 | 0·081d. | 199 | 0·097d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| **TOTAL COSTS** | £9,930 | 1·189d. | £13,769 | 1·311d. | £3,435 | 1·938d. | £4,159 | 2·034d. |
| **WORKS COSTS** | 6,165 | 0·738d. | 9,351 | 0·891d. | 2,610 | 1·472d. | 3,236 | 1·583d. |
| *Generation of electricity* | *5,695* | *0·682d.* | *8,406* | *0·801d.* | *2,222* | *1·254d.* | *2,956* | *1·446d.* |
| Fuel (including cartage, &c.) | 2,592 | 0·310d. | 4,727 | 0·450d. | 1,288 | 0·727d. | 1,994 | 0·976d. |
| Oil, waste, water, stores | 361 | 0·043d. | 402 | 0·038d. | 62 | 0·035d. | 74 | 0·036d. |
| Wages at station | 1,874 | 0·224d. | 2,447 | 0·233d. | 637 | 0·359d. | 639 | 0·313d. |
| Repairs and maintenance at station | 867 | 0·104d. | 830 | 0·079d. | 220 | 0·124d. | 245 | 0·120d. |
| *Distribution of electricity* | *470* | *0·056d.* | *945* | *0·090d.* | *217* | *0·122d.* | *178* | *0·087d.* |
| Wages, &c. | 224 | 0·027d. | 416 | 0·040d. | 165 | 0·093d. | 147 | 0·072d. |
| Repairs, renewals of mains, &c. | 246 | 0·029d. | 529 | 0·050d. | 52 | 0·029d. | 31 | 0·015d. |
| *Public lighting* | — | — | — | — | *171* | *0·096d.* | *103* | *0·050d.* |
| Attendance | — | — | — | — | 171 | 0·096d. | 102 | 0·050d. |
| Renewals | — | — | — | — | — | — | — | — |
| **MANAGEMENT AND PROPERTY CHARGES** | 3,764 | 0·451d. | 4,418 | 0·421d. | 825 | 0·465d. | 923 | 0·452d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *890* | *0·107d.* | *1,358* | *0·129d.* | *146* | *0·082d.* | *229* | *0·112d.* |
| *Management* | *2,874* | *0·344d.* | *3,060* | *0·291d.* | *679* | *0·383d.* | *693* | *0·339d.* |
| Salaries | 2,223 | 0·266d. | 2,485 | 0·237d. | 417[a] | 0·235d. | 410 | 0·201d. |
| Stationery, &c. | 137 | 0·016d. | 128 | 0·012d. | 50 | 0·028d. | 36 | 0·018d. |
| Establishment charges | 194 | 0·023d. | 247 | 0·024d. | 35 | 0·020d. | 24 | 0 012d. |
| Law charges, &c. | 320[c] | 0·038d. | 200[g] | 0·019d. | 177[b] | 0·100d. | 223[e] | 0·109d. |

| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
|---|---|---|---|---|---|---|---|---|
| **WORKING PROFIT FOR YEAR** | £26,291 | 9·73% | £29,900 | 8·85% | £1,765 | 3·89% | £1,433 | 2·78% |
| Sum carried to Depreciation Fund | — | — | — | — | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 5,316 | 1·97% | 7,633 | 2 26% | 930 | 2·05% | 1,051 | 2·04% |
| Net interest on loans (incl. Debenture charges) | 12,473 | 4·62% | 15,385 | 4·55% | 1,531 | 3·37% | 1,509 | 2·93% |
| **BALANCE FROM LAST ACCOUNT** | — | — | — | — | — | — | — | — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 8,502 | 3·15% | 6,882 | 2·04% | — | — | — | — |
| *Deficit* | — | — | — | — | *696* | *1·53%* | *1,127* | *2·19%* |
| **ORDINARY DIVIDEND PAID** | — | — | — | — | — | — | — | — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 27·4% | | 31·5% | | 66·1% | | 74·4% | |
| Expenditure per kilowatt capacity | £3. 5s. 3d. | | £3. 8s. 6d. | | £5. 9s. 11d. | | £6. 13s. 2d. | |
| **REVENUE PER KILOWATT CAPACITY** | £11. 18s. 0d. | | £10. 17s. 5d. | | £8. 6s. 5d. | | £8. 19s. 0d. | |
| Expenditure per 8-c.p. lamp capacity | 2s. 1d. | | 2s. 2¼d. | | 3s. 6¼d. | | 4s. 3d. | |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 7s. 7½d. | | 6s. 11½d. | | 5s. 4d. | | 5s. 8¾d. | |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 6s. 9¾d. | | 6s. 7¾d. | | 5s. 9¾d. | | 5s. 6¾d. | |
| Price charged for lighting, per unit | 4½d. to 5d.[d] | | 4¾d. to 5d.[d] | | 5d. | | 5d. | |
| Price charged for power, per unit | 2d. less 5% | | 2d. less 5% disc. | | 3d. | | 3d. | |
| Price charged for public lighting | — | | 4d. per unit. | | £20 per arc per ann.[e] | | £20 per arc per ann.[e] | |

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*Telephone:* 949 Holborn. *Telegrams:* Electrician Newspaper London

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## THE RAPID TRANSIT PROBLEM IN LONDON.

A prominent American electrical engineer, Mr. Frank J. Sprague, who probably has done more than any other individual to develop electric railroading in America, has been visiting England during the past few months, with the object of studying the local conditions of the so-called "rapid transit problem" in this country, and particularly in the metropolis. An outline of his observations and conclusions is embodied in an article which he contributes to the current number of the *Engineering Magazine*. The central idea in Mr. Sprague's article is the provision of an unified and adequate system of electric underground railways for London, making the best use of existing material in the shape of steam and other railways already constructed, and supplementing this by means of interconnecting lines and junction stations. Mr. Sprague does not, of course, claim to have originated this idea; he merely makes it the basis of a scheme of practical development, carrying this scheme to such refinement of detail as actually to have drawn up a map of the London railways which would realise the project in its entirety. According to this scheme no promoters would be permitted to construct any railway purely for the purpose of creating or deriving benefit on that railway by itself; the fitness of each proposed line as an element of the unified scheme would alone justify its realisation. "Any road," he says, meaning by "road" what we call a railway, "should be authorised only as a part of a well-planned general scheme of traffic under the supervision of a central authority fully alive to London needs." Elaborating this idea, Mr. Sprague writes:—

> Every underground railway in London should be operated by a single local corporation, with concentration of management and undivided responsibility, aided by the most advanced methods of equipment and transportation. They should form a network gridironing London, connecting all important centres, the intersections, although at different levels, having common stations, except in the City, and in close contact with the stations of the existing suburban railways. Such a system can, by proper parliamentary authority, be created by the absorption and harmonising of the best parts of authorised roads and the addition of such others as will accomplish the required object without unnecessary duplication of tracks and routes.

Mr. Sprague proposes, indeed, a gigantic problem; neither the "well planned general scheme of traffic" nor the "central authority fully alive to London needs" exists or is easily to

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be obtained, and both are essential to complete success. But we need not despair because complete success is not forthcoming; benefit may yet be derived from partial and limited success. The problem which Mr. SPRAGUE propounds can only be fully carried out when it is possible to build cities to satisfy fully the needs of future generations—when cities, that is to say, cease to grow by adaptation to immediate environment, but take shape and magnitude at the dictates of intelligent forethought. Nowadays, it is not a central ruling intelligence but the fortuitous concurrence of a thousand chances that determines what is the distribution of metropolitan traffic in any given decade. Perhaps it is happier that it is so; we need not now inquire; but, at any rate, we are at the present time suffering for the lack of foresight of our ancestral city builders in not providing each main thoroughfare with a capacious subway. Our ancestors dreamed not of electric supply nor of Post Office telephone tubes. Perhaps Mr. SPRAGUE and modern electrical engineers dream not—rightly—of the electric railway of the future generation when his scheme can have been fully matured.

Although it may appear hopeless, therefore, to crystallise a scheme of London underground railways to which all railway promoters, at present and in the immediate future, are to be rigidly confined, it is probable, as we have already said, that benefit could be derived from a limited adoption of this principle. We ourselves were the first to point out the need for organisation in the planning of metropolitan underground railways, and it is not our wish now to withdraw from this position. Difficult as it may be to realise the necessary conditions, the need for organisation by a central authority is evident, and it is no less pressing. The recent Parliamentary Committee on underground railways perceived this, and, although the matter lay beyond the limits of its reference, it embodied a tentative recommendation in its report, directing attenting to the necessity for such control. Assuming for the moment such a Metropolitan Railways Board to have been actually formed, one of its first duties would evidently be to settle upon a "well-planned general scheme of traffic." One of the most effective ways of obtaining such a scheme would be to offer a really substantial prize for the best scheme submitted under public competition. If the prize were to be made sufficiently tempting, the best talent in the kingdom would be engaged on the task; while the final public scheme could well embody all the best elements of all the good schemes submitted. With the publication of such a scheme, exhibited on a map, railway promoters would be informed as to the routes, &c., most likely to prove acceptable to the authorities; and, as Mr. SPRAGUE sagely observes, "capital will be more readily forthcoming" than it would be for an independent railway.

Upon the special example of "rapid transit in London" furnished by our Inner Circle and its accessory lines, Mr. SPRAGUE has much to say that is instructive and sometimes amusing. "The present operation," he writes, "is a travesty on rapid transit;" but he hopes that by the time his article goes to press arbitration will have settled upon an electrical equipment for this unlucky line. Alas, for the vanity of human expectations! the commencement of arbitration is just postponed until the end of this month. With regard to the future operation of this railway Mr. SPRAGUE makes definite recommendations, but it is too much to hope they will be adopted:—

> The eventual natural solution of the problem, so far as these roads are concerned, is their operation under one management, the abandonment of running rights of other roads over the Circle tracks, and equipment with a system which permits of the highest practical schedule, and trains varying in length and frequency according to service requirements. The Circle should be an exclusive highway, not a trunk stem for several railways, especially unless these are similarly equipped. The joint operation of steam and electric trains in the tunnel is, of course, not permissible, and until electric equipment is adopted on the branches there must necessarily be a delay of either passengers or trains at junction points. The needs of the travelling public as a whole will be much better met by a high-speed two-minute service on the Circle, with interchange of traffic at junction points, than by a 10-minute service, mixed with half-a-dozen outlying services which must in turn be also subordinated to the exigencies of local traffic.

Mr. SPRAGUE, by the way, describes the Inner Circle (between brackets) as an "ellipse"; which reminds us of the mathematician who objected to a certain London square not being called a parallelogram.

We have already stated that Mr. SPRAGUE expects to see existing suburban steam lines utilised in the general scheme of rapid transit. Upon this question he writes:—

> At certain hours of the day some of these have already nearly reached the limit of expansion by steam operation on existing tracks, and are seriously considering adding to their facilities by construction of tunnels for their suburban lines. Such construction is at present utterly unnecessary, and if these roads should operate their suburban traffic electrically, the trains at times of heaviest traffic being made up of two or three units, each having power enough to operate it at a proper schedule, the capacity of these roads could be very largely increased. On many of them there are from 11 to 13 cars in a train, even at times of light traffic, when the trains are often an hour apart. With station distances averaging 1¼ miles, the schedule speed is sometimes as low as 13 miles per hour. On such roads the train movements can not only be greatly increased at busy hours, but a traffic can be created at other hours by offering superior facilities in higher speeds, more frequent trains, and prompt connections with local feeders, which, quite apart from any economies of operation, would ensure a large return on the cost of an electrical equipment.

Whatever is to be said, in general, for or against the multiple-unit system, it is clear that Mr. SPRAGUE has misunderstood its applicability on our suburban steam lines, at any rate as a relief from their present congestion. It is the inability, at times of greatest congestion, to decrease the headway of the trains—*i.e.*, to run a more frequent service—which causes all the trouble. Upon many suburban railways the tracks are filled to the limit of safety during several hours every day, and a decreased headway is practically impossible. No multiple-unit system will ameliorate conditions such as these, admirably adapted as it may be to the service during hours of lighter traffic. Nor can the construction of tunnels near the termini greatly help any but the most favoured of these railways; while it is manifestly impracticable on those lines which, running south of the Thames, have their termini on its north bank. These and other lines bringing a mixed suburban and main traffic into London are certain ere long to experience serious decrease in the suburban traffic, through the competition of surface electric tramways. It seems probable, therefore, that the railways which now suffer congestion through excessive suburban traffic in certain hours, will find salvation in an almost complete abandonment of the short-distance suburban traffic, reserving their resources exclusively for the more distant suburban towns and the main line services.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Thermo-magnetic Properties of Bismuth.*—L. Lownds has measured the thermo-magnetic constants of bismuth within limits of temperature and field strength considerably exceeding those attained by Van Everdingen, Yamaguchi and other previous observers. He used a plate of crystalline bismuth cut from a large crystal so that the chief crystallographic axis lay in the plane of the plate and parallel to its length. For the longitudinal thermo-magnetic effect the highest percentage change of thermo-electric force was 8·54, obtained with a field of 6,100 units, with the crystallographic axis normal to the

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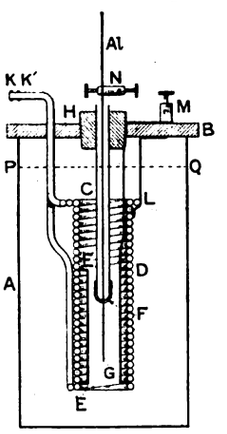
lines of force and parallel to the current of heat. With the crystallographic axis normal also to the heat current, the corresponding value was −3·50, and with the axis parallel to the lines of force and normal to the heat current the effect was 0·97 per cent. at 4,400 units. As regards the transverse thermo-magnetic effect, the author found for low temperatures (−130deg.) and large field strengths a diminution of the effect, whereas Yamaguchi found a continuous increase with falling temperature in electrolytic bismuth. The author also studied the thermo-electric force displayed by bismuth in various directions, and found that parallel to the axis it was 1·91 times as strong as normal to the axis. Perrot found 2·0 for the same ratio.

[L. LOWNDS, *Phil. Mag.*, October, 1901.]

*Glass Cutting.*—All glass-cutting processes are good when carried out by good operators, but some processes are more certain in their working than others. G. Roy recommends the use of the thermal cauteriser, which has given satisfaction in the laboratory of Dijon University for the last three years Instead of using the Berzelius carbon, or a hot copper wire, the author uses a "thermo cautère" in conjunction with an enamelling blast. To cut a tube a crack is made by means of a light blow. The instrument is heated and placed lightly in advance of the crack, and the latter at once extends in the direction thus marked. The operation succeeds the better after the course of the crack has been marked out with a diamond. The crack obeys with such precision that it can be made nearly to turn a right angle. It is thus possible to cut a tube in any direction, or to take the bottom out of a flask, or to prepare a spherical vessel with any aperture. In this connection it should be remembered that Dvorak makes glass sieves by puncturing a glass globe with a red hot arc carbon, touching the surface lightly with it. These sieves have been kept for months without cracks appearing in them.

[G. ROY, *Journ. de Phys.*, October, 1901.]

*Aluminium Rectifiers.*—W. Mitkiewicz believes that the electrode of an aluminium rectifier practically consists of a




large number of Wehnelt interrupters mounted in parallel. The glow on such an electrode resolves itself under the microscope into an infinitude of minute luminous stars, making as many punctures of the thin film of aluminium oxide which covers the electrode. If the analogy holds good, it is not surprising that one phase of an alternating current is suppressed, since Wehnelt's interrupter does the same. Since, in an aluminium rectifier, the whole surface of the electrode does not take part in the transmission of the current, but only a portion of it, it is not necessary to employ large surfaces. The author uses an aluminium wire, cleaned by scraping with a knife. The rectifier is shown in the diagram. It contains a solution of bicarbonate of soda. A is a 5-quart glass vessel, B a lid of oak, carrying the leaden cooling worm D. EE is the second electrode, a leaden cylinder. H is a perforated stopper carrying the glass tube C, which contains the aluminium wire, and carries a rubber cap F. The author gives instructions how to rectify two-phase and three-phase currents with this apparatus.

[W. MITKIEWICZ, *Physikal. Zeitschr.*, September 28, 1901.]

*Effect of Illumination upon Metallic Surfaces.*—When a metallic plate is illuminated by ultra-violet light it easily loses a negative charge, but this loss is not maintained at the same rate on prolonging the illumination while maintaining the potential. The discharging power of the ultra-violet rays seems to exhaust itself. After a prolonged exposure the plate is no longer sensitive, and requires keeping in the dark for some time before showing any photo-electric effect; or the action can be restored by renewing the surface, as is done easily in the case of amalgamated zinc by simply wiping it. M. Buisson, who has paid special attention to this matter, notices that it is connected with other physical properties of metals, notably the difference of potential established on contact. The illuminated metal becomes more strongly negative. But, again, this modification is not permanent, and it rapidly disappears in the dark. The effect is independent of the gas surrounding the metals. Various photographic facts also show analogies, notably the fact that an exposed plate cannot be developed after long storage in the dark. The modification of metallic surfaces only affects an extremely thin surface layer, and exerts no influence upon optical polarisation. It is due, according to the author's opinion, to condensed or occluded gas or vapour.

[M. BUISSON, *Journ. de Physique*, October, 1901.]

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

**A Treatise on Magnetism and Electricity.** ANDREW GRAY, LL.D., F.R.S. Vol. I. (London: Macmillan & Co., Ltd.) 14s. nett.

This treatise, to be completed in two volumes, deals with the subject of electricity and magnetism from the point of view of action in a medium. It is not merely a treatise on the mathematical theory of electricity, but combines to a certain extent practice with theory. While assuming some elementary acquaintance on the part of the reader with electrical phenomena and laws, the author has endeavoured first to look at the phenomena as they present themselves, and then to show how they fall into their places in the general scheme of electrical action, and to point out the consequences to which they lead.

Vector analysis is not employed, but the physical meaning of the quantities symbolised is insisted on as far as possible. A new and valuable feature in this work is the introduction of two chapters, occupying about 100 pages, on general dynamical theory and fluid motion. These two chapters provide in easily accessible form all that the student can require for an intelligent apprehension of the special dynamical methods used in the book, and so save him from having to disentangle what is wanted from a web of connected matter in a treatise on higher dynamics.

The first four chapters of Vol. I. deal with Magnetism. Chapter V. with Elementary Phenomena and Theory of Electrostatics. Chapter VI. with Steady Flow of Electricity in Conductors. The next two chapters with General Dynamical Theory and Motion of a Fluid. The succeeding chapters treat of Elementary Facts and Theory of Electromagnetism, Induction of Currents, General Electromagnetic Theory, the Voltaic Cell and Thermo-electricity. The chapter on General Electromagnetic Theory deals with the electromagnetic theory of light and Hertz's experiments, flow of energy in the electromagnetic field, and moving electric charges, giving the theory and experimental verification of the Zeeman effect.

This book, like all those by Prof. Gray, is admirably and clearly written. E. C. R.

**Telegraphy in the Nineteenth Century.**—In the October number of *St. Martin-le-Grand* Sir W. H. Preece gives a very full historical summary of telegraphic progress since the first practical trial in 1837. The article is well furnished with tables, which show the marvellous progress which is even still taking place.

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## MODIFIED BLAVIER TEST.

BY WALTER J. MURPHY.

There are occasions when tests on the Blavier principle are the only methods by which a fault can be localised, such as when an efficient assistant at the further station is not available, or because the apparatus necessary to obtain observations at that end of the cable cannot be obtained. The Blavier test itself is, as is well known, only reliable in a very limited number of cases. It is only really so when the resistance of the fault is somewhat about that of the line beyond it, and when great care is taken to so adjust the testing currents as to maintain a certain constant flow through the fault throughout the test. The reason for the unreliability of the Blavier lies in the fact that the further end of the cable is to earth during one stage of the test and free during another, a change in the conditions which makes it very difficult to maintain a constant current flow, and causes the fault to become very restive. Tests which require this change in the conditions are always very unsatisfactory.

With the above facts in view, the following method has been elaborated to afford a means of localising a fault with minimum assistance at the further end. Few cases can arise in which it will be impossible to insert and remove a resistance at the further station, for even the speaking instrument itself may be made to do duty as such on emergency. The rationale of the method is, that if the normal resistance of the line is subtracted from the results obtained with K earthed in the first place and K free in the second, and the ratio of the

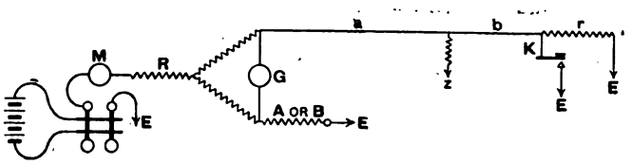


FIG. 1.

differences ascertained, a simple formula enables the distance of the fault from the far end to be quickly and easily calculated. The argument of the formula is as follows:—

$$L = a + b. \qquad A = a + \frac{bz}{b+z}. \qquad B = a + \frac{(b+r)z}{b+r+z}.$$

$C_A$ = current used when observing A.

$C_B$ = current used when observing B.

Best ratio of currents, $C_B = C_A \frac{A-a}{B-a}$.

$$f_1 = L - A = b - \frac{bz}{b+z} = \frac{b^2}{b+z}, \quad \therefore z = \frac{b^2}{f_1} - b. \quad . \quad . \quad (I.)$$

$$f_2 = (L+r) - B = (b+r) - \frac{(b+r)z}{b+r+z} = \frac{(b+r)^2}{b+r+z},$$

$$\therefore z = \frac{(b+r)^2}{f_2} - (b+r). \quad . \quad . \quad . \quad (II.)$$

Combining (I.) and (II.).

$$\frac{b^2}{f_1} - b = \frac{(b+r)^2}{f_2} - (b+r), \quad \therefore \frac{f_2}{f_1} b^2 = (b+r)^2 - f_2 r. \quad (III.)$$

If $\frac{f_2}{f_1} = n$ (III.) may be written

$$nb^2 = b^2 + 2br + r^2 - f_2 r,$$

$$b^2(n-1) - 2br = r^2 - f_2 r,$$

$$b^2 - 2b\left(\frac{r}{n-1}\right) + \left(\frac{r}{n-1}\right)^2 = \frac{r^2 - rf_2}{n-1} + \left(\frac{r}{n-1}\right)^2,$$

$$\therefore b = \frac{r}{n-1} + \sqrt{\frac{r}{n-1}\left(\frac{r}{n-1} + r - f_2\right)} \quad (IV.)$$

And when $n = 2$, $\quad b = r + \sqrt{2r^2 - rf_2}$. . . . . (V.)

A knowledge of the conditions under which $n$ becomes 2 affords a good guide for the adjustment of $r$, and assists in obtaining an appreciation of the sensitiveness of the test as it progresses. It will be the case when $\frac{(b+r)^2}{b+r+z} = 2\frac{b^2}{b+z}$, that is, when $f_2 = 2f_1$. (See I. and II.). Simplifying, $(b+r)^2 = 2b^2\left(1 + \frac{r}{b+z}\right)$.

Taking the case in which $z = b$, that is, when the resistance of the fault is equal to that of the cable beyond, $n = 2$ when $(b+r)^2 = 2b^2\left(1 + \frac{r}{2b}\right)$, or when $r = -\frac{b}{2} + \sqrt{b^2(1{\cdot}25)}$, that is, when $r = 0{\cdot}618b$.

Again, when $z$ is very high and $\frac{b+r+z}{b+z}$ is therefore practically $= 1$, $(b+r)^2 = 2b^2$ and $n$ will then $= 2$ when $r = -b + \sqrt{2b^2}$, or $r = 0{\cdot}414b$. So that to maintain $n = 2$, $r$ need only be changed from $0{\cdot}414b$ to $0{\cdot}618b$, though the fault vary from a very high resistance to the value of $b$. Thus the added resistance $r$ need never be higher than $b$ to give good appreciation.

*Errors of Observation.*—It is important to note that if in observing A an error of, say, $-e$ is made, causing a discrepancy of $+e$ in $f_1$, that an error in the *same* direction in observing B, tends to correct the value of the ratio $n$, and so reduce the error in the final result $b$; so much so that if the error in $f_2$ be $n$ times that in $f_1$ the error in $n$ vanishes. The error in the final result, however, is not thereby entirely eliminated because $f_2$ enters a second time into the formula, though with greatly diminished effect.*

Errors in A and B and consequently in $f_1$ and $f_2$, when in opposite directions, even if small, have on the other hand a powerful effect on $n$. Care should therefore be taken to ensure that all errors of observation are in the same direction. (This is true also of observations of the milammeter for current strength ratios.) It will, in fact, be as well to make sure they are so, and that they will cancel in calculating $n$, by deliberately adjusting both A and B slightly short of true balance, and making the discrepancy in B about $n$ times greater than in A. The amount of error thus allowed in B should be noted, and applied to the resulting $f_2$ to obtain a truer value of that factor for use in the second expressions of the formulæ (IV.) and (V.)

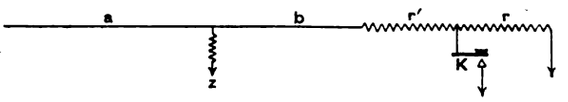


FIG. 2.

*To Increase the Sensitiveness.*—Since the $f_1$ and $f_2$ are practically proportional to the square of the resistance beyond the fault, the sensitiveness of the test is greatly increased by inserting a relatively small resistance, $r'$, between $b$ and K (Fig. 2). This can be done with advantage whenever $b + r$ is less than $z$. $L + r'$ is then taken as L and $r'$ subtracted from the result to obtain $b$, the distance of the fault from the further station.

*Check Tests.*—A check on the result of any series of tests may be obtained by increasing $r$, and so raising the value of $n$ towards 3 or 4, or by adding $r'$ and raising $r$ to maintain the value of $n$.

*The Resistance of the Fault.*—The resistance of the fault during tests should always be ascertained and kept in mind. It may be conveniently calculated as follows: $z = \frac{b^2}{f_1} - b$.

*Manipulation.*—Join up with a milammeter M, and an adjustable resistance, R, in the battery circuit; and having obtained a rough idea of the position of the fault, instruct the distant station to join up a key, K, and resistance, $r$ (whose value should be about half $b$), as shown, and to depress and raise the key every alternate minute for, say, 10 minutes.

*With Key Down* ($r$ not in circuit), adjust the testing current to as high a value as the fault will stand without showing

* NOTE.—An error in the value accepted for L (say, for instance, due to doubt as to ship's position) is comparatively unimportant for the same reasons.

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unsteadiness, or to as high a value as is prudent, other things considered. Observe E.C. *after* current has been on and balance to it to obtain A.

*When Key is Raised* at end of minute, reduce current to 0·75 of its previous value if $z$ is anything like the value of $b$, or to 0·5 if $z$ is very high (over 20 times $b$), and after applying battery for a few seconds observe the E.C. and obtain balance B.*

Having verified A and B by second readings adjust currents more closely for the remaining observations, making $C_B = C_A \frac{A-a}{B-a}$. This should ensure constant potential at the fault.

Take five or 10 readings each of A and B alternately, and choose two or three of their lowest and steadiest values (which should be the last observed) to calculate $n$.

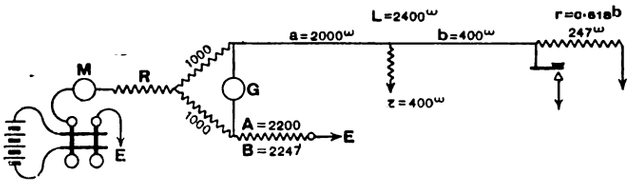


FIG. 3.—Case I.—$z$ low.

Reduce currents if fault unsteady and increase if appreciation not good or E.C. strong. Note appreciation and ascertain what difference in fault's position probable error will make.

M is placed in battery circuit to double the readings and so ensure closer adjstment of currents. *Use zinc to line only.*

It will be found that the longer an uninterrupted series of tests is continued, the lower and steadier the fault will become. It is best, therefore, to arrange for a long continued alternate freeing and earthing of K and to reduce the signalling of results, &c., during the localisation of the fault to a minimum. When the fault is very erratic and apt to seal it is as well to use Morse signals and zinc only for speaking, whatever the receiving instrument may be. One of the advantages of this method is that the receiving instrument may be kept in circuit either as $r$ or a part of $r$ or as $r'$, &c., and instructions to raise or lower $r$ by tens or hundreds

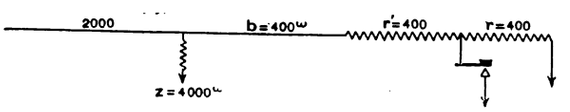


FIG. 4.—Case II. improved by adding $r'=400^\omega$ to $b$.

of units transmitted by the use of a simple preconcerted code of dots and dashes; thus, three dashes might be made to mean "Reduce $r$ 30 ohms," three dots "Increase $r$ 30 ohms," &c.

*Examples.*—Case I.—$z$ low.

$$C_A = 24{\cdot}7^{ma}, \quad C_B = 20^{ma}.$$

$$\left.\begin{aligned} f_1 &= L - A = 2{,}400 - 2{,}200 = 200^\omega \\ f_2 &= (L+r) - B = 2{,}647 - 2{,}247 = 400 \end{aligned}\right\} n = 2 \therefore b = r + \sqrt{2r^2 - rf_2}.$$

$$\begin{aligned} r^2 &= 247^2 = 61{,}009 & 2r^2 &= 122{,}018 \\ -rf_2 &= 247 \times 400 & &= 98{,}800 \\ 2r^2 - rf_2 & & &= 23{,}218 \\ \sqrt{2r^2 - rf_2} & & &= 153 + r = 400^\omega = b. \end{aligned}$$

Case II.—$z$ moderately high.

$$a = 2{,}000. \quad b = 400. \quad r = 0{\cdot}5b = 200, \quad z = 4{,}000^\omega.$$
$$A = 2{,}363{\cdot}6. \quad B = 2{,}521{\cdot}7. \quad L = 2{,}400^\omega.$$
$$f_1 = 36{\cdot}4. \quad f_2 = 78{\cdot}3. \quad n = 2{\cdot}15. \quad n-1 = 1{\cdot}15.$$

$$\therefore b = \frac{r}{n-1} + \sqrt{\left(\frac{r}{n-1}\right)\left(\frac{r}{n-1} + r - f_2\right)} = 400{\cdot}6^\omega.$$

Case II. improved by adding $r' = 400^\omega$ to $b$.

$$A = 2{,}667^\omega. \quad B = 2{,}923^\omega. \quad L + r' = 2{,}800^\omega. \quad r = 0{\cdot}5(b + r').$$
$$\left.\begin{aligned} f_1 &= 2{,}800 - 2{,}667 = 133^\omega \\ f_2 &= 3{,}200 - 2{,}923 = 277 \end{aligned}\right\} n = 2{\cdot}076. \quad n-1 = 1{\cdot}076.$$

$$\therefore b = \frac{r}{n-1} + \sqrt{\left(\frac{r}{n-1}\right)\left(\frac{r}{n-1} + r - f_2\right)} = 400^\omega.$$

*Note.*—$f_1$ and $f_2$ are thus nearly four times greater than in Case II. though A and B are only slightly higher.

* The limited range of the ratio the testing currents bear to one another is rather surprising at first sight, but it can be proved. For if $z$ is infinitely high, the ratio of the currents should be inversely as the combined resistances of the fault and the line beyond. (*See* Young's "Electrical Testing for Telegraph Engineers," page 161.)

$\frac{C_B}{C_A}$ should be as $\frac{zb}{z+b} \div \frac{z+b+r}{z(b+r)}$.

Taking $b=r$, where $z$ is infinitely high, the above reduces to $\frac{C_B}{C_A} = \frac{bz}{2bz}$ or 0·5. When, on the other hand, $z=b=r$,

$$\frac{C_B}{C_A} = \frac{b^2}{2b} \times \frac{3b}{2b^2} = 0{\cdot}75.$$

## A GRAVE SITUATION.*

It is a good many years since we instituted this column of observations upon the current aspects of those electrical industries, more especially electric lighting, in which the followers of the gas industry are interested as trade rivals. It has been our professed motive, in publishing these notes to exhibit the "seamy side" of the subject, which is not turned to the public gaze in any other periodical. While all the newspaper press, and most scientific journals, have agreed to puff electric lighting, here the cold facts of the matter have been displayed, without malice as without favour. We withstood the Brush mania at its height; predicted, and in due time recorded, the downfall of all the early electric light companies; and have exposed the craze of municipal electric lighting, which has saddled so many local government areas with additional burdens where they expected financial assistance. All this, from our selected point of view, has been quite the right and proper thing to do; but the time has arrived when it becomes incumbent upon us to ask ourselves and our readers how the case stands. We cannot tell, of course, whither these words of warning criticism have penetrated, nor whose money they may have helped to divert from a losing venture. The fact remains that, although there are no fresh electric lighting companies of the old pattern started, those that are actually in the business hang on; and the disappointment of local authorities who have electric lighting undertakings does not prevent others following in their tracks. A new one was started in Battersea only last week.

Far as it yet is from overtaking the annual increase of the gas industry, electric lighting holds on, and ever grows. This circumstance weighs more with the investing class of the community than those who keep their gaze fixed upon gas property are able to realise. The stoppage of the growth of one or two leading gas undertakings, although referable officially to the weather and all sorts of collateral circumstances, has been understood by outsiders as an indication that gas has seen its best days. Of course, we know that this judgment is mistaken; but the serious matter for gas people is that it should exist in any quarter. The story goes that a man who had a considerable sum of money to invest recently was minded to put it into gas, but was dissuaded by his broker, who advised a good railway stock instead, on the ground that gas is bound to go down in the long run before electric light. This is a grave situation, which no light-hearted optimism in gas company board rooms is competent to relieve. What is wanted, without question and without a moment's unnecessary delay, is a general rising to the occasion, on the part of gas officialdom. The way was indicated last week by the chairman of the Commercial Gas Co., who was able to claim that a serious check had been put upon the development of the public electric lighting in the company's district, by the adoption on their part of the system of incandescent lamp installation and maintenance, at cost price. This is the only way, at present, to carry the war into the enemy's country. It is fatal for gas companies to sit still and wait for custom. If gas directors and officials cannot come out of their shell and push trade, their fate will all too soon overtake them.

Experience proves, in many instances, that where gas companies go in heartily for incandescent burner maintenance, at cost price, electric lighting cannot make headway. Consequently, if it is prevented from growing, its premature decease is brought well within the bounds of possibility. That is the result which every right-spirited gas official should keep in view as his end and aim in this connection. Let but a single electric lighting company be killed by energetic gas competition, and the gloomy finance that threatens some big gas undertakings will be brightened up, as by magic. Too much good-humoured toleration of trade rivals has characterised leading gas companies in

* From the *Journal of Gas Lighting* October 8, 1901.

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the past. Some of these have now learnt how annoying even a slight check to their accustomed expansion may be ; and they ought to be thinking how best they can take their coats off to make trade again. The recipe is that found by the Commercial Company, after its value had been proved by Sheffield, the South Metropolitan Company, and many others. Only a gas undertaking can do the needful work, because nobody else has the necessary interest. Some gas officials talk in public and private about the cost and fragility of incandescent mantles, and querulously inquire when the first will be reduced and the latter corrected. Such questions are only a cloak for indolence and neglect of duty. If incandescent mantles were on sale at a penny a piece these grumblers would still have something to complain of them. As to the fragility, this is nothing in the hands of a person familiar with the fixing of the mantle, and they can never be made strong enough to endure the tender mercies of the average domestic servant. Let gas companies bestir themselves, and do the best they can with the means already at hand, and improvements will come in the natural order.

This, then, is the "moral" of the present story. Gas investments are not held in the estimation they should command, primarily because electric lighting has made inroads upon the preserves of some big undertakings. On the other hand, gas has not yet in a single instance definitely stopped the career of an electric lighting undertaking. The latter continue to grow ; and although their capital grows also, and their state is not usually prosperous, still they often appear to hurt gas if they do not benefit themselves. That is how the ordinary investor sees it. He would not put any money into electric lighting ; but neither will he entrust it to gas directors as a matter of course. It is for the gas interest to drop their reserve, and act like any sensible shopkeeper threatened with new competition. If his shopmen are not up to the mark, he gets younger and smarter ones in their stead. Let gas directors stop blaming the weather for their bad returns, and work incandescent lighting for all it is worth. Then we might see something of what gas is capable of doing on a competitive basis. It is to be feared, however, that some boards which most need reform are past it, through age and personal preoccupations.

## POWER-FACTOR INDICATORS.*

The Paper of Prof. William Hand Browne, Jun., read before the American Institute of Electrical Engineers, on the above subject opens with an examination of the principles involved in power-factor instruments for use on circuits where it is desirable to balance wholly or partly the wattless component of current due to induction motor, by the use of synchronous motors or converters. It is shown that measurements for determining the phase angle are unsatisfactory when involving the cosine, if the cosine approaches unity. We mus measure either the phase angle directly or indirectly, or what in most cases would be equally satisfactory, the wattless volt amperes ; that quantity Mr. Steinmetz has called the "wattless power." Unfortunately, few of the methods suggested for measuring these quantities are more than laboratory methods, and the instruments used are unsuitable for practical work. The split dynamometer of Blakesley, the three-voltmeter method of Fleming, and the three-ammeter method of Sumpner are too familiar to need description and are hardly applicable under the usual operating conditions. There are, however, two or three instruments which give satisfactory service under proper conditions.

Power-factor indicators are classified in the Paper under four heads :—

1. Phase meters, by which the phase angle is determined directly.
2. Power-factor meters, measuring a function of the phase angle.
3. Wattless power meters, measuring EI sin $\phi$.
4. Wattless current meters, measuring I sin $\phi$.

In the first class there may be included, in addition to types to be described below, all forms of oscillographs and curve tracers. The second class may include all instruments measuring sin $\phi$ and tan $\phi$ as well as cos $\phi$.

These classes may be further sub-divided, according to the means employed to obtain an indication, into four types :—

(*a*) Electromagnetic, using the force of attraction of electromagnets.

(*b*) Electro-dynamic, utilising the reaction between coils carrying currents.

(*c*) Induction, a rotating magnetic field is set up and used to deflect a disc.

(*d*) Electrolytic, depending upon electrolysis to secure a record.

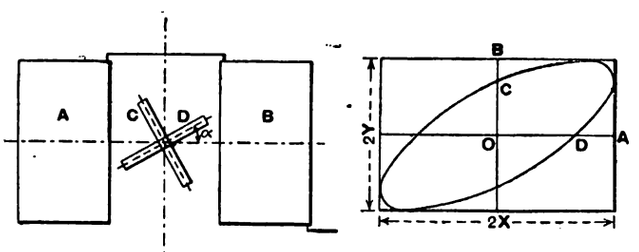
*Phase Meters.*—The various types of oscillographs and curve tracers are too well known to need description. In general they are laboratory instruments and not applicable to commercial working.

*Tuma's Phase Meter* (1*b*).—Let the pair of coils AB (Fig. 1) carry the current whose phase angle, referred to the E.M.F., is desired. Within the space between the two, suspended freely, is the movable system CD, consisting of two independent windings connected together mechanically at right angles. Let *a* be the angle which D makes with the axis of AB. The Paper then proceeds to show mathematically that *a* is the phase angle.

*Induction Phase Meters* (1*c*).—If we pass through two coils, concentric but set at an angle with each other, currents which set up equal fluxes differing, however, in phase, a rotating magnetic field of elliptical form will in general be created. If the two coils are inclined at an angle which is the supplement of the phase angle, the resulting field will have a constant value. An armature suitably placed in such a field will cause a ray of light reflected from an attached mirror to travel in a circle. In applying this method it is necessary to have the fluxes of equal value and to change the angle between the coils until the ellipse becomes a circle, when the phase angle is read off directly. The instruments of Angelmeyer, Korda, Hess, Rossi and one of Arno, make use of this principle.

*Electrolytic Phase Indicator* (1*d*).—A very simple device, due to Janet, consists of a metallic drum upon which rest two styli of iron. One of these is connected so as to have a difference of potential between it and the drum which is in phase with the current, the other one being in phase with the E.M.F. On the drum is stretched a sheet of paper which has been soaked in potassium ferrocyanide and ammonium acetate. When the difference of potential between either stylus and the drum reaches a certain positive value electrolysis begins, and the paper under that stylus turns blue. Now, if the drum be turned, each stylus traces a broken blue line on the paper, each blue mark representing part of a positive half wave. The angular distance from the centre of one of these short lines and that of the corresponding mark made by the other stylus, expressed in electrical degrees, is the phase angle. This is true only when the two waves have the same form.

*Power-factor Meters* (2).—Two harmonic motions acting at right angles and having the same frequency and amplitude, but a difference in phase of 90deg., will produce, if acting at the same time, a uniform circular motion. If the amplitudes are not the same, the result is an ellipse, the major and minor axes of which are the respective paths




FIGS. 1 AND 2.—POWER-FACTOR INDICATORS.

of the two harmonic motions. If the phase difference is not 90deg. the two axes of the resulting ellipse do not coincide in direction with the two harmonic motions.

*Puluj's Power-factor Meter* (2*a*).—The principle just described has been made use of by Puluj. Two electromagnets, through the winding of each of which, one of the currents, the phase difference of which is desired, is passed, act upon two armatures causing them to vibrate in planes normal to each other. A ray of light falling upon a mirror attached to one of these and reflected to a second mirror on the other, and thence to a screen, will describe an ellipse, the shape and position of which is determined by the values of the two currents and the phase difference. Referring to Fig. 2, it is shown in the Paper that sin $\phi = OC/OB = On/OA$.

*Morland's Power-factor Meter.*—In an apparatus described by Mr. Morland, the two conductors carrying the two currents pass between the poles of a permanent magnet. Each of these causes a small mirror to vibrate, producing the result just described.

*Claude's Power-factor Meter.*—Claude places the two electromagnets in direct opposition and causes them to actuate the same armature. Let the maximum flux set up by each coil be N. The ray of light reflected from the mirror will, under the influence of the flux N, oscillate along a path in length KN, K being a constant. If both coils were acting and if the currents were in phase, the length of this path would be 2KN. Call this $d_1$ and the path of the ray $d_2$ Then it is shown that

$$d_2/d_1 = \cos \phi/2.$$

It is evident from what has been said above that this method will not be accurate when $\phi$ approaches zero.

*Rayleigh's Power-factor Meter* (2*a*).—Lord Rayleigh's apparatus for measuring phase angles is somewhat similar to the above. The movable loop is replaced by a soft iron needle, and the two coils are placed on opposite sides of this. The deflections are measured as in a reflecting galvanometer. Mr. Edwin Place gives the results of a

* From the *Electrical World* of New York.



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great number of experiments made with an instrument of this type. He shows that the angle found in this way is that between the equivalent sine waves. The cosine of this angle, however, is not given by the ratio of true watts to volt amperes—the true power factor. Tuma describes an instrument similar to the above, but with the coils at right angles. One of these lies in the magnetic meridian. He shows that, with specially-wound coils, if $\phi$ is the phase angle and $\psi$ the angle between the needle and that coil which lies in the magnetic meridian, then $\cos\phi = \tan 2\psi$.

*Dynamometer Types.*—A Siemens electro dynamometer having two fixed coils may be used for phase angle measurements if the movable system be replaced by a coil closed upon itself and suspended in the plane of the other two. Suppose that with one current flowing in one of the coils the angle of torsion to keep the movable coil in its zero position is $d_1$, and with the other current flowing in the other coil it is $d_2$, and with both currents flowing at the same time the angle is $d_3$. Then $d_1 + d_2 - 2\sqrt{d_1 d_2}\cos\phi = d_3$, from which the phase angle can be deduced.

*Arno's "Tangent Phase Meter"* (2*b*).—A second power meter of Arno's consists of a Siemens' electro-dynamometer with an additional pair of coils closed upon themselves and fastened together at right angles. The pair, as a whole, is suspended within the two other coils and may be held in any position by a torsion spring. In Fig. 3 let A and B be the two coils of the dynamometer and C and D the pair of short-circuited loops.

Passing the two currents through A and B, respectively, the instrument becomes a wattmeter, and $d_1$ is the angle of torsion required to keep the movable coil in position. Now, fix B and pass one current through A, and the other through B. Let $d_2$ be the angle corresponding to the couple between A and B; then $\tan\phi = K d_1/d_2$.

*Breitfield's Method* (2*b*).—Mr. C. Breitfield has suggested an application of an ordinary wattmeter for measuring the power factor of a

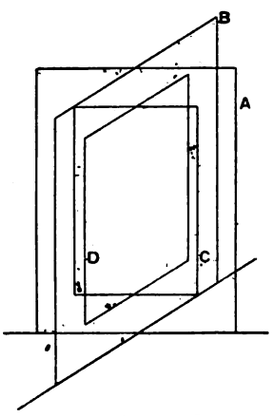


FIG. 3.—POWER FACTOR INDICATORS.

three-phase system. The current coil is placed in one line and one end of the pressure coil also connected to this line. The other end is first connected to the second line and then to the third. In the first case we have the deflection of $d_1$, and in the second a deflection of $d_2$. Then $\tan\phi = \sqrt{3}\left[\frac{d_1 - d_2}{d_1 + d_2}\right]$.

*General Electric Company's Instrument* (2*b*).—The well-known fact that the ratio of the readings of the two wattmeters used to measure the power of a three-phase system changes with the power factor and is unity when the power factor is unity, has been made use of by the General Electric Company to indicate the power factor. The instrument is simply two wattmeters of the dynamometar type, the movable coils of which are attached to the same spindle. The instrument deflects to the right or left, according as the current lags or leads, and stands at zero when the system is balanced and the power factor unity.

*Ferraris' Power-factor Meter* (2*c*).—Ferraris combines two harmonic fields, producing a rotating field of elliptical form. Within this field is suspended a short-circuited coil which can be held in any position, by a torsion spring, as is the movable coil of a Siemens dynamometer. The force required, and therefore, the angle through which the spring must be turned, to hold the coil in any position is proportional to the square of the intensity of the flux in that direction. Points can thus be determined and the ellipse plotted and the sine of the phase angle deduced as above. (See Puluj's method.)

*Power-factor Indicators* (3).—In the methods described above, the object sought was the determination of the phase angle. But few of these are applicable under the usual operating conditions. We might mention as useful forms, those of Tuma and the General Electric Company. In most cases, however, we are more concerned with the magnitude of the wattless component of current than with the power factor. We care less about the decrease in the total output than about the poor regulation caused by inductive loads. Instruments which will indicate the wattless current, or rather the wattless volt amperes, are easily made in commercial form.

*"Wattless Wattmeters." Dynamometer Type* (3*b*).—A Siemens dynamometer becomes a wattmeter indicating $EI\cos\phi$ when the current is passed through one coil and a current proportional to and in phase with the E.M.F. through the other. If the current in the pressure coil be in quadrature with the E.M.F. the instrument indicates $EI\sin\phi$, the wattless volt amperes. This is easily done with a two-phase system. With a single-phase system it is necessary to place a proper condenser or inductive reactance in series with the pressure coil.

*"Wattless Wattmeters." Induction Type* (3*c*). *Dobrowolski's Power-factor Indicator.*—In a fully-compensated induction meter the shunt flux is in quadrature with the series flux, the result of the two being a rotating or shifting field. If the shunt flux be brought into phase with the series flux an alternating field only will be set up as long as the current and E.M.F. are in phase. If, however, the current lags the field will rotate in one direction. If it leads the field will rotate in the opposite direction. The torque developed on a disc placed in this field is in either case proportional to $EI\sin\phi$, the wattless volt amperes. This is the principle of Dobrowolski's apparatus. The movable disc is held in its zero position by a spring when the wattless volt amperes are zero, but deflects one way or the other, when the current is out of phase, an amount proportional to $EI\sin\phi$. Any induction wattmeter can be used in this way provided the flux through the pressure coil be brought into phase with the E.M.F.

*Wattless Current Meters* (4).—The Allgemeine Elektricitäts Gesellschaft make an instrument which indicates the wattless current. This is really an induction wattmeter having the shunt flux in phase with the E.M.F. and indicates, therefore, only when there is a phase difference. As an instrument of this type indicates $EI\sin\phi$, it is presumed that this meter is graduated to read $I\sin\phi$ at normal voltage, and should properly come under "wattless wattmeters" (3*c*).

*The Siemens Electro-dynamometer.*—The Paper gives a set of curves which were taken with a Siemens dynamometer, the movable coil of which was in series with a capacity of 3·5 microfarads. The values of $\cos\phi$, $\sin\phi$ and $EI\sin\phi$ plotted have been computed from ammeter, voltmeter and wattmeter readings given in Table I. $EI\sin\phi$ is a straight line and is plotted above and below the axis to indicate lagging and leading currents respectively. The base is the deflection in degrees. These curves were taken for a constant power delivered of 500 true watts. The displacement of current was obtained by means of a phasing transformer. For comparison between $EI\sin\phi$ and $\cos\phi$ the axis of abscissæ was taken as unity for the latter, and the decreasing values plotted above and below this

**Table I.**—*Siemens Dynamometer as Power-factor Indicator.*

| Amp. I. | Volts. E. | Watts. EI cos $\phi$. | Deflection. | Direction. | Phase. | Apparent watts EI. | Power factors cos $\phi$. | Inductance factors sin $\phi$. | EI sin $\phi$. |
|---|---|---|---|---|---|---|---|---|---|
| 10·15 | 108 | 500 | 213 | Right | Lead | 1,096 | 0·456 | 0·889 | 975 |
| 8·4 | 108 | 500 | 158 | ,, | ,, | 907 | 0·552 | 0·834 | 755 |
| 7·58 | 107·9 | 500 | 141 | ,, | ,, | 818 | 0 611 | 0·791 | 647 |
| 6·51 | 108 | 500 | 106 | ,, | ,, | 703 | 0·711 | 0·703 | 494 |
| 5·63 | 107·8 | 500 | 78 | ,, | ,, | 607 | 0·823 | 0·568 | 294 |
| 5·25 | 107·8 | 500 | 53 | ,, | ,, | 516 | 0·884 | 0·467 | 241 |
| 4·78 | 105·5 | 500 | 13 | Left | Lag | 504 | 0·992 | 0·126 | 63 |
| 5·05 | 105·7 | 500 | 44 | ,, | ,, | 533 | 0·938 | 0·346 | 185 |
| 5·67 | 106·1 | 500 | 76 | ,, | ,, | 602 | 0·831 | 0·555 | 334 |
| 8·17 | 106 | 500 | 155 | ,, | ,, | 866 | 0·577 | 0·817 | 707 |
| 9·61 | 105·9 | 500 | 197 | ,, | ,, | 1,007 | 0·497 | 0·867 | 873 |

NOTE.—Pressure coil in series with 3·5 microfarads' capacity.

It is shown that these lines do not pass through the origin. The resistance of the pressure coil is not negligible, as the instrument shows a slight deflection at unity power factor. The curves show very clearly that a slight change in the power factor when near unity caused a comparatively large change in the value of $EI\sin\phi$. This fact is very striking when working with the instrument. It may be made to deflect considerably to the right or left without producing any appreciable change in the reading of the Weston wattmeter, the current and voltage remaining constant the while. Power factors for larger power delivered lie below the one just considered, and hence are still flatter when approaching unity. One for 1,000 true watts has been plotted from calculated values only. It shows that it would be practically impossible to say from ammeter, voltmeter and wattmeter readings alone when the current was in phase with the E.M.F. With the power-factor indicator, however, there would be no difficulty in getting an almost exact adjustment.

*Weston Wattmeter as Power-factor Indicator.*—The characteristic of a Weston wattmeter of 150 volts, 50 amperes capacity, used on a two-phase system in the manner described above, is given. The characteristic is a straight line, but does not pass through the origin.

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This may be due either to the slight inductance of the pressure coil or to a slight change in the phase angle between the impressed E.M.F.s, or to both. The method of calibrating consisted in connecting the pressure coils of the power-factor indicator and wattmeter respectively to the two primary windings of a two-phase induction motor, used as a phasing transformer. The current coils of the meters were in series and connected to the movable secondary. As the secondary is shifted the load is partially shifted from one phase of the primary winding to the other. This doubtless caused a slight change in the phase angle between the E.M.F.s at the motor terminals. The motor used was rated at 2 H P. The supply was drawn from two 4kw. transformers, both partially loaded, in addition, with lights.

**Table II.**—*Weston Wattmeter as Power-factor Indicator.*

| True watts. | Voltage. | Amperes. | Wattless volt amperes observed. | Phase relation. | Volt-amperes. | Power factor. | Inductance factor computed. | Wattless volt-amperes computed. |
|---|---|---|---|---|---|---|---|---|
| 1,970 | 111·5 | 44·4 | 4,530 | Lag | 4,950 | 0·398 | 0·917 | 4,540 |
| 1,970 | 111·5 | 29·8 | 2,690 | „ | 3,340 | 0·590 | 0·807 | 2,690 |
| 1,970 | 111·5 | 20·1 | 1,050 | „ | 2,240 | 0·879 | 0·477 | 1,070 |
| 1,970 | 111·5 | 17·7 | 180 | „ | 1,975 | 0·997 | 0·071 | 140 |
| 1,970 | 111·5 | 17·65 | 0 | ... | 1,970 | 1·0 | 0·0 | 0 |
| 1,970 | 111·5 | 20·1 | 1,130 | Lead | 2,240 | 0·879 | 0·477 | 1,070 |
| 1,970 | 111·5 | 29·8 | 2,785 | „ | 3,340 | 0·590 | 0·807 | 269 |
| 1,970 | 111·5 | 44·4 | 4,610 | „ | 4,950 | 0·398 | 0·917 | 4,540 |

The agreement between observed and calculated values of EI sin $\phi$ is good. Table II. gives observed and computed values for this instrument.

*Induction Motors.*—The Paper shows a set of curves obtained from a Shallenberger integrating wattmeter used as a power-factor indicator. The instrument is a 500 volt 10 ampere meter of the older type (1898). The reactive coil was replaced by a non-inductive resistance of 2,000 ohms. In series with this was a capacity of 3 microfarads, this being found to balance the inductance of the shunt coil at a frequency of 60 cycles. In this case the instrument was used as a recording meter. The curves plotted are EI sin $\phi$, cos $\phi$ and $\phi$, all on a revolutions-per-minute base, for a delivered power of 500 true watts. Table III. gives the instrumental readings and computed values for these curves. Table IV. gives results from the same meter under somewhat different conditions. Here the recording train was removed to lessen the friction, and a light steel spring attached to the spindle of the revolving disc. A pointer attached to the disc passed over a scale marked in degrees. The curves plotted are, as before, EI sin $\phi$, cos $\phi$ and $\phi$ for a delivered power of 500 true watts. The base is degrees deflection. It is shown that from 20deg. lag to 20deg. lead the deflection is almost directly proportional to the phase angle. The flattening of the curve for cos $\phi$ is very marked. This instrument was even more sensitive than the dynamometer and besides was dead beat, as the damping magnets were left in. Table IV. gives the instrumental readings and computed values for the curves.

**Table III.**—*Shallenberger Wattmeter as Power-factor Indicator. 10 amperes, 400 volts.*

| Amp | Volts. | Watts. | Revs. per min. | Direction. | Phase. | Apparent watts. EI | Power factor cos $\phi$ | Phase angle $\phi$ | Inductance factor sin $\phi$ | EI sin $\phi$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 01 | 111·3 | 505 | 30·8 | Left | Lagging | 1,114 | 0·449 | 630—10′ | 0·898 | 996 |
| 6 | 111·5 | 505 | 13·45 | „ | „ | 669 | 0·756 | 40—53 | 0·655 | 438 |
| 4·78 | 110·3 | 505 | 4·68 | „ | „ | 527 | 0·954 | 17—26 | 0·300 | 158 |
| 4·5 | 111·9 | 505 | 0 | „ | ... | 504 | 1·00 | 0 | 0 | 0 |
| 4·58 | 114·5 | 505 | 5·29 | Right | Leading | 525 | 0·962 | 15—50 | 0·273 | 143 |
| 6·09 | 112·2 | 505 | 14·6 | „ | „ | 684 | 0·738 | 42—26 | 0·675 | 462 |
| 10·0 | 111·2 | 505 | 30·6 | „ | „ | 1,112 | 0·454 | 63—00 | 0 891 | 992 |

NOTE.—Impedance coil cut out and shunt coil in series 3 microfarads and 2,000 ohms.

*Application of Power-factor Indicator.*—To illustrate the application of a power-factor indicator, the Weston wattmeter mentioned above was used to measure the wattless volt amperes taken by a General Electric 7½kw., 125-volt, four-pole synchronous converter for different values of field current. The converter was run on a two-phase system at constant input. The supply was drawn from two Westinghouse 7½kw. transformers, both fitted with a Hartford regulator. The output was absorbed by a lamp bank and water rheostat. Curves were plotted with armature current and wattless volt-amperes as ordinates, the base being field current. The imput was 3½kw. per phase. The flatness of the current curve alluded to above was quite noticeable here. The characteristic for wattless volt amperes was plotted above and below the axis of abscissæ to indicate lagging and leading currents respectively. The instruments were quite steady, a condition indicating but little hunting of the armature, although there were no devices on the machine to prevent this phenomenon. The power-factor indicator, although exactly like the wattmeter, was even steadier than the latter. There was no difficulty in setting the indicator to read any desired value by adjusting the field current. It was stated at a recent meeting of the National Electric Light Association, during the discussion of a Paper on synchronous converters, that it was practically impossible to operate a synchronous motor or converter at unity power factor. The reasons given were hunting of the armature and dissimilar E.M.F. waves of motor and generator. In the above experiment it was found that the power-factor indicator could be set at zero and under these conditions the true watts and the volt amperes were equal. This condition would seem to be that of practically unity power factor. A number of power-factor curves of synchronous converters have been published recently, in which the current passes from lag to lead without the power factor passing through unity. Even if it were impossible to hold the power factor at unity, it must pass through this value as it swings across the line. In Table V. are given the data which were obtained in a test, power factor being from wattmeter readings and inductance factor from the "wattless wattmeter" readings. In addition there were plotted two curves obtained by assuming these values to be cosines and sines of phase angles and the corresponding values of sines and cosines taken from tables and plotted on the same base. These deduced values do not agree at all with the observed ones. The discrepancy is greater for leading than lagging currents. This discrepancy, as has been pointed out by Mr. Steinmetz, is due to the distortion of the E M.F. and current waves.

**Table IV.**—*Shallenberger Wattmetsr as Power-factor Indicator.*

| Amperes. | Volts. | True watts. | Degrees deflection. | Direction. | Phase. | Apparent watts. | Cos $\phi$. | $\phi$. | Sin $\phi$. | EI sin $\phi$. |
|---|---|---|---|---|---|---|---|---|---|---|
| 8·29 | 110 | 500 | 75° | Left | Lag | 911 | 0·549 | 56°—42′ | 0·836 | 761 |
| 6·54 | 109 | 500 | 50 | „ | „ | 712 | 0·702 | 45—35 | 0·712 | 507 |
| 5·41 | 109·2 | 500 | 30 | „ | „ | 590 | 0 848 | 32—00 | 0·530 | 313 |
| 4·94 | 109 9 | 500 | 20 | „ | „ | 543 | 0·921 | 22—56 | 0·390 | 212 |
| 4·57 | 111·1 | 500 | 10 | „ | „ | 507 | 0·987 | 9—04 | 0·158 | 80 |
| 4·59 | 108·4 | 500 | 0 | ... | ... | 498 | 1 | 0 | 0 | 0 |
| 4·67 | 109 | 500 | 10 | Right | Lead | 509 | 0·982 | 10—53 | 0·189 | 96 |
| 5·35 | 108 | 500 | 30 | „ | „ | 578 | 0·865 | 30—07 | 0·502 | 290 |
| 6·45 | 109·7 | 500 | 50 | „ | „ | 707 | 0 708 | 45—05 | 0·706 | 498 |
| 8·16 | 108·7 | 500 | 70 | „ | „ | 886 | 0·564 | 55—40 | 0·826 | 732 |

NOTE.—Impedance coil removed and shunt coil in series with 3 microfarads and 2,000 ohms non-inductive resistance. Recording gear removed and light torsion spring attached to disc.

**Table V.**—*General Electric Synchronous Converter, 7½kw., 125-volt, Four-Pole 60 ∿, two-phase. Input, 3·5 kw. per phase.*

| Wattless kilovolt amperes. | Amperes armature current. | Voltage at brushes. | Amperes field current. | Phase relation. | Kilovolt amperes. | Power factor. | Inductance factor. | Sin computed from power factor. | Cos computed from inductance factor. |
|---|---|---|---|---|---|---|---|---|---|
| 5·55 | 61·6 | 109·9 | 0·57 | Lag | 6·76 | 0·518 | 0·822 | 0·855 | 0·569 |
| 2 62 | 40·9 | 109·9 | 1·03 | „ | 4·5 | 0·778 | 0·583 | 0·628 | 0·812 |
| 0 45 | 32·0 | 109·8 | 1·36 | „ | 3·51 | 0·997 | 0·128 | 0·077 | 0 992 |
| -0·05 | 31·9 | 109·8 | 1·47 | Lead | 3·50 | 1·0 | 0·014 | 0·0 | 0·999 |
| -0·45 | 32·1 | 110·0 | 1·55 | „ | 3·53 | 0·992 | 0·128 | 0·126 | 0·992 |
| -1·20 | 35·7 | 110·4 | 1·69 | „ | 3·94 | 0·888 | 0·306 | 0·460 | 0 952 |
| -3·65 | 51·3 | 110·0 | 2·22 | „ | 5·64 | 0·621 | 0·648 | 0·784 | 0·762 |
| -6·65 | 71·9 | 100·8 | 2·75 | „ | 7·89 | 0·444 | 0·844 | 0·896 | 0·536 |

*Conclusions.*—It would seem from the above that there is a decided need of an accurate power-factor indicator in all large installations, but especially in those in which induction and synchronous motors are used together. This method of operation has been adopted by the Deering Harvester Co., where adjustment of the exciting current of the synchronous machine is made by means of a wattmeter, and at Butte, Mont., where adjustment is made from ammeter readings. The advisability of adopting this composite system is not in question here. We are considering merely the best method of attaining the end sought. For accurate adjusting of the system the indications of the instrument should depend upon the values of $\phi$ or sin $\phi$ and not upon cos $\phi$. Instruments of the dynamometer or the induction type seem more suitable for operating conditions. If the meter be of the dynamometer type the resistance of the pressure coil must be negligible if it is to be used on a single-phase system, as the current in this coil must be in quadrature with the E.M.F. If the meter is to be used on a two or three-phase system the inductance of the pressure coil must be negligibly small and meter-connected in one of the methods described above. In this case care must be taken that the loads on the different phases be kept equal. In a two-phase system unbalancing the phases will shift the E.M.F.s relatively to each



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other. In a three-phase system, since the meters used are really wattmeters, unbalancing the phases will vitiate the indications of the instrument. If the meter be of the induction type the inductance of the pressure coil must be negligible, since not only is it undesirable to use condensers to compensate for this, both from their bulkiness and expense, but the presence of any reactance makes the deflection dependent upon the frequency. An attempt was made to improve upon the induction meter described above by removing the three-legged stampings of iron upon which the pressure coil was wound. The inductance was still too large for satisfactory working, and as the condensers in the laboratory were not sufficient to compensate for this, it was necessary, to make up for this lack of capacity and to avoid the use of iron, to add an auxiliary inductance wound on a wooden bobbin. The instrument thus modified was found to be so sensitive to slight changes in frequency that it was impossible to use it with any degree of satisfaction in the laboratory. Any change of load on the prime mover would so change the reading of the instrument as to make its indications extremely unreliable. Dobrowolski shows, in the reference given above, the application of his instrument for automatically adjusting the excitation of the synchronous machine so as to keep the power factor at unity at all times. The use of an instrument of this kind emphasises the fact that, when induction motors are used alone, the inductance factor is always a large percentage of the power factor. For instance, when the power factor is 0·85 the inductance factor, assuming sinusoidal waves, is nearly 62 per cent. of this—that is, for every 1,000 watts used by the motor, 620 "wattless watts" are, so to speak, borrowed. It would seem but fair that those who used induction motors should at least pay rental for the wattless volt amperes required. It is true this does not represent energy consumed, but it does, in a sense, represent energy borrowed and returned, and the station must have sufficient capacity in generators to meet all such calls for loans. The additional charge could be taken care of by over-compensating integrating wattmeters of the induction type, as suggested by Mr. Benischke. They would then read high on lagging reactive loads and low on leading reactive loads. This would put a premium on the use of synchronous motors as they, if not too greatly over-excited, help out in the regulation of the plant. The induction motor has so many points in its favour it can well afford to pay for what it needs—a large wattless component of current.

## CROSS-TALK IN TELEPHONE CABLES WITH WIRES LAID UP IN FOURS.*

BY JUL. H. WEST.

Calculating the electrostatic capacity in telephone cables, we find that we get lower capacity when the wires are laid up in fours than if they are laid up in separate pairs. In the former method the two wires lying diagonally opposite one another form the two conductors of each metallic circuit, and the calculation assumes that the planes of the two circuits will be normal to one another, so that the induction between both loops or circuits is balanced. It being of great importance, especially with long telephone cables, to lower as much as possible the electrostatic charge of the cable, the Post Office decided, in giving the order for the cable from London to Birmingham, that the wires should be laid up in fours; but when the greater portion had been put down, cross-talk was observed between the two loops of each four-strand. For this reason the rest of the line was made with wires laid up in pairs. In this article the reason why cross-talk appears and some means of eliminating it are discussed.

Fig. 1 represents a bundle of four wires insulated from one another by means of paper wound round each wire. As long as this bundle is *not* stranded, each wire will be concentric to the paper covering, as represented in Fig. 1, the wires resting on the edges of the loosely wound paper strips. But as soon as the bundle is stranded a pull occurs, which draws the wires (1) inwards towards the axis of the bundle, and (2) round the axis in the direction of stranding. As this pull only acts on the wires themselves, and not on the paper coverings, the wires are drawn out of their concentric position to the coverings, as shown in Fig. 2, in which figure the arrow *p* indicates the direction of the stranding. The first effect of stranding the bundle is, therefore (as it is also the case with the wires laid up in pairs), to increase the capacity by bringing the wires closer together. The effect is greater the tighter the wires are stranded, and therefore it is good to take as long a lay as possible. But even now no cross-talk will occur, the planes *ab* and *cd* of the two loops being still at right angles to one another.

In practice, the cross-section of the strand will never be as illustrated in Fig. 2, for the reason that, in stranding the four wires together, the four drums which carry the four wires will never have the same friction, one rotating easier than the others. The result is that one drum will effect on its wire a greater pull than the other drums on their wires, and this difference in the pull must necessarily cause a change in the cross-section of the bundle. This may be shown in the special case that one drum is rotating with very high friction whilst the other drums are rotating easily. In this case we get the section shown in Fig. 3, in which D represents the wire on which a strong pull is exerted, so that the wire D is pulled so tight that it forms the centre of the strand, whilst the three other wires, $D_2$, $D_3$ and $D_4$, are wound spirally round $D_1$, lying at first on the right side of $D_1$, then passing above it to the left side and returning below it to the right side again. The paper covering of $D_1$ will be pressed out to the other side, so that $D_1$ lies eccentric in its insulation but symmetrically to the insulations of $D_2$, $D_3$ and $D_4$. The smaller pull exerted on the wires $D_2$, $D_3$ and $D_4$, running spirally round $D_1$, forces these wires, as in the case of Fig. 2, not only centripedally towards the centre of the strand—*i.e.*, towards $D_1$, but also parallel to the direction of stranding, and in this way the section represented in Fig. 3 is obtained. From the sketch it is seen at once that the plane *ab* of the one loop is *inclined* to the plane *cd* of the other loop; to show this more clearly the dotted line *ef* represents the normal to *ab*.

A somewhat similar position of the wires will be obtained if the pull on the wires $D_1$ and $D_3$ is greater than on the two others, $D_2$ and $D_4$. Also in this case, as in any other case in which the pull on the four wires is not of the same amount, the two planes will be inclined to each other. Now, as a matter of fact, it will be impossible in practice to obtain the same tension on all four wires, and therefore it is impossible to obtain the section shown in Fig. 2; the planes of the two loops will always be inclined to one another, and hence the one loop will always disturb the other. It is probable that this is the reason why cross-talk is observed in cables with wires laid up in fours.

In the above remarks it has not been taken into consideration that the paper wrappings of the four wires pressing against each other lose their circular shape. It will be understood that this deformation of the paper wrapping will necessarily have the result of increasing this defect.

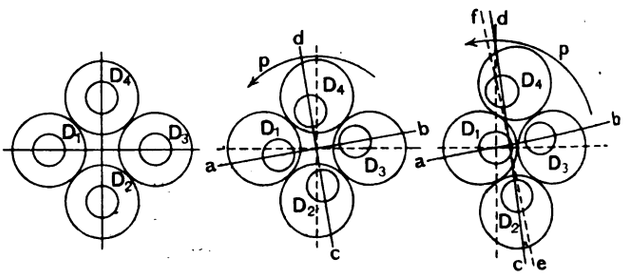


FIG. 1. FIG. 2. FIG. 3.

The question now is, how the cross-talk occurring in this way can be eliminated; it would be useful to have a means of doing this, as every possible way of lowering the electrostatic capacity of telephone cables for inter-urban lines will be of practical value. There seem to be various methods. At first it is obvious that, as the cross-talk has its origin in the stranding of the wires, the trouble can be lessened by stranding the wires as little as possible. This also has the effect that the wires lie further apart from one another, as it is the winding itself which pulls them together; therefore the electrostatic capacity will be lower the longer the lay is, and hence the lay should be made as long as possible with regard to the flexibility which the cable must have during manufacture and laying. Next, precautions should be taken to ensure an easy rotation of the drums carrying the wires during the winding, and to secure as far as possible equal friction at all four drums.

In these ways the trouble cannot be entirely removed, but only lessened. The cross-talk which will therefore occur in such cables must, then, be eliminated by means of balancing the cable when the different sections are joined together. For instance, if cross-talk occurs between two loops of a strand, then it will be easily understood that it would disappear if the strand were cut in two halves, and wires $D_1$ and $D_3$ changed—*i.e.*, if $D_1$ of the one section were connected to the former wire $D_3$ of the second half, and vice versa. Therefore, if cross-talk occurs in a cable, it will be possible to remove it by changing the position of the wires of one loop at proper places; or, instead of changing the two wires of one loop, changing all four wires, so that after cutting the cable, $D_1$ of one section is connected to the former wire $D_2$ of the following section, $D_2$ with $D_3$, and so on.

Another method would seem to be to change the direction of the winding at intervals, that is to say, to make some lengths of cable with the wires wound in one direction (say clockwise), and other lengths of cable with wires wound in the opposite direction. If the wires of the first section are numbered A, B, C, D, and of the second section *a*, *b*, *c*, *d*, then, if cross-talk occurs when A is connected to *a*, B to *b*, and so on, it must disappear when A is connected to *b*, B to *c*, and so on.

* From the *Elektrotechnische Zeitschrift*, Oct. 3, 1901.

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These methods, of course, are not applicable to subscribers' cables containing 400 to 500 wires; but for such cables of comparatively short length, the gain in relation to electrostatic capacity would not be of great practical importance. With inter-urban cables, on the other hand, which contain a much smaller number of wires—from 20 to 60—the work of balancing would pay. The work could easily be carried out in the following way: In laying the cable the different sections would at some places have to be connected together only provisionally, by means of small connecting boards; if then, in going on laying the cable, cross-talk occurs, the connections at the boards would have to be changed until the cross-talk disappeared. The extra work this would necessitate would be worth while, as with the wires laid up in fours the electrostatic capacity of the line would be considerably lower than if the wires were stranded in pairs.

## ELECTRIC RAILWAYS.*

BY MAJOR P. CARDEW.

(*Continued from page 725.*)

### Series Parallel Control.

The most usual means resorted to for diminishing the waste of energy at starting is the series parallel controller. If two motors are run in series their counter E.M.F.s are added to oppose the impressed E.M.F., and they tend to an ultimate speed such that the counter E.M.F. of each motor is one-half that applied less the amount used to produce the current required by the load, which now becomes $(E-2e)$. That is to say, full speed for motors in series is about one-half of that obtained with the motors in parallel. With more than two motors in series the ultimate speed is reduced in inverse proportion to the number. If now just before this ultimate speed be attained the motors are switched into parallel in the case of two motors, or series parallel with four motors, the motors tend to double the speed of the series connection. The effect upon the efficiency is this—whereas at starting under any conditions the efficiency must start from zero, with a simple parallel connection the efficiency increases with the speed up to the full load efficiency, say 90 per cent., and thus averages about 45 per cent., for the whole starting period, while with a series parallel connection it rises to a possible 90 per cent. at half speed, then falls at once at the change of connection, not to zero, but to 45 per cent., from which it again rises to 90 per cent., giving, say, 67 per cent. efficiency for the parallel step, or for the whole starting period an efficiency of about 56 per cent. With four motors three steps can be used—viz., all motors in series tending to $\frac{1}{4}$ speed, two in series and two in parallel from $\frac{1}{4}$ to $\frac{1}{2}$ speed, and all in parallel from $\frac{1}{2}$ to full speed. The possible efficiencies are 45 per cent., 67 per cent., and 67 per cent., or a mean efficiency during the period of acceleration of nearly 60 per cent., but the slight increase of efficiency is hardly worth the extra complication involved.

These various connections of the motors, and the insertion and variation of the resistance added to the circuit to prevent excessive current when the total counter E.M.F. is much below that applied, are effected by means of an instrument known as a controller, furnished with a handle moving between fixed stops over a circular arc, on which are marks indicating the conditions of connection for each position of the handle. There is a second handle by means of which the motion may be reversed, which is interlocked with the first handle, so that it can only be moved when the first handle is in the zero position, and no current is passing. In order to reverse the direction of motion of a motor it is necessary to reverse that of the current in either the field magnet or the armature coils. Reversing the current given to the motor as a whole has no effect upon the direction of rotation. If both the field and armature current be reversed the torque remains in the same direction as before.

The controller appears at first sight to be a simple affair, but in reality its evolution has cost much time and money, great difficulties having been encountered from the sparking produced by varying an electric magnetic circuit, by sudden changes of large amount. In some controllers a step is provided beyond that of motors in series without resistance. On this step the fields are weakened by shunting part of the current past them—this reduces the counter E.M.F. for a given speed, and if the load is not too heavy the motors accelerate to restore the balance; the efficiency, however, and the torque for any given current are both reduced by weakening the field. With shunt or separately excited fields the motors can be changed from series to parallel with the same effect as in the case of the series motor, but the whole arrangement is simplified. It is also possible to control by variation of the strength of field to a greater extent, and with less waste than series wound fields.

The next detail in the arrangement to which I will direct your your attention is the question of gearing.

* Cantor Lectures delivered at the Society of Arts.

### Gearing.

Elementary mechanics teaches us that a small force moving quickly can do as much work in a given time as a large force moving slowly, or it can exert equal power. Thus a small motor moving quickly can move a train as well as a large motor moving slowly. In order to adapt it to the purpose suitable gearing is required, whereas the large, slow-moving motor may be mounted directly on the driving axles. In the case of tramcars, where the speed of the driving axle is not so great as with trains, and where the available space for the motors is extremely limited, the use of gearing is practically universal. It was much objected to at first on account of the noise made by the gearing, and gears with teeth formed of wood, hide or fibre were tried, but improved methods of cutting and shaping the teeth have much reduced this objection.

In the case of motors for railway trains the question has not yet been definitely settled. Direct driving motors are quite practicable, especially where the principle of the separate locomotive is retained, and considering the greater power that is necessary the speed of a direct-driving motor is fairly high. Still, even in this case the geared motors have the advantage of reduced weight for the power exerted, and as the weight of the motors is a considerable proportion of the total weight to be moved this advantage is of importance.

### Unspringborne Weight.

But another advantage to which attention has been recently especially directed is claimed for gearing in that by its use a greater proportion of the weight of the motor may be transmitted through springs to the axles than is possible with direct driving, where the whole of the weight of the armature and most of that of the field magnets comes directly upon the driving axle. The effect of this unspringborne weight is to produce a continuous hammering action at all joints or inequalities in the rails. This hammering certainly tends to increase the inequalities, and shortens the life of the rails. It also is no doubt injurious to the motors themselves, and, finally, it produces a vibration which can be felt at a considerable distance from the railway.

In the case of the Liverpool Overhead Railway, where the motors are direct driving, the magnets, although bearing upon the axles, have the weight relieved by springs when the car is at rest, but this does not prevent a considerable blow being imparted to the axle at an inequality when running.

On the City and South London Railway part of the magnet weight is also spring-borne, when considered statically. The prejudicial action, however, is a kinetic and not a static effect. Even with the use of gearing each part of the motor must maintain an unvarying distance from the axle. The motor may turn as a whole upon the axle, but the latter cannot rise and fall independently and without moving the mass of the motor, as in an ordinary carriage the axles can move by compressing or extending a spring. Any such freedom of movement would certainly strip the teeth of the gearing. On this account the motor is partly carried by bearings on the axle.

Without gearing the armature is, of course, entirely on the axle, and the magnets must have bearings upon it, since the clearance that can be allowed between armature and magnet faces is far too small to admit of relative motion between the parts. The comparative superiority of the geared motor as regards hammering is due to its smaller mass and the greater distance of this from the axle compared with the ungeared motor, but in either case the effect of a sudden jolt of the axle is to enforce sudden motion on a heavy mass; in other words, a blow on the mass and a more destructive blow on the axle, transmitted by the wheels to the rails. On the Central London Railway no attempt was made to relieve this hammer effect by means of springs, and there seems to be little doubt that prejudicial results have ensued. A remedy must be found, and many proposals have been made with this view.

A promising solution of the problem how best to reduce the unspringborne mass appears to me to be the arrangement adopted by Messrs. Ganz & Co., of Budapest, for their three-phase traction equipment. I have a model of their device here. It consists in mounting the armature of the motor upon a hollow cylindrical axis normally concentric with the solid axle on which the wheels are fixed. The motor and hollow axle are carried by the under frame of the motor-car or locomotive, and this is supported through springs as usual upon the solid axle. The difference between the diameter of the latter and the inside diameter of the hollow cylinder amounts to several inches, and gives ample freedom of movement. The hollow axle has three projections symmetrically disposed; to two of these connecting rods are attached, while the third is for balancing. The connecting rods are attached at their other ends to bell cranks pivoted on spokes of the driving wheel, and these bell cranks are connected by a third rod; the whole forms a jointed system whereby the torque is transmitted from the hollow axle to the wheel, while allowing considerable relative motion between the two axles in a vertical direction. It will be seen that the mass movement involved in a jolt of the wheels over an inequality is by this means effectively limited to the light connecting rods in addition to the movement of the mass of the wheels and axle

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themselves. This arrangement appears to be a far more complete remedy than the introduction of gearing with its attendant evils of great noise in tunnel, loss of efficiency, and extra complication.

## Lecture II.

### Polyphase System.

We will next turn our attention to the polyphase current traction system which is in operation on several Swiss railways, and has been very completely worked out by Messrs. Ganz & Co. for a line in Italy now being equipped. Although only recently developed this system appears likely to occupy the field of electric traction, at any rate on long distance lines. The term polyphase current is applied to alternating currents transmitted through several conductors, the current in each conductor having the same frequency as, and a definite phase relation to, the currents in the other conductors.

Alternating currents, as has been stated, reverse in direction many times per second, varying from a maximum in one direction to a maximum in the other by continuous increment and decrement. The time which elapses between the successive maxima in one direction is called the "period" of the current, and the number of periods per second is the "frequency." When currents having the same frequency attain their similar maxima at the same instant they are said to be "in phase" with each other. When this is not the case they are "out of phase," but they have a definite "phase relation." Currents not having the same frequency have no definite phase relation. In practice the currents are derived from one generator or from several generators working in "parallel," although it is possible to produce polyphase current by means of two or more generators mechanically connected.

This species of electric current does not require a generator differing to any degree in principle from the ordinary continuous-current generator, or the ordinary alternating-current generator. In fact, identically the same machine can be arranged to produce any variety of current, whether continuous, simple alternating, two-phase, three-phase, &c. Our concern at present, however, is rather with the motor than the generator. Now there are two kinds of polyphase motor—one kind is exactly similar to a generator, as in the case of continuous currents. A machine of this nature generally has a magnetic field provided by a continuous current, and the machine has the additional drawback that it is not self-starting under load, but requires to be run up to the same speed as it would have to be run as a generator to produce a current of the same frequency as it is receiving. It is hence called a synchronous motor. For these reasons the type of machine is not suitable for traction, and we need not further consider it.

### Induction Motor.

The other kind of motor is known as the asynchronous or induction motor. It is self-starting under load and has a torque very nearly equal to that of a continuous-current motor under similar conditions. In these machines no continuous current is required and there is no magnetic field fixed in space. They have, it is true, a fixed and a moving portion, but the fixed portion (called the tator) is supplied with the polyphase currents, while the rotating portion (or rotor) receives no current from outside, but, on the contrary, has currents generated in its own coils by induction. The principle of action is that the polyphase current produces a magnetic field in the stator which rotates at a speed proportional to the frequency of alternation of the current. The coils of the rotor are generally connected to insulated rings on the axle in order that the currents generated may pass through variable external resistances. Now, when the rotating field of force is acting upon the rotor its coils acquire E.M.F. exactly as if the field of the stator were fixed and the rotor were turning in this field of force with the same velocity, but in the contrary direction to the rotation of the field. It is the relative motion between the field and the coils which generates E.M.F. Current is, therefore, caused to flow in the circuit consisting of the rotor coils and the external resistances, energy being thereby wasted by degradation to heat.

Although some energy is wasted in external resistances, still the loss would be greater were no resistances used, and, moreover, the starting torque obtained would be much smaller, although the rotor current would be greater. This rather curious fact arises from the laws of alternating current, and cannot be fully explained without discussing the full theory of the subject. It must suffice to state that the waves of current in stator and rotor would be out of adjustment for production of force. It would, of course, be necessary to provide the turning force of an engine to rotate the rotor coils in a fixed field of force, and produce the energy running to waste, and the turning force of the engine when the motion was uniform would be opposed by an equal turning force in the opposite direction in the coils.

By means of the rotating field in the stator produced by the polyphase current we have, therefore, obtained an effect in the rotor equivalent to forcibly turning it in the opposite direction by an engine, consequently the force with which it would oppose the turning effort of the engine exists in the rotor, and unless it is opposed by an equal force will cause the rotor to turn in the opposite direction to that of the generation in a fixed field, *i.e.*, in the same direction as the rotating field. Thus we see the cause of the torque in an induction motor. When the rotor is turning the relative motion between the rotating field and the rotor coils is diminished, because they are turning in the same direction, consequently the current produced by the rotor tends to fall off; but it can be maintained at full strength by reducing the external resistance until the speed of the rotor has attained very nearly synchronism, or a speed equal to that of the rotating field in the stator when the external resistances are entirely cut out and the rotor coils short-circuited upon themselves.

You must, therefore, consider the rotor of an induction motor as an electromagnetic mechanical appliance which receives energy by induction, as it is called, from the stator, wastes part of that energy, like all other machines by converting it into heat, and gives out mechanical power by means of the rest of it. It cannot quite run up to synchronism, even when unloaded, because of friction and other opposing forces; there must always be a slight slip or deficiency in speed. On the other hand, a very slight slip develops a considerable torque; but there is a limit to the increase of torque with increased slip. If the motor be overloaded until the slip exceeds about 15 per cent. with a short-circuited rotor it will stop. A greater slip, or, in other words, reduced speed, can be obtained by again inserting resistance in the rotor circuit, but at the expense of efficiency. The diagram,*

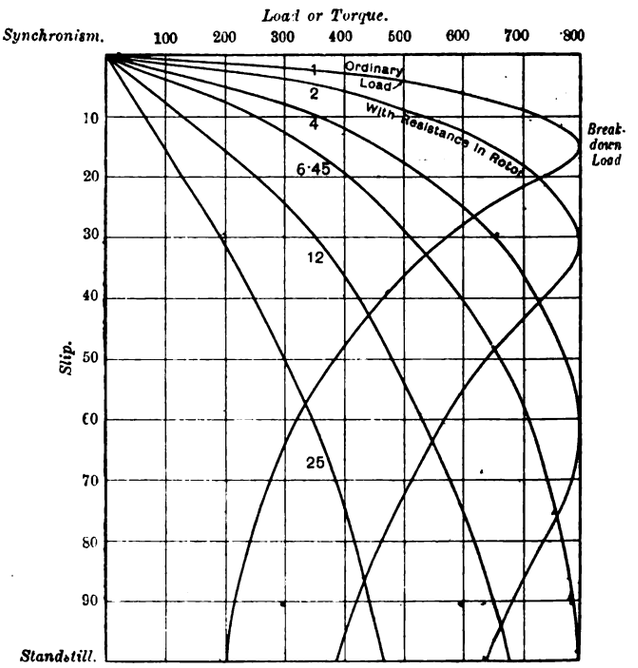


Fig. 1.

Fig. 1 shows the torque obtained at various speeds expressed in percentages of slip (100 per cent. slip being stand still), and with various resistances external to the rotor expressed as multiples of the rotor resistance. Naturally, in practice, care is taken that the greatest possible load that can be applied to the motor is far below breaking-down point. On the Valtellina Railway, in Italy, now being equipped on the three-phase system by Messrs. Ganz & Co., the maximum torque does not exceed one-third of the break-down torque. In fact, the break-down point cannot be reached, for the wheels would skid first. The diagram of torque supposes that the supply to the stator is maintained at a constant pressure. If this pressure be increased, the break-down load and the torque at any slip is also increased. In fact, the torque varies as the square of the pressure of supply—a very important law.

### Differences between Continuous and Polyphase Motors.

Looking at things from the point of view of practical traction requirements, the chief points of difference between the continuous current and the polyphase motor are:—

1. That with the continuous-current motor the speed depends upon the electrical pressure of supply and the load. For a steady load the speed increases proportionally to the pressure; for a steady pressure the speed may be reduced considerably by increasing the load. With the polyphase motor, on the other hand, the speed within practical limits is nearly exactly determined by the frequency, or, in other words, by the speed of the generators, and is very slightly reduced

* This and several other of the diagrams shown have been reproduced from Prof. Wilson's Paper on "Polyphase Electric Traction," by kind permission of the Institution of Mechanical Engineers.

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by increase of load. The diagrams, Figs. 2 and 3, well exemplify he difference of behaviour in respect to variation of speed under varying load of the two classes of motor. The short lines cutting the curves give the maximum rated load.

2. That in the continuous-current motor the supply current must traverse the armature entering by the brushes and the commutator. The pressure of supply must on this account be limited to avoid damage. Even in the case of large continuous-current generators a high

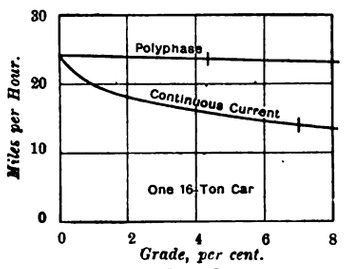


FIG. 2.

pressure is a difficulty, and this difficulty is much increased in a motor which has to be fitted into a small space and is exposed to weather. The controlling arrangements would also become impracticable with a high pressure. On the other hand, in the polyphase motor the supply current traverses the stator coils only, and no commutation or variation of this circuit is necessary. A high pressure is, therefore, perfectly practicable.

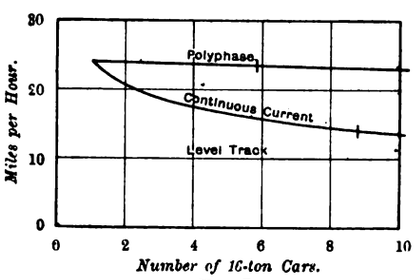


FIG. 3.

The question of efficiency must next be considered. We have seen that in the case of the continuous-current motor the efficiency, or proportion which the power given out bears to that absorbed, varies from 0 at starting to, say, 90 per cent. at full speed. The poly-

### CASCADE CONNECTION.

When a polyphase motor is running at synchronous speed no E.M.F. is produced in the rotor because there is no *relative* motion between the coils of wire and the rotating field, but when "slip" exists E.M.F. is produced, the frequency of this E.M.F. being the same proportion of that of the supply as the slip is of the speed of synchronism. Thus if there be a 10 per cent. slip the frequency of the rotor E.M.F. and current will be $\frac{1}{10}$th that of the supplied power. Now, if the rotor, instead of being connected to a variable rheostat, is connected to the stator of a second motor before starting, it will generate currents in this stator at a frequency proportional to the slip, *i.e.*, starting at that of the supply and becoming slower as the motors speed up. The second rotor being connected to an external resistance will generate current at a frequency proportional to its slip. Now suppose the motors to be mechanically connected so that both motors must move at the same speed, and let this speed be one-half the synchronous speed for the first motor. Under these conditions the slip of the first motor is 50 per cent., the frequency of the current supplied by it to the second motor is one-half that of the supply current, and the slip of the second motor is zero or it is running at synchronous speed. No current will, therefore, be passing in its rotor even if short-circuited. But what of the current from the rotor of the first motor? This is choked back by counter E.M.F. exactly as with one motor the supply current is choked back when synchronism is attained, thus there will only be a very small current. In short, it will be evident that, with two motors connected as described, half-speed is the limit to which they tend, exactly as in the case of two continuous-current motors in series. It will be observed, however, that whereas with continuous-current motors in series, each motor received half the energy directly from the supply, with polyphase motors in "cascade," as it is termed, the whole energy is taken by the stator of the first motor and transmitted inductively to its rotor, which applies one-half mechanically to the axle, and tranamits the other half electrically to the second motor.

In order to accelerate from half to full speed it is not practicable to put the motors in parallel, because the second motor is not wound to take the high pressure of the supply, for it would not be expedient to generate high pressure in the rotor of the first motor. The practice is, therefore, to disconnect the second motor at half-speed, substituting a rheostat, and letting the first motor do all the work. The torque obtainable is, therefore, less for the second period of acceleration. The efficiency is suddenly reduced when the change is made, just as in the change from series to parallel, with continuous-current motors, and increases again with the speed. The diagram, Fig. 4, show the maximum power, total energy, and time required to attain two different speeds according to Messrs. Ganz & Co., assuming that the automatic rheostat is set to give the best result. These quantities are connected by the following relationships, neglecting the resistance to motion due to friction and air

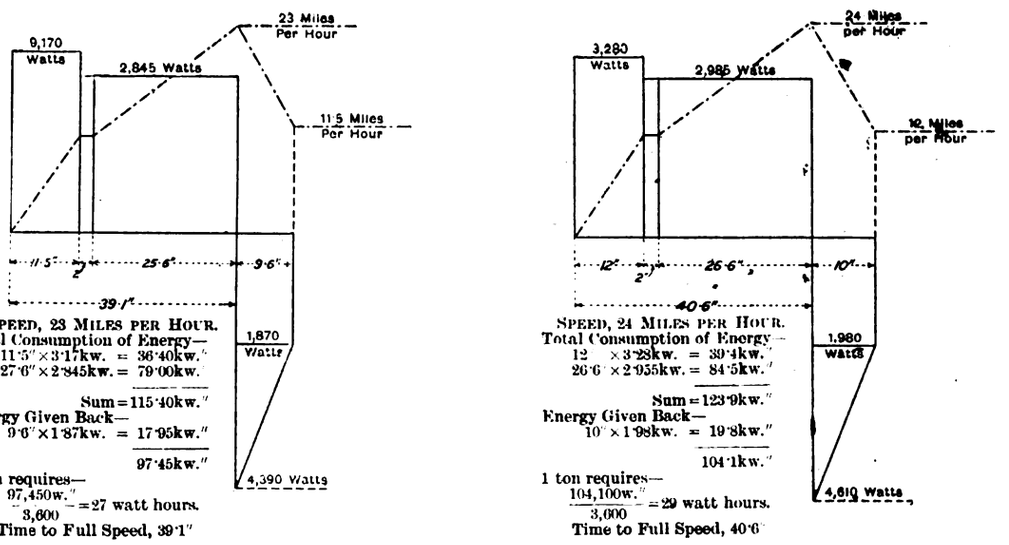


FIG. 4.—Diagrams of Energy at Starting in the Case of Three-phase Current. Watt consumption per ton on straight and horizontal line calculated with an average traction coefficient of 10·1 lbs. per ton.

phase motor is much the same in this respect, although the curve of efficiency is rather different, being affected by the lag of the wave of current behind that of pressure, which must always be considered when dealing with alternating currents supplying induction motors. We have also seen how the inefficiency of starting is reduced by the series parallel system of control. A somewhat similar system has been worked out for polyphase traction. It depends upon these facts.

displacement, and considering merely the acceleration of the mass of the train:—

1. The maximum power taken is proportional to the rate of acceleration and the maximum speed required.

2. The total energy required varies as the square of the speed attained, and is independent of the acceleration.

These laws are modified by the variation of the resistances to

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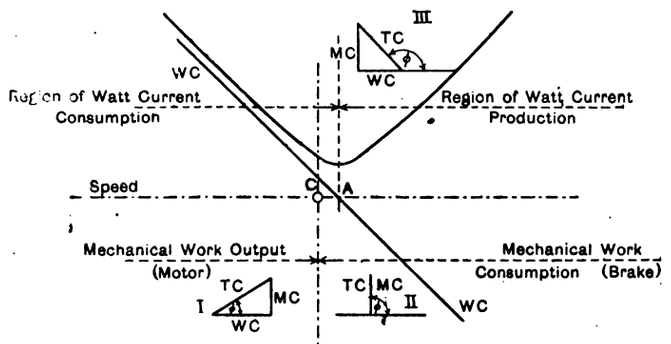
motion. These certainly increase with the speed, and a great many formulæ have been suggested to express the connection between speed and resistance. No simple relationship appears to hold through a wide range of velocity. The frictional resistance is distinctly greater at the moment of starting from rest than when the train is running, and is probably less at very high than at moderate speed if the lubrication is efficient; on the other hand, the air resistance increases very rapidly with the speed. It may be thought that it is not worth while to carry about a secondary set of heavy motors, in order to obtain increased efficiency in starting, or that it might be better to retain the motors, winding and using them as primary motors, and thus obtain increased acceleration, but we have not yet realised the full advantage of the "cascade" connection. We have seen that a polyphase motor tends to synchronous speed, but can never quite reach it so long as it has to provide mechanical power. If, however, as is the case on down grades, when the slope is such that the force of gravity acting in the direction of motion exceeds the retarding forces of friction and air resistance, the motor has not to provide power, but is accelerated above the speed of synchronism, it begins to act as a generator and return electric power to the supply circuit. It takes the power required for generation from the axle, on which it, therefore, exerts a retarding force or negative torque.

We have seen the analogous action in the case of a shunt or separately excited continuous-current motor, and the action is more easily grasped in this case, because the continuous-current armature takes current from the supply as a motor and returns current as a generator. But the polyphase rotor does not receive current directly from the supply, being completely insulated from it, nevertheless current flows in its own circuit. This current, however, when it is acting as a motor, is derived by induction from the primary current, and the greater the induced current the greater the primary current; but when acting as a generator, the rotor current actually becomes the primary source of energy, and nearly reverses the phase of the supply current, so that the current from the stator is opposed to




WC = Watt Current. MC = Magnetising Current. TC = Total Current.

FIG. 5.

the impressed E.M.F. The diagram, Fig. 5, shows the variation of the total current and of the energy producing or restoring current at speeds below and above synchronism, which is at the point A on the line of speed. Energy is consumed by the motor up to this point, although no external work is done by it beyond the point C on account of its internal losses. In polyphase traction, therefore, the train is compelled to a practically constant speed up-hill, down-hill, or on the level. It is out of the power of the driver to endanger the lives of the passengers by running at an excessive speed to "make up time."

By the "cascade" connection principle this braking action, with return of energy to the line, is available not only down steep grades, but whenever a reduction of speed is necessary, whether for stopping at a station or slowing for signals, and from full speed to nearly half speed. The amount of energy returned is about 16 per cent. of that used for acceleration on the level, or about 30 per cent. of the kinetic energy of the train, and the efficiency of the system is on this account certainly greater than what can be possibly obtained with series wound continuous-current motors. If the traffic can be so arranged, the best advantage will be obtained by starting a train on the up line just as an incoming train on the down line begins to slow down, and as the running time on the polyphase system is absolutely fixed, such working is quite possible. The braking action at high speeds has other advantages over mechanical braking in that the wheels cannot be skidded and the destructive action on both wheels and rails is much reduced.

### COASTING.

In comparing the "cascade" system with the ordinary continuous-current system, it must be pointed out that although with the latter no return of energy to the supply is possible, a considerable proportion of the kinetic energy developed by acceleration in the train may be utilised by an experienced driver by "coasting," *i.e.*, by cutting off the power completely shortly after full speed has been retained, and allowing the train to gradually reduce speed through friction and mounting grades. This practice, however, may obviously lead to considerable variation in the time schedule, and can only be advantageously used by a very careful driver with a thorough knowledge of the road.

### REVERSING.

With continuous current reversal of motion is effected by reversing the connections of the armature brushes; but with polyphase motors no alteration of rotor connection will cause reversal, since the motion is a consequence of the rotating field of the stator, and it is necessary to reverse the connections of two of the wires bringing in the line currents to the stator, in order to produce a reversal of the direction of rotation of the magnetic field.

### FREQUENCY.

The question of frequency is an important one in connection with polyphase traction. We cannot discuss it fully here, but I may state generally that the frequency should be kept low, especially when the "cascade" connection is employed. On the other hand, low frequency increases the weight and expense of motors, and brings in difficulties with regard to electric lighting.

### LIGHTING.

The frequency adopted by Messrs. Ganz & Co. is 15 periods, which is far below that at which it is possible to use any separate phase of current for lighting, because the blinking effect caused by the waves of current is painfully perceptible. In order to prevent this, they propose to use a three-phase lamp, having three filaments all united together at one extremity, while the other ends are connected to separate leading-in wires. In such a lamp, the total light is constant, although the emission from each filament is fluctuating, and if an obscured globe be used, these fluctations cannot be noticed. It is, however, preferable for train lighting, to ensure a constant steady light by the use of a small accumulator battery, charged during running by means of a motor generator. The same motor which is used for the air compression for the brake can also do this work.

### CONTROLLING.

The controlling arrangements for the polyphase "cascade" system have to provide for:—

(*a*) The connection of the stator coils of the primary motor to the source of supply, and for reversing these connections for running backwards. This is effected by means of a separate plunger switch having six plungers.

(*b*) The connection of the rotor of the primary to the stator of the secondary motor.

(*c*) The connection of the rotor of the secondary motor to a variable rheostat, and the gradual reduction of the external resistance to zero.

(*d*) The cutting out of secondary motor and substitution of the rheostat for it, in circuit with the rotor of primary motor, and the gradual reduction of external resistance as before.

(*e*) The cutting in of secondary motor, with rheostat connected to its rotor, and the gradual reduction of resistance as before.

(*f*) The cutting off of the supply current.

I have not time to enter minutely into the details of these arrangements, but the following are very important items on the system:—

1. The whole control is effected by means of compressed air, so that the driver cannot possibly get a shock by manipulating a switch.

2. The rate of cutting-out resistances in the rheostat is limited by means of a valve regulating the flow of compressed air; and this valve can be set after determining the best rate, so that the driver cannot waste power by cutting out too fast, or lose time by cutting out too slow.

3. The rheostat is not, as in other cases, formed of wire resistance, but of iron plates above an alkaline solution, which is forced up by means of compressed air into contact with the plates, reducing the resistance as it mounts higher; and the plates are so shaped that the immersed surface increases rapidly as the liquid rises, the effect being to maintain the starting torque uniform up to full speed.

The above-mentioned controlling arrangements admit of several pairs of motors being worked from one end of the train. In fact, the multiple unit principle has been thoroughly worked out with the compressed air system of control.

### LINE EQUIPMENT AND CONTACT DEVICES.

Having thus glanced at the principal features of the continuous and polyphase current motors and their controllers, we must next obtain some idea of the line equipment or arrangements for bringing the electrical power within reach of the train, and the contact devices by which it is delivered to the train. The idea of all electric traction systems using energy transmitted to a distance is to equip the line with one or more continuous insulated conductors, kept charged by the generating station, and with which one or more insulated conductors attached to the train or vehicle make continuous sliding or rolling contact. On tramways we have the ordinary trolley wire, or the conductors in a conduit, or the surface contact studs, which are successively connected to the continuous-charged conductor as the car comes over them. On railways the amount of current which has to be collected has required a larger conductor than a trolley wire, and the usual system has been the third rail, as it is called, being an insulated rail, generally of channel iron, supported

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on insulators, placed either between the running rails, or, especially when two insulated rails have been used, on each side of the running rails. So far, porcelain insulators have answered best, but the material is, of course, brittle, and a moulded insulator of material similar to that used for trolley wire insulators has been recently introduced. The insulated rails are made in lengths of from 30ft. to 60ft., and each length is bonded to the next.

BONDING.

Bonding is necessary to ensure sufficient conductivity at the joints. When a current flows along a metallic conductor, the resistance depends upon the cross section and specific conductivity of the metallic conductor, but when the current passes from one conductor to another in contact with it there is a special resistance at the surface of contact depending upon the extent of this surface, the nearness of the opposed surfaces, and the force with which they are pressed together. In the case of iron or steel rails copper bonds are generally employed. These consist of a copper conductor often made flexible to provide for the slight relative motion of the ends of the rails caused by the passing weights and by expansion and contraction with change of temperature. The copper conductor spans the gap between the rails, and is furnished with two large terminals which pass through holes in the web of the rail, which are rimered out clean just before the bond is put in. These terminals are then expanded with considerable force so as to drive the metal of the terminal into intimate contact with that of the rail, either by hammering a steel conical pin into a small hole passing through the centre of the terminal, or in the case of large bonds as used for railway work, hydraulic pressure is used to expand the terminal as in rivetting. The single-rail system, with running rails as return, has been adopted on the Liverpool Overhead, City and South London, and Central London Railways; the double-rail system was used on the experimental line on the District Railway. Along these rails slide several insulated iron shoes, attached to the train to collect the current for the motors. The insulated charged rail, although it appears the most practical device, is not without certain disadvantages. It encumbers the permanent way to some extent, and owing to its proximity to the running rails, short circuits, caused by crowbars or other pieces of metal falling across the two, are not infrequent. The employés are liable to get shocks and burns, which are not generally serious, but may cause injury, and there have been one or two fatal accidents. The insulation also is not perfect, and it is affected considerably by the weather. The possibility of danger is much reduced by the use of two insulated conductors. On the other hand, the inconvenience is increased.

In the case of the South London Railway, I suggested that a strip of wood should be provided at stations to guard the charged rail, so that inquisitive passengers should not be able to touch it with umbrellas, and possibly sustain a shock sufficient to cause them to fall on to the line. These wooden protectors have been used in several instances. For reasons of safety it would be much preferable to put the insulated conductors overhead, as in the case of tramways, but as the current collected from these conductors by one heavy train may exceed 2,000 amperes, this is impracticable with the continuous-current system. With the polyphase current, however, no such limitation of pressure is necessary, as the stator coils can be safely wound for high pressure. On the other hand, two insulated wires are necessary, as well as the use of the rails to form the third conductor. Messrs. Ganz use 3,000 volts with their system, and the insulated conductors are ordinary trolley wires suspended overhead. Instead of 2,000 amperes at 500 volts continuous current, less than 250 amperes are required at 3,000 volts three-phase, and the collection of the current at this pressure is easily effected. There is, however, one very important consideration, viz., public safety. Five hundred volts may, under certain conditions, cause serious injury, or even death, but the slight contact which is generally made by an accidental touch does not produce a serious shock. No one, however, can trifle with 3,000 volts. The Board of Trade regulations prescribe an insulating coating for wires charged to this pressure, which would, of course, prevent their use for this purpose; but these regulations are concerned with wires erected in the public streets, and carried over houses, past windows, &c., where they may be accessible, or where other wires may get into contact with them. The case is very different on a line of railway to which the public have no right of access, and which is, in any case, a dangerous place for a stroll.

SAFETY DEVICE.

So long as the wires remain suspended, they are well out of reach, and in order to provide against danger from a broken wire, an arrangement has been devised whereby any broken wire must be brought into contact with an earthed conductor before it can fall within reach, the short circuit thus produced causing the cutout to act and disconnect the wire from the charged circuit. This device will also act should a wire by stretching, or by the failure of an insulator, droop below its proper position. On the whole, I consider the danger from properly erected and guarded wires at 3,000 volts along a railway is no greater than that from a charged rail at 500 volts put between the running rails or in the 6ft. way.

*(To be continued.)*

# LEGAL INTELLIGENCE.

## National Telephone Co. v. Howell.

At Cardiff County Court last week, before Judge Owen, the National Telephone Co. sued Mr. A. J. Howell, contractor, for £9, one year's rent of a telephone. Defendant counterclaimed for damages suffered by inefficient service.

After evidence for plaintiffs had been given, defendant said he had constant need of the telephone, but could seldom get connection with subscribers, and he had continually complained.

Mr. MARSH, local representative of the company, said they had record of 10 complaints from Mr. Howell, and when investigations were made it was found that the line had been lately split, and that the work of repair had not been completed. Other defects, caused by wet weather or high wind, were not preventible, but the company put them right. Most of the complaints were of ordinary accidents which could not be prevented. There were from 1,300 to 1,400 subscribers at Cardiff, and always from 22 to 25 operators to attend to them.

Mr. INGLEDEW, for the company, contended that the counterclaim must fail, as the contract stated that the company would not be liable for damage caused by delay, and nothing had happened except ordinary accidents incidental to the telephone service.

The JUDGE said the contract must not be taken to refer only to cases where there had been gross carelessness. Mistakes might arise from the company being shorthanded at the exchange. Judgment must be for plaintiffs for £9 and costs on the claim, and for defendant for £5 and costs on the counterclaim.

## London United Tramways (Ltd.) v. Hilton.

At Brentford, Middlesex, yesterday, James Hilton, of Hayes Bridge, answered an adjourned summons for causing an obstruction on the lines of the London United Tramways at Hanwell in August. The first hearing took place a fortnight ago, when, owing to the summons being held invalid, it was dismissed. As the summons then read, defendant was charged under the company's private act, but the magistrate (Mr. Montagu Sharpe) pointed out that the particular portion of the tramway line which defendant was alleged to have obstructed was not a tramway within the meaning of the act, but a light railway. Ordnance maps were consulted, and it was found that this was the case. On the crest of the canal bridge at Hanwell the tramway going westward towards Southall becomes a light railway. The summons against defendant being for obstruction on a "tramway" it was dismissed as invalid, and an amended summons was issued.

Mr. OSWALD HANSON now relied upon the last section of the company's private act of 1900, which was to the effect that any person who impeded, or caused to be impeded, any apparatus used in connection with the tramways would be liable, on summary conviction, to a fine not exceeding £20. He contended that the word "tramways," which was used throughout the act, was a term which comprehended all such sections as were properly called "light railways." He had found that if he could not proceed under this section there was nothing in the Light Railway Act to enable him to do so, as that measure related only to the construction of the line.

Mr. MONTAGU SHARPE, however, held that the term was not inclusive, and that consequently the company had no power to prosecute for obstruction on such portions of their line as were light railways. He therefore thought the best thing to do would be to dismiss the summons for the second time and to state a case which could be proceeded with elsewhere.

This course was adopted.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Bexhill District Council invite applications for the position of chief assistant engineer, and also engineer's clerk. Applications to the electrical engineer (Mr. Walter T. Le Feuvre) by 17th inst. See advertisement.

A chief assistant for mains is required at Tynemouth electricity works. Applications to borough electrical engineer (Mr. C. Turnbull). See advertisement.

A competent inspector of telegraphs and electrical signal apparatus is required for the West African Government railways. Further particulars are given in an advertisement.

Bristol electricity department have a vacancy for an assistant. Applications to city electrical engineer (Mr. H. Faraday Proctor) by noon 23rd inst. See advertisement.

A shift engineer is required for a London electricity station. Applications to chief engineer, County of London Company, Moorgate-court, Moorgate-street, E.C. See advertisement.

Newcastle-upon-Tyne Electric Supply Co. intend to appoint several junior assistants, and will receive applications from apprentices out of their time or young men who have been through a college course in electricity. An advertisement contains further particulars. Applications to the general manager (Mr. J. S. Watson), 50, New Bridge-street, Newcastle-upon-Tyne.

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Two experienced men used to estimating for switchboard work are required in the fittings department of the Edison and Swan works, Ponder's End, Middlesex. See advertisement.

A switchboard attendant is required at Bradford electricity works. Applications to the city electrical engineer (Mr. R. A. Chattock). See advertisement.

Manchester Tramways committee require a number of trolley linesmen. Applications to the general manager (Mr. J. McElroy), 55, Piccadilly, Manchester. See advertisement.

Bootle Corporation require a resident electrical engineer. Application to town clerk (Mr. J. Hy. Farmer) by 10 a.m. Oct. 14.

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Mr. W. Ryle Wright, borough electrical engineer, Bootle, has been appointed tramway engineer to Wellington, New Zealand, at a salary of £1,250 per annum, and expenses out. Mr. Wright is to act as consulting and administrative engineer in the conversion of the present tramways to electric traction at an estimated cost of £250,000. Previous to his appointment to Bootle in 1899 Mr. Wright was borough electrical engineer at Burnley from 1896 to 1899, and assistant engineer at Manchester from 1893 to 1896. Between 1888-1893 he was engaged with the Electric Construction Co. and Elwell-Parker (Ltd.).

Mr. R. H. Campion, chief assistant at Blackburn, has been appointed borough electrical engineer at Dewsbury at £300 per annum.

In connection with recent changes in the engineering department of the postal telegraph service, Mr. G. W. Hoak, assistant superintending engineer, London, has been appointed to the position of superintending engineer of the South Midland district.

Mr. H. England, of Bolton, has been appointed manager of the Sunderland electric tramways.

Mr. J. M. Beck, of Bradford, has been appointed charge engineer at Wigan.

Mr. James Albert Seagar, of Stoke Newington, London, has been appointed demonstrator in electrical engineering at University College, Nottingham.

## EDUCATIONAL NOTICES.

**Saddler's Scholarships.**—*Correction.*—With reference to the note appearing in our last issue, page 921, it is pointed out to us by Prof. S. P. Thompson that these scholarships are of the value of £30 per annum.

**Salford Technical Institute.**—A bulky calendar of the sixth session (1901-2) of the Royal Technical Institute, Salford, is published. Premier position is given to particulars relating to the mathematical, mechanical engineering, applied physics and electrical engineering, and chemistry departments. Principal William Wilson, M.A., is assisted by a large teaching staff. The chief lecturer in the engineering department is Mr. W. Beckit Burnie, A.I.E.E. Both day and evening classes are held, as well as a special series of Saturday classes, and it should be observed that certain courses of study at Salford are accepted by the Victoria University as qualifying towards certificates and degrees. The course in applied physics and electrical engineering extends over three years. There is a special laboratory for junior work in this department, an advanced laboratory, a laboratory for heat, and, beside photometric, dynamo and storage battery rooms, a well-equipped electrical testing room. The electro-technical department has been fitted up with special regard to alternating current work. A large number of photo illustrations of laboratories, workshops, drawing office, &c., are given, and the general particulars relating to the courses of study are very full.

**Technical Education.**—Loughborough Technical Education committee have received an offer from the Brush Company to give £21 in prizes to students of classes taking subjects most nearly related to the industries carried on at Loughborough by the Brush Company.

The annual report of the Glasgow and West of Scotland Technical College has been issued, and can now be obtained in pamphlet form.

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**Aberdeen.**—A proposal is under consideration for constructing an electric tramway from Woodside to Dyce and from Mannofield to Colter.

**Accrington.**—An additional unit of plant is to be put down at the electricity works.

**Algeria.**—The establishment of a second overhead telegraph line between Algiers and Laghouat has now been completed, making a total length of overhead telegraph lines in Algeria of 6,487 miles, and there are 7½ miles of underground lines. Nearly 500 miles of these lines were erected in 1900.

The heavy charges for the equipment and installation of telephones in Algeria accounts for the country being much behind in the matter of telephonic communication.

**Barking.**—An inquiry has been held into the Council's application for sanction to a further loan of £2,100 for condensing plant for the electric lighting undertaking.

**Benwell.**—A ratepayers' resolution has been passed protesting against the Council transferring their provisional order, and urging the establishment of municipal electricity works.

**Bermondsey (London).**—The Borough Council have notified the London County Council that, as the new southern approach to the Tower Bridge is a metropolitan improvement, they will not lay electric light cables along the thoroughfare unless the County Council pay the whole cost of the work.

**Bournemouth.**—The Council have rejected, by 12 to 10, a proposal to apply for powers to construct an electric tramway from Lansdowne along Bath-road to the Pier, and from the Pier along Exeter-road to the Square. The Parkwood-road, Boscombe, extension was approved.

**Brighton.**—The Council have decided to obtain powers to extend their electric tramway system around Old Steine and along a portion of the London-road.

**Bristol.**—It has been decided to appoint a committee of the Council to consider the desirability and possibility of acquiring the tramways undertaking of the Bristol Tramways and Carriage Co. In discussing the resolution for the appointment of the committee, Ald. Pearson (chairman of the Electric Light committee) said he had a list of 22 towns in England which were working their own tramways. If anything was wanted to show the growth of tramway undertakings when moderately well managed they certainly had it in the figures of Glasgow, where in six years the passengers had grown from 57 to 132 millions, and the receipts from £221,000 to £484,000. The St. George's power station of the Bristol Company was situated in a district considerably away from the civic stations, and for the present, at any rate, would enable the city to supply power in St. George's where they were at present unable to supply current owing to the expense of cables to the district. That station would facilitate the arc lighting of the city if it was hereafter thought desirable to extend that form of lighting. Other economies could be effected by the proposed purchase, which he had always advocated. He believed the Council would be met by the directors of the company in a fair and reasonable spirit. The proposal was adopted by 40 votes to 12.

**British Borneo.**—The Government of British Borneo has established a very complete telephone service at Kuching, Sarawak, with which all the Government offices are connected up. The service is also used for commercial purposes by the Chinese merchants. Upper Sarawak is connected with Bau, Busan and Bidi, a distance of 26 miles.

**Cheltenham.**—The Council have sanctioned the extension of the light (electric) railway to Charlton King's and Leckhampton.

**Coventry.**—The application of the Corporation to borrow £23,200 for electric lighting lighting extensions was investigated by a Local Government Board inspector on Friday. Particulars were supplied by the town clerk and the borough electrical engineer (Mr. J. A. Jeckell). There was no opposition.

**Customs Changes.**—Under the new customs tariff of Newfoundland imported telephone and telegraph instruments, electric and galvanic batteries, electric lamps, side lights, head lights, lanterns and chandeliers, and electric light machinery and material of every description (including carbons, meters and general apparatus) are rated at 35 per cent. ad val.

Electric motors and machinery for power imported into Cuba under paragraph 318 of the Cuban customs tariff are now dutiable at 5 per cent. instead of 10 per cent ad val.

The new tariff of the Federated Australasian States, which was presented in the House of Representatives at Melbourne on Tuesday, proposes to introduce a system of bonuses for the encouragement of new local industries, such bonuses to particularly apply to locally made machinery. The bonuses come into effect in July, 1902, but are surrounded by conditions which give the concession little effect for the present.

**Douglas (Isle of Man).**—On Wednesday the Council confirmed the proceedings of their committee to purchase the horse and cable lines of the Isle of Man Tramways and Electric Power Co. within the borough for £50,000.

**Electric Light Inspection Boxes and the London Building Act.**—Stepney Borough Council proposes to convene a conference of metropolitan councils to consider the recent decision of the Divisional Court upholding the finding of the magistrate in the case of Crow *v.* Whitechapel Board of Works (reported in *The Electrician* for Dec. 21, 1900, p. 328; May 3, p. 67; and May 10, p. 108). The Divisional Court is the final court for a matter of this kind under the Summary Jurisdiction Acts. In consequence of this decision Stepney, which has absorbed Whitechapel, approached the London County Council with a request that facilities might be afforded for raising the point in a civil action, so that a decision of the Court of Appeal might be obtained, or that the district surveyor should be asked not to insist upon strict compliance with the section on which he founded his action. The County Council was unable to grant either request,

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and Stepney therefore proposes a conference to consider the question. It is held that if the decision is allowed to stand the effect will be to retard the progress of electric lighting and at the same time involve the boroughs in heavy and unnecessary expense by having to pay fees to district surveyors in connection with inspection chambers and boxes.

**Electric Traction in Victoria.**—In a report by the committee appointed to consider the question of electric traction on standard lines, recently submitted to the Legislative Assembly, it is stated that inquiries had induced the committee to come to the conclusion that electricity as a motive power for railways was quite equal to steam. It is recommended that an experiment be made on the St. Kilda line, the cost of the electrical equipment of which would be £43,000. It is estimated that if operated electrically, even with double the existing service and additional stopping places, a saving of £8,000 per annum would be effected. It is further recommended that the Collingwood line (under construction) be worked electrically.

**Electrically-controlled Clocks.**—At the meeting of the Glasgow Corporation last week, Mr. Primrose asked that the electrically-controlled clocks in the town be abandoned and timepieces of the ordinary type be substituted. On Tuesday several of these clocks were standing at 4:12 o'clock at 11 a.m. Bailie Anderson said, of course if one clock was wrong all must be wrong, as all 12 clocks were on two circuits. Experiments with the same system, with a little difference in the mechanism, had been made during the course of the exhibition, and the results had been entirely satisfactory. The committee were endeavouring to introduce the exhibition type of clock in substitution for that now used in the town.

**Exhibitions.**—The area plan of the Twentieth Century Electrical Exhibition, which is to be held at the Royal Aquarium, Westminster, London, from Dec. 16 to Jan. 26 next, is now ready, and copies of the plan and other particulars can be obtained from the organiser, Mr. M. J. G. Ritchie.

A proposal having been made for the holding of an international exhibition in Edinburgh in 1904 or 1905, a meeting of the leading citizens was held last week to consider the question, and a committee appointed to consider and report upon the site, date and other preliminary questions.

**Farnham.**—The Council recently invited offers for their provisional order, but only one communication was received—from Edmundson's Electricity Corporation, with whom the Council had previously been in communication. The corporation renew their offer of Oct. 1900, in which they proposed that the Council should arrange the necessary loan for the works, and the corporation would then enter into a contract to carry out the work under the supervision of the Council's engineer. They offer to take a lease for 14 years, paying as rent a sum equivalent to the amount which the Council had each year to pay for interest and sinking fund. The Council could terminate the lease at seven years, by six months' notice, on paying the company a sum equivalent to 15 per cent. on the capital expended. A special meeting of the Council will consider the matter, and the consulting engineer (Sir William Preece) will attend.

**Great Grimsby.**—The electrical equipment of the tramways was inspected by Mr. A. P. Trotter on Thursday last week.

**Guayaquil (Ecuador).**—A 35 years' charter has recently been granted to a syndicate for the construction of an electric tramway in this city, and for the establishment of electricity supply for lighting and power. At the end of the period of the concession the tramways revert to the municipal authorities without compensation. The present mule-driven tramways have been very successful, and have paid large dividends for many years.

**Harrow.**—The charge for electric current has been increased from 7d. to 8d. per unit by the Harrow Electric Light and Power Co.

**Islington (London).**—Extensions of the electric lighting mains, estimated to cost £2,545, were authorised last week.

**Lane End (Bucks.).**—It has been decided to adopt electric lighting.

**Leek.**—Messrs. Burstall and Monkhouse have been asked their terms for reporting on electric lighting.

**Leyton.**—Sanction to a loan of £10,145 on account of £15,545 applied for has been obtained.

**Light Railways.**—An inquiry has been held this week into the application of the British Electric Traction Co. for an order to authorise the construction of the South Shields, Sunderland and District light railway, to form a connecting link between the South Shields and Sunderland tramway systems by way of the main road between the two towns. Mr. Sydney Morse appeared for the applicants and supplied particulars of the scheme. The North-Eastern Railway opposed on the ground of competition, and the Commissioners came to the conclusion that it was a through line which should be submitted to Parliament.

The Light Railways Commissioners have authorised the construction of light electric railways in the Wakefield district. The lines will connect Horbury with Ossett and Lofthouse with Leeds, and the existing Wakefield and Agbrigg line will also be extended. The total mileage is about 6½, and powers to raise £107,364 have been obtained. The permanent way is estimated to cost £43,764, and the electrical equipment, cars, &c., £63,500.

**Light Railways in the Soudan.**—Major Count Gleichen, in dealing with the subject of trade openings in the Egyptian Soudan, considers that there are opportunities for the introduction of light tramways or railways there, one to cross the Gezireh, the angle between the Blue and White Niles, from Wad Medani to Kawa or El Duem. These light lines would tap a very rich grain province. Another suggested line would be from Gedaref to Gallabat on the Abyssinian frontier.

**London County Council.**—At Tuesday's meeting (the first of the session) the following electricity loans were approved :—Hampstead, £9,525, £19,525 and £9,620 ; Stepney, £10,000.

*Tramways.*—It was resolved to withdraw the application to the Light Railway Commissioners for power to construct a light railway along the Archway-road, Highgate.

*Electricity Meters.*—The Highways committee reported on the question of the use by undertakers under the electric lighting orders of uncertified electricity meters. The report stated that it was the practice of some of the electric lighting companies who tested their own meters to mark them in such a manner as might give the impression that they had been tested by an independent authority, and not by the company selling the current. The committee had brought the matter before the Board of Trade, but the Board, while in sympathy with the object of the committee, was of opinion that, having regard to the small number of meters which had yet been approved, the time had not come for compulsory legislation ; that, as the question was one which affected electricity supply generally, the expediency of the Council taking action in the matter appeared to be doubtful ; and that, with regard to future electric lighting orders, the Board, as at present advised, would not be prepared to insert any special provision requiring the use only of certified and approved meters.

*Central London Railway.*—The following motion was approved :—

That, in view of the extension of underground railways in London, it be an instruction to the Public Health committee to report on the condition of the atmosphere in the tube of the Central London Railway.

*Electric Clocks.*—A motion to the following effect is on the agenda :—

That it is very desirable that clocks worked by electricity (or by some other means), synchronised hourly from Greenwich, and lighted at night by electricity, should be placed in all the principal thoroughfares of the metropolis, and that the General Purposes committee consider and report upon the best method for carrying out the work.

*Opening of Roads.*—The following motion is to be made :—

That, in consequence of the growing evil, resulting in loss of life and injuries to persons, damage to business, and danger and delay to vehicular traffic, caused by the frequent and continuous opening of roads, the Highways committee consider and report as to the best means for the Council to procure such statutory powers as to secure that all persons or companies having parliamentary powers to open the roads shall be compelled to give adequate notice to the Council before exercising such powers, and that the Council shall have the power to make such regulations, and have such supervision as will ensure such work being done expeditiously, and with full regard to the public safety and business interests.

**London Underground Railways.**—The report of the proceedings of the Parliamentary Select Committee, which recently dealt with the subject of London underground railways, has been issued in the form of a blue book.

**Louth.**—A committee has been appointed by the Council to report upon the establishment of municipal electricity supply.

**Lowestoft.**—There are at present 166 customers of the electricity department, representing an equivalent of 8,250 8 c.p. lamps connected, and 1,730 additional awaiting connection. Sanction to the borrowing of £10,000 for street lighting has been obtained.

**Metropolitan Railway Re-Assessment.**—Owing to the diminution in the receipts of the Metropolitan Railway Co., an application was made to the City of London Union for a re-assessment of the property within the city area, upon which it is alleged that the reduction in the receipts represents £9,000 per annum out of a total of between £90,000 and £100,000 on the whole system. The re-assessment will involve the revaluation of stations, permanent way, bookstalls, refreshment rooms, &c., and it was agreed to appoint Mr. Walter Barnett, surveyor, Winchester House, Old Broad-street, London, to make the valuation for a fee of £100.

**Milan.**—It is reported that the telephone service in this city and its suburbs has been suspended since the beginning of October owing to a strike of telephone employés.

**Monmouth.**—The charge for electric current for motive power has been fixed at 3d. per unit.

**Municipal Telephony.**—West Hartlepool Corporation have decided to apply to the Postmaster-General for a licence to establish a municipal telephone service.

A conference of local authorities in the Burnley district was held last week to consider the establishment of a municipal telephone

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system for the district. The Burnley, Nelson, Colne and Todmorden Councils and other local bodies were represented. It was decided to consult an expert and to obtain further information to be submitted at a future conference.

In forwarding a draft licence for establishing a municipal telephone exchange, the Postmaster-General intimates to the Hull Corporation that it will be necessary to state the minimum and maximum limits within which they propose to fix the actual rates for subscribers to the exchange. In settling those limits he would be guided chiefly by the wishes of the Corporation, but that the maximum rate for unlimited calls should not be less than the corresponding charge of the National Telephone Co. The Telephone committee recently waited upon the local director of the National Telephone Co. (Mr. Geo. Franklin) in order to ascertain the terms upon which the Hull system of the National Company could be acquired. The suggested terms were, however, considered too onerous, and the committee therefore recommend the Corporation not to purchase. A deputation has been appointed to visit Glasgow to inspect the municipal exchange, and a consulting engineer is to be appointed to draw up plans for and supervise the equipment of the service at Hull.

A conference of representatives of local authorities in the Manchester telephone area was held last week to consider the proposal to establish a municipal telephone board. Ald. Southern, Manchester, presided, and representatives were present from Manchester, Salford, Stockport, Eccles, Wilmslow, Whitefield, Swinton and Pendlebury, Gorton, Sale, Moss Side, Withington, Stretford, Levenshulme, Bowdon, Heaton Norris, Audenshaw, Denton and Droylsden, and Alderley Edge. The conference resolved to accept the draft scheme submitted at the last conference as a basis for the establishment of a telephone board. The chairman then moved that a bill be promoted in Parliament for powers to carry out the scheme. He said the suggestion first of all was that the cost of the undertaking should be borne by Manchester subscribing $\frac{5}{8}$ths of the capital, Salford $\frac{1}{8}$ths, and three of the outer districts $\frac{1}{8}$th each. Since that proposition was made it had been found that there were other districts desirous of contributing and of being represented on the board, but that was a matter upon which future decision would have to be come to. If other districts were included it would be necessary to re-arrange the scale of contribution. Ald. Holland (Salford) seconded the motion, which was carried. He said that all districts, whether they contributed or not would be entitled to equal service, and there would be no preference shown or special advantage given by the joint board for the transaction of telephonic business within the defined area. Another meeting is to be held next week.

**Newport (Isle of Wight).**—Electric current was supplied for the first time on 2nd inst. from the new works of the Isle of Wight Electric Light and Power Co.

**Nicolaieff (Russia).**—Messrs. Siemens and Halske are erecting and equipping extensive electricity supply works in this town, which, after completion, will be taken over by the municipality.

**Nottingham.**—On Monday the Council resolved to apply for sanction to a further loan of £15,000 for extensions of the electric lighting mains, house service connections and meters. Consideration of the remainder of the report, abstracted in our last issue, was deferred.

**Presentation.**—On Saturday the staff and employés of the Woolwich District Electric Light Co. presented Mr. A. J. Fippard, the engineer and manager of the company, with an aneroid barometer, with clock and thermometer, together with two pipes in case, on his leaving the company to take up consulting work with Mr. W. T. Pressland at Broad Sanctuary-chambers, Westminster, S.W. A movement is on foot amongst consumers in the district to present Mr. Fippard with some recognition of his efficient management of the company.

**Proposed Hazelmere-Farnham Electric Tramway.**—A proposal to establish electric tramway connection between Hazelmere and Farnham is being discussed in the local press, and has, on the whole, been received with favour. The line would connect two branches of the L. and S. W. Railway, and would afford communication between the important residential localities of Shotter Mill, Hindhead, Grayshott, Headley and other populous places which are at present without any vehicular service. Access would also be given to many beautiful parts of this favoured district.

**Provisional Order Transfer.**—Denton District Council give notice of intention to transfer their electric lighting order (1897) to the Manchester Corporation. Right of purchase at 21 years or any subsequent five years is reserved, and the charges for current in Denton are to be the same as in Manchester.

**St. Anne's-on-the-Sea.**—An inquiry will be held on Tuesday into the Council's application to borrow £7,230 for electric lighting extensions.

**Sheffield.**—On Wednesday the Council passed a resolution that the application to the Local Government Board for sanction to borrow £83,237. 10s. 4d. and £416,762. 9s. 8d. for the electricity undertaking, authorised on Aug. 14, be not further proceeded with until the proposed application had been communicated to the Finance committee, and such committee shall have conferred thereon and reported.

Ald. Franklin, who moved the resolution, complained that the Electric Light committee had already spent £111,000 without statutory authority, and thought they should have submitted their proposals to the Finance committee.

Ald. Styring (the Chairman of the Electric Light committee) contended it was never intended that the rule as to reference to the Finance committee should apply to revenue-producing departments. The moneys required by the Electric Light, Tramways and Water committees had to be raised in order that those committees might meet their statutory obligations. The Tramways and Electric Light committees had previously raised money without going to the Finance committee.

**Siam.**—The Siam Electricity Co., of Bangkok, a Danish company with a capital of £150,000, has now practically absorbed the Bangkok Tramway Co., another Danish concern. In addition to the electric lighting undertaking, which has now been run successfully for some years, the new company has acquired the concession for a new tramway line 5½ miles in length, running to the suburb of Samsen. Current for the tramways, both the old and the new, will be supplied from the generating station of the Siam Electricity Co.

The telephone system of Bangkok is owned by the Government, forming part of the postal telegraph department. Much complaint is made of the service, and especially of the instruments in use. It is generally agreed that the city affords an excellent opportunity for an improved telephone service, its position on both sides of the river lending itself to a considerable extension.

**Sleaford.**—£1,000 further has been voted for extensions of the municipal electricity works.

**Smoke Nuisance.**—At Willesden (London) yesterday the Metropolitan Electric Supply Co. were summoned for permitting black smoke to issue from their works on nine days in June, July and September. The nuisance was admitted, but it was said the notices of complaint from the Willesden Council did not get further than the works. A promise to abate the nuisance was accepted on payment by the company of 40s. and 12 guineas costs.

**Southampton.**—The Council received 72 applications for the position of borough electrical engineer. This number was reduced by the Electricity committee to nine—viz., Messrs S. W. Newington (Oldham), W. C. Thomson (Electrical Department, G.N. Railway, Holloway), J. A. Jeckell (Coventry), H. F. Street (Halifax), J. M. Smyth (Keighley), H. E. Yerbury (chief assistant, Sheffield), F. B. Aspinall (superintendent engineer, City of London Company), H. Boot (Tunbridge Wells), and J. T. Baron (St. Pancras). At a meeting of the committee this number was further reduced to four:—Messrs. Newington, Street, Boot and Aspinall. A deputation was appointed to visit Oldham, Halifax, London and Tunbridge Wells to interview these gentlemen.

**Stafford.**—Extensions of the electric light cables, estimated to cost £2,500, have been authorised.

**Stockport.**—The Board of Trade inspection of the electrical equipment of the tramway between Woodley and Reddish took place on Thursday last week.

**Sunderland.**—Application has been made for sanction to borrow £32,000 for extensions of the electric lighting mains.

On Wednesday the Council passed a formal resolution to apply for a provisional order for the working of electric tramways.

**Telegraphists for South Africa.**—The Telegraph Battalion of Royal Engineers at Aldershot have received orders to prepare another draft for early embarkation for South Africa.

**Telephone in South Africa.**—The telephone has formed an important adjunct in connection with the military operations in South Africa from the first, and the construction of telephone lines for commercial as well as military purposes is now being actively pushed forward throughout the Transvaal and Orange River Colonies.

**Telephone in Greece.**—It is reported that a project is under consideration for the construction of a telephone line between Patras and Athens.

**Telephone Trunk Line Extension.**—Telephone trunk line communication has been extended to Keswick.

**Tunbridge Wells.**—The salary of the borough electrical engineer (Mr. Horace Boot) is to be increased from £350 to £500 per annum.

The report and accounts of the electricity department for the year ended March 31 have been issued. For the first time in the history of the undertaking there is a loss of £482 on the year's working, mainly due to increase in the coal bill, the increase in this item alone amounting to £13,080. A payment of £488 towards interest and sinking fund on capital not yet earning income further militated against a favourable financial position. The deficit will be met out of reserve. In the report of the borough electrical engineer (Mr. Horace Boot), accompanying the accounts, it is stated that the average price obtained from private consumers was 4·46d. per unit against 4·8d. last year, and for public lighting 1·03d. against 1·19d., and a recom-

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mendation is made that the charge for public lighting should be increased, as at present current is being sold under cost. Mr. Boot further suggests that the price charged for side street lighting should be the same as that of the gas company. The number of consumers is 600, an increase of 135, the equivalent number of 8 c.p. lamps connected being 35,260, an increase of 6,658 in the year.

**Watford.**—In future the charge for current for power will be 5d. per unit for the first hour's maximum demand and 1½d. after.

**York.**—Owing to an increase of 4d. per 1,000 in the price of gas, the Streets committee are conferring with the Electric Lighting committee as to substituting electric for gas lighting for the streets.

The report on extensions of the electricity supply undertaking referred to in our last issue, at an estimated cost of £50,000, was adopted by the city Council on Monday.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.]*

### TENDERS INVITED.

*London County Council* invite tenders for wiring and fittings for the electric lighting of fire brigade stations at Homerton, West Hampstead, East Greenwich and Perry Vale. Specifications, &c., from the chief engineer's department, County Hall, Spring-gardens, S.W. Further particulars are given in an advertisement. Tenders by noon, Oct. 31, to the clerk of the Council (Mr. G. L. Gomme), County Hall.

*London County Council* also require tenders for stores for 12 months from Jan. 1, including engineers' goods and electrical stores. Tenders by 28th inst.

*Ilford* District Council invite tenders for water-tube boiler (with fittings, pipework, &c.), a 550kw. steam dynamo (vertical enclosed high-speed engine), and main switchboard and connections. Some particulars are set out in an advertisement. Specifications from the clerk to the council (Mr. John W. Benton), and further information from the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C. Tenders to chairman of Council by noon 29th inst.

*Manchester* Electricity committee invite tenders for the supply and erection at the Stuart-street generating station, and sub-stations, of two 6,000 H.P. triple expansion engines and two 3,750kw. three-phase alternators, and 48 motor generators for sub-stations. Specifications, &c., from the secretary (Mr. F. E. Hughes), Town Hall, and can be inspected at, but not obtained from, the chief engineer (Mr. G. F. Metzger), Dickinson-street electricity works. Tenders to chairman by noon Nov. 6. An advertisement contains some further particulars.

*Swindon* Corporation invite tenders for three Lancashire boilers, economiser, two jet condensers, feed pumps, pipework and accessories, water-cooling tower and 10-ton overhead travelling crane. Specifications, &c., from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, S.W. (and may be seen at Manchester offices, 78, King-street). An advertisement contains further particulars. Tenders to the town clerk (Mr. Robert Hilton), Town Hall, Swindon, by Nov. 12.

*Dudley* Electric Light and Tramway committee invite tenders for pipework. Specification from the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. Henry C. Brettell), Town Hall, Dudley, by noon Oct. 25. See advertisement.

*Leyton* Electric Lighting committee invite tenders for a multipolar dynamo of about 450kw. capacity, and a balancer. Specifications from the engineer and manager (Mr. F. Harman Lewis), to whom tenders by 26th inst. See advertisement.

*Chesham* District Council invite schemes for the erection of electricity works and for the transfer of their provisional order. An advertisement contains further particulars. Schemes to the clerk (Mr. John Gibbon How) by Nov. 16.

*Limerick* City Council invite tenders for the supply, delivery and erection of electrical plant and apparatus, including cables, arc lamps, Westinghouse gas engines, dynamos, boosters and Dowson gas plant. Specifications from the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., after 18th inst, and tenders to the town clerk (Mr. Wm. M. Nolan), Town Hall, Limerick, by 28th inst. See advertisement.

The burgomaster and councillors of the City of *Amsterdam* invite tenders for electrical (overhead) tramway construction. An advertisement contains further particulars, and specifications, &c., can be obtained at the city printing office. Further information of the director of municipal street railways, Nieuwe Achtergracht, 164, Amsterdam. Tenders by noon, Nov. 18.

The directors of the *Great Western Railway* require tenders for the supply of stores from Dec. 1, 1901, to Nov. 30, 1902, including telegraph instruments and apparatus, telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, copper and gutta-percha wires, telegraph poles and yellow pine, &c. Samples and patterns can be seen at Swindon up to 17th inst., where specifications, &c., can also be obtained. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London, W., by 21st inst.

*Newport* (Mon.) Corporation invite tenders for winches for steel chimney shaft, outside coal handling, piping, switchboard, cables, cable-ways, overhead construction, complete electric motor car and repair shop equipment. Tenders by 5 p.m. Oct. 21.

*Stepney* (London) Electrical committee require arc lamp columns, lamps, fittings, &c., and switchboard. Tenders to Chairman by noon Oct. 17.

*Wrexham* Corporation require tenders for wiring two markets. Tenders by 5 p.m. 14th inst.

*Ashton-under-Lyne* Corporation require tenders for steel poles, bases, section boxes and overhead lines for about 1½ miles of electric tramway. Tenders to Mr. John Neal, Town Hall, Ashton-under-Lyne, by noon 29th inst.

*Blackpool* Corporation invite tenders for poles, plinths, cables, &c., overhead materials, trolley wire and bonds and 20 electric car equipments. Tenders to Chairman Tramways committee by noon Oct. 21.

*Wakefield* Electricity committee require a 550 B.H.P. high-speed engine and a 400kw. two-phase alternator. Tenders to Chairman by Oct. 15.

*Kirkcaldy* Corporation invite tenders for a main switchboard. Tenders to town clerk by 10 a.m. Oct. 24.

*Levenshulme* District Council invite tenders for refuse destructor. Tenders by Nov. 2.

*Jaca* (Huesca, Spain) Municipality invite tenders for an electric lighting concession. Tenders by 28th inst.

Tenders are invited until Nov. 5 for the construction and working of a telephone exchange in *Valdepeñas* (Spain).

### TENDERS RECEIVED AND ACCEPTED.

The following tenders have been accepted by Maidenhead Corporation for the supply of electricity generating plant :—

*Boilers.*

Babcock and Wilson ..... £930
14 tenders received, ranging from £930 to £1,200.

*Economiser.*

Arthur Lowcock (Ltd.) ..... £173
11 tenders sent in, ranging from £173 to £225.

*Steam Dynamo.*

Clayton Engineering Co. (own engine)..... ... £1,736
No less than 48 tenders were received for this part of the contract, the prices ranging from £3,122 to £1,577. 16s.

Darlington Town Council have accepted the following tenders for their electricity department :—

| | |
|---|---|
| R. Taylor & Sons ..... | Lancashire boiler. |
| Thomas Parker (Ltd.) .. ... | 350 H.P. steam engine and dynamo. |
| Babcock and Wilcox .. ..... | Steam pipes and valves. |

Hammersmith (London) Borough Council have accepted the tender of Sir Hiram Maxim Electrical and Engineering Co. for pipework and tanks in connection with the condensing plant contract for the electricity department at £1,881. 15s. The full list of tenders appeared in our issue of 27th ult.

The Ilford Council have accepted the tender of Macartney, McElroy & Co. for the track and permanent way equipment of their tramway undertaking at about £66,000, the work to be completed in nine months.

Leyton District Council have accepted the following tenders :—

British Insulated Wire Co., for 1 mile 0·1 sq. in. cable at £182 and 2 miles 0·2 sq. in. at £282 per mile, and for 1,500 yds. of 7/18 cable at £56. 5s.

Pierson & Co., for nine arc lamp-posts at £9. 7s. 6d. each.

Oliver & Co., for 10 arc lamps and accessories at £92. 17s.

Bertram Thomas, for switchgear at £66, and a distributing plug board at £16. 5s. 6d.

Exeter City Council are recommended to accept the inclusive tender of the British Westinghouse Company for the equipment of the new electricity generating station at £29,707. This tender has been adopted on the advice of the consulting engineer, Mr. Robert Hammond.

Cheltenham Town Council have accepted the tender of Messrs. E. Green & Son for a new economiser at the electricity works for £614. 8s., less £100 allowance for old economiser.

Nelson Town Council have accepted the tender of D. Bruce Peebles & Co. for a 200kw. set at £2,189.

Hull Electric Lighting committee have accepted the tender of Messrs. Browett, Lindley & Co. for two steam engines at £4,510. 17s.

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## BUSINESS NOTICES.

Messrs. A. Reyrolle & Co. (Ltd.) of Pancras-street, London, W.C., have transferred their head office to Hebburn-on-Tyne, where large works have been erected to meet the increased demand for their manufactures. This firm manufactured the large distributing switch-boards at Newcastle-on-Tyne and Wallsend, recently described in our columns, and have also supplied boards for a number of supply stations. The company have erected special stoves for slate enamelling.

Mr. A. E. Blower informs us he has resigned his position as South Coast and West of England representative of the Edison and Swan Company, and has joined Mr. Ernest Roberts in partnership under the style of Ernest Roberts and Blower, manufacturing electrical engineers, 6, Holborn-place, London, W.C. The new firm has been appointed agents for the Jandus arc lamp for the South Coast and West of England.

Messrs. W. J. Bishop and J. L. Tahourdin (trading as W. J. Bishop & Co.), electricians, 88, George-street, Croydon, have dissolved partnership. Debts by Mr. Bishop.

Rosa Ada Barnes and Abraham Hacker (trading as Barnes and Hacker), electric light fittings makers, &c., 113, Suffolk-street, Birmingham, have dissolved partnership. Debts by R. A. Barnes, who continues.

Mr. F. N. Dowling has taken over the business of general electricians and contractors hitherto carried on by Messrs. Dowling and Rendell at Birmingham.

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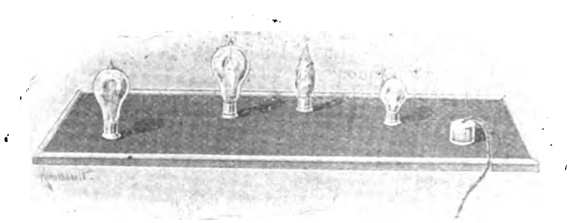
**Plant for Sale.**—The Electrical Accessories Supply Co., 1, Portland-road, Notting Hill, London, W., have some electric lighting plant for sale. See advertisement.

An advertisement contains particulars of four 120 H.P. and two 60 H.P. gas engines, four 60kw. and 225kw. dynamos, also a compressed air plant, which are for sale. Particulars from the city electrical engineer (Mr. Victor A. H. McCowen), Belfast.

**Electric Lighting, &c., for Estate Work.**—Messrs. Merryweather & Sons, of Greenwich-road, London, S.E., have recently erected at Emo Park, Portarlington, Queen's County, Ireland, a pair of oil-engines which drive the electric generating machinery for lighting, and, in addition, provide power for various estate duties. The pumps in a 100ft. well are worked by an electric motor.

**Electric Lighting Boards.**—A well-got-up pamphlet, dealing with the "E.L.B." system of electric illumination, is issued, and shows groupings of incandescent lamps for many kinds of outdoor illumination, as well as examples of temporary indoor lighting. If, as we sincerely hope (and in spite of rumours), all should go well with the King, there should be a large demand for this system of illumination in connection with the coronation festivities. The illustrations herewith show (1) the method of "pricking" the incandescent into the surface of a specially prepared board, and (2) a thin board which can be used for inserting into a show case or other fitting. We may add that considerable extensions to the company's London factory premises have been made to meet the demand for these boards. A formidable list of users of electric lighting boards is issued with the pamphlet under notice; and in connection with the recent visit of the



Czar of Russia to France some extensive illumination contracts were carried out by the company. There was, in addition, a demonstration of this system of illumination before the Czar and a number of Grand Dukes and Duchesses of Russia and the chief Ministers of State, during which the Czar and Grand Dukes personally manipulated a number of lights and took a more than usually active interest in the details of the "E.L.B." system.

**Award.**—A first prize and diploma d'honneur has been awarded to Mr. John Robson, Ives-street, Shipley, for his "Nonpareil" gas engine exhibited at the recent agricultural show at Vielsohn, Belgium. The demand for his engine for home and export has (Mr. Robson informs us) necessitated the building of more extensive works premises, stores and offices at Shipley, and these are now in course of construction.

**Glassware and Electrical Fixtures.**—We referred last week to the issue by the General Electric Co. of a fine new catalogue of glassware and electrical fixtures. The catalogue contains, in addition to numerous examples of the classes of fittings and fixtures which have become a settled part of general installation work, an entirely new series of fittings, which are claimed to be a distinct departure from anything previously placed before the trade. The object has been in this case to adapt the best home and Continental styles, avoiding the "eccentricities" of both. The company's extensive range of showrooms, where these fittings are well set out, are available to buyers. Fittings are furnished in polished brass or copper, natural bronze, oxydised silver and hammered iron (either black or armoured steel). A special class of fittings to which much space is devoted is that for which a large demand has arisen from the extension of electric lighting to shop premises, public buildings and tramcars, for all of which special designs have been provided. The number of outside fittings, which are always a feature of the General Electric Co.'s catalogue, has been greatly extended, and includes a patent incandescent street lantern. The hood and reflector of this lantern have incandescent lamps securely attached, and the fitting is hung in such a manner that the whole of the upper part can be swung back for changing and cleaning the lamps. Other features which facilitate the work of cleaning and tending, and for reducing this work to a minimum, have been applied. This lantern has already been supplied in considerable quantities, and the attention of municipal engineers and others engaged in public lighting work is especially directed to this fitting. In bronzes, electroliers, pendants and standards a very fine display is made, and the fittings on pages 1714 and 1715 may be specially mentioned. The get-up of the book is in the best style, and the skilful arrangement of the mass of illustrations and the printing of the book are a credit to all concerned in its production. In glassware the catalogue is particularly strong, and provides for every variety of taste. It only remains to be said that the company at their works in Birmingham employ over 500 hands on fittings manufacture alone, and, while the large range of London showrooms are equipped with examples of practically every fitting required in electric installation work, examples of a large number of these fittings can also be seen at the company's branches in Glasgow, Manchester, Newcastle, Birmingham, Cardiff and Dublin.

**A Remarkable Watch.**—Messrs. S. Smith & Sons (Ltd.), of 9, Strand, London, W.C., hold an unique position in the watch-making world, and are, we think, well known to the electrical profession. This firm are now exhibiting, at their premises in the Strand, a watch of their own manufacture set in a transparent case made of rock crystal, the watch movements being fully exposed to view. This watch, which is a distinct novelty, has been submitted to the Kew authorities, and has obtained 82 3 marks out of a possible 100, and the award "Especially good." The watch is provided with the revolving or *tourbillon* experiment, which represents the latest important improvement in watch-making, and is now brought into use for the first time. This is the first English watch of the kind ever constructed, and it is claimed that solidity and strength are maintained, and that every detail of mechanical skill and finish is present. We may take this opportunity of directing attention to Messrs. S. Smith & Son's prominent stand at the Glasgow Exhibition, where a show is made in jewellery of all kinds, watches, clocks, and everything that goes to the make-up of a fine display of the jeweller's handiwork. This is one of the most imposing stands at the exhibition.

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during September was £46,651, against £42,096 in the preceding month and £97,107 in September last year. The total for the nine months ended Sept. 30 was £683,820, against £794,699 for the corresponding period last year.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 2 to Oct. 8, with the ports of destination:—

*Africa*—Cape Town, £1,194 (telegraph sundries); Durban, £22; East London, £72 (telegraph sundries); Sierra Leone, £20,040 (telegraph cable); Zanzibar, £76. *Argentina*—Buenos Ayres, £1,560; Rosario, £35. *Australasia*—Auckland, £195 (telegraph material); Gisborne, £261; Melbourne, £663; Port Chalmers, £71; Sydney, £1,253; Wellington, £1,283 (including £628 telegraph material). *Brazil*—Rio Janeiro, £65 (telegraph material). *Canary Islands*—Teneriffe, £25. *Ceylon*—Colombo, £254 (including £235 telegraph material). *China*—Shanghai, £7,591 (including £7,549 telegraph material). *Denmark*—Copenhagen, £825 (including £65 telegraph wire). *Gibraltar*, £25. *Holland*—Amsterdam, £33; Rotterdam, £43 (telegraph wire). *Hong Kong*, £93. *India*—Bombay, £355; Calcutta, £1,180 (including £200 telegraph material). *Malta*, £17. *Norway*—Christiania, £33 (telegraph wire). *Russia*—St. Petersburg, £266. *Spain*—Grenada, £60. *Straits Settlements*—Singapore, £43,080 (including £48,000 telegraph cable). *Sweden*—Gothenburg, £1,521 (telegraph cable); Stockholm, £657 (including £476 telegraph cable). Total £87,818 against £13,666 in the corresponding week last year (Oct. 3 to 9).

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# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

June 6, 1901.

11,582. E. . EVERETT and K. EDGCUMBE. London. Improvements in the construction of electrical measuring instruments.
11,584. K. W. HEDGES. London. Improvements in lightning conductors.
11,600. J. J. H. HUNTE. London. Improvements in or relating to the formation of positive plates for electric accumulators or secondary batteries. (J. Lurgen, Germany.)
11,619. E. W. JUNGNER. London. A method of producing electrodes for electric accumulators.*
11,625. THE ELECTRICAL POWER STORAGE CO. (LTD.) and W. H. HANSON. London. Apparatus for applying plastic material to matrices, more especially intended for use in applying the paste to the grids in making secondary battery elements.

June 7, 1901.

11,640. A. E. ROOKE and J. PATTERSON. Glasgow. Improvements in trolley heads for overhead electric traction.
11,648. G. RUSHTON. Halifax. Improvements in trolley heads.
11,660. E. CADETT and H. DICKINSON. London. Improvements in wireless telegraphic signalling.
11,676. T. S. PERKINS. London. Improvements in rheostat elements or resistance boxes. (Date applied for under Patents, &c., Act, 1883, sec. 103, November 9, 1900, being date of application in United States.)
11,677. P. H. THOMAS. London. Improvements in protecting devices for the coils of electrical apparatus. (Date applied for under Patents, &c., Act, 1883, sec. 103, November 9, 1900, being date of application in the United States.)
11,702. B. J. LÜRGEN and the D.P. BATTERY CO. (LTD.) London. Improvements in and relating to electric accumulators.
11,703. C. GRUNDY. London. Improvements in electrical distribution boards.
11,709. W. L. ALLCROFT. London. Improved construction of contact maker or current conductor for electric motors.

June 8, 1901.

11,730. C. M. STEAD. Leeds. An improved fitting for incandescent lights specially applicable for electric incandescent lights.

June 10, 1901.

11,838. P. M. JUSTICE. London. Improvements in regulators for electric or other motors operating air or other fluid compressors. (The Long Arm System Co., United States.)
11,845. A. J. ADKINS. London. Improvements in or relating to electric wire switch couplings.
11,847. G. L. ADDENBROOKE. London. Improvements in or relating to electrostatic instruments.*
11,854. D. A. LOWERY. London. Improved automatic electric cutout for overhead wires or conductors.
11,857. E. ARNOLD and F. COLLISCHONN. London. Improvements in armature windings for dynamo-electric machines.

June 11, 1901.

11,922. L. GUTMANN. Liverpool. Improvements in or relating to electric meters, motors and methods of compensating for phase-displaced currents.*
11,925. H. H. LAKE. London. Improvements in apparatus for connecting the ends of electric cables and the like. (Francis H. Stillman, United States.)*
11,931. W. L. ALLCROFT. London. Improved method of regulating and controlling the speed or power of electric motors.
11,949. F. H. LITTLEFIELD. London. Improvements in electric telegraph apparatus.*
11,951. H. HELBERGER. London. Ampere meter for the registration of the maximum consumption of electrical energy.*

June 12, 1901.

11,992. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in means for accentuating electrical contacts. (Elihu Thomson, United States.)*
12,016. SIEMENS BROS. & CO. (LTD.). London. Framework for alternating-current electrical machines. (Siemens and Halske, Aktiengesellschaft, Germany.)*
12,020. G. HOOKHAM. London. Improvements in electricity meters.
12,023. W. KIELPINSKI. London. Improved mechanically-operated and electrically-controlled alarm apparatus.*

June 13, 1901.

12,061. THE SCOTTISH WIRELESS ELECTRIC SYNDICATE (LTD.) and W. JAMIESON. Glasgow. Improvements in etheric telegraphy.
12,071. S. DE JONG. London. Electrical ignition and valve operating mechanism for oil or petrol engines for motor cycles. (Date applied for under Patents, &c., Act, 1883, sec. 103, Dec. 22, 1900, being date of application in Belgium.)
12,088. G. WEISSMANN. London. Improved method of and means for taking electric current from transformers. (Date applied for under Patents, &c., Act, 1883, sec. 103, Dec. 5, 1900, being date of application in France.)
12,089. J. E. SPAGNOLETTI. London. Improvements in automatic electrical signalling apparatus for railways.
12,094. F. TREMAIN. London. Improvements in electric cables.
12,119. J. P. GORTON. London. A new or improved method of and combination of apparatus for translating and relaying telegraph cable signals.*

June 14, 1901.

12,121. A. F. PETCH. Machinery for pressing the copper segments and insulating strips of electric commutators into annular form.
12,134. C. A. LEE. London. Improvements in or relating to electric arc lamps and electrodes therefor.
12,139. C. JONES. Blackburn. An improved device for the prevention of accidents from overhead trolley wires.
12,153. C. ADAMS-RANDALL. London. Improvements in electrically-propelled cycles, autocars and other like vehicles.
12,195. W. P. THOMPSON. London. Improvements in and in the construction of electrodes. (R. J. Gülcher, Germany.)
12,210. C. E. DOLBEAR. London. Improvements in electrostatic separators.*
12,217. N. M. WATSON. London. Improvements in coin-actuated medical batteries.
12,218. G. B. BOWELL. London. Improvements in electric clocks and automatic alarm transmission.
12,220. P. M. JUSTICE. London. Improvements in electric telegraphy. (The Rowland Telegraphic Co., United States.)*
12,223. J. C. WILSON. London. Improvements in or connected with the field regulation of electro-dynamic machinery.

June 15, 1901.

12,230. J. W. GILBERT. Birmingham. Improvements in ceiling roses for use in electric lighting.
12,241. W. BOEHM. London. Improved manufacture of electric illuminating bodies.*

June 17, 1901.

12,329. A. O. FOX. London. Improvements in electric motors.*
12,342. T. SCHÄFFER. London. Improvements relating to electro-magnetic winding mechanism for clocks.
12,350. A. G. RONAN. London. Improvements in revolving electric igniters.

June 18, 1901.

12,382. G. F. CAMPBELL and S. T. ISHERWOOD. Liverpool. Improvements in portable electrically-driven drilling apparatus.
12,400. J. LIDDLE. Glasgow. Trolley for electric cars (Laclede Car Co., United States).*
12,403. J. S. HOLME. Egremont. Improvements in bonding electric railway and tramway rail joints.
12,408. T. B. KINRAIDE. London. Improvements in and relating to static rectifiers and other electric apparatus for producing or maintaining continuous or unidirectional discharges.*
12,456. J. G. LISTER. London. Improvements in or relating to trolleys for use in electric traction.
12,466. SIEMENS BROS. & CO., LTD. London. Improvements in apparatus for deriving continuous current from a source of alternating current (Siemens and Halske, Aktiengesellschaft, Germany).*
12,468. A. H. HOWARD. London. Improvements in the manufacture and production of troughs or conduits specially intended for the reception of electric cables.
12,469. B. J. BERTHELON. London. An improved current transformer for telephones.

June 19, 1901.

12,496. L. FRANCKEL and R. R. HARPER. London. Seeing by electricity.
12,508. SIEMENS BROS. & CO., LTD. London. Improvements in apparatus for deriving continuous current from a source of alternating current (Siemens and Halske, Aktiengesellschaft, Germany).*
12,509. SIEMENS BROS. & CO. (LTD.). London. Improvements in apparatus for deriving continuous current from a source of alternating current (Siemens and Halske, Aktiengesellschaft, Germany).
12,514. J. C. FULLER and G. FULLER. London. Improvements in or connected with storage or secondary batteries.

June 20, 1901.

12,551. R. WYLIE. Glasgow. Improvements in and relating to trolley pulleys for electric tramcars and the like.
12,552. CROMPTON & CO. (LTD.), A. J. HODGSON and J. W. EWART. Chelmsford. Improvements in electric arc lamps.
12,587. R. W. BOYD. London. Improvements in and relating to apparatus for lighting and heating by means of electric lamps.*
12,607. E. B. VILES. London. Improvements in and relating to plates for electric batteries and methods of manufacturing the same.
12,622. EVERSHED AND VIGNOLES (LTD.) and S. EVERSHED. London. Improvements in electric instruments.

June 21, 1901.

12,685. S. JEVONS and E. W. BONSON. Birmingham. An improved method of registering electric currents.
12,691. R. E. LEVE. London. Improvements in electric cloth-cutting machines.*
12,720. W. B. ESSON. London. Improvements in or connected with electric cables for three-phase alternating currents.*
12,721. H. TIRMANN and H. TIRMANN. London. Improved machine for use in the manufacture of electric fuses or cartridges.*

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June 22, 1901.

12,730. C. C. METCALFE. Cheshire. Improvements in cleats, ceiling roses, cutouts and the like for electrical purposes. (H. C. Blackwell, Russia.)

12,739. G. POTT and R. WILLIAMSON. Glasgow. Improvements in electrically driven centrifugal and similar machines.

12,755. J. MATTHEWS and W. DAVIES. Birmingham. Improvements in electric motors.

12,770. O. IMRAY. London. Apparatus for automatically regulating the tension of electric currents. (Moritz Lindner, Austria.)*

12,774. M. GEHRE. Liverpool. Improvements in cell switching devices for electric accumulator batteries.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BRAZILIAN RUBBER TRUST (LTD.)**—Reg. Sept. 28, capital £37,500 in 5s. shares, to acquire certain rubber-producing properties in Para, Brazil, and to carry on the business of planters, growers, collectors, manufacturers, curers, importers and exporters of and dealers in indiarubber and other articles and substances, &c.

**SOCIETE IBERIQUE THOMSON-HOUSTON.**—This company has been registered at Madrid, with a capital of 10,000,000 pesetas, to acquire, work and exploit the Thomson-Houston patents in Spain and Portugal, and also to acquire the tramway concession for Cadiz from the Société anon. Thomson-Houston de la Méditerranée.

**BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)**—The annual return to July 26 gives the capital as £20,000 in 1,000 preference and 1,000 ordinary shares of £10 each, of which 1,000 preference and 892 ordinary have been taken up. £10 per share has been called up and paid on 790 preference and 707 ordinary and £5 per share on 35 ordinary shares. £3,600 is considered as paid on 210 preference and 150 ordinary shares. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26$\frac{1}{16}$d. per oz. (Oct. 10). Consols (2$\frac{3}{4}$ per cent.) 92$\frac{15}{16}$—93$\frac{1}{16}$ for money, 93$\frac{1}{16}$—93$\frac{3}{16}$ for account; 2$\frac{1}{2}$ per cent. 94—94$\frac{1}{2}$ (Oct. 10). Consols Pay Day, Nov. 6; Stocks and Shares Continuation Days, Oct. 23 and Nov. 10; Ticket Day, Oct. 24; Pay Days, Oct. 11 and 25; Mining Share Carry-over Days, Oct. 22 and Nov. 8.

**AKKUMULATOREN FABRIK ACTIENGESELLSCHAFT (BERLIN-HAGEN).** A dividend of 10 per cent. has been declared for the year 1900-1901, the same rate as for the previous year.

**CUBA SUBMARINE TELEGRAPH CO. (LTD.)**—An ordinary dividend at the rate of 4 per cent. per annum (tax free) for the half-year ended June 30 is declared.

**DEWSBURY, BATLEY AND BIRSTALL TRAMWAYS CO. (LTD.)**—At a meeting on Monday, it was decided to sell the undertaking to the British Electric Traction Co. for £27,769. 16s. The capital of the company is £43,000, and the distribution to shareholders will be at the rate of £4. 17s. 6d. per £9 ordinary share and £10 for each £10 preference share. The Batley and Birstall local authorities were also negotiating for the purchase of the lines. The B.E.T. Co. has obtained an order to construct light (electric) railways in the heavy woollen district, and propose to connect these lines with the existing system, which will be converted from steam to electric traction. All the local authorities, except Batley, have agreed to purchase the sections of the system in their various districts, and then to sell or lease them to the company. Batley Corporation have powers to construct electric tramways, and will, therefore, purchase the lines in their own district.

**DIRECT UNITED STATES CABLE CO. (LTD.)**—An interim dividend has been declared of 3s. per share, tax free (at the rate of 3 per cent. per annum), for the quarter ended Sept. 30, payable 26th inst.

**MUNICIPAL ISSUE**—Doncaster Corporation invite offers for a loan of £25,000 for electricity supply. Applications to the Finance committee by 21st inst.

**NEW ST. HELENS AND DISTRICT TRAMWAYS CO. (LTD.)**—At the meeting on Monday the chairman (Sir John Willox, M.P.) referred to the negotiations with the St. Helens Council and said that, while the company took prompt measures to provide a full equipment of cars, which were ready and waiting for the opening of the lines, the Corporation had not fulfilled its share of the contract, and was behindhand in laying the track. For the loss thus sustained the company had received no compensation. Concessions had been recommended by the Electricity committee, but were rejected by the Corporation. The expenses of working had been cut down to the lowest point consistent with efficiency, and the service had been maintained with regularity. If their rent and liabilities to the Corporation were reduced to a reasonable sum the original calculations they had made as to income and expenditure would be very nearly accurate.

**NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)**—At the last general meeting the directors intimated their intention to issue further capital in connection with the recent extensive developments of the company's business. In accordance with this notification, the company recently issued to its shareholders, proportionately, 11,000 ordinary and 6,250 preference shares of £5 each at a premium of £2 and £1 per share respectively. The result of the issue was an application from shareholders for 12,742 ordinary and 8,244 preference shares. The premiums amounted to £28,250, and this has been added to reserve, which now stands at £72,000. The total capital issue of the company is £300,000 in £150,000 ordinary and £150,000 preference shares. The whole of the company's nominal capital having now been allotted, the directors will proceed to the issue of debentures at the end of October or the beginning of November.

**NORWICH ELECTRIC TRAMWAY CO.**—At the meeting last week Baron E. B. d'Erlanger said the tramways were opened for traffic in August, 1900, but some portions of the line were not opened till late in the autumn of that year. He was glad the first year's working showed a profit. Under their act they had a concession for 50 years, at the end of which the Corporation could purchase compulsorily their undertaking, or could purchase the lines after 14 years from 1897, on paying the then value, as a going concern, and a premium equivalent to three years' earnings, or after 21 years, and at each seventh year thereafter up to 50, upon paying the value of the undertaking, as a going concern, without premium. If, however, Norwich Corporation elected to purchase before the expiration of 50 years, it had to pay, in addition, a substantial amount in respect of money spent by the company on street widenings, amounting to a rateable proportion of a maximum of £44,000. Their system comprised 20 miles of single track, divided into 10 routes, all converging towards the centre of the town. The existing lines would meet all the wants of the population for some years to come. The total earnings amounted to £35,665; £700 for interest was to be added to this. Expenses amounted to £22,497, or just under 61 per cent. of gross receipts. They thought that the earnings would increase steadily over the past year's figures, but the expenses of operation would remain nearly the same. They had run 924,789 miles, transported 7,816.222 passengers, the average receipts per car mile had been 9·25d., and the average cost per car mile 5·83d. After allowing for debenture interest, there was a distributable balance of £11,568. 2s. 5d., out of which they proposed a dividend at the rate of 4$\frac{1}{2}$ per cent. upon the paid up capital, absorbing £10,864. 1s., and that £704. 1s. 5d. be carried forward. The report and accounts were adopted.

**ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)**—An interim dividend has been declared of 2$\frac{1}{2}$ per cent. (the same rate as this time last year) on the paid-up capital, tax free. Warrants will be posted on the 31st inst.

**REUTER'S TELEGRAM CO. (LTD.)**—An interim dividend has been declared at the rate of 5 per cent. per annum, tax free, for the half-year ended June 30.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed 24th inst. as a special settling day in £171,300 5 per cent. mortgage debentures of £300 each (Nos. 1 to 1,713) of the *New General Traction Co. (Ltd.)*, and has ordered the same as well as £400,000 4 per cent. £100 first debentures (Nos. 1 to 4,000) of the *Primitiva Gas and Electric Lighting Co. of Buenos Ayres (Ltd.)* and 160,000 6 per cent. £1 fully-paid cumulative preference shares (Nos. 1 to 160,000) of *John I. Thornycroft & Co. (Ltd.)* to be quoted.

**SUBMARINE CABLES TRUST.**—After Tuesday, 15th inst., the coupon due on that date will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, London, E.C.

**WESTERN UNION TELEGRAPH CO.**—The annual report for the year ended June 30 shows gross earnings $26,354,000, increase $1,595,000; net $6,685,000, increase $520,000; surplus after meeting dividends and interest charges $861,000, increase $470,000.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Oct. 5 | 739 | + 69 | 18 | 15,514 | + 1,632 |
| *Birmingham Tramways. | ,, 5 | 5,104 | + 535 | 13 | 63,483 | + 4,768 |
| *Blackburn Corporation.. | ,, 4 | 587 | + 111 | 40 | 20,153 | + 2,122 |
| Blackpool Corporation... | ,, 3 | 1,146 | + 473 | †27 | 33,745 | + 8,599 |
| Blackpool and Fleetwood | ,, 5 | 664 | + 256 | 14 | 18,541 | + 470 |
| Bolton Corporation ..... | ,, 6 | 1,466 | + 118 | 27 | 41,605 | + 4,648 |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ..... | Aug. 21 | 1,924 | + 83 | 34 | 69,215 | + 8,151 |
| *Bristol Trams & Carriage | Oct. 4 | 4,289 | + 984 | 13 | 53,994 | + 7,639 |
| *Buenos Ayres & Belgrano | Sept. 8 | 2,797 | - 297 | 10 | 26,278 | + 4,038 |
| Calcutta Trams. Co. ... | Oct. 5 | R22,443 | + R663 | 14 | R189,469 | +R15,653 |
| Carlisle Trams. Co. ..... | ,, 5 | 172 | - 4 | 14 | 2,907 | + 80 |
| Central London Railway | ,, 5 | 6,152 | +1,049 | 11 | 80,144 | ... |
| City & South London Ry. | ,, 6 | 2,031 | + 415 | 14 | 26,239 | + 5,002 |
| Cork Elec. Trams ..... | ,, 3 | 466 | + 8 | 39 | 18,803 | + 2,178 |
| Dover Corporation ..... | ,, 5 | 244 | + 20 | 27 | 6,915 | + 325 |
| Dublin & Lucan Rly. ... | ,, 6 | 106 | + 4 | 14 | 1,895 | + 261 |
| Dublin United ..... | ,, 4 | 3,722 | + 71 | ‡14 | 54,945 | + 1,220 |
| Dublin Southern Dist.... | ,, 4 | 834 | - 2 | ‡14 | 15,283 | |
| *Dundee Corporation ... | ,, 2 | 711 | + 242 | 14 | 9,942 | + 3,298 |
| *Glasgow Corporation ... | ,, 5 | 13,184 | +3,743 | 17 | 213,396 | +53,256 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ..... | ,, 5 | 1,670 | + 394 | 14 | 24,109 | + 5,599 |
| Liverpool Corporation... | Sept. 28 | 9,954 | +1,053 | 39 | 349,854 | +43,688 |
| *Liverpool Overhead Rly. | Oct. 6 | 1,440 | - 152 | 14 | 23,560 | - 712 |
| *Manchester Corporation | ,, 5 | 2,248 | ... | §17 | 34,602 | - 43 |
| Perth (W.A.) Elec. Trams | ,, 5 | 887 | + 354 | ‡14 | 12,060 | + 6,700 |
| Portsmouth Corporation | ,, 5 | 1,278 | + 476 | ... | ... | ... |
| *Sheffield Corporation ... | ,, 6 | 3,693 | +1,102 | 14 | 52,961 | +16,657 |
| Southampton Corporat'n | ,, 3 | 993 | + 299 | 14 | 14,034 | + 4,144 |
| Southend Corporation... | ,, 5 | 235 | ... | 11 | 3,537 | ... |

Except where otherwise indicated, all amounts are in sterling.
(a) These comparisons are for the corresponding period last year.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 2. | | Price Wednesday, Oct. 9. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 9. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 39/4½ | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) xd | 95 | 100 | 95 | 100 | ... | ... | 100 | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ | 10½ | 9⅝ | 10⅝ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. | 7⅜ | 8¼ | 7⅜ | 8¼ | 4 4 10 | ... | 8 | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¼ | 8¾ | 8¼ | 8¾ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅛ | 8 | 7⅛ | 8 | 2 3 9 | ... | 7⅛ | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 5 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5⅝ | 5½ | 5⅝ | 3 18 3 | ,, ,, | ... | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 104 | 106 | 104 | 106 | 3 16 2 | ... | 105½ | 105 |
| 34,000 | 5 | 2/6 | Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-40,500) | 5½ | 5¾ | 5 | 5½ | 5 0 0 | March | 5⅝ | ... |
| 10,436 | 5 | 1/5·42 | Do. (Nos. 40,501-50,936) xd | ... | | 5 | 5½ | 5 0 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 1 4 | June and December | ... | ... |
| 70,579 | 10 | ... | City of London Electric Lighting Ord. | 8½ | 9½ | 9 | 10 | ... | February and August | 9¼ | 8⅛ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 4 16 0 | January and July | 12¼ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 19 6 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 104 | 102 | 105 | 4 6 10 | ... | 103 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8⅞ | 9½ | 4 4 3 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 | 13 | 12 | 13 | 4 12 4 | March and September | 9 3/16 | 9 |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 104 | 107 | 104 | 107 | 4 5 4 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5¼ | 5⅝ | 5¼ | 5⅝ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary | 7⅛ | 8¼ | 7⅛ | 8¼ | 2 10 0 | ... | 5 5/16 | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅞ | 7 | 6⅞ | 7 | 4 5 9 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 | 104 | 101 | 104 | 3 17 6 | ... | ... | ... |
| £100,000 | Stock | 4% | Kensin. & Knytbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 101 | 104 | xd101 | 104 | 3 16 11 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 1⅝ | 1½ | 1⅝ | ... | ... | ... | ... |
| 49,840 | 5 | ... | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | ... | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 | 100 | 96 | 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 98,767 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 | 14 | 13 | 14 | 4 5 9 | April and October | 13½ | 13 3/16 |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 8 | June and December | 113¾ | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 3 | ... | 98 | ... |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15⅞ | 16⅛ | 15½ | 16⅛ | 4 4 10 | March | 16⅛ | 15⅝ |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5⅝ | 6⅛ | 5 | 6 | 4 3 4 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 | 102 | 99 | 102 | 3 19 0 | ... | ... | ... |
| 300,000 | 1 | ... | Rand Electric | ⅜ | ⅝ | ½ | ¾ | ... | ... | ... | ... |
| £135,000 | Stock | ... | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb | 60 | 70 | 60 | 70 | ... | January and July | ... | ... |
| £107,800 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs. xd | 100 | 102 | 100 | 102 | 4 8 3 | April and October | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 5 | 16 | 15 | 16 | 4 10 8 | February and August | 15¾ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9⅛ | 8½ | 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3¼% | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 3 10 6 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2⅛ | 2 | 2⅛ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 9 8 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2 | 3 | 2 | 3 | ... | ... | ... | ... |
| 109,518 | 5 | 5/0 | Westminster Electric Supply Ordinary | 11½ | 12½ | 11½ | 12½ | 4 4 0 | March and September | 15⅜ | 11¼ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 | 4¼ | 4 | 4¼ | 4 14 1 | April and October | ... | ... |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 125 | 128 | 125 | 128 | 4 14 10 | ... | ... | ... |
| 20,000 | 10 | ... | Barcelona Tramways Ordinary | 8 | 9 | 8 | 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 96 | 101 | 96 | 101 | 4 19 9 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 | 97 | 92 | 97 | 4 13 6 | ... | 93 | ... |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 13 | 14 | 13 | 14 | 4 12 10 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ | ¾ | 2⅝ | 3 | ... | ... | 2⅝ | 2⅝ |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ | 5 | 4⅝ | 5 | ... | ... | 4⅝ | ... |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 103 | 105 | 103 | 105 | 4 6 7 | ... | ... | ... |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary | 21½ | 22½ | 21½ | 22½ | 3 13 4 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅜ | 10⅝ | 10⅜ | 10⅝ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 | 115 | 112 | 115 | 3 10 2 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 | 6¼ | 6 | 6¼ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9¼ | 9⅝ | 9¼ | 9⅝ | 5 2 7 | May and November | 9⅜ | 9⅝ |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. | 101⅝ | 103⅞ | 101⅞ | 103⅞ | 4 9 1 | ... | 10 1/16 | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 14 | 15 | 14 | 15 | 6 0 0 | ... | 14⅝ | 14¼ |
| 90,000 | 10 | 6/0 | Do. 5% Cum. Pref. | 11⅞ | 12¼ | 11⅞ | 12¼ | 4 18 0 | February and August | 12¼ | 11⅞ |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 121 | 124 | 121 | 124 | 4 0 8 | ... | 122½ | 122 |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅞ | 2⅛ | 1⅞ | 2⅛ | ... | ... | 2 | 1⅞ |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5¼ | 5⅝ | 5¼ | 5⅝ | 5 4 4 | ... | 5⅝ | ... |
| 27,500 | 5 | 3/0 | Do. "B" | 5¼ | 5⅝ | 5¼ | 5⅝ | 2 3 6 | ... | 5⅝ | ... |
| £320,000 | Stock | 5% | Do 5 per Cent. Debentures | 174 | 107 | 105 | 118 | 4 13 10 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 98 | 101 | 100 | 103 | 4 18 6 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11⅛ | 12⅛ | 11⅛ | 12⅛ | 2 8 0 | ... | 12 | 11⅞ |
| £350,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 105 | 108 | 105 | 108 | 4 4 6 | ... | 106½ | 106 |
| 400,000 | 1 | 1/2⅞ | Cape Electric Tramways Shares | 1⅞ | 2⅛ | 1⅞ | 2⅛ | 2 16 6 | ... | 2 | 1⅞ |
| £1,969,800 | Stock | 4% | Central London Ordinary Stock | 101 | 104 | 101 | 104 | 3 2 6 | June and December | 103½ | 102 |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 104 | 107 | 105 | 108 | 3 15 2 | ... | 106¼ | ... |
| £440,100 | Stock | ... | Do. Deferred Stock | 93 | 101 | 98 | 101 | ... | ... | 101 | 100 |
| £898,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 | 118 | 113 | 118 | 3 8 3 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5¼ | 5⅝ | 5¼ | 5⅝ | 4 6 11 | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 103 | 106 | 103 | 106 | 3 16 11 | ... | ... | ... |
| £365,000 | Stock | 1¾% | City and South London Railway Con. Ordinary | 51 | 54 | 51 | 54 | 2 15 7 | February and August | 53 | 52⅜ |
| 47,500 | 10 | 2/0·84 | Do. Ordinary (Nos. 22,501 to 70,000) | 5 | 5¼ | 5 | 5¼ | 3 15 9 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 | 134 | 129 | 134 | 3 15 2 | ,, ,, | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 123 | 127 | 123 | 127 | 3 19 2 | ... | ... | ... |
| £413,913 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 | 118 | 113 | 118 | 3 8 6 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 12 | 13 | 12 | 13 | 3 16 11 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 8½% | Do 3½ per Cent. Mort. Debs. (red.) | 97 | 100 | 97 | 100 | 3 10 0 | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| 78,600 | 10 | 2/9½ | Great Northern and City Railway Pref. Ord. (4%) | ... | | 7⅜ | 8½ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 21½ | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 | 113 | 111 | 113 | 4 0 6 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 6⅞ | 7 | 6⅞ | 7 | 3 18 7 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference xd | 13 | 13½ | 13 | 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 104 | 103 | 104 | 3 17 8 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 | 107 | 105 | 107 | 3 15 6 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 | 114 | 110 | 114 | 4 8 6 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908) | 100 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 100 | 102 | 100 | 102 | 4 8 11 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 2½ | 3½ | 2½ | 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4 | 5 | 4 | 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11½ | 12¼ | 11½ | 12½ | 1 12 0 | ... | ... | ... |
| 10,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10½ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 108 | 109 | 108 | 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | | ... | | ... | ... | ... | ... |
| 51,132 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | | ... | | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | | ... | | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | | ... | | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 91 | 94 | 91 | 94 | 3 3 10 | June and December | ... | ... |



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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 9. | Price Wednesday, Oct 9. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 9. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 100 103 | 3 18 5 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅜ 4⅛ | 3⅜ 4⅛ | | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | | | ... | ... |
| £804,720 | Stock | 15/0 | Anglo-American | 53 56 | 53 56 | 5 11 9 | Feb., May, Aug., Nov. | 99⅜ | 98⅞ |
| £3,097,640 | Stock | 30/0 | Do. Preferred | 98 100 | 98 100 | 6 1 3 | ,, ,, | 103⅜ | 103 |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10⅛ 11 | 10 10⅛ | 2 7 7 | ,, ,, | | |
| 13,333,300 | $100 | $1⅛ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | 101¾ | 101½ |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 5 | ,, ,, | | |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 6 | 5 6 | 7 10 0 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 13½ 14½ | 13½ 14½ | 6 17 11 | ,, ,, | ... | ... |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ 104 | 100⅞ 104⅞ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 4/0 | Direct United States Cable | 10⅛ 11⅛ | 10⅛ 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | 11 | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 4 | June and December | ... | ... |
| £4,000,000 | Stock | 65/0 | Direct West India Cable [to 1,200) (red.) | 141 146 | 141 146 | 4 15 11 | Jan., Apr., July, Oct. | 144 | 141½ |
| £1,930,807 | Stock | 17/6 | Eastern Ordinary [to 1,200) (red.) | 96 99 | 96 99 | 3 11 0 | ,, ,, | 96¼ | 96 |
| £1,432,268 | Stock | 4% | Do. 3½ per Cent. Preference Stock | 113 116 | 114 117 | 3 9 6 | May and November | 118 | |
| 300,000 | 10 | 2/6 | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 14 14½ | 14 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14 1/16 | 14⅛ |
| £320,000 | Stock | 4% | Eastern Extension | 114 119 | 114 119 | 3 7 6 | February and August | 114 | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. Debenture Stock | 100 103 | 100 103 | 3 18 1 | February and August | 100 | ... |
| £200,000 | 25 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 101⅞ 104⅛ | 101⅞ 104⅛ | 3 18 3 | May and November | ... | ... |
| 150,000 | 10 | 5/0 | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 30 32 | 30 32 | 4 13 9 | January and July | ... | ... |
| £78,000 | 100 | 4½% | Great Northern of Copenhagen | 100 103 | 100 103 | 4 8 3 | June and December | 102½ | ... |
| 17,000 | 25 | 37/6 | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos. | 41 45 | 41 45 | 5 11 1 | May and November | ... | ... |
| £100,000 | 100 | 6% | Indo-European [1 to 1,200) (red.) | 102 105 | 102 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 100 103 | 100 103 | 3 18 5 | June and December | ... | ... |
| £155,600 | 100 | 5% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 102 | 99 102 | 4 17 10 | March and September | ... | ... |
| 30,008 | 2½ | ... | *West African Telegraph 5% Debentures (red.) | ½ ⅝ | ½ ⅝ | | | ... | ... |
| £150,000 | 100 | 4% | West Coast of America | 100 103 | 100 103 | 3 18 5 | January and July | ... | ... |
| 88,321 | 10 | ... | * Do. 4 per Cent. Debentures | ½ ⅝ | ½ ⅝ | | May and November | ... | ... |
| 34,563 | 10 | ... | West India and Panama | 5 6 | 5 6 | | ,, ,, | ... | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 1st Preference | 3 5 | 3 5 | | | ... | ... |
| £80,000 | 100 | 5% | Do. 6 per Cent. 2nd Preference | 101 104 | 101 104 | 4 17 4 | January and July | ... | ... |
| 207,930 | 10 | 3/0 | Do. 5 per Cent. Debentures | 14¼ 14¾ | 14½ 15 | 4 13 4 | Mar., June, Oct., Dec. | 14 1/16 | 14⅛ |
| £75,000 | 100 | 5% | Western Telegraph (late Br zili'n Submarine) | 103 1 6 | 103 106 | 4 15 6 | June and December | ... | ... |
| £348,777 | Stock | 4% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 106 | 103 103 | 3 16 2 | | 105 | ... |
| | | | Do. 4 per Cent. Deb. Stock (red.) | | | | | | |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 5/0 | Chili Telephone (fully paid) | 3⅜ 4 | 3⅛ 4 | 6 5 0 | August | ... | ... |
| 224,850 | 10/0 | 1¼d. | Consolidated Telephone Con. and Manfg. | 2/0 2/6 | 2/0 2/6 | 6 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ½ ¾ | ½ 1 | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ⅜ ½ | ½ ¾ | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 3⅝ 4⅛ | 4 4⅛ | 5 17 8 | February and August | 4 1/16 | 4 1/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | 12⅜ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4¾ 5 | 4¼ 5 | 5 0 0 | ,, ,, | ... | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 93 99 | 96 99 | 3 11 5 | June and December | £6⅜ | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 95 98 | 4 2 6 | ... | ... | ... |
| 171,504 | 1 | 0/8½ | Oriental | ⅝ 1 | ⅜ 1 | 6 0 0 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5½ | 5 5½ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4¾ 5¼ | 4¾ 5¼ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 16 5 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | ⅜ ½ | ⅜ ½ | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | 8 9 | 8 9 | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 5⅛ 5¾ | 5½ 5¾ | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 4¾ 5⅛ | 4¾ 5⅛ | 5 4 4 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 1⅜ 1¾ | 1½ 1¾ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | ... | ... | 5 14 3 | September | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | 2 2½ | 2 2½ | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | ... | ... | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 102 105 | 102 105 | 4 5 9 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 9 1 | January and July | 15⅜ | 15⅛ |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 16 | 15 16 | 4 13 9 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¾ 6¼ | 5¾ 6¼ | 4 0 0 | November and May | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 110 114 | 111 115 | 3 19 0 | ... | ... | ... |
| £450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 95 | 92 95 | 4 15 6 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 8 0 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3¼ 3¾ | 3 3⅛ | 6 8 6 | January and July | 3 1/16 | 3⅛ |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red. | 100 105 | 100 105 | 4 15 8 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid | ¼ ½ | ¼ ½ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1½ 2¼ | 1½ 2⅛ | ... | ... | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red. | 80 85 | 80 85 | 4 15 3 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 84 89 | 84 89 | 5 12 4 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5¼ 6¼ | 5¾ 6 | 5 12 0 | Half-yearly | 5 1/16 | 5⅛ |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5⅜ 6 | 5⅜ 6 | 5 0 0 | ... | 10 3/16 | 10⅛ |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 105 108 | 105 108 | 4 4 6 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. | 1¾ 2¼ | 1¾ 2¼ | 5 6 8 | January and July | 11 1/16 | ... |
| 31,390 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2¼ 2¾ | 2¼ 2¾ | 5 1 10 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red. | 98 102 | 98 102 | 3 18 10 | January and July | 10⅛ | 10⅛ |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9¾ 10¼ | 9¾ 10¼ | 4 17 7 | ... | ... | ... |
| £150,000 | Stock | 4% | Do. 4% 1st Mortgage Debentures | 97 100 | 97 100 | 4 0 0 | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary | 16½ 17½ | 16½ 17½ | 6 1 5 | February and August | ... | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅜ 6 | 5⅜ 6 | 3 15 0 | ,, ,, | ... | ... |
| £49,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 110 114 | 111 115 | 3 18 9 | ,, ,, | 22¾ | 22⅜ |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 22 23 | 22 23 | 4 6 11 | ,, ,, | ... | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red. | 100 103 | 100 103 | 3 17 7 | March and September | ... | ... |
| 7,500 | 10 | ... | Parker (Thomas) Limited Ordinary | ... ... | 15½ 16½ | ... | ... | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 33 42 | 38 42 | 5 0 0 | March and July | 40½ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 106 | 104 106 | 3 16 2 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10⅛ 11⅛ | 10½ 11½ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference xd | 5⅜ 6 | 5⅜ 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 7/0 | Willans and Robinson Ordinary | 10 11 | 10 11 | 5 9 0 | April and October | 10⅜ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. | 6½ 7 | 6½ 7 | 4 5 9 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 7 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 6 | 5 5⅛ | 5 9 1 | ... | 5 | ... |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 11 11½ | 11 11½ | 4 11 4 | Jan., Apr., July, Oct. | 11 1/16 | 11⅛ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14¾ 15½ | 15 15⅜ | 3 17 5 | ,, ,, | 15⅝ | 15 |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | 7⅜ | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust | 127 132 | 127 132 | 4 12 6 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.

† The London Stock Exchange Committee refuses to quote these

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# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,222. [No. 28. Vol. XLVII.] FRIDAY, OCTOBER 18, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 3d., or 15 cents, or 30c., or 70pf.


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## NOTES.

AT Finchley there is an electric lighting company without statutory powers supplying electricity through overhead cables. There is also a Finchley Urban District Council which has possessed, since 1899, a provisional electric lighting order, but it does not supply electricity and owns no electricity works. Recently the local Council's surveyor ordered the cable crossing one of the roads to be cut; and, accordingly, litigation ensued, a report of which appears in our Legal Intelligence column this week. Counsel for the local authority claimed that the cable cutting was done "upon behalf of the public," basing this extrordinary plea upon the curious principle that "a person without statutory powers cannot be in a better position than one who has them," even, forsooth, when the former can supply the public with what the latter refrains from using its powers to supply. This is, indeed, quite a new gospel of the pigeon-holed provisional order—an exaltation of municipal supineness to the level of a superior virtue. It is not surprising that judgment was given for the plaintiff company.

THE thirtieth annual report of the Local Government Board for 1900-1, which has recently been published, is a bulky blue book of some 750 pages, crammed with statistics that, if not exciting, are for the most part instructive. The chief point of contact between this Board and electrical engineering is where local authorities seek power to borrow money for the undertaking of electricity supply. Apart altogether from the statutory powers obtained directly from Parliament or through the Board of Trade, each separate sum of money required for the commencement or continuation of a municipal electrical supply undertaking can only be obtained after receiving—and in accordance with the terms of—the consent of the Local Government Board, which thus in some measure applies a much-needed brake upon the enthusiastic spendthriftiness of certain municipal traders.

THE total amount of the loans sanctioned annually by this Board for all purposes, for urban and rural authorities, has steadily increased from £267,562 in 1871 to £10,829,747 in 1900. Of this total last year the amount sanctioned for use under the Electric Lighting Acts was £3,023,692, or nearly one-third of the total increment of municipal debt. The rate at which the electric lighting item has increased since 1888 is very large. In that year only £20,000 was authorised; in the following year there was a complete reaction against this form of municipal adventure, and no applications for borrowing powers were granted. In 1890 the sum was £62,500; in 1891 only £115; in 1892 it was £315,545; the following year it rose to £773,722; the next year it fell to £357,886. Thereafter there was a steady increase up to £1,058,164 in 1898, a figure which was more than doubled in the following year, being then £2,390,235. Rapid as this increase latterly has been, the amounts are by no means large when compared with the sums invested in rival and other national industries. Moreover, it is justly the conviction of every electrical engineer that modern electrical engineering has sufficient vitality and permanence to enable local authorities advantageously to redeem these and even far larger debts, provided that the money is expended, not in a spirit of commercial speculation, but wisely for the real benefit of the community.

IN a recent issue (*The Electrician*, September 27th) we published an abstract of an article by Dr. F. PETERS, relating to the Edison secondary cell. The publication of the English patent (No. 10,505 of 1901) for this new cell has led to its reproduction in German in the issue of the *Centralblatt für Accumulatoren-und Elementenkunde* for October 1st, and, in a note on the translation, Dr. F. PETERS has further criticisms to make regarding the value of this new form of storage cell. He points out that in the earlier patent it was admitted the dry oxide is only slightly reduced by the current, while in



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the patent under discussion this disadvantage is wholly ignored, and ferrous oxide is held up as the ideal material for the negative electrode. The method described in the patent for preparing the special form of this oxide is stated by Dr. PETERS to be old, and he gives a reference to the literature of the subject in DAMMER'S "Hanbuch der Anorganische Chemie." This critic, moreover, refuses to admit the novelty of Edison's method for converting the nickel hydrated lower oxide into the higher form by means of chlorine, and casts doubt on the possibility of further oxidation occurring by electrolysis. The new "patent" is, therefore, in Dr. PETERS' opinion, of value only in its detailed description of the mechanical side of the manufacture of the electrodes.

IN a recent issue of the *Motorwagen* Dr. ALBERT NEUBURGER discusses the value of the Edison secondary cell from the motorman's point of view. The durability of the new cell he considers to be doubtful when all the special disadvantages of motor car work are taken into account. In order to obtain the same driving power a battery of the new accumulator cells will occupy double the space of a battery of lead cells; and the price will probably be higher. The high charging E.M.F. will also raise the cost of charging the battery 20 per cent., while the solubility of ferrous oxide in caustic potash will cause internal resistance changes in the cell. From these and numerous other criticisms appearing in the German technical papers it will be seen that German electricians are not much impressed by the latest of EDISON'S inventions.

"WE have not eaten of the heavy dinner of the Germans, but we are suffering from their indigestion all the same." These words do not refer to the recent visit of the Institution to Germany, but are the dyspeptic utterance of an unhappy Austrian manufacturer, who complains of the industrial depression in that country. Whatever may be the true cause of the depression which has affected engineering and other industrial circles in Germany during the past 18 months, it is practically certain that the reaction has spread over the frontier to Austria, owing to financial causes. The Vienna correspondent of the *Standard* attributes the German crisis to "over-production, over-speculation, and over-confidence." He further states that the worst sign of the crisis in Austria is that prominent industrial undertakings have to resort to considerable reductions of establishment, and he mentions, among these, various electrical works, tool works and other works relating to engineering. In striking contrast with this article are the remarks of the Moscow correspondent in the same issue of the 15th inst., on an article in the Russian *Bourse Gazette* on "England as a Commercial Power":—

The *Bourse Gazette*, struck by the return for British trade in the past two years, speaks in a tone of high praise of England as a commercial power. After quoting figures to show the position England holds in the commerce of the whole world, that she owns one-half the mercantile fleet of the world, and carries five-eighths of all the imports and exports of the Continent of Europe, the *Gazette* suggests that it might be well to pause in the rush to attack England from the political point of view, and first inquire whether her policy were not, in fact, at the bottom of this splendid structure of her wealth and consequence in the world of commerce. It is not enough to explain British policy as the outcome only of covetousness, selfishness, cunning, and a host of other vile qualities, but while recognising these as characteristic features of British nature one must also look upon the results produced by her policy, whether inspired by such feelings or not. The economic conditions of England are also passed under favourable review, especially the free use of credit, which leads to the utmost possible productiveness, the good wages paid to workers, and under the same heading the excellence of the food supplies of the country, which must be reckoned as an addition to the high wages of the poorer classes, and other points that compare favourably with the conditions prevailing elsewhere. Upon this firm basis England is able to stand alone, isolated from the rest of the world, and to show figures of enormous strength at the end of a two long years' war in a far distant region of the earth.

**Institution of Junior Engineers.**—The annual general meeting of the Institution of Junior Engineers will be held on Friday next, October 25th, at the Westminster Palace Hotel, at 8 p.m.

**The Institution of Electrical Engineers.**—We are informed that the opening meeting of the session for the presentation of premiums and the presidential address will be on Thursday, November 21st, instead of on November 14th.

**Institution of Mechanical Engineers.**—The first meeting of the coming session takes place to-night at Storey's Gate, St. James' Park, at 8 p.m., when Prof. F. W. Burstall will present the second report to the Gas Engine Research Committee.

**The German High-Speed Railway Experiments.**—The experiments between Berlin and Zossen with Messrs. Siemens and Halske's train are proceeding, in order to work up gradually to the high speed aimed at. So far it is reported that 100km. an hour has been attained with success, and 260km. an hour is the ultimate speed which it is hoped to arrive at.

**Electric Light for Indian Railways.**—According to the *Madras Mail* the South Indian Railway will shortly have seven mail trains fitted up with Messrs. Stone & Co.'s system of electric lighting with double accumulators. One good feature will be a convenient little reading lamp fixed in each first class compartment near the head of the passenger, which can be used, or not, as required, and will be equal to 8 c.p.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus ..... | June 21, 1899 ... | — |
| Pará—Maranham ..... | Mar. 2, 1900 ... | — |
| Bolama—Bissao ..... | Aug. 16, 1901 ... | — |
| Bolama ..... | Sept. 12, 1901 ... | — |
| Zanzibar—Mombasa ..... | Sept. 27, 1901 ... | Oct. 12, 1901 |
| Cayenne—Tinherros ..... | Oct. 15, 1901 ... | — |
| Saigon—Haithong ..... | Oct. 17, 1901 ... | — |

**Physical Society.**—The first meeting of the Physical Society after the summer recess will be held on Friday next, October 25th, in the rooms of the Chemical Society, Burlington House, Piccadilly, at 5 p.m. The following two Papers are on the agenda:—(1) "On the Variation with Temperature of the Thermo-electromotive Force, and of the Electric Resistance of Nickel, Iron, and Copper, between the Temperatures of −200deg. and +1,050deg.," by E. P. Harrison. (2) "On the Asymmetry of the Zeeman Effect," by G. W. Walker.

**The Institution of Civil Engineers.**—The Council of the Institution of Civil Engineers have, in addition to the medals and prizes given for communications discussed at the meetings of the Institution in the last session, made the following awards in respect of other Papers dealt with in 1900-1901:—A Telford medal and a Telford premium to Reginald Pelham Bolton (New York); a Watt medal and a Telford premium to J. Emerson Dowson (London); a George Stephenson medal and a Telford premium to W. T. C. Beckett (Calcutta); a Manby premium to E. K. Scott (London); a Trevithick premium to T. A. Hearson, R.N. (London); a Telford premium to J. A. W. Peacock (Tantah, Lower Egypt). For students' Papers the awards are:—A Miller scholarship (tenable for three years), and the "James Forrest" medal to E. V. Clark, B.Sc. (London); Miller prizes to C. E. Inglis, B.A. (London), H. E. Wimperis, B.A. (Cambridge), J. L. Cridlan (London), F. K. Peach (London), G. H. Whigham (Glasgow), F. Taylor, B.A. (Manchester), A. C. Walsh (Newcastle-on-Tyne), and H. O. Jones (Manchester).

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**High-Pressure Switch Fuses.**—A correspondent writes us as follows:—

Referring to the article in the current issue of *The Electrician* on the "Essen Power Station," I notice that you say, "If a feeder is to be switched out independently of the others connected to the 'bus bar, it is necessary to do this by removing the fuse." I understand the voltage of the system is 5,000, and shall be glad to know whether the article intends your readers to understand that the circuit is broken on the fuse *when alive*, or whether the three-pole switch shown above the fuses is broken in the event of any circuit being disconnected, thus switching off all feeders in use. As it seems to me impossible that the current and voltage can be broken on the fuse, I shall be very much obliged if you can let me have a few more particulars regarding the arrangement.

In the arrangement described the only way to switch out a live feeder without switching off the current from the others is to withdraw the fuses. Our special correspondent who viewed the station was informed that this had been done on emergency by a man protected with smoked glasses and india-rubber gloves, but of course the main idea of the design is that the feeders will not have to be switched off individually while charged. In referring to the switching arrangement as being "almost too simple for British tastes," our special correspondent evidently alludes to these feeder connections.

**Mountain Wireless Telegraphy.**—For some time past a difficulty has been experienced in maintaining communication with the observatory on the Zugspitze mountain, 3,000 metres high, on the Austrian frontier of Bavaria, during the whole of the year. Last September the Bavarian Postal Telegraph Administration put the matter into the hands of the Allgemeine Elektricitäts Gesellschaft, who have now solved the difficulty by establishing a wireless telegraph installation between the observatory and the post office of Eibsee on the Slaby-Arco system. The difference in altitude between the summit of the mountain and the Eibsee post office is 2,000 metres. In designing the apparatus such a wave length was chosen, so that deflection from the surfaces of rocks, &c., on the mountain should assist rather than impede the transmission of the signals. Another difficulty which has been overcome is that of the power supplied to the apparatus. The transport of heavy batteries, &c., to the top of the mountain would have been extremely difficult, and therefore the company has designed the apparatus so that it should require a minimum of power and the dry cells which are employed with it have proved sufficient. Instead of the wire which has been used in many recent Slaby-Arco experiments, ordinary steel rope has been employed, and this has been fixed in a slanting direction to the surface of the rocks without the assistance of either a mast or insulators. It is stated that the system has so far given entire satisfaction to the Post Office authorities.

**Electrically-Driven Workshops at San Francisco.**—In a recent number of the *Journal of Electricity, Power and Gas* an account is given of the electrical transmission at the Union Iron Works, San Francisco. At present a plant of 600kw. is installed which sometimes works at 25 per cent. overload. Thirty-five electric cranes are in use, of from 2½ to 60 tons capacity, and there are also two electric capstans and three electric winches. The motors for driving line shafts are never larger than 50 H.P. size. At present there are five 50 H.P., 11 25 H.P., five 15 H.P., seven 10 H.P., and one 7½ H.P. motors. Besides these are a number of individual stationary electrically-driven tools in the machine, erecting, and boiler shops. A large quantity of portable electrically-driven tools are also used. The total installed power of the motors is over 3,800 H.P., the amount represented by the crane motors being about 1,780 H.P. One man with a helper attends to all the shop-tool motors with the exception of the crane motors, which are attended by another couple. Electricity is also used for the annealing of armour plates. The contact pieces are brought up against the brightened surface of the plate to be annealed and wedged into position, straddling the spot to be annealed. The distance between the contact pieces for annealing a spot ⅞in. diameter is 1¾in.; the heating period occupies about three minutes, using from 3,500 to 6,000 amperes at 8 volts. The cooling period takes about 12 minutes, and the spot annealed is elliptical, with a major axis of 4in. and a minor axis of 2½in.

**"Electrolytic Grinding Tools."**—Under this somewhat misleading title J. Rieder, of Leipzig, discusses, in a recent issue of the *Zeitschrift für Elektrochemie*, the manufacture and use of special forms of emery and carborundum grinding tools. The use of the word "electrolytic" is explained by the method of manufacturing these tools. Grains of emery or carborundum —its artificial substitute—are coated with graphite and used as horizontal cathode in an electrolytic bath, containing a metallic salt solution as electrolyte. The deposition of copper or other metal is allowed to proceed until the metallic backing to the emery or carborundum is thick enough for the purposes to which the finished tool is to be applied. The details of this method of embedding grains of emery or carborundum in a flat metal surface, while leaving one surface of the grains free, are described at some length, but it is not clear how the method is applied to the production of some of the cylindrical and hollow forms of tool illustrated in the original Paper. One advantage claimed for this method of building up grinding tools from the loose grains of emery or carborundum, is that each grain is firmly held in the metallic backing, and performs a maximum of work when used. Using an emery disc 140mm. in diameter, coated on one side with emery by this method, 70 grms. steel can be ground away with only 10 grms. loss by the emery disc, while with the usual form of wheel not more than 20 grms. steel could be removed under similar conditions of speed and loss. By increasing the velocity of these discs, and by use of carborundum in place of emery, much higher efficiencies can be obtained. As these tools can be manufactured in practically any form, and of any size, the author of the Paper is probably correct in his opinion that these "electrolytic grinding tools" will be found of great value in many of the metal-working industries.

**New Form of Trolley-Wire Protecting Device.**—A correspondent (Mr. W. Johnston, of Santiago, Chili) furnishes us with particulars of a device which has been brought out by Prof. A. E. Salazar, of the Chili University, and is being tried in Santiago for protecting trolley wires. Prof. Salazar's modification of the usual arrangement of earthed guard wires consists in connecting the guard-wire to the rails through an electromagnet and added resistance of about 250 ohms. This electromagnet works a switch in the feeder circuit should the guard wire touch the trolley wire, the main circuit being opened with a current of 2 amperes in the guard wire. This device has been subjected to a series of tests before the various engineering bodies of Santiago, and the results, we are informed, have been in every sense successful. Our correspondent states that the trolley system recently established in Santiago is very extensive, and that the Chilian Electric Light and Tramway Co. (Ltd.) has obtained a concession giving it permission to lay its lines through all the principal streets of the city, and even along all sides of the principal square (Plaza) in the very centre of the busiest traffic. As there are two telephone companies with overhead wires and several cable and telegraph companies, and also the State telegraphs, whose systems are overhead, the question of contact between these wires and the trolley wire has caused considerable anxiety. There have already been several accidents in which horses have been killed by contact with falling telephone wires, in consequence of which the municipality has been contemplating ordering all overhead telephone and telegraph wires underground. Some of these undertakings, however, have such a struggle for existence, owing to the financial conditions of the country, that such an order would mean their disappearance, and therefore the matter was last year referred to a committee, composed of the Director-General of Public Works, one of the engineers of the same department, and Prof. Salazar. This committee decided that the only effective system is that in which the guard wire is earthed to the rail, which, as is well known, has already been tried successfully in England and obtained the approval of the Board of Trade. As the traction company objected to this system, on the ground that its poles would not carry the extra weight of the heavy guard wires required, and also because their whole system would be subjected to a severe shock in case of an accident, Prof. Salazar worked out the system described above.

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## CONTEMPORARY ELECTRICAL SCIENCE

[Compiled by E. E. FOURNIER D'ALBE.]

*Curves Traced by Point Discharges.*—De Heen described some time ago a novel experiment, in which a plate of resin was charged and then held over a number of Bunsen flames. Each flame discharged a portion of the plate, and the various portions were sharply marked off from each other along lines which could be made visible by dusting with sulphur, lycopodium, and carmine. R. H. Weber has repeated the experiment, not with flames, but with point electrodes, and found that exactly the same phenomena are produced by them. The tracings show lines resembling honeycombs. The plates remained charged along these lines, and the author attempts to give an explanation of this fact. A single point opposite a metallic surface produces a discharge which proceeds along a paraboloidal path, and the paraboloid can be traced by laying a piece of tissue paper over the metal and observing the luminous effect. It can also be traced photographically by introducing a piece of bromide paper between the plate and the tissue paper. Two such paraboloids side by side behave like elastic bodies, and flatten each other where they touch. That the discharge consists of material particles may be proved by directing an air blast at right angles to it, when it is found that the straight lines described bulge out in the direction of the blast.

[R. H. WEBER, *Ann. der Physik*, No. 9, 1901.]

*Cathode Rays.*—W. Seitz has repeated and extended a number of experiments in connection with the reflection and absorption of cathode rays. These rays are, as we know, diffused by metallic surfaces they impinge upon. At normal incidence the intensity of the reflected rays decreases approximately as the cosine of the angle of reflection. At slanting incidence different metals show a different behaviour. In aluminium, zinc, iron, and copper the maximum intensity of the reflected rays is displaced towards the direction of metallic reflection, while platinum, gold, and silver reflect most strongly in a direction comprised between the incident ray and the normal to the surface. In the first class of metals the reflection distinctly increases with the angle of incidence, while it decreases somewhat in the second class. At normal incidence the reflective power increases with the atomic weight, but zinc does not fall in well with the series. An important result of the author's work is that the coefficient of absorption increases with the thickness of the absorbing film, and Lenard's law, according to which films possess equal absorbing power if they have equal masses per unit of area is, therefore, only true as a first approximation. That this difference is not of a frictional nature is proved by the fact that no difference in the electric or magnetic deflection is produced by passage through an aluminium window.

[W. SEITZ, *Ann. der Physik*, No. 9, 1901.]

*Photo-electric Effects.*—The lowering of the spark potential by ultra-violet light discovered by Hertz, and the dissipation of an electric charge under the same influence discovered by Hallwachs, show a marked difference in the extent to which they are influenced by the material of the electrodes. Iron, which is particularly sensitive in the Hertz effect, behaves with marked indifference in the phenomenon described by Hallwachs and studied in detail by Elster and Geitel. The greater the anodic character of the metal, the greater its sensitiveness; and the maximum sensitiveness lies at greater wave-lengths in the same proportion. Almost all heavy metals only respond to ultra-violet light of great refrangibility. H. Kreusler has sought to reconcile these differences by bringing the potential of the electrodes close up to the actual sparking potential, when the reaction becomes exceedingly sensitive. If $V_0 = 4{,}060$ volts is the spark potential and V the cathode potential in the photo-electric apparatus, then for $V_0 - V = 560$ the sensitiveness of copper is nearly 30 times that of iron. But when $V_0 - V = 30$, copper is only three times as sensitive as iron. Under ordinary circumstances copper is about 37 per cent. more sensitive than zinc. But when a copper and a zinc ball are taken and well polished the zinc turns out to be some 10 per cent. more sensitive than the copper.

[H. KREUSLER, *Ann. der Physik*, No. 10, 1901.]

*Photometry of Ultra-violet Light.*—Since the photo-electric effect shows a great increase of intensity in the neighbourhood of the sparking potential, it suggests itself to employ this circumstance for the photometry of ultra-violet light. The only difficulty lies in the doubt as to whether, at the stage in question, the photo-electric effect is proportional to the intensity of illumination. H. Kreusler answers this question in the negative, and is therefore obliged to employ a very sensitive apparatus and a potential somewhat inferior to the spark potential. As electrodes he employed various metals, but always aluminium as a negative pole, since only thus a steady light could be secured. The photo-electric cell contained an anode formed of two parallel platinum wires and a cathode of platinum whose distance from the anode could be adjusted by a micrometer screw, thus securing a large range of sensitiveness. The cell contained hydrogen at a low pressure. Measurements were made to determine the absorption of various bodies for ultra-violet light. NO showed a sudden increase of absorption at a wave-length of $250\mu\mu$, and water at $200\mu$. At $220\mu\mu$ the coefficients of absorption for water and NO were 0·007 and 0·095 respectively. But the author suspects that the water contained some glass in solution.

[H. KREUSLER, *Ann. der Physik*, No. 10, 1901.]

*Brush Discharge through Diaphragms.*—M. Toepler has noticed some interesting modifications of the "brush-arc" in the open air between a metallic point and a semi-conducting plate, such as slate or basalt. These modifications are produced by introducing a small block of metal or a metallic diaphragm into the path of the discharge. The block or diaphragm becomes an intermediate electrode to a portion of the discharge, whose size varies with the size of the obstacle. As the obstacle is displaced to and fro between the point cathode and the plate, the anode and cathode light immediately adjoining it travel to and fro with it, and so do all the light phenomena between the obstacle and the plate, whereas those between the obstacle and the point retain their positions unless obscured. When brush-arc phenomena are at play on both sides of a diaphragm, it is seen that the latter is always filled with a luminous mass, with its point towards the anode. In the case of a metallic block, the blue cathode light appears on one end of it and the positive glow on the other; but these are absent in the case of the diaphragm. The fact that the shape of the luminous mass in the opening of the diaphragm is the same as that of the ordinary brush-arc discharge, makes it probable that the latter is characterised by alternate widenings and constrictions of the current path.

[M. TOEPLER, *Ann. der Physik*, No. 10, 1901.]

*Magnetic Properties of New Irons.*—E. Gumlich and E. Schmidt, of the Reichsanstalt, have collected a large amount of valuable material in regard to the various new types of iron and steel lately introdnced, such as Kohlswa iron, Remscheid dynamo steel, Gelsenkirchen cast steel, and Böhler and Remscheid tungsten steel. The last shows the greatest hysteresis, and the greatest permeability is shown by Kohlswa iron No. 52, annealed five times over. The figures are 3,680 for the permeability of the latter and 8,240 for the permeability of Remscheid dynamo steel. Measurements extending over some 46 specimens bring out a clear relation between hysteresis, resistance, and the other magnetic properties. The rule holds good with few exceptions that a high hysteresis loss means a high electric resistance, a greater remanent magnetism, a greater coercive force, and a lesser maximum permeability. The authors mention a new material of secret composition which forms a striking exception. It has a higher resistance than hardened steel, shows an extraordinary remanence and maximum permeability, and at the same time a small coercive force and hysteresis loss. This specimen, labelled No. 15, guarantees a small loss both from hysteresis and from eddy currents in dynamos.

[GUMLICH and SCHMIDT, *Elektrotechn. Zeitschr.*, 35, 1901.]

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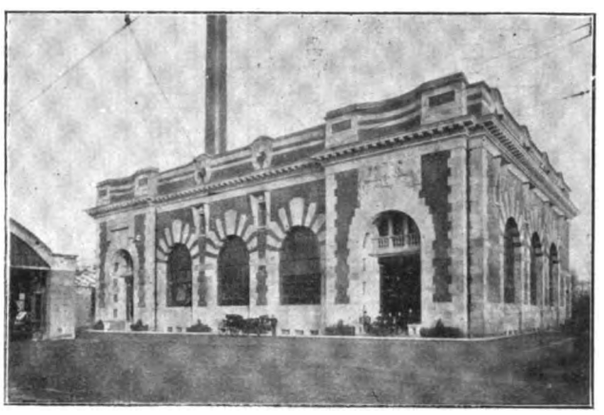
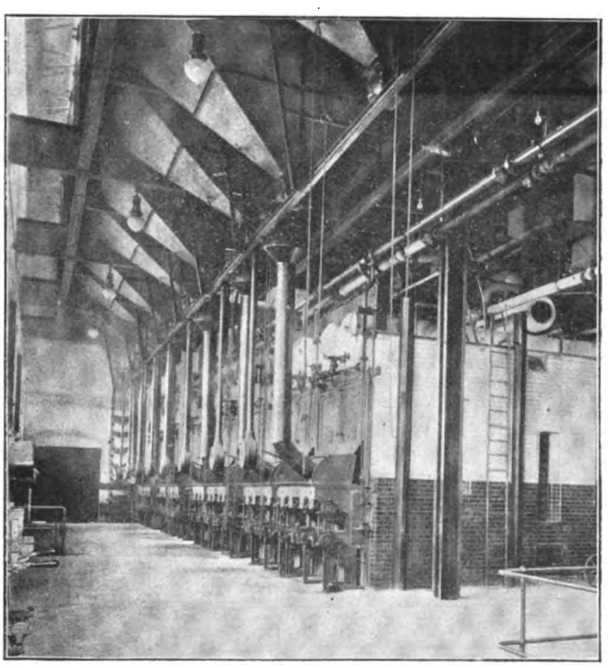
# ELECTRIC TRAMWAYS OF THE LONDON UNITED TRAMWAYS.

The London United Tramways (Ltd.), under agreements made with the London County Council, the Vestry (now Borough Council) of Hammersmith, the authorities in Acton, Ealing, Hanwell, Brentford, Chiswick, Hounslow, &c., obtained its first act in 1898 for the conversion and extension of the tramway system in the western districts of London, and in the same year, under a provisional order granted by the Light Railway Commissioners, power was acquired to construct a



VIEW OF GENERATING STATION.

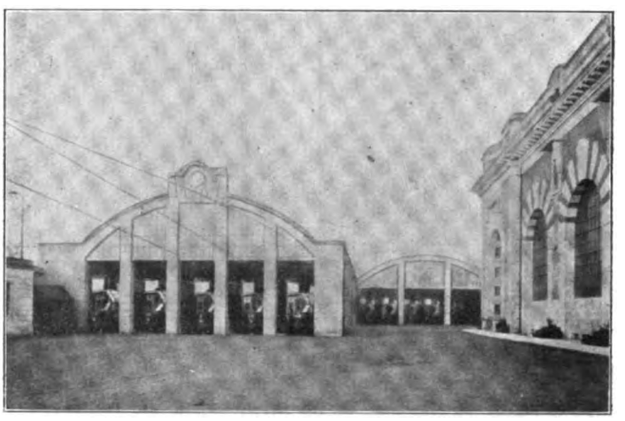
light railway, to be worked as a portion of the company's electric tramway system, and extending from Hanwell to Southall, Hayes, Hillingdon and Uxbridge. In the 1900 session of Parliament the company was given power to make the needful connection through Acton and Ealing to Hanwell,



INTERIOR OF BOILER HOUSE.

&c., and in the same act statutory power was obtained for the extension of the southern line already authorised from Kew Bridge through Brentford to Hounslow, so as to construct tramways in Heston, Isleworth, Twickenham, Teddington, Hampton and Hampton Wick.

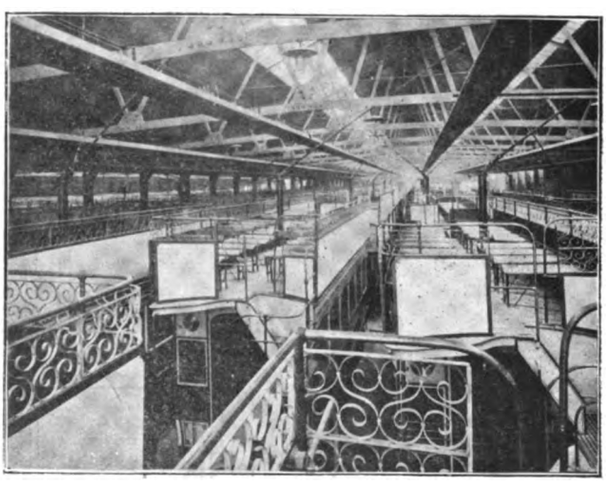
Power was obtained last session to construct lines to Teddington, Hampton Wick and Surbiton, as well as to East Molesey, Kempton, Malden and Coombe, whilst further powers will be asked for during the ensuing session. On April 4th last, 7½ miles of electric tramway route were brought into operation, connecting the terminus of the Central London Railway to Acton, Chiswick and Kew Bridge, enabling an excursionist to make the trip from the Bank to Kew Gardens and back for the sum of 8d., the company being tied down by statute to a fare not exceeding 1d. per 2 miles, and the single journey occupying under the hour. On July 10th 8 miles of extensions were opened, including a line from Acton



VIEW OF CAR SHED.

through Ealing and Hanwell to Southall, and from Kew Bridge through Brentford to Hounslow.

The company's headquarters, covering an area of 4 acres, are situated in High-road, Chiswick. The depôt is shaped like the letter Y, with the narrow end to High-road; at the left-hand side of the entrance are the administrative offices, within which rooms are provided for the managing director, engineer, traffic superintendent, &c. Beyond these and facing the entrance are car sheds, and to the right of the space facing the car sheds is the power house, built of brick, with massive freestone quoins and other adornments, more like a nation's library than an electricity supply station. This handsome building, measuring 154ft. by 106ft., consists of



INTERIOR OF CAR SHED.

the engine room and boiler room. The internal walls of both are faced with glazed bricks, and the engine room floor is laid with mosaic tiles.

The equipment in the boiler room consists of 10 Babcock and Wilcox boilers, each capable of evaporating 11,000lb. of water per hour at a steam pressure of 150lb. per square inch, with a draft as measured in the main flue equivalent to a column of water ¾in. in height. The total heating surface in each boiler is 3,140 sq. ft. Arranged in five batteries of two



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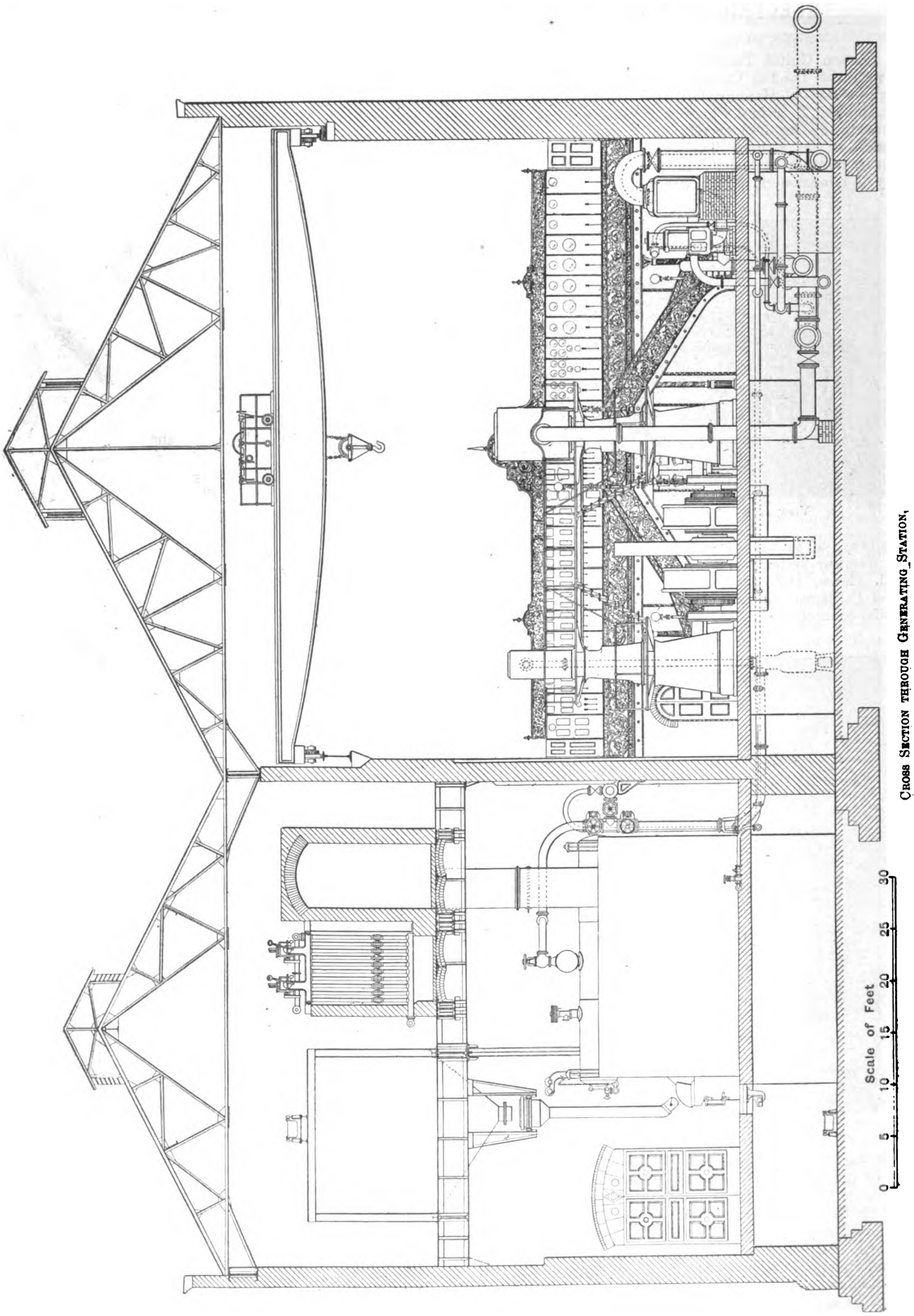


CROSS SECTION THROUGH GENERATING STATION.

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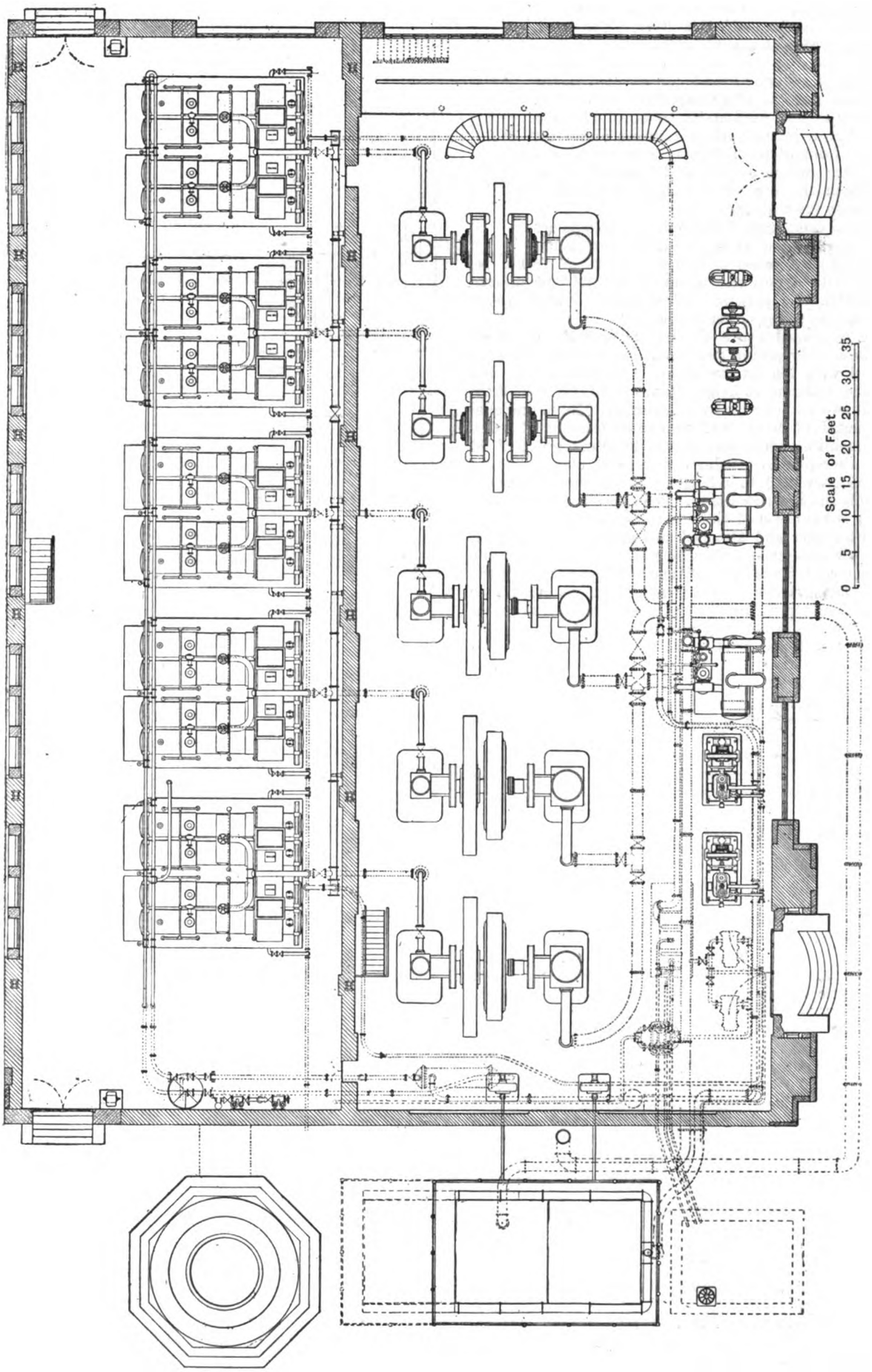


PLAN SHOWING COMPLETED ARRANGEMENT OF GENERATING PLANT.

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boilers, each boiler is fired by a mechanical stoker of the coking type, and these stokers are driven by shafting placed underneath the floor. The coal-conveying apparatus is capable of handling 40 tons of coal per hour, and is driven electrically by a 10 H.P. motor, the driving gear being situated on the top of bunkers capable of storing 500 tons of coal. The conveyor is also used for the removal of ashes by means of a series of buckets running along the basement in front of the ash-pits, from which the ashes are taken by the buckets and dumped into an ash-bin, which in turn shoots the ashes into a receiver outside the building.

Two vertical compound Wheeler duplex pumps are located at the north end of the building, each being designed to work against a boiler pressure of 180lb. per square inch with a normal piston speed of 50ft. per minute. Each is capable of supplying the feed water for 4,000 H.P. at 15lb. of steam per horse-power per hour.

The flue is located above the boilers, and the gases are taken up to it by breeching pieces. It is constructed of steel plates, lined with 9in. of firebricks, it is 150ft. long and 6ft. 3in. wide, widening in height from 3ft. to 13ft. 6in., from which point two branches go to the chimney. These branches are constructed of brick, and in one of these is placed a Green's economiser, containing 360 tubes in one group of 36 sections, the scraping gear being driven by an electric motor.

The smoke stack is 260ft. in height with a diameter at the top of 10ft. inside the firebrick lining. The upper portion (200ft.) of this stack is built of steel plates in rings securely lap-jointed and riveted together and attached to a massive base plate of cast-iron made in segments, the whole being held down to the masonry by steel bolts of large diameter passing through the masonry to the surface of the concrete foundations hereinafter mentioned. The top is furnished with an ornamental cap of galvanised steel. The chimney base below the steel stack has been worked out in red brick and Portland stone, to correspond with the power station. As the main flue, after leaving the economisers, passes to the smoke stack at a height of over 30ft. above the ground, the space below the entrance of this flue is used as a store. The chief point of interest in the smoke stack lies in its foundation. Borings were made at several points on the site, and water was met with at depths varying from 8ft. to 10ft., according to the seasons, &c. The soil was found to consist of sand and ballast, with blue clay underlying at about 28ft. below the surface, and while it was decided to carry the foundations down to the clay, the method to be adopted was not so readily arrived at.

The site most suitable for the stack, and now occupied by it, is at the north end of the boiler room, between it and a building used as a store, with only a few feet between the proposed concrete sub-structure and the footings of the two walls. It was feared that were a solid mass of concrete put down so near to these buildings, the necessary pumping operations might endanger the stability of the walls, and a simple concrete block was for this reason abandoned. Instead, a hollow rectangular structure of pitch pine was prepared at ground level, tied together in the strongest possible manner with bolts and straps, and provided with a cast-iron cutting edge. This shoe was filled up with cement concrete, and when this was well set the ground inside was removed, so that with the aid of the pumping operations the whole might gradually subside. A further layer of concrete was then filled in, and these operations were repeated until the blue clay was reached, when the whole of the lower portion was filled up solidly with concrete, so as to equally distribute the weight of the superstructure.

Between the flue and the coal bunkers are placed two feed water tanks, each having a capacity of 6,000 gallons. The plant for softening the feed water is located outside the building, and is capable of treating 10,000 gallons of water per hour, reducing its water hardness to 5 per cent. on Clarke's scale. It consists of a cast-iron tank divided into equal compartments, 19ft. 6in. by 19ft. 6in. by 10ft., with a reagent tank and a carbonating apparatus.

Water is obtained from three wells, consisting of 6in. tubes driven down 30ft., and provided with strainers at the bottom.

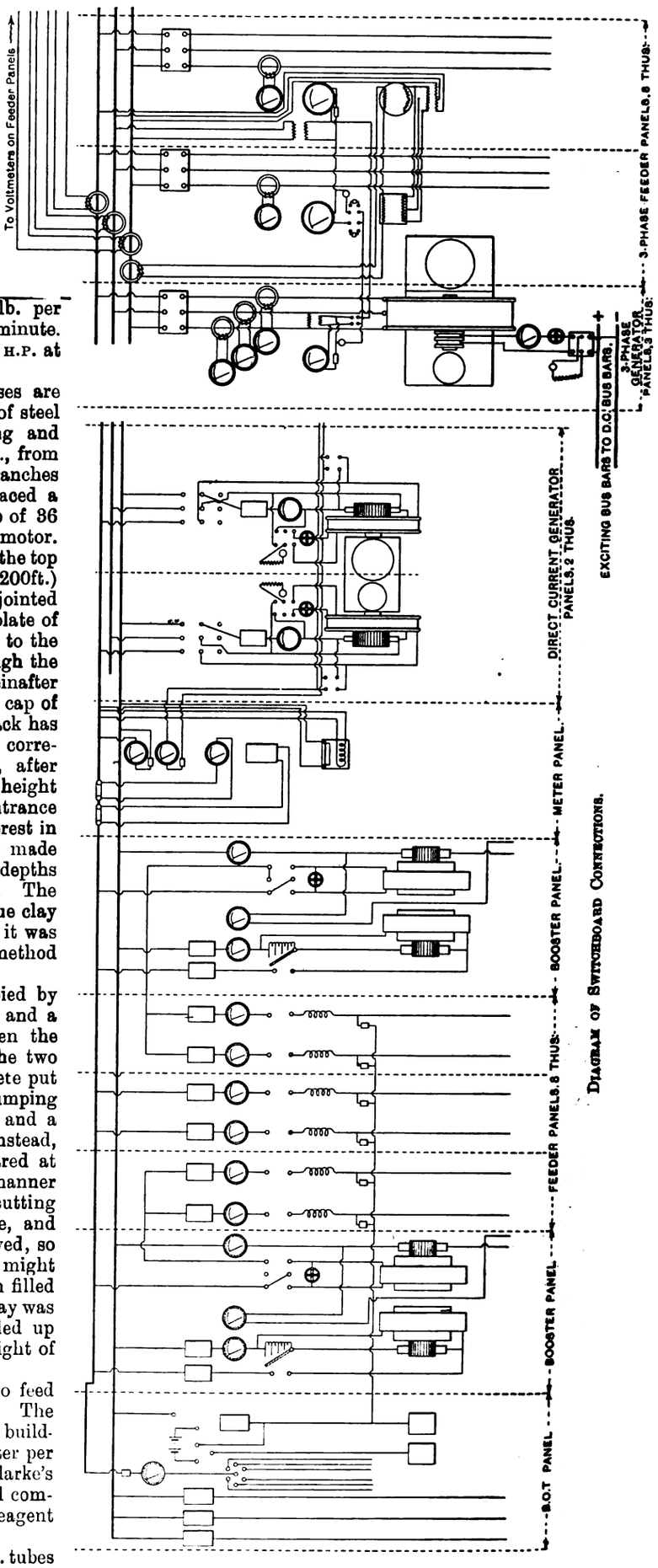


DIAGRAM OF SWITCHBOARD CONNECTIONS.

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These tubes are 20ft. apart and are connected with an internal pipe 4in. in diameter, this being connected to a 6in. main. The wells are capable of yielding 8,600 gallons per hour each, with a water level of not more than 16ft. below the surface; thus 10,000 gallons per hour may be obtained continuously from the three wells. An electrically-driven three-throw pump, capable of dealing with 50,000 gallons per hour, delivers the water into the water-softening tank, whence, after being softened, it is discharged into a reservoir under the cooling towers.

In the engine room there are two vertical cross-compound condensing Allis engines with cylinders 22in. and 44in. by 42in. stroke, running at 90 revs. per min. Each of these engines is directly connected to two 250kw. compound-wound continuous-current generators, one placed on each side of a 86-ton flywheel. The variation in speed does not exceed 2½ per cent. from no load to full load. These engine sets are used for supplying current to the lines in the vicinity of the power station, and, in addition, there is now one 500kw. to be increased afterwards to two 1,000kw. three-phase sets for the transmission of power to the sub-stations. These latter run at 94 revs. per min., and to each is directly coupled a 5,000 volt 32-pole three-phase alternator, the frequency being 25 ~ per sec. These generators are of the revolving field type, the fields consisting of a cast-steel ring of high permeability, with outwardly projecting poles of sheet iron bolted through the rings to the spider, which is keyed to the shaft. The fields are excited from the continuous-current 'bus bars at a pressure of 500 volts.

It was originally intended to use continuous current throughout on the three-wire system, with 1,050 volts between the outers, and hence the two generators to each engine, and the third set was in the same way shipped with two continuous-current dynamos.

The switchboard is erected at the south end of the engine room, upon an ornamental gallery 9ft. from the floor level. It consists of white marble panels, 7ft. 6in. high by 2ft. wide, bolted to angle iron frames, there being 27 panels in all. The board extends practically the whole width of the room, one half being for the continuous-current panels and the other for the three-phase panels. The continuous-current board consists of four railway generator panels, two booster panels, eight feeder panels, one Board of Trade panel, and one instrument panel. The high tension board contains three three-phase generator panels and eight three-phase feeder panels. The switches and 'bus bars for the high-tension current are supported by joists in a closed chamber underneath the switchboard floor, the switches being of the oil break type, and operated through levers on the switchboard. In addition to this main switchboard there is a lighting switchboard underneath the main gallery, consisting of two lighting and two power-circuit panels, together with two panels for operating the rotary converter above described.

The car sheds at the central depôt are capable of holding 100 cars, and a complete series of repairing shops has been provided. The sheds, which contain 11 lines of track in all, are furnished with pits for inspection purposes, and all the movements of the cars to, from, and within the sheds and shops are effected electrically by the trolley wires.

(*To be continued.*)

## GLASGOW INTERNATIONAL EXHIBITION.

(BY OUR OWN CORRESPONDENT.)

(*Continued from page 783.*)

§ 27. **British Insulated Wire Co.'s Stands.**—Stands Nos. 406 and 407 are occupied by the B.I.W. Co., and an illustration of the latter is shown in Fig. 21. Following is a summary of the principal exhibits: (1) A large collection of samples of the various types of paper insulated cable manufactured, the most noticeable of which are 1 sq. in. triple cable, of which 27 miles have been supplied to the Glasgow Corporation; a 312 pair telephone cable, which is being laid at the present time for the Glasgow Corporation in connection with their municipal telephone department. A similar type of cable has

STAND No.407
THE BRITISH INSULATED WIRE Co. LIMITED PRESCOT LANCASHIR
THE BRITISH INSULATED WIRE Co. LTD.
SCOTCH OFFICE MORRIS WARDEN & Co 25 GORDON ST. GLASGOW
STAND No.406

FIG. 21.—THE BRITISH INSULATED WIRE CO.'S STANDS.

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been supplied to the British Government for their trunk line from London to Birmingham. A 0·15 sq. in. three-core armoured cable for 5,000 volt tri-phase working; 33 miles of this cable has been supplied to the Manchester Corporation. A 0·14 sq. in. twin concentric cable for two-phase working at 7,500 volts, being supplied to the Midland Electric Corporation for Power Distribution (Ltd.). A 0·25 sq. in. concentric cable working at 11,000 volts. This cable has been constantly at work for the last five years, without a single fault, at Deptford. The same type of cable has been put to work by the Metropolitan Electric Supply Co. (Ltd.) in their trunk main from Willesden to London—a 1·6 sq. in. single cable, as used by the Bradford Corporation. Also various other samples of cable for varying pressures and systems, including tramways for over 40 towns and supply

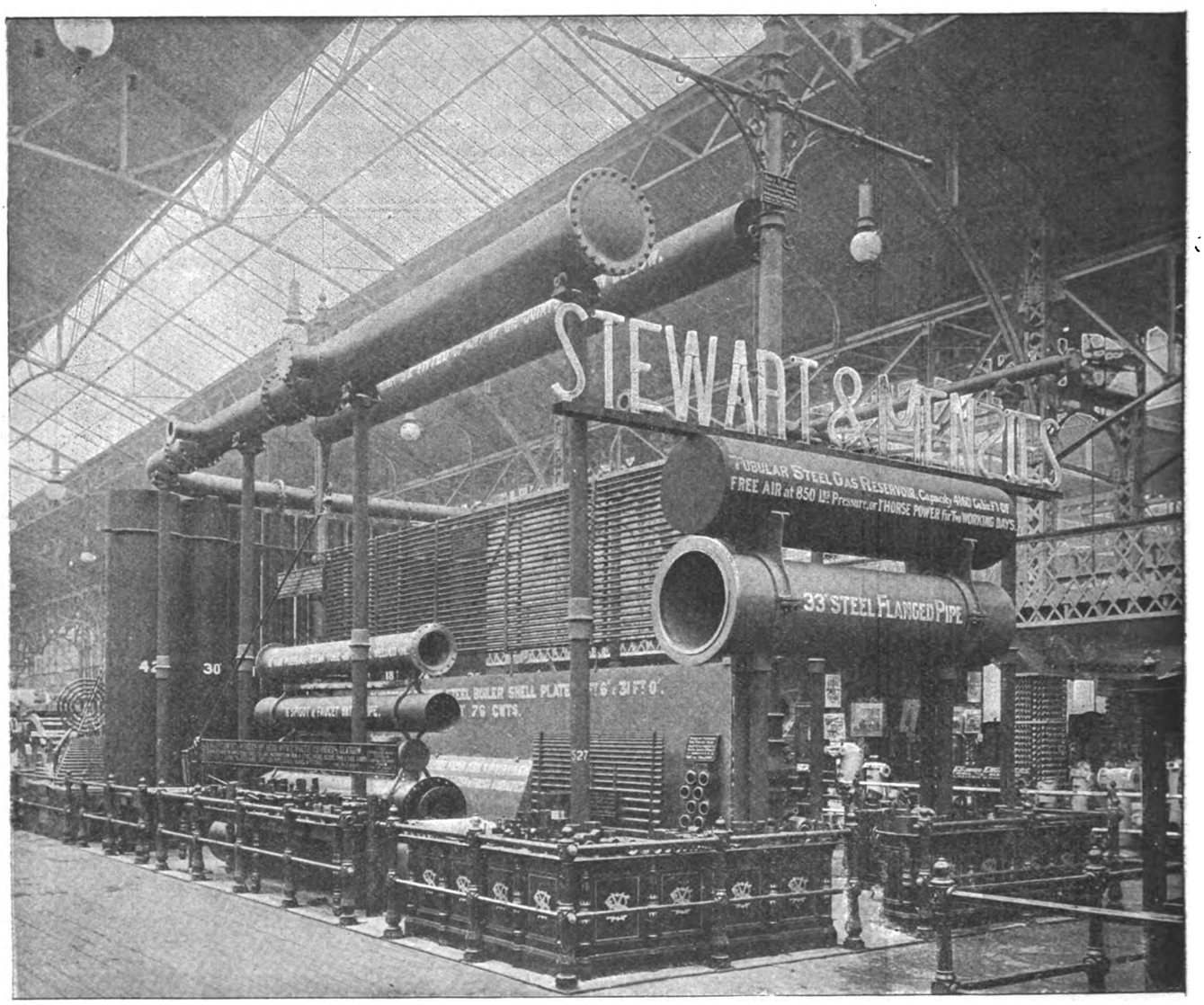


FIG. 22.—MESSRS. A. AND J. STEWART AND MENZIES' STAND.

companies. An interesting feature of these cables is the use of segmental strip in the place of wires; also the patent hammered conductors in three-core and twin cables.

All main cables for the exhibition buildings and grounds have been supplied by this company.

(2) Numerous samples of underground junction boxes, manhole covers and pavement frames, end connections, &c., including a four-way box for eight low-tension triple concentric cables. This box and its internal fittings are of substantial design. The cables are led into the box through glands, which are sealed with a water-resisting compound. The box is split along its horizontal centre to facilitate the jointing up of the cables. The fittings are so arranged that the different poles can be connected to their respective 'bus bars by spring contacts drawn or inserted by means of insulated handles. A straight-through disconnecting box for high-tension twin cables, in which several novel points are embodied. The cables are led in through a gland, which is a combination of the brass gland wiped to the lead of the cable by a plumber's joint and the compound pocket. The lid of the box is on the diving bell principle, and is provided with two lips which seat into two troughs filled with heavy oil. The cable terminals are in separate compartments built of ebonite, and are connected by means of a spring contact bar, which bridges the intervening wall of ebonite, and is drawn or inserted by means of an insulated handle. A straight-through fuse box for low-tension triple cable, which type of box has been supplied to the Grimsby Corporation. It is provided with porcelain disconnecting handles which carry a fuse breaking 500 amperes at 440 volts. A concentric disconnecting box for feeder and distributor cables, the connections of which are so arranged that by means of plug links the feeder cables can be put in parallel with the distributors, and either cable can be disconnected in itself or from the other cable. A concentric house cut-out box, in which the concentric cable is brought into a separate sealing chamber. The box is so arranged that it can be used either as a right or left handed box; all fittings are mounted on porcelain and are interchangeable. The box is provided with a hinged cover, which permits of ready access to the fuses and sealing device.

§ 28. Messrs. A. and J. Stewart and Menzies' Stand.—Fig. 22 illustrates the spacious and ornamental stand of Messrs. A. and

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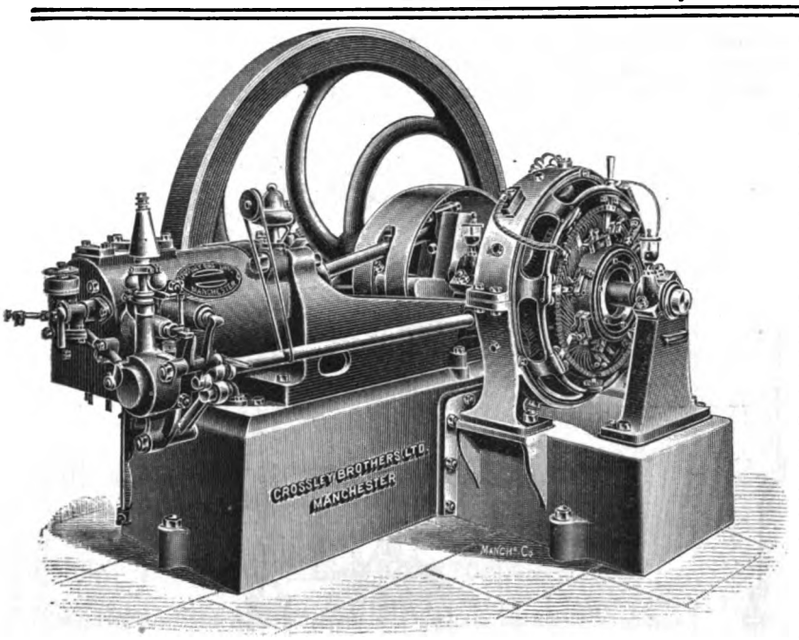


FIG. 23.—DIRECT-COUPLED HIGH-SPEED CROSSLEY GAS ENGINE AND DYNAMO.

J. Stewart and Menzies. The exhibits of this firm include examples of main steam pipes, flanges, and fittings, steam valves, tramway poles and fittings, welded and weldless cylinders, &c. Among the interesting features are a 30in. valve, also a 36ft. length of 2ft. tube. Other exhibits relate to armour plating and kindred steel manufactures.

§ 29. Messrs. Crossley Bros.' Exhibits.—The gas engine exhibits of Messrs. Crossley Bros. & Co. form an interesting and prominent feature of the machinery hall. The latest and probably most interesting type of gas engine exhibited is that shown in Fig. 23, which depicts an 18 H.P. direct-coupled gas engine and continuous current multipolar dynamo, as built by this firm. The combination runs at 250 revs. per min., the engine being fitted with an exceptionally heavy flywheel 6ft. 10½in. diameter by 5½in. face. The weight of this flywheel necessitates an out-end bearing, not shown in the illustration. The effect of this heavy flywheel, together with the accurate balancing of the reciprocating parts, is to produce very steady running, notwithstanding that this is an engine of the internal combustion type. The dynamo is of the Thomson-Houston make, and has a capacity of about 11½kw. Among other exhibits is one of the smallest horizontal gas engines built—viz., for ¾ H.P. effective working load. This little engine runs at 300 revs. per min. A number of other engines up to about 40 H.P. are exhibited, together with a selection of details and auxiliary parts used in gas engine manufacture and working.

§ 30. Sisson-Clarke-Chapman Steam Dynamo Set.—In Fig. 24 is shown a steam dynamo balancing set conjointly exhibited by Messrs. W. Sisson & Co. and Messrs. Clarke, Chapman & Co. The engine develops from 150 B.H.P. to 180 B.H.P. at 400 revolutions. It is of the double-acting compound side-by-side vertical type with a throttle governor. The speed and cut-off can be varied by means of the hand-wheel shown in the extreme left of the crank chamber. This wooden wheel can be turned while the engine is running, and thereby alters the arrangement of the valve gear. An interesting feature of this engine is the perfect arrangements for preventing oil from escaping from the crank-shaft through the door, the provision of a simple groove in the door frame serving to trap all the oil that otherwise would escape in this way. The dynamo is of the two-pole continuous-current type running at 100kw.—*i.e.*, giving 400 amperes at 250 volts. It is shunt-wound.

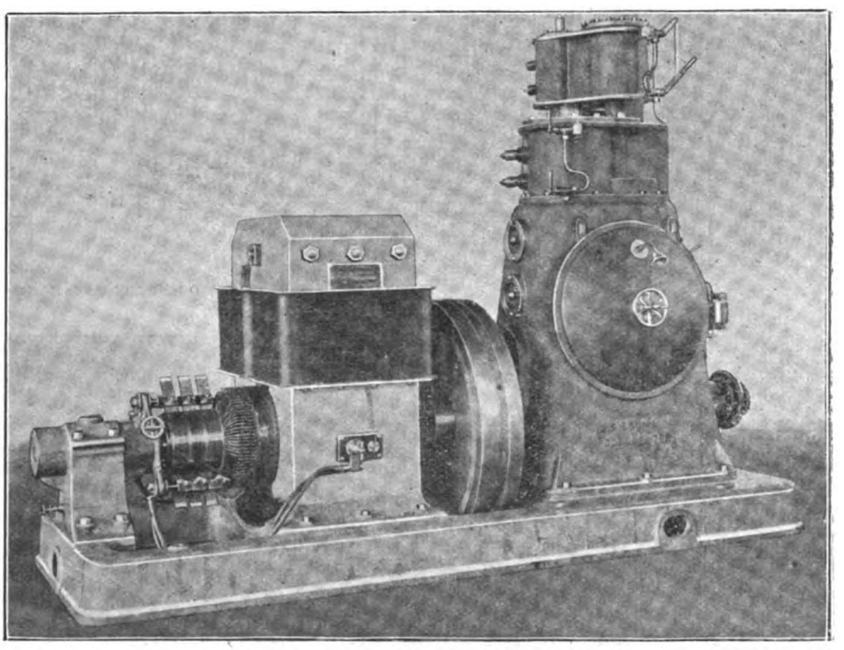

FIG. 24.—SISSON-CLARKE CHAPMAN STEAM DYNAMO SET.

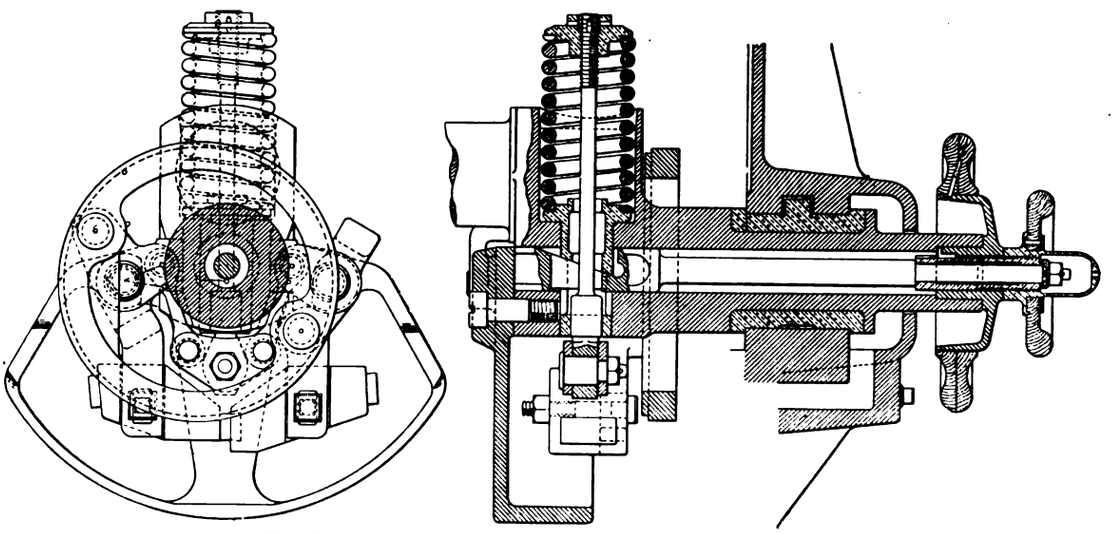

FIG. 26.—HAND SPEED-REGULATOR ON SISSON STEAM ENGINE.

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In Fig. 25 the Sisson engine is shown in longitudinal and transverse section, while in Fig. 26 are shown the details of the hand regulating mechanism for varying the speed while the engine is running. The high-pressure cylinder is built partially above the low-pressure cylinder, and its piston rod passes close by the latter, thus allowing of the cranks being built close together. This design naturally tends to diminish vibration, which is further reduced by the careful balancing of the reciprocating high-pressure and low-pressure parts. The valves on both cylinders are of the piston type in seats of nickel iron alloy. The high pressure valve has inside steam admission and the low pressure valve outside steam admission.

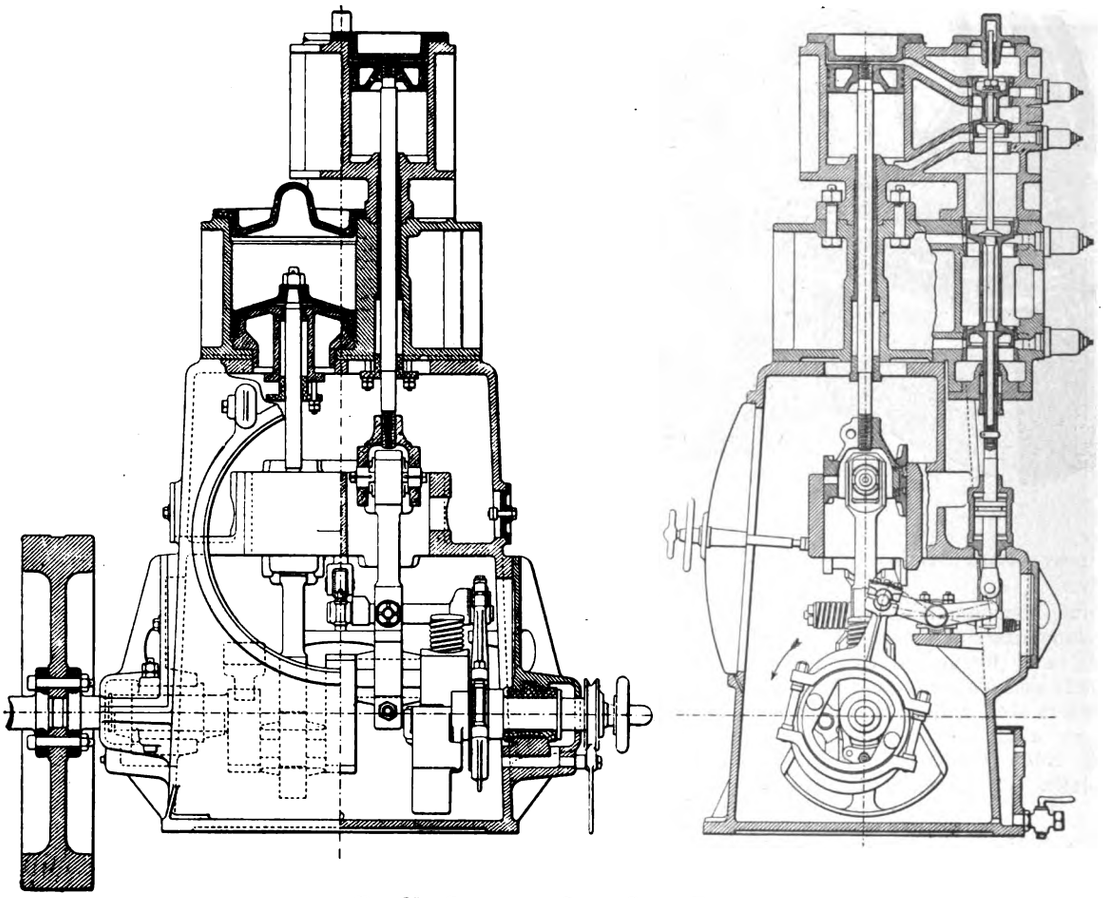

FIG. 25.—SECTIONS OF SISSON STEAM ENGINE.

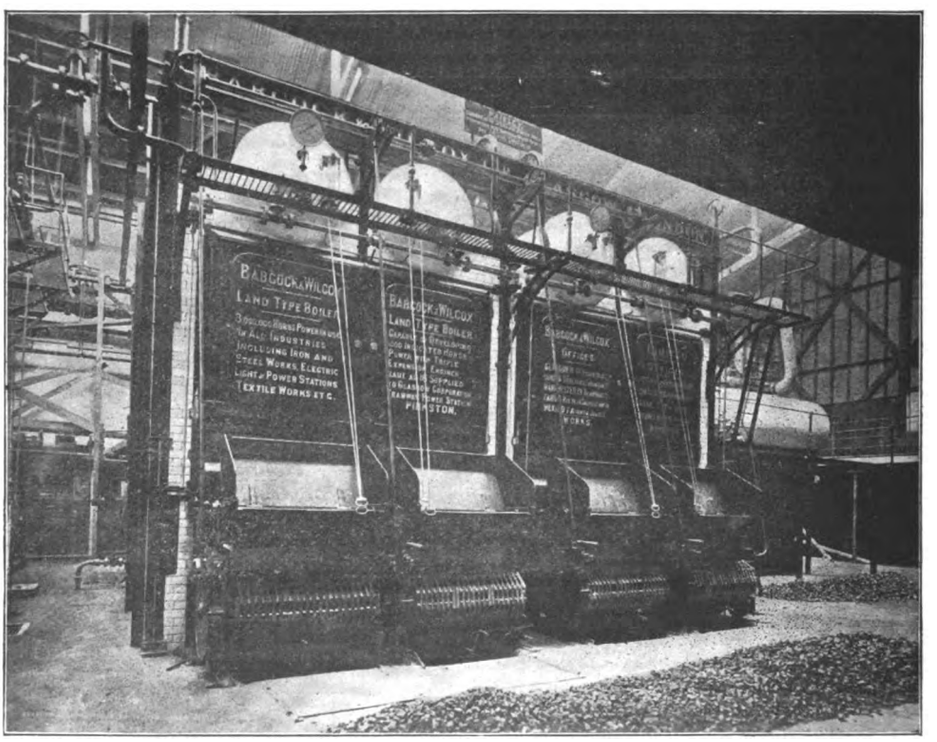


FIG. 27.—MESSRS. BABCOCK AND WILCOX'S WORKING EXHIBIT OF BOILER PLANT.

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§ 31. Messrs Babcock and Wilcox's Boiler Exhibit.—Some description of the Babcock and Wilcox boilers in the exhibition boiler house appeared in an earlier article in this series. I now give an illustration of this exhibit in Fig. 27. There are two boilers of the land type, each containing 5,137 sq. ft. of heating surface and constructed for a working pressure of 160lb. Each boiler is composed of 18 sections of tubes, each section having 12 tubes in height with an additional row of tubes, constituting the firm's well-known Scotch furnace. These tubes are 4in. in diameter and 18ft. long, and are connected at the front and rear to two steam and water drums, 48in. in diameter and about 23ft. long, and connecting these two drums is an extra steam chest, 20in. in diameter. The boilers are fitted with superheaters and chain grate stokers, designed for the efficient and smokeless combustion of semi-bituminous fuel. In addition, the firm are exhibiting a marine boiler built for 1,000 I.H P., and constructed for a daily working pressure of 200lb. per square inch.

## THE "MAX" ACCUMULATOR CELL.

The issue of the *Centralblat für Accumulatoren- und Elementenkunde* for October 1st contains an interesting illustrated description of the "Max" secondary cell, by P. Gasnier, taken from the *L'Industrie Electrique*.

The cell is manufactured by the French firm of Ruphy & Co., and is distinguished by cylindrical electrodes built up of the usual lead paste upon a core of hard lead. The cylinder is finally enveloped in a casing of asbestos thread, to guard against short circuits and loss from crumbling.

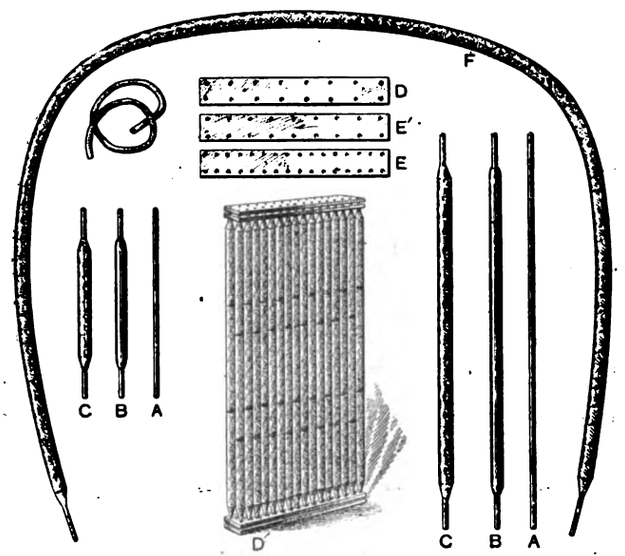


FIG. 1.

In Fig. 1, A represents the hard lead core, B the core covered with the lead paste, and C the finished electrode covered with its envelope of asbestos. These electrodes are manufactured in two sizes—80 and 220mm. long respectively, but F shows that the form of electrode can be made in almost any length. The plates D, E and E, Fig. 1, are also of hard lead, and are used to build up the cylindrical electrodes into groups. Fig. 2 shows a finished set of electrodes ready for immersion in the electrolyte, the two broad plates of hard lead being used as current connections for the positive and negative groups respectively.

A complete element built up of these cylindrical electrodes weighs 11·35kg., the dry electrodes themselves weighing 5·11kg., or nearly one-half of the total weight. The cell gave the following results for discharge at varying rates:—

| | | | |
|---|---|---|---|
| 26·4 | watt-hours per kilog., with a discharge period of | 7 hrs. | 15 min. |
| 22·2 | ditto | ditto | 4 hrs. 42 min. |
| 18·6 | ditto | ditto | 2 hrs. 20 min. |

The special advantages obtained by this form of accumulator are, a high capacity in proportion to the gross weight; and durability, resulting from the special form of the electrodes. Both of these are important considerations in the choice of accumulator cells for motor car work.

The manufacture of the cylindrical electrodes is carried out by a specially-designed machine, which covers the hard lead cores with the lead paste, and cuts off the electrode to the required length in one operation. In charge of one person this machine can turn out 40 electrodes 220mm. long by 6mm. in diameter per minute. Great pressure is used in

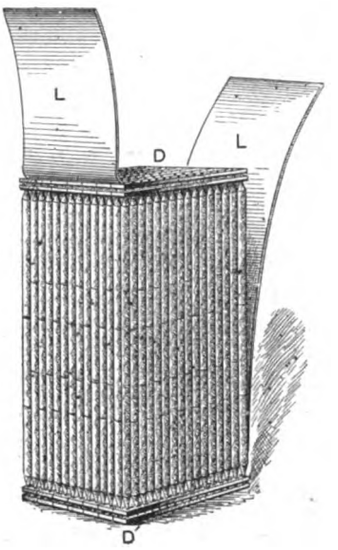


FIG. 2.

fixing the lead paste on the core, and this renders the electrodes more durable in use. The envelope of asbestos thread is spun on the electrodes after drying, this operation also being carried out by a specially-designed machine.

(*To be continued.*)

## MOTOR-GENERATORS v. ROTARY CONVERTERS.*

A good opportunity recently offered itself at the Oerlikon works to test exhaustively two different types of motor-generators of considerable capacity, as to their efficiency, power factor, rise of temperature, regulation and individual losses. The machines tested are part of a large order for two central stations. The machines are of three-phase direct-current motor-generator type, in one case consisting of a synchronous motor for 3,500 volts and 50 cycles, coupled to an 8-pole direct-current dynamo for a normal output of 260 volts and 1,350 amperes at 375 revs. per min. In the other case, the set is made up by a three-phase induction motor for 6,000 volts and 50 cycles, coupled to a four-pole direct-current dynamo for a normal output of 450 volts and 510 amperes at 370 revs. per min. As several machines of each type were available, the set under test could be run under permanent full load without the expenditure of much energy. This was done by running one set with its three-phase current side as a motor and with its direct-current side as a generator, whilst the other set worked on the same circuits with its direct-current side as a motor and with its three-phase current side as a generator. The measurements were for the greater part made by the same instruments. The results obtained are given herewith in the form of curves, but it should be said that some of the curves—notably the V-curves of the synchronous motor—were obtained by a calculation based on a limited number of observed values. The differences between the values representing the efficiency calculated from the individual losses and the values directly measured at different loads, were so trifling that the mean values were taken as the basis for the efficiency curves. In Fig. 1 are represented the characteristic curves of the synchronous motor at no load and on short circuit, plotted as a function of the exciting current. The same engraving also gives the individual losses as a function of the energy absorbed, and finally the V-curves at full load, half load, and no load. The dotted curves represent the power factor ($\cos \phi$) at full load and half load as a function of the exciting current. Fig. 2 gives the curves of the eight-pole, direct-current generator coupled to the above synchronous motor, the characteristic curve at no load being a function of the excitation, and the individual losses and the total efficiency a function of the output

* From the *Electrical World* of New York.



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in kilowatts. Fig. 3 shows a total efficiency of this set and the power factor at two different values of exciting current kept constant, and as a function of the output of the direct-current generator. Fig. 4 contains the usual curves for the efficiency, cos $\phi$, primary and secondary current, and the individual losses of the 350 H.P., three-phase induction motor. Fig. 5 gives the curves for the four-

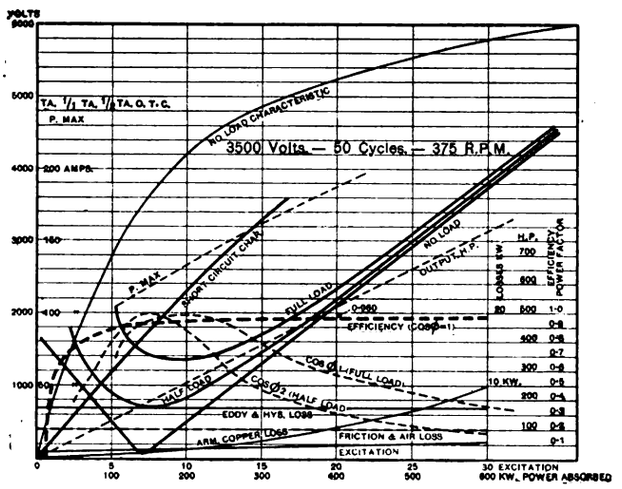


FIG. 1.—Curves of 525 H.P. Three-Phase Synchronous Motor.

pole direct-current generator for 450 volts, coupled to the induction motor referred to in Fig. 4.

Fig. 6 represents the total efficiency and the power factor of this latter set.

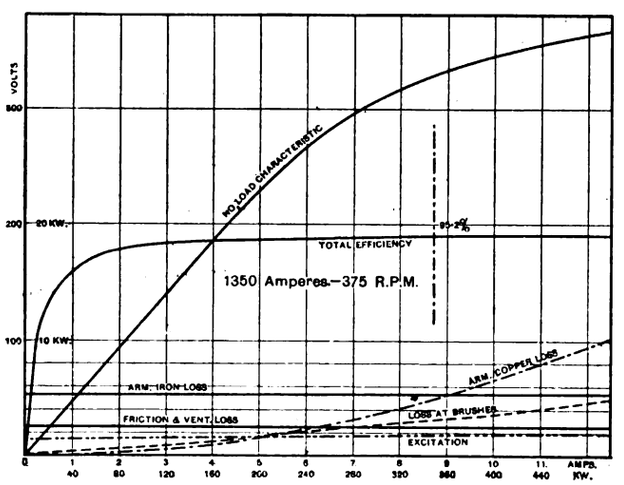


FIG. 2.—Curves of 350kw. Direct-current Generator.

It may be added that after a 10 hours' run under full load the temperature rise did not exceed 30°C. in any part of the windings and in the iron core of the three-phase current motors, nor of the direct-current generators. The commutators showed a temperature rise of only 35°C. By specially dimensioning and forming the pole cores, all sparking of the carbon brushes on the commutators

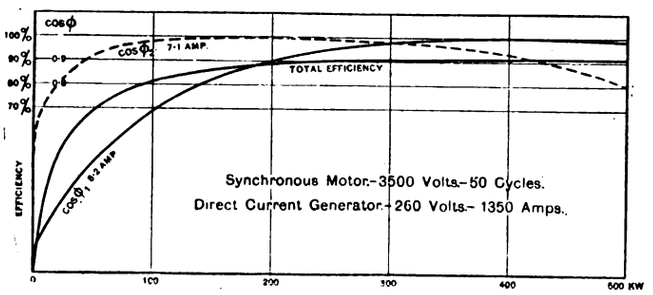


FIG. 3.—Power Factors and Efficiency of 350kw. Motor-generator.

was avoided without adjustment of the brushes when the load was changed from full load to no load. It is quite evident from the values of the individual losses that if the carbon brushes were replaced by copper brushes, the efficiency of the direct-current generators, and thereby of the whole set, would be increased fully ½ per cent.

For comparison with the data of some machines by another manufacturer, consisting of a static transformer and a rotary converter

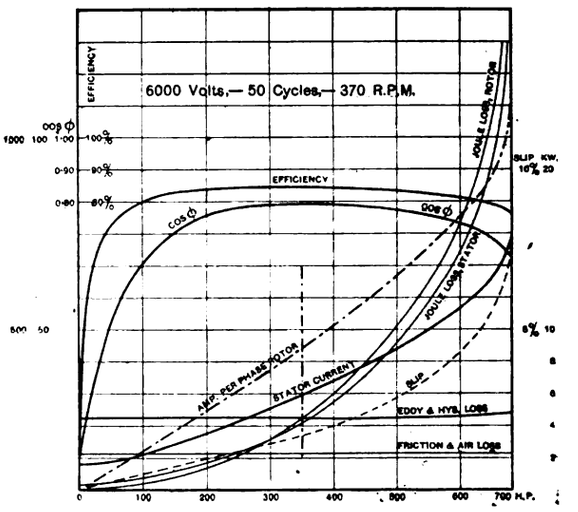


FIG. 4.—Curves of 350 H.P. Three-Phase Induction Motor.

with a common armature for three-phase and direct current, values taken from the curves are given in the accompanying table. These sets consist each of three single-phase transformers and a rotary converter for 550 volt direct current, the frequency being 25 cycles and the rated capacity 250kw. and 500kw. respectively. To make the comparison more conclusive the starting, the capacity and the "falling out of step" of the machines of the different types may also be considered. The motor-generator set with induction motor starts

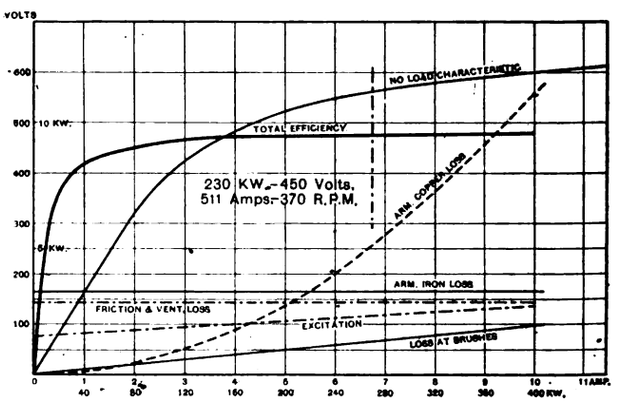


FIG. 5.—Curves of 230kw. Direct-current Generator.

with a current which at the most exceeds the no-load current by 10 per cent., or, in other words, with about one-fourth of the normal current. On the hub of the rotor is fixed a rotating starting resistance which, by means of a special connection, cuts out one phase after the other of the rotor circuit. This starting switch is so dimensioned that it just suffices to start the set, and is thrown in

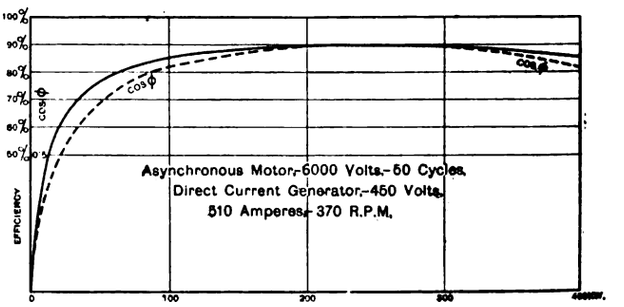


FIG. 6.—Power Factor and Total Efficiency of 230kw. Motor-generator.

and short-circuited by a lever having four different positions, which manipulation takes about 40 seconds. The motor is capable of standing an overload of at least 100 per cent. of the normal load, provided the tension at the terminals remains normal.

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*Comparison of Motor-generators and Rotary Converters.*

| | Oerlikon H.T. synchronous motor, coupled to a direct-current generator of 350kw., 375 r.p.m. and 50 cycles. | | | | Oerlikon H.T. induction motor, coupled to a direct-current generator of 230kw., 370 r.p.m. and 50 cycles. | | | H.T. static transformer, with artificial ventilation, and rotary converter of 250kw., 750 r.p.m. and 25 cycles. | | | H.T. static transformer, with artificial ventilation, and rotary converter of 500kw., 500 r.p.m. and 25 cycles. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Load. | Motor. | Gen. | Total. | Motor. | Gen. | Total. | Trans. | Conv. | Total. | Trans. | Conv. | Total. |
| Weight (tons) | ... | 12 | 11 | 23 | 8 | 9·5 | 17·5 | 4·65 | 8 | 12·65 | 6·9 | 14·5 | 21·4 |
| Efficiency (per cent.) | Full | 96 | 95 | 91 | 94·5 | 95 | 90 | 96 6 | 92·7 | 89·5 | 97 | 93·2 | 90·5 |
| | ½ | 93 | 92·5 | 87 | 93 | 92·6 | 86 | 95·2 | 89·2 | 85 | 95·8 | 89·5 | 85·5 |
| | ¼ | 88 | 90 | 80 | 89 | 88 | 78 | ... | ... | ... | 92·2 | ... | ... |
| Power factor (total) | Full load ..... 1·0* | | | | 0·91 | | | .. ... | | | ..... | | |
| | Half load ..... 0·9 | | | | 0·84 | | | ..... | | | ..... | | |
| | Quarter load ..... 0·7 | | | | 0·68 | | | ..... | | | ..... | | |
| Temperature rise (C.) | Iron core ..... 30 | | | | 30 | | | 45 | | | 45 | | |
| | Windings ..... ..... 30 | | | | 30 | | | 45 | | | 45 | | |
| | Commutator ..... 35 | | | | 30 | | | 55 | | | 55 | | |

* This is the power factor if the excitation is constant; if this is regulated, then the power factor is unity under all loads.

The well-known properties of the induction motor make it possible for the set to operate if the circuit suffers a momentary and sudden interruption, as, for instance, through lightning striking the line. The motor will again attain its normal speed without an excessive call for current even if the number of revolutions falls off as much as 10 per cent., so that even in the latter case the disturbance of service on the direct-current side is insignificant. The consequence of this falling out of step are quite different in the case of the synchronous motor and of the rotary converter. Any momentary interruption of the line or momentary short circuit (through atmospheric discharges or any other cause) will in every instance cause a serious falling out of step, and the set must be re-started anew, which means an interruption of service on the direct-current side of more or less duration. Another feature in favour of the induction motor is the total absence of any tendency to "hunting" and "pumping." In the present case the motor-generator set with the synchronous motor is set to work by starting the direct-current generator as a motor from the direct-current 'bus bars. The starting current amounts to about 10 per cent. of the current at normal load.

The overload which the synchronous motor is capable of standing depends largely upon the value of the exciting current used for regular running. If the exciting current is so regulated that under full load the power factor is unity, then the Oerlikon type of synchronous motor will stand an overload of about 90 per cent. If, however, the excitation is increased in such a manner that the power factor at full load is about 0·97 with a component of the current in advance, then the motor is capable of an overload of more than 100 per cent. of the normal load. The transformer sets with rotary converter are generally also started from the direct-current side with equally small currents. The above comparison indicates that with respect to the efficiency attainable, the three different systems are about on a par, at least, in all cases where the line voltage of the alternating current is not so high that the induction or even the synchronous motor requires a previous step-down transformation. As far as the power factor is concerned, the induction-motor system appears to be, depending upon the regulation of the excitation, from 5 to 10 per cent. behind the system employing a synchronous motor. If, however, the decision depends upon the merits of the simplicity of the starting manipulation, upon the extremely great safety of service in the case of interruption to the line and the absence of tendency to hunting of the generators, then the induction motor system appears to be by far the most advantageous of all. The motor-generator, as compared with the rotary converter, has the advantage that the tension of the direct current is independent of and can be regulated independently of the alternating-current voltage, and is free from the fluctuations of the alternating current. Finally, from the point of view of the designer, the variable number of poles in both machines of the motor-generator system is a very essential feature, which permits of fixing the number of poles just as small as is necessary to secure perfect commutation of the current, no matter how high the line frequency and the speed of the three-phase current motor. On the other hand, in the case of the rotary converter system, a periodicity exceeding 30 cycles per second necessitates such a large number of poles as to give rise to very unfavourable conditions for the commutation of the direct current.

## BOOKS RECEIVED.

**(Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.)**

"Wireless Telegraphy." By G. W. de Tunzelmann. (London: "Knowledge" Office.) 1s. 6d.

"The 'Mechanical World' Pocket Diary and Year-Book for 1902." (Manchester: Emmott & Co.) 6d.

"Confronto Sperimentale Fra L'Isteresi Alternativa, Statica E Rotante." By Alberto Diba. (Milan: C. Rebeschini.)

## THE SMALL SCREW GAUGE.*

The committee report that the present condition of the matter submitted to them is as follows:—In the report presented at the meeting of the Association which was held at Bradford in 1900 it was recommended that the shape of the thread of the British Association screw gauge for the use of instrument makers should be altered in the following particulars for all screws from No. 0 to No. 11 inclusive.

*For Screws.*—That the designating numbers, pitches, outside diameters, and the common angle of 47½deg. remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by one-tenth of the pitch, the diameter of the solid core being in consequence diminished by one-fifth of the pitch.

*For Nuts.*—That the designating numbers, the pitches, the diameters of the clear holes, and the common angle of 47½deg. remain unchanged; but that the top and bottom of the thread shall be cylindrical, showing flats in section, and that the depth of the thread shall be increased by $\frac{1}{10}$th of the pitch.

The effect of these alterations is as follows:—The threads of the screws and taps are of a very simple form, being cut with a single point tool or grinding wheel, with straight sides and a flat top, and the top of the thread is part of a cylinder. Though the form of the bottom of the thread depends on the correct grinding of the end of the tool, great accuracy is unimportant, as the screws and nuts do not come into contact there. The threads of the nuts and ring gauges will be accurate in proportion as are the taps used to cut them, the edge of the thread forming the through hole being part of a cylinder. The actual differences between the screws and nuts of the old form and that recommended are so small that it is believed the old stocks will in practice be interchangeable with the new screws, so that the amount of inconvenience caused by the change will be exceedingly small.

The British Association screw gauge has been in use in England for 17 years. Many firms in England have originated the threads and constructed gauges for sale or for their own use, but the difficulty of producing them is great, and the market obtainable may have been insufficient to induce them to perfect the processes necessary for making them accurately interchangeable. In short, the British Association screw gauge of 1884 was of too complicated a form to allow of its accurate realisation except at a cost which has proved prohibitive.

That very accurate gauges with rounded threads can be produced is not disputed, but the difficulty of doing so for small screws is very great. The names of three firms in America and of one in Germany have been proposed to the committee as being competent, and probably willing, to undertake the production of gauges and tools of the rounded thread. The Birmingham Small Arms Co., who produce interchangeable work on a very large scale, and to a high degree of perfection, use only round-topped screws, fitting all over, for bicycle work; and Mr. Clements exhibited gauges used by that firm, illustrating his Paper read before the section at Bradford. This firm does not produce these gauges for sale. The American firm of Pratt and Whitney have manufactured a large number of sets of gauges and screwing tools for the English Government, but declined to submit these to the committee on the ground that they

* Report of the committee of Section G of the British Association, consisting of Sir W. H. Preece (chairman), Lord Kelvin, Sir F. J. Bramwell, Sir H. Trueman Wood, Major-Gen. Webber, Col. Watkin, Lieut.-Col. Crompton, A. Stroh, A. Le Neve Foster, C. J. Hewitt, G. K. B. Elphinstone, E. Rigg, C. V. Boys, J. Marshall Gorham, O. P. Clements, W. Taylor, Dr. R. T. Glazebrook and W. A. Price (secretary), appointed to consider means by which practical effect can be given to the introduction of the screw gauge proposed by the Association in 1884.



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were not sufficiently accurate to satisfy us. After long delay they submitted to us three specimens which were reported upon by this committee at the Dover meeting. Though the best we had seen, they were distinctly inferior to the screws used in the ordinary micrometers purchasable in tool shops, which have threads of the character which this committee has recommended for adoption.

While the round thread is only produced satisfactorily by a very few firms who have made a special study of this class of work, the committee believe that the form of thread they have proposed can be made in any fairly-equipped tool room; and that this facility in producing or obtaining the necessary appliances must very greatly encourage the maintenance of an accurate standard in small screws, to promote which has been the object in the view of the committee. If, on the other hand, these tools and gauges are very special, and perhaps costly appliances, obtained only by the refined processes of certain factories, their use in workshops will extend slowly. The committee aim at putting the matter on such a footing that the common every-day appliances in the hands of workmen shall be of a good order of accuracy, and this is only possible if they are produced easily and cheaply.

It is not suggested by the committee that the form of thread recommended is the best for all purposes and for all sizes of screws, and they have expressly excluded sizes of screws below No. 11 British Association gauge, which are produced by pressure and not by cutting. Their recommendation applies only to the screws used in instrument making and similar trades for assembling parts, of which screws a large proportion, perhaps 95 per cent, are of brass. Considerations affecting the use of screws for other purposes have been put before the committee, especially by Mr. Clements in the case of bicycle and gun screws, and by Mr. Taylor in the case of lens screws. These have thrown suggestive light on the question before the committee, and will be closely considered by them if re-appointed.

Since the last report the committee's proposals have attracted much attention, but no sets of gauges or tools of the new thread have been submitted to them, and so far their recommendation has had no practical result. They are informed, however, that one firm of manufacturers in England is occupied in producing tools and gauges for their own use, and if they succeed in producing them of satisfactory accuracy will submit them to the committee.

Mr. O. P. Clements, the author of a Paper on screw threads used in bicycles, read before the section at Bradford, has been elected to the committee. Mr. W.Taylor, who has taken a leading part in the standardisation of the screws of photographic lenses, and has been in communication with the committee, has also been elected a member. Dr. R. T. Glazebrook has been elected a member of the committee. Correspondence has passed between the committee and Dr. R.T. Glazebrook, the Director of the National Physical Laboratory, respecting the examination of screw gauges, and the following arrangements have been made:—The National Physical Laboratory will undertake to examine and to report upon gauges of the British Association submitted to them. The committee have applied the grant of £45 made to them at Bradford to the purchase of apparatus for the examination of gauges by the National Physical Laboratory, and have appointed Mr. C. V. Boys, Lieut.-Col. Crompton, Dr. R. T. Glazebrook, Mr. W. A. Price, and Col. Watkin to be a sub-committee for the expenditure of the grant. The committee are of opinion that the previous grant of £45, made in 1900, will be insufficient to purchase the necessary apparatus, and recommend their re-appointment, with a grant of £45.

## ELECTRICITY WORKS ACCOUNTS.

### Sunderland Muncipal Electric Supply Works.

The accounts of this undertaking for the last financial year indicate most satisfactory results. A general reduction in the costs was effected in spite of the increased cost of fuel. From the engineer's report we learn that the average price per ton paid for coal was 14s. 9d., as against 6s. 3d. three years ago. It is only natural to find that the fuel item has again increased, and this only renders more creditable the substantial reduction of nearly 0·34d. per unit which was effected in the total costs. As they now stand all the items—fuel of course excepted—have figures below the average in 1899-1900.

The effect of these economies is shown in the increased working profit, which represented 7·09 per cent. of the mean total capital expenditure over the year as compared with 5·62 per cent. in the preceding year, and this with a total revenue from all sources of only 3·25d. per unit.

The lamp connections at March 31 last were 43 per cent. above those on the same date in 1900. The year's output was 90 per cent. higher, and the load factor works out at 12·5 per cent. for last year as compared with 10·7 per cent. in 1899-1900.

During the year four new generating sets for traction, each of 450 I.H.P., have been added, together with four Galloway boilers and other plant. The whole of the available space at the Dunning-street station is now utilised. A site has been purchased and building is in progress for a new station at Hylton-road.

### Belfast Municipal Electric Supply Works.

The management of the Belfast undertaking is to be congratulated on the results which we publish in our second analysis. Judging from the load factor the character of the load continues to be anything but conducive to low costs, but notwithstanding this and an increase here, as elsewhere, of the fuel cost the total costs have again been reduced from 2·22d. to 1·88d. per unit. Good progress is shown in the expansion of the business. The lamp connections increased by 55·4 per cent., and the output by nearly 46 per cent.

The table given at the bottom of this page contains interesting figures relative to the undertaking.

**The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—**

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Sept. 27, 1901 | Kingston-upon-Hull (Mun.) | July 18, 1900 |
| Ayr (Municipal) | Oct. 11, 1901 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Bath (Municipal) | April 20, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bedford (Municipal) | Aug. 8, 1900 | Leeds (Municipal) | Oct. 11, 1901 |
| Belfast (Municipal) | July 6, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Birmingham (Company) | Sept. 15, 1899 | Leith (Municipal) | May 17, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Blackpool (Municipal) | Oct. 4, 1901 | Liverpool (Municipal) | Mar. 22, 1901 |
| Bournemouth (Company) | May 3, 1901 | London (Company) | July 26, 1901 |
| Bolton (Municipal) | Nov. 30, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bradford (Municipal) | July 12, 1901 | Manchester (Municipal) | Sept. 13, 1901 |
| Brighton (Municipal) | May 10, 1901 | Morley (Municipal) | June 14, 1901 |
| Bristol (Municipal) | Aug. 30, 1901 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Norwich (Company) | Dec. 28, 1900 |
| Bury (Municipal) | Aug. 9, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Bristol (Municipal) | Aug. 30, 1901 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Norwich (Company) | Dec. 28, 1900 |
| Bury (Municipal) | Aug. 9, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Cambridge (Company) | April 12, 1901 | Nottingham (Municipal) | Sept. 21, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Oldham (Municipal) | Feb. 1, 1901 |
| Cardiff (Municipal) | Jan. 11, 1901 | Oxford (Company) | April 12, 1901 |
| Charing Cross (Company) | Mar. 15, 1901 | Pontypool (Company) | May 3, 1901 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Prescot (Company) | Dec. 8, 1899 |
| Chester (Municipal) | Aug. 16, 1901 | Preston (Company) | Dec. 14, 1900 |
| City of London (Company) | July 26, 1901 | Reading (Company) | Dec. 21, 1900 |
| Clerkenwell (Company) | April 19, 1901 | Richmond (Company) | June 29, 1900 |
| Coventry (Municipal) | Feb. 23, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| Croydon (Municipal) | July 20, 1900 | Scarborough (Company) | July 13, 1900 |
| Crystal Palace District (Co.) | Sept. 13, 1901 | St. Helens (Municipal) | Jan. 25, 1901 |
| Derby (Municipal) | Jan. 26, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | St. Pancras (Municipal) | July 5, 1901 |
| Dover (Company) | April 26, 1901 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Eastbourne (Company) | May 4, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South London (Company) | May 31, 1901 |
| Exeter (Municipal) | Aug. 5, 1898 | South Shields (Municipal) | Sept. 20, 1901 |
| Folkestone (Company) | April 26, 1901 | Southampton (Municipal) | Feb. 8, 1901 |
| Glasgow (Municipal) | Sept. 27, 1901 | Southport (Municipal) | July 7, 1899 |
| Gloucester (Municipal) | Aug. 20, 1901 | Stafford (Municipal) | Aug. 16, 1901 |
| Great Yarmouth (Mun.) | Dec. 28, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Greenock (Municipal) | Aug. 30, 1901 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 14, 1901 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | April 19, 1901 |
| Hanley (Municipal) | Aug. 9, 1901 | Westminster (Company) | Mar. 29, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | May 17, 1901 |
| Hastings & St. Leonards (Mun.) | July 12, 1901 | Windsor and Eton (Co.) | July 19, 1901 |
| Hove (Company) | May 10, 1901 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Hull (Municipal) | Sept. 20, 1901 | Woolwich (Company) | May 31, 1901 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | July 19, 1901 |
| Kensington & Knightsbr'(Co.) | Mar. 16, 1900 | | |

| Year ended | Units generated. | Units sold. | Maximum supply demanded. Kw. | Equivalent 8 c.p. lamp connections. | Plant capacity. Kw. | Load factor. | Per cent. of total output gas generated. | Costs per unit sold. Fuel. | Oil, waste, &c. | Wages at station. | Repairs & maintenance at station. | Generating costs. | Works costs. | Total costs. | Revenue per unit for current. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dec. 31, 1897 | 235,972 | 201,832 | 360 | 21,000 | 500 | 6·4% | 100 0 | 1·30d. | 0·15d. | 0·78d. | 0·19d. | 2·42 1. | 2 63d. | 3·54d. | 6·04d. |
| ,, 1898 | 414,007 | 356,526 | 721 | 38,500 | 900 | 5·65% | 54·7 | 1·07d. | 0·14d. | 0·66d. | 0·14d. | 2 01d. | 2·18d. | 2 92d. | 5·41d. |
| ,, 1899 | 742,590 | 622,486 | 956 | 51,500 | 2,080 | 7·41% | 3·54 | 0·68d. | 0·09d. | 0·44d. | 0·14d. | 1·35d. | 1·52d. | 2·22d. | 4·36d. |
| Mar. 31, 1901 | 1,091,895 | 908,067 | 1,398 | 80,000 | 2,500 | 7·93% | 0·0 ) | 0·7t.d. | 0·07d. | 0·28d. | 0·14d. | 1·25d. | 1 34d. | 1·88d. | 3·76d. |

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| | SUNDERLAND. | | BELFAST. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Sunderland Corporation. | | Belfast Corporation. | |
| *Date of Commencement of Supply* | Mar., 1856. [districts. | | Jan., 1895 (steam station started July, 1898). | |
| *System of Supply* | 3-w. con. curr. with batts. Alt. H.T. for outlying | | 3-wire continuous-current. | |
| *Chief Engineer* | John F. C. Snell. | | Victor A. H. McCowen. | |
| **YEAR ENDED** | MAR. 31, **1900.** | MAR. 31, **1901.** | DEC. 31, **1899.** | MAR. 31, **1901.** |
| **QUANTITIES—** | | | | |
| Units generated | 746,753 | 1,331,844 | 742,590 | 1,091,895 |
| „ **SOLD (TOTAL)** | 640,079 | 1,218,768 | 622,486 | 908,067 |
| „ sold to consumers | 559,897 | 1,135,576[f] | 616,294[a] | 897,856[g] |
| „ sold for public lighting, &c. | 80,182 | 83,192 | 6,192 | 10,211 |
| „ used on works | 31,730 | 57,468 | 33,076 | 51,195 |
| **UNITS SOLD PER 8-C.P. LAMP CAPACITY** | 18·3 | 16·7 | 9·58 | 11·6 |
| Maximum supply demanded | 682 kilowatts | 1,114 | 955·7 kilowatts | 1,308 kilowatts |
| Number of public lamps | 50 arc | 54 arc | 60 glow | 58 glow[h] |
| Number of consumers | 448 | 640 | 505 | 660 |
| Connections to mains in 8-c.p. lamps | 35,024 | 50,092 | 51,500 | 80,000[i] |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 35,000 | 72,900 | 65 000 | 78,100 |
| **CAPACITY OF PLANT IN KILOWATTS** | 1,120 | 2,330[g] | 2,030 | 2,500 |
| **CAPITAL—** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** | **Total.** / **Per kilowatt capacity.** |
| **AUTHORISED (TOTAL)** | — / — | — / — | £190,000 / £91·3 | £190,000 / £76·0 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | — / — | — / — | 190,000 / 91·3 | 190,000 / 76·0 |
| **RECEIVED (TOTAL)** | £88,315[a] / £78·8 | £122,805[a] / £52·7 | 117,039[b] / 56·2 | 175,493 / 70·2 |
| Share | — / — | — / — | — / — | — / — |
| Loan (including Debenture charges) | 83,315 / 78·8 | 120,305 / 51·6 | 116,360 / 56·0 | 172,360 / 68·9 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | — / — | — / — | 73,640 / 35·4 | 17,640 / 7·06 |
| Share (unissued) | — / — | — / — | — / — | — / — |
| Share (uncalled) | — / — | — / — | — / — | — / — |
| Loan (including Debentures) | — / — | — / — | 73,640 / 35·4 | 17,640 / 7·06 |
| **REPAID (TOTAL)** | 1,830[b] / 1·63 | 2,815[b] / 1·21 | 250 / 0·12 | 250 / 0·10 |
| **RESERVE OR SINKING FUND** | 28 / 0·025 | 236 / 0·101 | — / — | — / — |
| **DEPRECIATION FUND** | — / — | — / — | 1,148 / 0·552 | — / — |
| **EXPENDED (TOTAL)** | 82,159 / 73·4 | 122,433 / 52·6 | 138,394 / 66·6 | 173,889 / 69·6 |
| Lands and buildings | 12,829 / 11·5 | 17,166 / 7·67 | 34,590 / 16·6 | 35,713 / 14·3 |
| Plant | 34,675 / 31·0 | 57,948 / 24·9 | 46,522 / 22·4 | 68,979 / 27·6 |
| Mains | 29,705 / 26·5 | 44,538 / 19·1 | 54,559 / 26·2 | 66,367 / 26·5 |
| Miscellaneous | 4,950 / 4·42 | 2,082 / 0·894 | 2,723 / 1·31 | 2,831 / 1·13 |
| **BALANCE OF CAPITAL ACCOUNT** | +6,156 / +5·49 | +372 / 0·160 | −21,355[c] / −10·3 | +1,604 / 0·642 |
| **REVENUE—** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** | **Total.** / **Per unit sold.** |
| **TOTAL** | £9,805 / 3·676d. | £16,496 / 3·218d. | £11,679 / 4·505d. | £14,898 / 3·939d. |
| Revenue from supply | 8,641 / 3·240d. | 15,441 / 3·039d. | 11,308 / 4·364d. | 14,226 / 3·760d. |
| „ meters, &c. | 273 / 0·102d. | 331 / 0·065d. | 316 / 0·122d. | 642 / 0·170d. |
| „ public lighting | 697 / 0·261d. | 718 / 0·141d. | — / — | — / — |
| „ sale of lamps, &c. | 162 / 0·061d. | 6 / 0·001d. | 56 / 0·022d. | — / — |
| „ miscellaneous sources | 32 / 0·012d. | — / — | — / — | 30 / 0·008d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | |
| **TOTAL COSTS** | £5,757 / 2·158d. | £9,242 / 1·820d. | £5,744 / 2·215d. | £7,133 / 1·885d. |
| **WORKS COSTS** | 4,095 / 1·535d. | 6,915 / 1·361d. | 3,936 / 1·518d. | 5,093 / 1·345d. |
| *Generation of electricity* | *3,776* / *1·416d.* | *6,360* / *1·252d.* | *3,490* / *1·346d.* | *4,739* / *1·251d.* |
| Fuel (including cartage, &c.) | 2,027 / 0·761d. | 4,190 / 0·825d. | 1,755[d] / 0·677d. | 2,857 / 0·756d. |
| Oil, waste, water, stores | 281 / 0·105d. | 422 / 0·083d. | 247 / 0·095d. | 267 / 0·071d. |
| Wages at station | 1,072 / 0·402d. | 1,337 / 0·263d. | 1,135 / 0·438d. | 1,079 / 0·285d. |
| Repairs and maintenance at station | 396 / 0·149d. | 411 / 0·081d. | 353 / 0·136d. | 534 / 0·141d. |
| *Distribution of electricity* | *127* / *0·048d.* | *340* / *0·067d.* | *428* / *0·165d.* | *331* / *0·087d.* |
| Wages, &c. | 127 / 0·048d. | 340 / 0·067d. | 330 / 0·127d. | 241 / 0·064d. |
| Repairs, renewals of mains, &c. | | | 98 / 0·038d. | 90 / 0·024d. |
| *Public lighting* | *192* / *0·072d.* | *215* / *0·042d.* | *18* / *0·007d.* | *26* / *0·007d.* |
| Attendance | 192 / 0·072d. | 215 / 0·042d. | 12 / 0·005d. | 22 / 0·006d. |
| Renewals | | | 6 / 0·002d. | 4 / 0·001d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 1,663 / 0·624d. | 2,328 / 0·458d. | 1,809 / 0·698d. | 2,039 / 0·539d. |
| *Royalties* | — / — | — / — | — / — | — / — |
| *Rent, rates, taxes* | *320* / *0·120d.* | *691* / *0·136d.* | *724* / *0·279d.* | *728* / *0·192d.* |
| *Management* | *1,343* / *0·504d.* | *1,637* / *0·322d.* | *1,085* / *0·419d.* | *1,311* / *0·346d.* |
| Salaries | 955 / 0·358d. | 1,155 / 0·227d. | 504 / 0·194d. | 590 / 0·156d. |
| Stationery, &c. | 85 / 0·032d. | 47 / 0·009d. | 201 / 0·078d. | 126 / 0·033d. |
| Establishment charges | 172 / 0·065d. | 458 / 0·090d. | 235 / 0·091d. | 266 / 0·070d. |
| Law charges, &c. | 131[e] / 0·049d. | 177[h] / 0·303d. | 145[e] / 0·056d. | 329 / 0·087d. |
| **FINANCIAL RESULTS—** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** | **Total.** / **% to mean cap. exp'nded** |
| **WORKING PROFIT FOR YEAR** | £4,077 / 5·62% | £7,254 / 7·09% | £5,936 / 5·06% | £7,765 / 4·97% |
| Sum carried to Depreciation Fund | — / — | — / — | — / — | — / — |
| Sum carried to Reserve or Sinking Fund | 1,824 / 2·53% | 3,023 / 2·95% | 976 / 0·832% | 2,232 / 1·43% |
| Net interest on loans (incl. Debenture charges) | 1,756 / 2·44% | 2,974 / 2·91% | 2,837 / 2·42% | 5,057 / 3·24% |
| **BALANCE FROM LAST ACCOUNT** | — / — | — / — | 533 / 0·454% | 2,655 / 1·70% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 467[d] / 0·648% | 1,257 / 1·23% | 2,655 / 2·26% | 3,132 / 2·01% |
| *Deficit* | — / — | — / — | — / — | — / — |
| **ORDINARY DIVIDEND PAID** | — / — | — / — | — / — | — / — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 58·7% | 56% | 49·2% | 47·9% |
| Expenditure per kilowatt capacity | £5. 2s. 10d. | £3. 19s. 3d. | £2. 1 5s. 2d. | £2. 17s. 0d. |
| **REVENUE PER KILOWATT CAPACITY** | **£8. 15s. 0d.** | **£7. 1s. 7d.** | **£5. 12s. 4d.** | **£5. 19s. 2d.** |
| Expenditure per 8-c.p. lamp capacity | 3s. 3½d. | 2s. 6½d. | 1s. 9½d. | 1s. 10d. |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | **5s. 7¼d.** | **4s. 6½d.** | **3s. 7d.** | **3s. 9⅝d.** |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | **5s. 7¼d.** | **6s. 7d.** | **4s. 6½d.** | **3s. 8½d.** |
| Price charged for lighting, per unit | 5d. to 2½d.[e] | 5d. to 2½d.[e] | 7d. to 2d. | 6d. to 2d. |
| Price charged for power, per unit | 2½d. | 2½d. | 4d. to 1½d | 3d. to 1d. |
| Price charged for public lighting | £16 per arc per ann. | £16 per arc per ann. | £2. 7s. 6d. per pair of lamps. | £2. 7s. 6d. per standard of 2 (16 c.p.) lamps. |

**SUNDERLAND.**—REMARKS—*a* Includes value of lands appropriated £2,500. *b* Repaid during year. *c* Insurance £128, law £3. *d* To general district rate. *e* On Wright system, 1½-hour scale. *f* Of which 256,240 units were sold to tramways. *g* Includes 1,350kw. lighting and 980kw. traction capacity. *h* Insurance.

**BELFAST.**—REMARKS—*a* Includes 278,515 units at 7d., 8,087 units at 5d. and 255,631 units at 2d. for lighting; 25,500 units at 4d., 20,289 units at 2¾d., and 28,152 units at 1½d. for motors; also 120 units at 6d. for charging batteries. *b* Includes £214 from sale of copper scrap and for work done. *c* Over expended. *d.* Gas and coal. The gas to generate 22,000 units cost £277, or 3·02d. per unit, and the coal to generate 600,486 units cost £1,478, or 0·557d. per unit. *e* Insurance £104. *f* On Wright system with one-hour scale. *g* Being 382,644 units at 6d., 16,635 units at 5d., 77 units at 4¾d. and 352,556 units at 2d. for lighting; 4,000 units at 4d., 53,769 units at 3d., 22,218 units at 2¾d., and 65,627 units at 1½d. for motors; also 330 units at 6d. for charging batteries. *h* 29 standards of 2 (16 c.p.) lamps each. *i* Inclusive of 525 H.P. in motors.

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Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

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## WATER COMPANIES AND ELECTRIC TRACTION.

We report in another column the proceedings during an appeal to the Board of Trade, made by the Lambeth Water Works Co., concerning the confirmation of the order granted by the Light Railway Commissioners to the Croydon Rural District Council for the construction of three miles of light railway on the trolley system in Mitcham. This length of railway, if constructed, will ultimately connect the recently-opened Croydon electric tramways, which are also on the trolley system, with the network of electric conduit tramways projected by the London County Council for South London. Although, therefore, the actual length of line is not great, the proposed Mitcham light railway—to all intents and purposes practically an electric tramway—would form an important link; and it is highly desirable, if electric tramway traction is ever to bring the outlying districts within easy reach of London, that every facility should be given by the Board of Trade and by local authorities for the construction and multiplication of such linking lines. In many localities, however, these interconnecting lines would have to pass through sparsely populated districts, the line under immediate consideration being of this description. Such lines cannot pay unless they can be cheaply constructed and equipped; and, even though they may join the conduit lines at their London termini, it is quite out of the question, on the score of expense, to equip them on the conduit system. Possibly, where a rural interconnecting line would at both ends feed conduit lines, there would be justification for equipping it on an uniform system, in order that through cars could be run without interruption. But the proposed Mitcham light railway would, in any case, make a junction with trolley lines at Croydon. There is no good reason, therefore, why any other system than the ordinary overhead trolley should be selected for it.

The Lambeth Water Works Co., however, thinks differently, and has made an effort to persuade the Board of Trade to introduce into the Mitcham light railway order two amazing new clauses, the effect of which would be twofold. Their first effect would be to render the owners of the line liable to make compensation to the water company "for any loss or damage which they may sustain by reason of any fusion or electrolytic action on their mains, pipes, or apparatus which may, in any way, be caused by the exercise of any of the powers by this act conferred upon the Council." The second effect would be to allow the Board of Trade at any

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time, at its discretion, to insist upon the conversion of the line to an insulated return system of electric traction. Not a jot or tittle of expert evidence was brought before the Board of Trade to show that there is any real danger of electrolytic corrosion or fusion of the water mains; the claim was audaciously rushed on the statement at second hand that "Profs. AYRTON, DEWAR and PERRY" had expressed strongly the opinion that damage would be done sooner or later.

Our readers will remember that the evidence of these scientific professors, which was given in direct conflict with the expert evidence of leading electric traction engineers, was not accepted by the committee before which it was brought forward, and was not successful in preventing the adoption of the trolley system. It is amazing that the Lambeth Water Works Co. could have imagined that upon the slender basis of weak and inconclusive "expert evidence" of these professors it could persuade the Board of Trade to depart from its settled policy and create a precedent that would affect not only three miles of light railway in Mitcham, but every future electric tramway and railway order which owners of buried metal pipes might choose to oppose. It was only the thin end of the wedge, and, with apparently such a trifling tramway scheme at stake, doubtless it was assumed that it could be driven in while the Board of Trade was off its guard. At any rate, it behoves electric traction engineers to take more careful heed, for it is evident that no opportunity, however small, is to be missed by the gas and water companies to create the desired precedent which will give them the powerful leverage they seek against the spread of the trolley system. Nay, more, it was the desire of these opponents that the new regulations embodied in the two astounding clauses referred to should be made "retrospective in the sense that they should be made to apply to all future damage arising from schemes previously sanctioned." The effect of such a change in the power and policy of the Board of Trade would be that every existing tramway equipped on the trolley system might, at any moment, be ordered to be converted to an insulated return system—at a cost which we leave our readers to imagine. Conceive the effect of such an injunction at busy well-tramwayed towns like Bristol or Glasgow. Such an ill-judged change of policy would be a fatal set-back to the spread of electric tramway traction, except exclusively in the busiest centres; and it would add one more to the series of damaging blows which the Legislature of this country has directed against electrical engineering.

## A CADMIUM STANDARD CELL.

BY HENRY TINSLEY.

Various notices have appeared in *The Electrician* in past numbers as to the feasibility of using a cadmium cell for a practical standard, and in the same paper of September 10, 1897, a notice by Prof. Callendar was reprinted which had special reference to such cells and also to a method of construction of the ordinary Clark cell which eliminated the errors due to diffusion lag in the zinc sulphate solution. The writer has been trying to follow out the ideas advanced in Prof. Callendar's Paper. More especially the aim has been to obtain a cell which would bear a perceptible current being taken from it without polarising, and which would bear a short circuit with a certainty of almost immediate recovery without artificial means, such as charging, being used to bring the E.M.F. back to its nominal value.

After several attempts and also several failures, the cell illustrated in Fig. 1 has been made and proved to fill the above-mentioned conditions to an extent which must be regarded as very fairly satisfactory. A description of the cell may perhaps be repeated which, along with Fig. 1 (which is a full-size sketch of such a cell), will give a clear idea of its construction.

The negative electrode is composed of an amalgam of cadmium and mercury suitably proportioned, above which is a layer of cadmium sulphate. After this is the usual mixture of mercurous and cadmium sulphate crystals, in which is placed an amalgamated sheet of platinum. Connection to this is made by a platinum wire, and the same material is also used to act as a connection to the amalgam. A layer of glass wool prevents the chemicals shifting unduly, and the whole cell is sealed with marine glue. Very little free moisture is present, as Prof. Callendar has shown that cells made thus are generally more stable in their E.M.F. under varying conditions of temperature.

The question of an accurate reproduction of these cells is one of the first that rises, and the following table will give an idea as to the great accuracy on this point. These cells were made on different dates and with chemicals from two different makers.

| No. | Volts. | No. | Volts. |
|---|---|---|---|
| 31 ..... | 1·0191 | 34 ..... | 1·0192 |
| 32 ..... | 1·0192 | 35 ..... | 1·0190 |
| 33 ..... | 1·0191 | 37 ..... | 1·0191 |

The writer attributes this closeness in value as being partly due to the method of only using platinum wire for connections, as soldering usually causes a slight local action, especially if any trace of chemical happens to get on the join.

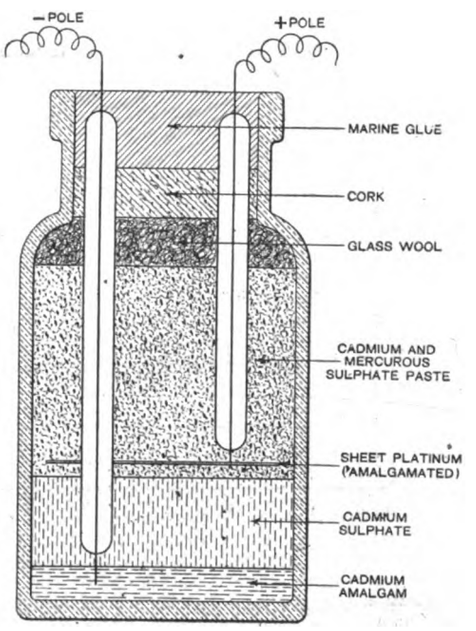


FIG. 1.—SKETCH OF CELL, FULL SIZE.

The question of low internal resistance is best solved by studying the curve Fig. 2, which was taken on a Callendar recorder working as an automatic potentiometer. A volt box, having a resistance of about 520 ohms, was arranged for the cadmium cell to discharge through, and potential points were taken off, so that a drop of 50 millivolts might fall on the bridge wire. This would correspond to 1 volt across the scale, so that $\frac{1}{500}$th of a volt might be easily read.

Curve No. 1 shows the discharge curve of one of the cells, and we see at once that the primary drop is about 7 per cent., showing that the internal resistance of this cell was only about 40 ohms when sending a current of about 1·8 milliamperes.

During the next four hours a steady fall set in, probably owing to an increase in the internal resistance of the cell, but the current still averaged 1·6 milliamperes. In looking at this curve it is as well to bear in mind the fact that the cell is still sending a current of a fairly large amount, and that the cell has no saving factor of an unduly large internal resistance. The particular cell from which the above curve was obtained had also been previously discharged under similar conditions for at least 24 hours.

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The bend over of the curve at 1 a.m. is worth noticing and is probably due to the electrode of the cell becoming completely covered with hydrogen. At this point the cell appears to become incapable of maintaining a current of any useful value. The supposition that this rise in internal resistance is due to the accumulation of hydrogen is strengthened by the curious little flat in the curve at 2:15 a.m. At this time someone walked across the room in which the experiment was being undertaken, and presumably shook the table on which the cell was resting. Any slight shaking such as this is sufficient to liberate the accumulated hydrogen and thus reduce the internal resistance or polarisation of the cell. I have noticed the same curious break in at least half a dozen instances. It appears that the slightest shaking is sufficient to cause a release of hydrogen and lower the resistance of the cell. Perhaps this will account for the fact that Clark cells, when in constant use, keep in better condition than those that stand idle. The healthy condition of used cells is not so much due to the current being allowed to flow through them as to the shaking they undergo during repeated handling, &c.

tions I have made I am of opinion that when once the cell has been allowed to discharge to a point beyond the sharp bend over shown above, it is somewhat difficult for the cell to regain its normal healthy condition unless a large amount of liquid is present in the cell. Seldom, or indeed never, in practice are standard cells subjected to such a severe strain as to send 1·5 milliamperes for 30 or 40 hours at a stretch; and such cells as that above described ought to be very useful where a small current of, say, about 1 milliampere is required for short periods.

In regard to the recovery after such a long strain, it may be mentioned that an exceedingly quick recovery takes place when first released from a closed circuit, but it takes four or five hours to recover the last 20 millivolts. I have not yet found one of these cells more than a few tenths of a millivolt out six hours after the most severe discharge.

The most serious drawback to the above type of cell seems to be the liability of the cadmium amalgam to dissociate when subjected to heavy jars such as those that happen in the post. This is partly avoided by keeping the other constituents of the

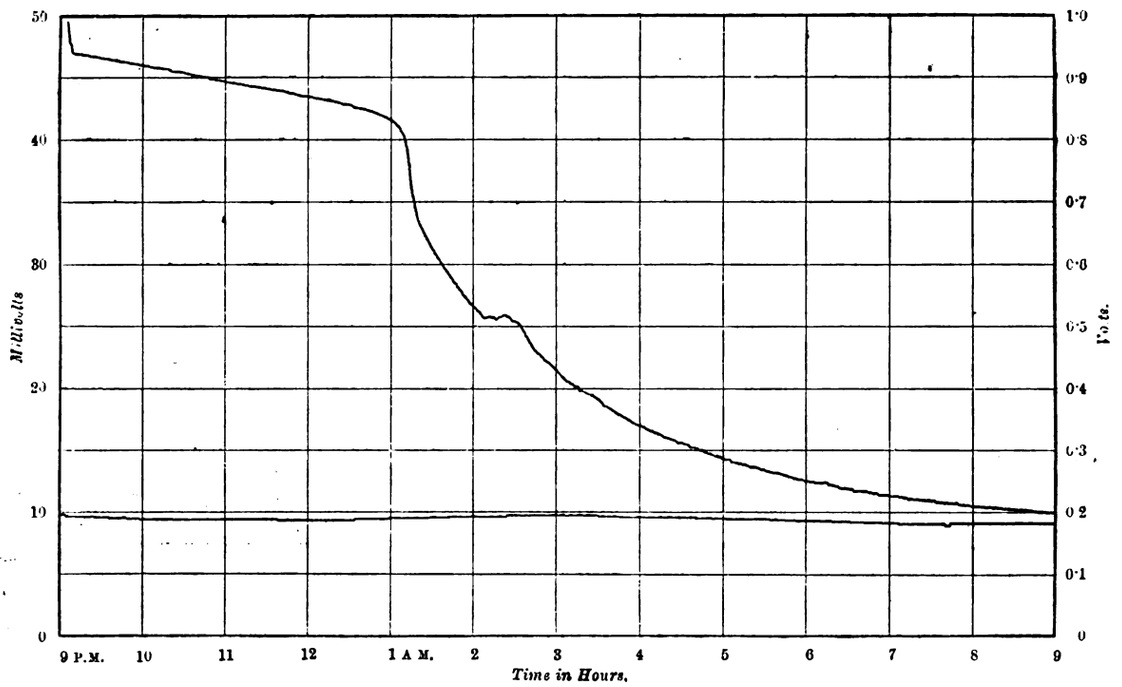


FIG. 2.—DISCHARGE CURVE.

In the curve we see that after the above-noticed flat, the internal resistance of the cell still continues to rise rapidly until after about 12 hours' discharge, when apparently a level is reached at which no noticeable increase in resistance or polarisation takes place.

I have taken several such curves, but refrain from producing them as the one given above appears to be thoroughly typical of the discharge of one of these cells. From observa-

cell as solid as possible so that the amalgam is kept down by their weight.

I hope later on to continue experiments of the recovery of such cells when artificially charged and under other conditions which have suggested themselves, but offer the above remarks with a due sense of my obligation to Prof. Callendar for his many useful suggestions and to the Scientific Instrument Co. for placing one of their Callendar recorders at my disposal.

## ELECTRIC RAILWAYS.*

BY MAJOR P. CARDEW.

*(Concluded from page 963.)*

### RETURN CONDUCTOR.

The question of the use of running rails as part of the circuit has been lately very hotly debated. There is no doubt that if this use is not strictly limited it will cause trouble from electrolytic action on pipes and other metallic bodies or structures laid underground, and also that it may interfere with and disturb other electrical circuits using the earth, or the delicate instruments of magnetic observatories. The Board of Trade regulations prescribe a strict limit to the fall of potential on the rails, which must not be allowed to reach 7 volts. The only practical way to work within these limits with the large currents required on railways with the continuous-current system is to tap off the current from the rails at numerous points at short distances apart. In fact, the rails must be used rather for the collection than the transmission of current. This tapping off of current is automatically effected by an arrangement first suggested by myself, and now much used on electric tramways. Each section of line is supplied from the generating or sub-station by means of a pair of feeders, one from the insulated rail or other conductor, and the other for the return current from the rails. These feeders are connected at the station to a dynamo called a booster, the line feeder being connected to the magnetising coil and the return feeder to the armature. The dynamo is kept revolving at a constant speed by means of a motor. When there is no train upon the section of line, and, therefore, no current passing in the line feeder, the dynamo does not generate E.M.F., but when current is passing in the line feeder a magnetic field, and, therefore, an E.M.F., is produced proportional to the amount of current. This E.M.F. is

* Cantor Lectures delivered at the Society of Arts.

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in such a direction as to increase the current which would otherwise naturally flow in the return feeder, and it may be so adjusted that all the return current will take this path. It appears curious at first sight, but it is a fact that this limit of fall of potential is almost as troublesome in the case of the 3,000 volts system as when the pressure is only 500 volts, in spite of the much smaller current used. The reasons for this are as follows :—

In the first place, the resistance offered by iron rails to alternating current is much greater than to continuous. It appears to be about two and a-half times as great, even with the low frequency of 15. Secondly, 7 volts is a much greater proportion of 500 than it is of 3,000, and it is therefore much nearer to the limit which would be worked to were economy of distribution the only consideration. It is true that the electrolytic effect of alternating current is far less than that of continuous, while as regards disturbance an alternating current of 15 periods is as little disturbing to any instrument or circuit at present in use as any form of current can be, so that it may be possible to allow some extension of the limit laid down in the case of such currents. But the general opinion as regards the Board of Trade regulations has lately rather inclined to the view that it is unduly lenient—a great change from my time—so that I think the alternating-current people had better be prepared to work to the limit now laid down if the rails are used as a return. It is very doubtful whether in the case of full-scale railways, at any rate, it will be practicable to make much use of the rails. It will certainly be uneconomical to do so if a satisfactory means of providing a completely insulated circuit can be devised. With continuous current and low pressure, the use of two insulated rails for each line laid in the permanent way is a considerable objection, but the chief difficulty to be overcome is in providing for points and crossings where both insulated rails have to be discontinued. With polyphase current and two overhead wires one wire alone has to be discontinued, and the train can get one phase of current so long as the rails are used as a conductor. In this case, however, it seems quite practicable to provide for the return a fairly-insulated copper conductor in the permanent way to be rubbed by shoes attached to the train, and the breaks in this conductor at crossings need only be short ones. This conductor would be connected to earth at each transforming station, so that very moderate insulation would suffice, and no shock from it need be apprehended.

### Ganz's Trolley Pole.

The contact device proposed by Messrs. Ganz is a kind of double trolley pole, carrying elongated rollers, one for each wire. The wires, therefore, need not exactly follow a curve, but can take it by successive angular changes of direction, and shift along the rollers. The trolley poles are mounted on the roof of the motor coaches, and are hinged to lie flat on the roof, but are elevated to the required angle by means of springs. These springs are extended by a piston actuated by compressed air, so that at any time contact with the high-pressure wires can be broken by releasing this air pressure, and can be re-made without exposing the driver to the slightest risk of getting a shock. It is further provided that the key to give access to the high-pressure apparatus is only available for use when the valve controlling this piston is open, so that there is no possibility of any connection with charged wires.

## Lecture III.

### Generation and Transmission.

We now come to the generation and transmission of the electrical energy, and the question, How far apart the generating stations should be? Although so much doubt exists at present as to the relative advantages of continuous and polyphase current for driving the trains, there is a general agreement that for the long distance transmission the right thing is three-phase current. There are great difficulties in the construction and winding of continuous-current machines for even moderately high pressures and of large power; 2,500 volts is about the practical limit, and this would necessitate generating stations spaced about 10 miles apart, and even then the expense of mains, or the loss in transmission, would be very considerable. With three-phase machines, however, pressures of 15,000 or 20,000 volts are quite practicable, and the limit is determined, not by the generator, since the pressure may be raised by transformation at the generating station, but by the conditions of safe working of the transmission line and apparatus. I do not myself think it probable that the electrical pressure will in this country much exceed what is already being worked, whether the transmission be by underground cables or possibly by overhead wires. At a pressure of 12,000 volts at the generating station, and a density of 600 amperes per square inch in the cables, a density which should not be exceeded in high-pressure cables of large size, energy may be transmitted 15 miles by three-phase current with a loss of only 5 per cent., or with this loss the generating stations may be situated 30 miles apart.

Putting the saving to be effected by concentration of plant as high as the most fervid advocate of such concentration can expect, I do not think it likely that it will justify the spacing of the generating stations at more than from 30 to 50 miles apart, having regard to the heavy expense of transmission lines and the continual waste of energy, and also the amount of dislocation of service caused by a serious breakdown. Electrical effects which are inconsiderable with ordinary pressures and distances, become of formidable magnitude when certain limits are exceeded. I allude especially to effects of what is called "capacity" and "inductance" in cables.

Future developments and discoveries may very probably alter the conditions, but as they are to day, I regard 12,000 volts and transmission to 15 to 25 miles as good limits to adopt. The use of the three-phase current for transmission from the generating stations to the sub-stations, where the conversion from the high pressure to the lower pressure supplied to the trains takes place, effects some economy in capital cost compared with continuous-current transmission, even assuming equal working pressure possible in the two cases. The amount of copper necessary with three-phase transmission is only 75 per cent. of that required for simple phase or continuous current with a non-inductive load, such as supply to lamps, or where the current can be kept "in phase" with the pressure, as when supply is given to "rotary converters." Even when the load is inductive a saving of from 15 to 20 per cent. of copper is practicable. On the other hand, three separately insulated conductors must be used, and each of these may acquire the full potential from earth as well as from the other two.

With continuous or single-phase current the cables used may be concentric, the outer conductor being earthed at one point, and only differing in potential from the earth at any other point by the amount of fall of potential due to its resistance and the current passing in it. Thus a very slight insulating covering is sufficient for the outer conductor, and it may be handled while under pressure without any risk. With two-phase current also, concentric cables with earthed outer conductor may be used, but with three-phase current and three conductors all the conductors should be similar as regards insulation. On this account the practical saving effected by the use of three-phase current with underground cables is not very important, and would not of itself justify the use of the system as it certainly does in the case of long-distance transmission where bare overhead wires can be used and the cost of copper is the chief item of expense.

### Transforming Stations.

It is in the number and equipment of transforming stations that the system of using three-phase current to supply the motive power for the trains has a great advantage over any system using continuous current, in that with the latter the electrical pressure is practically limited to about 500 volts, and the conversion from the higher pressure which must be used for the long-distance transmissions requires the use of running machinery, whereas with the former 3,000 volts is quite practicable, and higher pressure may be reached and conversion is carried out by means of statical transformers alone. The reason for the fixed limit of pressure with continuous current is that the motors cannot be constructed to take a pressure high enough to admit of the charged conductors being overhead wires, while if they are put in the permanent way a pressure of 500 volts is quite high enough considering the risk of accidental contact with these conductors to which the employés must be exposed. It is very difficult in electrical engineering to set a fixed definite limit. What is the *ne plus ultra* of to-day may be merely the starting point of to-morrow. Still it certainly appears unlikely that for continuous current traction motors the limit of 500 volts will be much exceeded.

I believe that in one instance in America those conductors have been placed in a form of conduit beneath the track, but this again is an expensive arrangement, and involves greater liability to faults of insulation and short circuits. On the other hand, once get the conductors overhead on a railway line, where they can be kept perfectly free from crossing wires, which have caused several serious accidents on trolley lines, and many of the difficulties connected with line equipment are removed.

If continuous current is to be used for supply of power to trains, the conversion from the three-phase high-pressure transmission system is generally accomplished by means of statical transformers to reduce the pressure and rotary converters to convert from three-phase to continuous current.

### Transformers.

A statical transformer is a very simple and efficient apparatus. It consists essentially of two coils—one for the high pressure and the other for the low pressure—wound on a core of soft iron. An alternating electric pressure is applied to one of the coils, and the resulting current produces waves of magnetic induction in the iron, corresponding in periodicity and within limits in amplitude. These magnetic waves again induce waves of E.M.F. in the other or secondary coil, and of counter E.M.F. in the primary coil. The E.M.F. in each coil is proportional to the number of turns, hence any desired proportion can be obtained. The iron is so shaped that the magnetic induction or flux of force completes the circuit within the iron, and no free poles or external field is produced, the total induction being thus much greater than it would be if the magnetic circuit had to be completed through air. The iron is also finely laminated to avoid the waste energy and heat which would result from the generation of spurious electric currents within the iron itself.

The losses of energy in a transformer are relatively small. There is no rotating mass involving friction at bearings, but there is a

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constant loss caused by the changes of magnetisation in the iron and probably of the same nature as frictional loss, and a varying loss due to the resistance of the coiled conductors to the currents. The total loss at full load is about 3 to 4 per cent. of the energy transformed. Still, even this small proportional loss produces so much heat that in large sizes of transformers it is necessary to resort to artificial means for dissipating it, since the natural ventilation of a transformer is not so good as that of a machine with rotating coils.

### Rotary Converters.

The rotary converter exemplifies what I have already pointed out, viz., that every kind of current can be obtained from a dynamo machine. It is, in fact, a multipolar continuous-current machine having points in the armature winding connected to a set of contact rings so as to admit of continuous connection being made with each point from the outside while the armature is revolving. The number of points corresponds with the number of different phases of currents for which it is intended, and they are spaced at equal distances apart. The most general arrangement for traction work is a six-phase current derived from a three-phase current by keeping each phase entirely separate in the secondary circuits from the statical transformers. The machine, when connected to the polyphase current supply, must run in synchronism with the frequency as a synchronous motor, and should be started on the continuous current. These machines are highly efficient, but require considerable attention and skill in management.

In some respects the motor generator arrangem ent, in which the alternating and continuous current armatures are separate, is to be preferred to the rotary converter.

### Accumulators.

Where continuous current is used for supply of power to the trains, a battery of accumulator cells is a very useful adjunct to the equipment of the sub-station, especially where the load is of a very intermittent character, as it must be on lines of considerable length, since the frequency of the service, even with electric trains, cannot be such as to give a continuous load at each sub-station. If no accumulation is provided, it is obvious that each sub-station must be equipped with sufficient power to deal with the maximum possible load, although such a load may not be reached at all during any ordinary day, and the aggregate of machinery in the sub-stations must exceed that at the generating station. All this machinery has to be paid for and maintained, and also has to be run practically unloaded for a considerable portion of each day.

By using an accumulator battery, combined with an automatic "booster," it is possible to supply the traffic requirement of a very intermittent or varying load, and still have a practically uniform load on the converting machinery. The diagram, Fig. 6, is taken from a paper by Mr. G. A. Grindle, and shows results obtained at the St. Helens generating-station supplying the tramways load.

Where polyphase currents are used throughout accumulation is at present impracticable, and the transformers in each sub-station must be capable of dealing with the maximum possible load. They are, however, cheap in first cost and maintenance, and their efficiency, even at light loads, is high. In this case, too, since the supply pressure is so much higher, the sub-stations may be further apart, and, consequently, will have a higher "load factor," as it is called, which means that the average load is larger in proportion to the maximum load than is the case with more frequent sub-stations.

### Summary of Relative Advantages of Continuous and Polyphase Current.

Before passing to the discussion of the equipment of a typical railway of the sort which I have indicated as being likely to benefit by electrical working, it will be desirable to summarise the relative advantages and disadvantages of the continuous current and the polyphase current systems of traction as they exist to-day for application to full scale railway working.

To the credit of continuous current must be put:—

1. That it is a two-wire system, while the rival is a three-wire system. Every additional contact that has to be made to complete the connection for a running train is a disadvantage, especially at high speeds.
2. That with it accumulators may be used distributed in the various sub-stations, thus reducing the necessary running power both at the sub-stations and at the generating stations to what is required for the mean load, including in this the surplus load required to maintain the batteries properly charged.
3. That there is no "wattless" or idle current with the continuous current as there is with the induction polyphase motors. These idle currents may even be practically eliminated from the high-pressure circuit where a high-pressure polyphase supply is converted by means of statical transformers and rotary converters to continuous current for traction. In other words, the polyphase system has to provide for about 15 per cent. more current than would be necessary for supply of the same electrical power at the same pressure on the continuous current system.
4. That to reduce this idle current very small clearance is necessary between the fixed and revolving parts of the polyphase motor.
5. That variations of speed such as are often required in running can be more easily and efficiently provided with continuous-current than with polyphase equipment.

On the other hand, the polyphase system possesses the following advantages, viz.:—

1. Great simplification in sub-stations, dispensing with all runnin machinery and with one transformation of energy, thus considerably reducing both the capital cost and working expenses, since no attendance is required.
2. Use of pressure as high as 3,000 volts is quite practicable for supply to motors. This increased pressure has the following distinct advantages:—That the line conductors may be overhead wires in place of heavy rails, which encumber the permanent way and require to be electrically connected by bonding; that the sub-stations may be placed at greater distances apart and the power installed reduced proportionately to the better load factor obtained; and that the current required is proportionately reduced and can be collected with greater ease.
3. The generating plant may be less expensive, as provision has not to be made for running rotary converters.
4. The motors are much simpler and more mechanical machines. The absence of the commutator and the low pressure in the rotating portion tend to diminish the cost of repairs, and the motor may easily be arranged to be entirely supported by springs.
5. The speed of trains is governed by frequency, which is absolutely constant all over the line, and not by pressure, which is more variable.

The return of energy to the line when stopping or descending grades may also be put to the credit of the polyphase system, as compared with the continuous-current system, unless separately-excited motors prove practicable. Even without taking this into account, however, I consider that the advantages obtained in regard to means of conversion and from the use of higher pressure sufficient to indicate that the polyphase system is that most suited for use on full scale railways. The picking up of current has been well worked

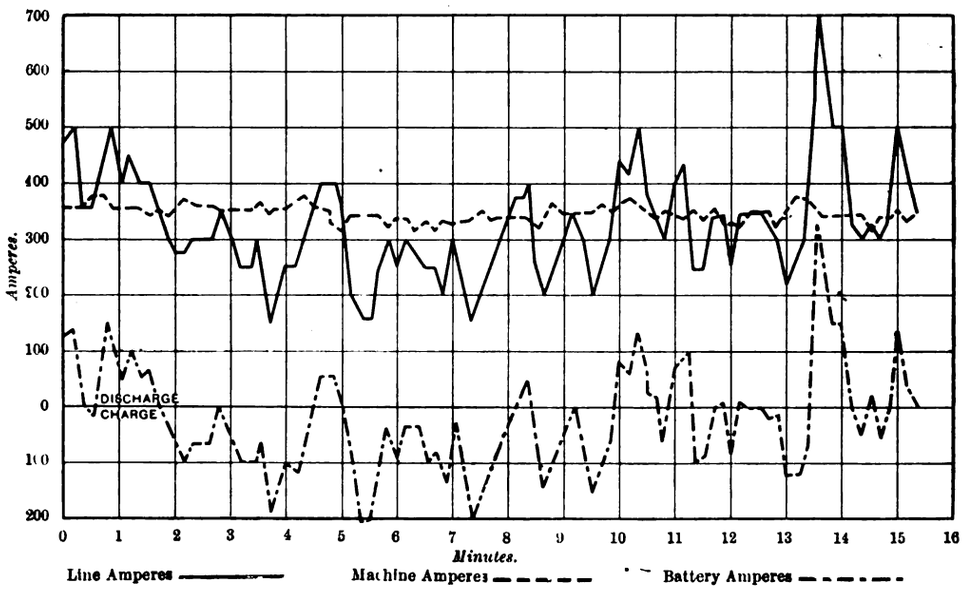


Fig. 6.

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out, and as against the economic advantage of accumulators must be weighed the great expense of installation, maintenance and attention, the complication of the sub-stations and the increased consumption of energy.

Exactly 20 years ago I read a paper at what was then the Society of Telegraph Engineers suggesting the application of electric motors for driving trains, and pointing out the advantages that would result from the distribution of electric power throughout the train, and from the braking action that could be obtained from the motors. I have seen these anticipations fully realised, and I feel equally confident in prophesying the successful application of the polyphase system to the working of full scale railways.

### Equipment of Full Scale Railway.

In order to give you some idea of the nature and cost of the equipment of a railway of the class which I consider could decidedly use electric traction to advantage, I propose to discuss in some detail the traffic arrangements and equipment of the lines shown in Fig. 7, which, although somewhat analogous to existing lines, is of course not taken from any particular railway system. The lines consist of two metropolitan termini, A and B, from each of which there are four lines of rails to a junction, C, about 10 miles distant from each terminus. Two of these lines are for local or suburban traffic, forming a loop, ACB, with stations about 1 mile apart. The other two form a junction with each other at C, and thence a double line extends to D, the town terminal station, which we may suppose to be at a fashionable resort, capable of supporting a heavy and continuous passenger traffic with the metropolis. D we will take to be 40 miles from C, or 50 from A or B. It is a centre of a populous district, and can support a considerable suburban traffic, as indicated by lines DE and DF, each about 6 miles long. Further, points G and H, about 4 miles from A and B respectively, are connected by

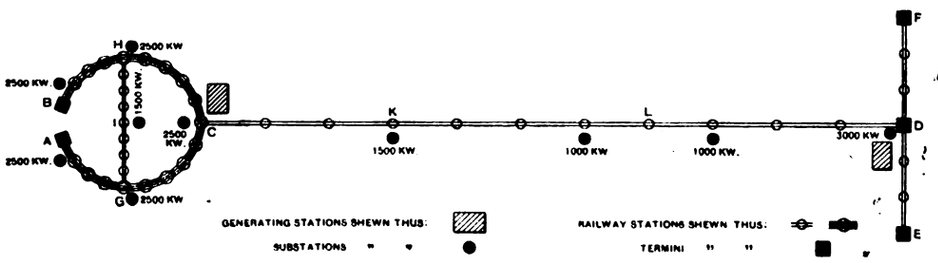


Fig. 7.

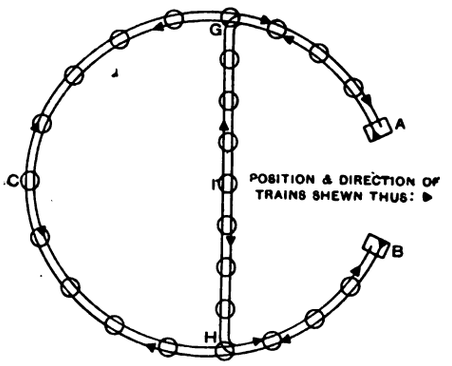


Fig. 8.—Suburban Lines.

a cross line; G, I, H, K, 10 miles from C and L, 15 miles from K, are supposed to be important towns. Intermediate stations are indicated by small circles.

The scheme of traffic during the busy hours of the day is as follows:—

1. A suburban service at frequent intervals over A, G, I, H, B and reverse.
2. A semi-suburban service at frequent intervals over A, G, C, H, B and reverse.
3. An express every half-hour from A or B alternately to D and reverse (stopping at H and L).
4. A service of stopping trains connecting with these expresses.
5. A frequent suburban service over E, D, F and reverse.

It will be understood that goods traffic will be worked during the hours when the line is not required for passenger traffic. The main generating station I have supposed to be located at C, this being a very advantageous position for supplying the two metropolitan termini and intermediate stations. As, however, the suburban traffic at D would necessitate the transmission of a large power to a distance of 40 miles from C, it is more economical to place a second generating station at D should there be no objection to such an arrangement. The sub-stations are situated as shown on the diagram.

Dealing with the suburban traffic between A and B first (vide Fig. 8), a reasonable arrangement would be to run trains at quarter-hour intervals over the line A, G, I, H, B, and at the same intervals over A, G, C, H, B. Thus between A and G and B and H the trains will be at 7 min. and 8 min. intervals. Assuming that the traffic varies considerably in amount at different times of day, trains consisting of three motor cars and three trailers, seating, say, 420 persons, would be very suitable for this service, and would weigh, fully loaded, say, 150 tons. At times of minimum traffic one motor and one trailer car can be dropped.

Since the stations are supposed to be at distances apart of only about 1 mile the time of running will depend, to a considerable extent, upon the acceleration obtainable, as upon the full speed of the trains. Full speed must necessarily bear a simple proportion to that of the express trains on the main line. This we may take to be 60 miles per hour with four-pole motors, giving a frequency for the current between 15 and 20 periods per sec., depending upon the exact diameter of the driving wheels. Then six-pole motors will give a speed of 40 miles per hour, eight-pole motors a speed of 30 miles per hour. A speed of 60 miles per hour is obviously impracticable when the stations are only 1 mile apart, since full speed could not be attained.

Let us consider a full speed of 40 miles per hour. With a mean acceleration of 1ft. per sec., and retardation of 1·5, the train will run

580 yards in 59 seconds accelerating.
380 " " 39 " retarding.
800 " " 40 " full speed.

Allowing 25 sec. stop, this gives a time from start to start of 163 sec., or a schedule speed of 1 mile in 2 min. 43 sec., or for the 15 miles from A to B by the route A, G, I, H, B 40 min. 20 sec., since there are only 14 stops. Thus the running time for the double journey will be 80 min. 40 sec., and the traffic will require six trains, allowing 4 min. 40 sec. stop at each terminus.

On the other hand, if full speed is 30 miles per hour, with the same acceleration and retardation, the train will run—

323 yards in 44 seconds accelerating.
215 " " 29 " retarding.
1,222 " " 84 " full speed.

or, with the same allowance for stop, this gives 182 sec. from start to start. So the train cannot complete the cycle in 90 min., or seven trains will be required in place of six trains. If we allow 30 sec. stops, the 40-mile trains would still have 3 min. 30 sec. at each terminus.

The power taken during acceleration by the 40-mile train would be about 900kw., while the 30-mile train, allowing for the saving of weight due to the smaller power required, would only take about 600kw., and when running at full speed on the level the powers taken would be 200kw. and 115kw. respectively, assuming resistances at 15lb. and 12lb. per ton in the two cases.

Since the stations are assumed to be 1 mile apart the energy taken per mile in the two cases would be in kilowatt seconds:—

For 40-mile train—

| | | |
|---|---|---|
| Accelerating ..... | 900 × 59 = | 53,100 |
| Running ..... | 200 × 40 = | 8,000 |
| | | 61,100 |
| Returned in braking, say ..... | | 7,000 |
| | | 54,100 |

or about 15 Board of Trade units.

For 30-mile train—

| | | |
|---|---|---|
| Accelerating ..... | 600 × 44 = | 26,000 |
| Running ..... | 115 × 84 = | 9,660 |
| | | 36,060 |
| Returned ..... | | 3,060 |
| | | 33,000 |

or about nine Board of Trade units.

The 40-mile trains do 20 miles per hour, and there are six of them, the total hourly consumption for the service will be, therefore, 1,800 units. The 30-mile trains do the same number of train miles per hour, so the total hourly consumption in this case will be 1,080, the difference being 720 units, or, at ½d. per unit, 30s. per hour, against the quick service.

The maximum power required will also be greater with the quick than with the slow service, necessitating additional capital expenditure in the generating sub-stations. On the other hand, we have with the slower service the extra capital cost of one train and its proportionate reserve, and the charges of the staff required for this train, not only for running, but for cleaning and looking after it, and that of its maintenance and repair. But the main consideration is the greater popularity of the quicker service. An additional 3d. earned per train mile will pay for the extra consumption, while the capital expense is nearly equal in the two cases. An argument in favour of deciding for the quick service is, that the exigencies of traffic on the main line will certainly necessitate the use of motors

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calculated for 40 miles per hour speed, and by adopting the same speed for the suburban trains the complication of a different pattern of motor and equipment is avoided. On the whole, the balance of advantage is with the fast trains, if stops averaging 30 sec. can be worked. In America, stops of 20 sec. are found sufficient in similar cases, but we are not quite so "spry" here.

It would, of course, be quite practicable to run a 10 min. service of 100-ton trains over the suburban lines without any additional rolling stock, and some saving of power would be thus secured. Probably the service between E, D and F might be worked by 100-ton trains, consisting of two motor and two trailer cars, at quarter-hour intervals.

We will next consider the main line service. The diagram, Fig. 9, shows the scheme of traffic I would suggest. The black lines are expresses starting every half-hour alternately from A and B, stopping only at K and L, and reaching D just under the hour. Stopping at D 21 minutes they return to B and A respectively, whence they start again in 12 minutes' time. Thus a train from A takes five hours for a complete cycle to D, then to B, then to D again, and finally to A before starting from A again, and five trains are required for the service. The normal trains might consist of two motors and two trailer cars, total weight, say, 100 tons.

At the intermediate half-hours a stopping train starts from A or B, or at the same time that the express starts from A the slow train starts from B and vice versa. This stopping train stops at G or H, C, and all stations from C to K, doing the 20 miles in about 43 minutes, and arriving at K 9 minutes before the express leaving half-hour later, which takes 22 minutes to do the 20 miles. Full speed of stopping train 40 miles per hour. This slow train does not go beyond K. It waits there until after the next up express has left, and then returns to the same terminus from which it started, stopping at the same stations. These trains would have two motor cars, one at each end, and three trailer cars, since an acceleration of 0·75 mean will be quite sufficient. Total weight, say, 120 tons.

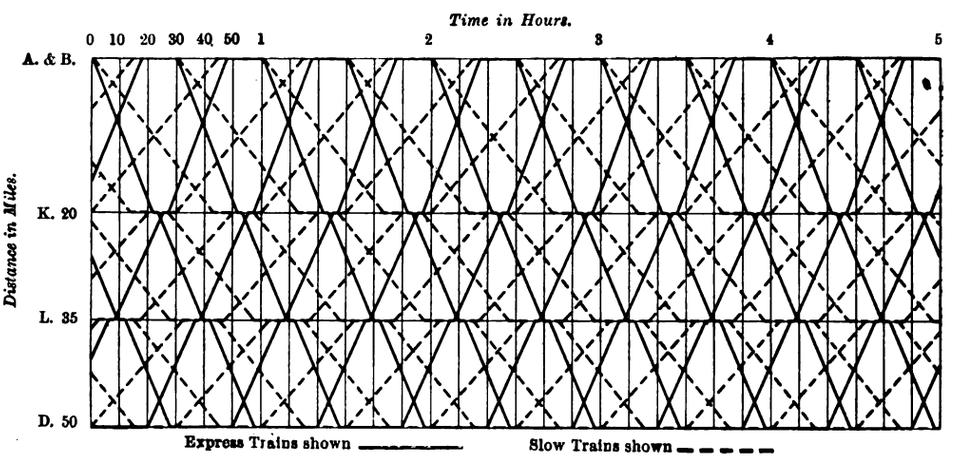


FIG. 9.

Four trains are required to work the service. Immediately after the down expresses leave K and L, slow down trains start from these stations to L and D respectively, returning in each case after the next up express so as to reach K and L well before the succeeding up express, full speed being 40 miles per hour. These will in ordinary times consist of three cars, two being provided with motor equipment, together equal to one motor car. Total weight, say, 70 tons. Three trains are required to work the service between K and L, and the same number between L and D.

With this service it will be seen that every station on the line has the advantage of a half-hourly service at fixed schedule in both directions, and that to reach a terminus from any intermediate station it is not necessary to travel in a stopping train for a greater distance than something under 15 miles. The arrangement would, however, be somewhat inconvenient for passengers travelling between intermediate stations passing K or L, and for their convenience it might be desirable to run a few of the stopping trains through. The time taken would be the same, but passengers would not be obliged to change carriages.

The power taken by the expresses depends upon the steepness of the grades to be encountered, since rapid acceleration is not required in this case. We may assume that the steepest grade will not exceed 1 in 100, and in this case the maximum effort will not exceed 600kw. per train of 100 tons, and this will give a mean acceleration on the level of $\frac{3}{4}$ ft. per sec. per second. The power taken at full speed on the level will be about 300kw. The maximum power taken by the 120-ton slow train from A or B to K accelerating at 0·75 mean on the level will be 550kw., and for running on the level 160kw., and that taken by the slow trains weighing 70 tons between K, M and D will be 285kw., the mean acceleration being 0·66, and for running on the level 95kw.

With the proposed arrangement, therefore, two motor equipments will be necessary, one for the express service with four-pole motors, and one for the slow service with six-pole motors. Each motor bogey truck would be fitted with two motors, one primary and one secondary, the primary motors being capable of taking a load of 150kw. for short periods. It would not be desirable to provide different equipments for the varying requirements of the slow trains, since a power represented by 300kw. per motor car will satisfy all requirements. In the case of the 70-ton trains, however, one bogey truck at each end of the train would be fitted with motors.

We can now assess the maximum demand for electrical energy on the various sub-stations as indicated in the diagram. Taking station A, the maximum output occurs when a main line train taking 600kw. synchronises in starting with a local train taking 900kw. At this time the next local train on the down line, starting, say, 7 minutes earlier, should be midway between the second and third station from A, running at full speed, taking, say, 200kw., also a local train on up line leaving for A having just finished accelerating. If at all delayed this train might be taking 900kw. The next local trains will be the other side of G. The incoming main line train should be 6 miles off at this time, or well the other side of G. Since A will not have to provide all the power for the trains intermediate between it and G, an allowance of 2,500kw. in transformers appears sufficient; B, of course, requires the same equipment; G and H may possibly have to accelerate two local trains and a main line train, and provide some power for an express running, so that the same power will be required; I has nothing to do with the main line and 1,500kw. will be quite sufficient; C should have the same power as G or H; K has its maximum load when an up local train starts; two expresses and three other local trains being then partly supplied from this station, 1,500kw. will suffice for this.

The two other intermediate sub-stations divide the starting load of the expresses at L, and at these times the nearest local trains are well away from them; an equipment of 1,000kw. each should be sufficient if there are no severe grades. The sub-station at D must be able to start an express and carry on the local traffic simultaneously, and assist in running another express. Total power, say, 3,000kw.

The next estimate is that of the power required to be delivered by the generating stations at C and D respectively. Station C has to provide for all local service on the two routes between A and B. These services require, as we have seen, 14 trains, and it will be safe to take it that at any one time seven of these may be accelerating, four running, and three stopping or at rest at stations. It also has to provide for the main line requirements as far as sub-station K, and all power supplied from it. The maximum call is when an express is starting from A or B. At this time the station has to provide for, say, 1½ expresses running at full speed, two 120-ton stopping trains accelerating, two 120 ton stopping trains running, and say 300kw. for light stopping trains. The power taken by these trains will be as follows:—

| | |
|---|---|
| 7 local trains accelerating | = 6,300kw. |
| 4 do. running | = 800kw. |
| 1 express accelerating | = 600kw. |
| 1½ do. running | = 450kw. |
| 2 stopping trains accelerating | = 1,100kw. |
| 2 do. running | = 320kw. |
| Add for light trains | = 300kw. |
| Do. grades | = 300kw. |
| | 10,170kw. |

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We have now to allow, say, 15 per cent. for line and transformer losses, making a maximum effort from the station of 11,700kw. With proper allowance for spare, six sets of 3,000kw. each will be a suitable equipment. For station D we require to provide for the local traffic five trains, one express accelerating, 1½ at full speed, and four stopping trains. A total power of 4,000kw. running will be sufficient, or say six sets of 1,000kw. each. It should be noted that it will not be necessary to put down boiler capacity for this power running continuously, since the mean load will be only about one-half of the maximum effort.

The overhead wire equipment would be the largest size of trolley wire in use. No. 0000 S.W. gauge, erected on supports at intervals of about 88ft., and properly guarded so as to prevent any risk from a broken wire remaining charged. The third conductor would be preferably formed by a flat copper strip of twice the sectional area of the trolley wire, supported at the side of the track on fairly insulating supports. The maximum drop on the line will be 130 volts, or 64 volts on the strip. This gives under 8 per cent. loss.

The 12,000 volt mains would be arranged so that a breakdown in any one cable will not stop the supply to any sub-station. This, however, only necessitates one cable between K and D, since the intermediate sub-stations can on emergency be supplied from C, and this will provide for shutting down the station at D and undertaking the whole supply from C during periods of light loads. It would probably be found preferable to keep the two stations quite distinct and not to attempt synchronising. The loss in these mains should not exceed about 3½ per cent. unless the transformers at the sub-stations are specially wound to compensate for the loss, and this limit can be worked to without undue cost.

The exact cost of the equipment I have sketched would, of course, depend upon many conditions which would differ in different cases, but at present prices the amounts would be somewhat as follows:—

| | |
|---|---|
| Generating stations, complete | £400,000 |
| Sub-stations and equipment | 62,000 |
| Mains | 160,000 |
| Line equipment | 228,000 |
| | £850,000 |

The expense of the rolling stock which would be required would naturally depend upon how much of the existing stock it was proposed to retain. The cost of a complete equipment to run the traffic as given above would be probably about £424,000.

## THE WRIGHT ELECTROLYTIC METER.*

BY J. R. DICK.

In all cases of electrolytic decomposition, the amount of electrolyte decomposed per second is directly proportional to the current. Meters constructed on this principle will, therefore, record (in the absence of polarisation or secondary actions) ampere-hours perfectly. Unlike motor meters, they require no compensation for frictional errors, and no special brakes to correspond with the law of the driving torque. In fact, the meter has a natural straight-line law of registration. In spite of these initial advantages, electrolytic meters generally have not obtained, from the station engineer's point of view, a lasting popularity. They have earned a bad reputation for various reasons, chiefly because they are "messy," and require attention for the renewal of electrodes or electrolyte, and because of the great drop of pressure with the unshunted varieties.

In Mr. Gibbings' Paper in 1898, the unshunted types were discussed at considerable length. However useful this type may be for very small currents, it presents serious difficulties when large currents have to be dealt with. In such cases, the drop in pressure must either be increased to an impracticable extent or the meter must be shunted.

In employing a shunt to an electrolytic cell which has a back E.M.F., some compensating E.M.F. has to be inserted in the cell circuit in order to obtain a constant linear ratio between the main and the shunt currents. Several ways of effecting this compensation have been recently proposed by Mr. Arthur Wright. The most practicable appears to be that of placing a shunt across the supply mains (Fig. 1), and interpolating such a fraction of this in the cell circuit as will give a pressure exactly equal to the back E.M.F. A direct proportionality will then exist between the main and shunt currents. For example, in Fig. 1, if the back E.M.F. of the voltameter is 1·5 volts, the ratio of $r$ to R must be the same as 1·5 to V—the supply pressure. The P.D. across $r$ is then equivalent to a cell inserted in the shunt circuit, having a constant E.M.F. in the positive direction of the same amount as the counter E.M.F. of the voltameter. It is obvious that no current will pass through the voltameter when there is no current in the main circuit, as then the two E.M.F.s in the shunt circuit exactly counterbalance each other.

* Abstract of a Paper on "Electricity Supply Meters of the Electrolytic Type," read at the Glasgow International Engineering Congress.

The shunt circuit constantly running with this arrangement detracts from the simplicity of the electrolytic method of registration, and increases the total loss of energy in the meter. To avoid this loss, and the complication of a compensated shunt circuit, it is infinitely preferable to utilise, if possible, an electrolytic cell where no back E.M.F. exists. The necessary characteristic of having a low back E.M.F. is common to all meters in which the amount of mercury liberated from a solution is used to measure the quantity

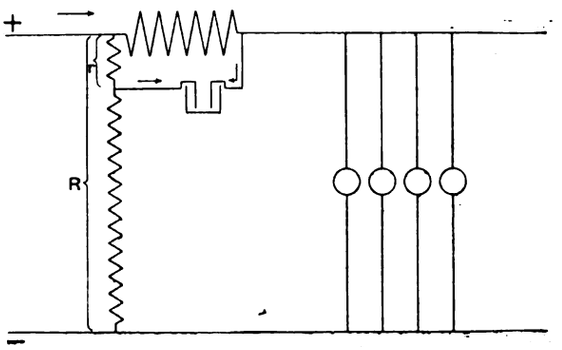
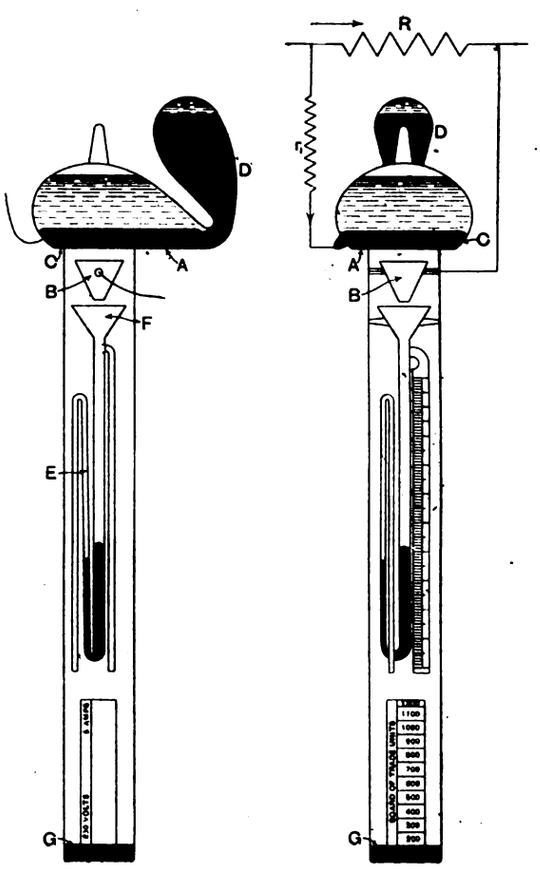



FIG. 1.

of electricity passed through it. The highest accuracy can, therefore, be guaranteed even with very low currents. The meter illustrated in Figs. 2 and 3, which has been devised by Mr. Arthur Wright, is the outcome of much thought and experiment in this province, and after being subjected to exhaustive tests, has given thoroughly satisfactory results. The general principle of the meter is that the amount of mercury deposited from a solution of a mercurous salt is employed to measure the quantity of electricity. The various parts




FIGS. 2 and 3.

of the electrolytic cell are enclosed in a hermetically sealed glass tube, and advantage is, of course, taken of the fluidity of the metal to measure the volume deposited instead of the weight. The method of connecting up the meter is seen in Fig. 3. The total resistance (including the cell) in the shunt circuit is about 40 ohms, and the maximum current in it is about 0·025 ampere for a meter of 5 amperes capacity. The resistance R in the main circuit is of platinoid wire, and has a value of 0·2 ohm. What differentiates it at once from the other types is the



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change in the relative position of the anode A and cathode B. The former is now placed *above* instead of *below* the latter. The mercury of the anode is contained in a circular trough, C, which is filled to such a height that the more concentrated solution formed by the electrolytic action falls off the convex surface of the mercury by gravity, and thus automatically mixes the liquid and tends to keep it of a uniform density. The aid of gravity in thus promoting diffusion would soon be ineffective if the mercury of the anode were to sink below the level of the lip of the trough. This is prevented and constancy of level is obtained by the employment of an anode "feeder," D, after the manner of the well-known "bird-fountain." When any portion of the mercury has been electrolysed from the anode and the level sinks to the smallest extent, it is quickly restored to its former height by a slight flow from the anode "feeder," while a corresponding amount of solution replaces the mercury thus withdrawn from the "feeder." The cathode usually consists of a hollow cone of platinum foil or carbon, arranged concentric with the annular trough forming the anode.

The circulation of the electrolyte above described is reinforced by the cathode, as the lighter liquid produced at its surface tends to rise and replace the dense solution formed at the anode. The stream lines showing the relative circulation of the rich and impoverished solutions are illustrated in Fig. 4. This interchange of solution goes on continuously, and there is no need for agitation or stirring. The formation of crystals on the mercury anode, as explained above, was practically unavoidable in the earlier meters of this class unless extremely small currents were employed in the cell, and a long

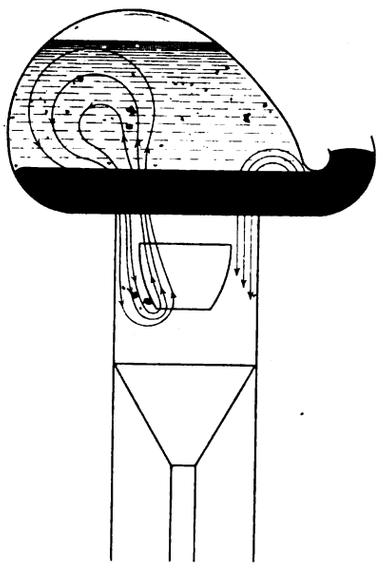

Fig. 4.

period of rest was occasionally given to permit the crystals to dissolve and the saturated solution to diffuse. The large surface of the anode makes the internal resistance of the cell very small, and its symmetrical relation to the cathode makes the current density equal at each point, and therefore minimises any tendency to crystallise. The gravitational effect and the large extent of active anode surface permit of comparatively large currents in the cell before any signs of saturation of the solution become visible. Consequently there is a large factor of safety between the working current density and that causing crystallisation. This factor of safety may be as high as four or five.

To secure accuracy with a shunted meter it is a *sine quâ non* that the resistance of the cell itself should be constant, or nearly so. This is only possible where no change takes place in the areas of the electrode surfaces, or in the distance between the two electrodes, or in the density of the electrolyte. In the present meter these first two essentials are fulfilled completely by the operation of the "anode" feeder in keeping the surface of the mercury in the trough always at the same height and of the same area, and the third is secured by the automatic circulatory process.

As seen in Fig. 3, the meter is provided with two scales. The first of these is equal to 100 units and is fixed alongside one of the limbs of the syphon or U-tube E. The mercury that is deposited on the platinum cone drops in the form of minute globules into this tube, which opens out at its upper end into a glass funnel F, luted on to the main tube, so that none of the mercury can escape falling into it and being measured. When a quantity of mercury calibrated to be equal to 100 units has collected in the right-hand limb, it will stand at a level somewhat higher than the top bend of the syphon tube. This difference of head is sufficient to cause the syphon to come into action, and the whole of the mercury contained in the U-tube to be drawn over and fall into the lower receptacle G. This is graduated in such a manner that one division on its scale is equal to the complete volume of the U-tube. It therefore acts like the "second dial" of a clock-train counting mechanism; in other words, the range of the meter is very much increased, while the sensitiveness of the lower readings is not in the least impaired. A 5 ampere meter furnished with these two "dials" will register conveniently up to 1,200 units. In fact, the range of the meter is only limited by the weight of mercury it is advisable to have in the anode feeder. Of course, a simpler type of meter having a range of about 250 units can be made in which the mercury deposited does not fall into a syphon tube, but into an ordinary tube reading direct in units.

When a full record has been obtained on the meter, it is necessary to reset it. This is done by tilting it up (like a demand indicator) on its hinged terminals, when all the mercury in the lower part of the tube will flow back into the anode chamber. A small hole is left in the glass funnel at the top of the syphon tube for the passage of the mercury. By this simple operation the meter is brought back exactly into its original condition. The cycle of operations can now recommence, and be repeated *ad infinitum*. It is interesting to note that this resetting is required only at long intervals. For a consumer with a 5 ampere demand on 230 volts, 1,200 units would represent at least 1,000 hours all taken at the maximum load. This is equivalent to a year's consumption with 2·75 hours' use per day of the maximum demand. In most cases, therefore, there would be no need to reset the meter oftener than once a year.

As previously mentioned, the glass tube is hermetically sealed. This is possible, as the chemical action does not give rise to the production of gas, and, consequently, there is no internal pressure. As there is no opening to the air there is no evaporation, no efflorescence, and no deterioration in the quality of the materials. The meter is not affected by atmospheric pressure, and only to a very small extent by external temperature. For this a simple means of compensation is available. In very cold weather, there is the possibility of the solution in the meter freezing. This does not take place, however, even at a temperature of $-4°$C., and in the situations where meters are usually fixed, the temperature is not likely to fall below this figure.

The adjustment of the meter to read in Board of Trade units is an easy matter. The first essential is to obtain a clear reading. A quantity of mercury sufficient to occupy about 1mm. length of the U-tube gives a quite sensitive enough indication for one unit. The syphon tube, although of very uniform bore, is always calibrated with a moving column of mercury like a thermometer tube, so that each of the divisions exactly equals one unit. The number of grammes of mercury per millimetre or per unit can then be calculated from the volume of the tube.

The consideration that determines the amount of the resistance in the main circuit is the all-important one of the permissible drop in pressure. It ought to be as low as possible to prevent undue loss of energy, yet high enough to give a good reading for one unit. A limit of 1 volt drop at full load has been chosen on 200 to 250 volt supply, this being a convenient figure and one that allows of a fairly large resistance being inserted in the shunt circuit. The current in the main which will convey a unit per hour is $1{,}000/V$, where V is the declared pressure. The approximate value of the resistance in the shunt circuit is then found from the following formula, derived from the equation $W = CTz$ grammes per millimetre on scale $= 1{,}000\ Rz/Vr$, where R is the main and $r$ the shunt resistance, and $z$ is the electrochemical equivalent in grammes of mercury in the mercurous state. The resistance of the cell is measured by a potentiometer method; knowing this, we can at once find the additional resistance $r_1$ to be placed in the shunt circuit to equal $r$.

A final correction in the relative values of the main and shunt resistances is provided for after they have been checked by a "time" test of the meter by the following arrangement:—The platinoid spiral of the former has two straight pieces near its ends which can be slid up or down in two terminals, and thus vary its amount. When exact adjustment has been made the terminal screws can be sealed, and there is no further possibility of altering the resistance or tampering with the meter's registration.

Various measurements have been made with a view to checking the theoretical deductions described above, and also to ascertain the lowest current it is possible to register accurately. The counter E.M.F. was determined very carefully at full load by direct reading, and the mean result of numerous tests on different meters gave a value of 0·0001 volt.

The equation for E, the total E.M.F. between the electrodes of an electrolytic cell, has been shown to be

$$E = Ri + \frac{\phi(i)}{i} + e,$$

where $e$ is the counter E.M.F., $i$ the current, R the resistance, and $\phi(i)$ is some function of the current. Tests were taken to ascertain the importance of the last two factors on three meters, of which the

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first was freshly made up, the second had its cathode very thiny coated with mercury, and the third had the usual amount of mercury adhering after a long period of working. The curves in Fig. 5 are plotted to show the relation between E, the applied E.M.F., and $E/i$, the apparent resistance of the cell. If the function $\frac{\phi(i)}{i} + e$ were equal to zero and R were constant, the curves would be straight lines parallel to the horizontal axis. The first diverges very little from parallelism, the second less, and the third (or working condition) is, within the limits of experimental error, almost parallel. The small counter E.M.F. in the first two instances may be accounted for by the fact that (according to Oberbeck) when a platinum plate is coated electrolytically with a metal, the E.M.F. between it and a solution of that metal only gradually assumes the value observed for the massive metal as the thickness of the deposit grows.

It is extremely satisfactory to note from these tests that there is no counter E.M.F. due to the different degrees of concentration of the solution at the anode and cathode. In other words, the precautions taken to secure good diffusion have fulfilled their purpose.

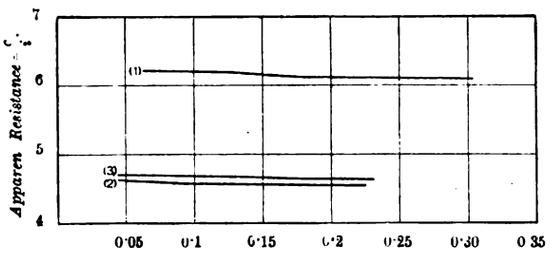


FIG. 5.

How great a value this counter E.M.F. of concentration may reach can readily be tested with a cell made up of half-normal and twentieth-normal solutions of mercurous nitrate and two mercury electrodes. A rough experiment gave an E.M.F. of 0 016 volt, which would be sufficient to cause very serious errors with small currents.

*(To be concluded.)*

## DAMAGE TO GAS AND WATER PIPES BY LIGHT RAILWAYS.

### APPEAL TO THE BOARD OF TRADE.

On Friday last an appeal on the Mitcham light railways order was heard involving the whole question of damage through fusion or electrolytic action of light railways.

Mr. Hopwood, C.B., C.M.G., secretary of the Board of Trade, who was accompanied by Sir Herbert Jekyll and Mr. A. D. Erskine, assistant secretary of the Railway Commission, presided. The question arose on objections to the confirmation of an order granted by the Light Railway Commissioners for the Mitcham light railways.

Mr. Vesey Knox appeared for the Croydon Rural District Council, who are the promoters, and there were also present Mr. James Wilson (town clerk of the Council), and Mr. R. M. Chart (surveyor).

Mr. May, appeared for the Lambeth Waterworks Company, with Mr. H. Wilkins, secretary to the company.

Mr. MAY, on behalf of the Lambeth Waterworks Company, asked for two new clauses for the protection of the mains and pipes of the company from electrolytic action of the light railway. He said the special provisions as to the use of electricity as motive power were not sufficient. The model clause was the outcome of the Joint Committee of 1893, but they had learnt a great deal since then, and opinion was pretty well divided amongst the experts as to what effect the escape of electricity had upon the pipes and mains of gas and water companies. The proposed light railways at Mitcham might hereafter be worked as an extension of the system of tramways which the London County Council proposed to work by means of the conduit system; in other words, with an insulated return current. It was doubtful whether accidents and damages resulting through this electric railway would cover damages to mains by fusion or electrolysis. What the water company wanted was to have it made clear that the damages, &c., included damages arising from the exercise of their statutory powers, and to make good damages to mains by electrolysis under all circumstances. Further, the Board of Trade should be empowered to amend their regulations from time to time, and make them retrospective in the sense that they should be made to apply to all future damage arising from schemes previously sanctioned; and that the Board should also be empowered at any time to require insulation of return currents if they deemed such desirable, notwithstanding that another system of traction might have been introduced and working at the time. He submitted that the Board could not object to have fuller powers of control. If the powers were not needed they would not be exercised, but it was necessary to have those powers to give compensation for future damage to gas and water companies. The new clauses he proposed were as follows:—

"As to powers of Board of Trade in respect of use of mechanical power. The powers of the Board of Trade under sections 50, 51, and 52 of this order shall be deemed to include power, subject to the provisions of those sections, to make regulations requiring the Council to use such reasonable precautions, including insulated returns, as the Board of Trade might think necessary for the purposes of the said section 32, and the Board of Trade may in like manner from time to time alter any such regulations."

The second clause was as follows:—

"For the protection of the company of proprietors of Lambeth Waterworks the following provisions shall, unless otherwise agreed between the Council and the protected company, have effect with respect to the use of electricity as a motive power on the light railway. The Council shall make full compensation to the protected company for any loss or damage which they may sustain by reason of any fusion of or electrolytic action on their mains, pipes, or apparatus which may in any way be caused by the exercise of any of the powers by this act conferred upon the Council."

The real protection against electrolysis was by providing insulated returns

Mr. HOPWOOD: The promoters have a right to elect whether they shall use insulated returns or uninsulated metallic returns of low resistance, you say?

Mr. MAY: Yes. We ask that the Board of Trade shall have a right to prescribe one or the other at their option; and if, in time to come, the system they have prescribed is found to be a wrong system, they may then revert to the other system. At present the Board has no such power. In the London United Tramways case this question was discussed at great length, and after expert evidence on both sides the Committee refused to give what the gas and water companies asked for—viz., insulated returns. Mr. Balfour Browne persuaded the Committee that the Board of Trade had full power at any time to alter the system originally authorised. He said the Board could alter their regulations, and if they were satisfied that uninsulated returns were unsatisfactory, they could order the system to be converted to insulated returns.

Mr. HOPWOOD: Your view is that the Board cannot call upon the company to alter the system, and, further, that the Board may or may not alter the regulations.

Mr. MAY: They may alter the regulations but they cannot alter them in such a fundamental point that they could alter the system. The statute gives the option to the promoters of the undertaking to adopt a system of insulated or uninsulated returns. On that material factor the Board have no power to make any regulations. We agree they may make and alter regulations as to the method in which insulated and uninsulated returns are to be used, and prescribing safeguards with regard to them; but they cannot say absolutely that you shall not use uninsulated returns.

Mr. HOPWOOD: How are you damnified if the regulation of the Board is effective whichever system is used?

Mr. MAY: Our view is that it will be ultimately proved that uninsulated returns, if used with any sort of protective clause, will be inoperative.

Mr. HOPWOOD: That is, that no regulations made by the Board of Trade would be effective to prevent damage in the case of uninsulated returns?

Mr. MAY: That is it. Our scientific advisers tell us that sooner or later that state of affairs will arise, and this company could go on doing damage *ad infinitum*. We say the Board should have power, if that state of things should arise, to prescribe insulated returns to the exclusion of uninsulated returns. If we should turn out to be wrong by all means let the Board of Trade prescribe uninsulated returns.

Mr. VESEY KNOX, for the promoters, said that if insulated returns were put upon them they would drop the order, as they could not stand the cost.

Mr. MAY said it had been agreed between them that as this order only referred to 3 miles of railway neither side should be put to the expense of bringing expert witnesses, though recent experiments had proved that insulated returns must cause a great deal of damage.

Mr. VESEY KNOX said he agreed that the Board of Trade had no power, under the model clause inserted in the order, either to require insulated returns in the first instance if the promoters objected, or afterwards to make such an alteration in their rates as would require the promoters to employ insulated returns where they had employed uninsulated returns of low resistance in the first instance. At the same time, subject to that restriction, he could not agree with Mr. May that there was no power to alter the regulations.

Mr. MAY: The regulations may be altered, but the system cannot be altered.

Mr. HOPWOOD: What do you say as to the prospective damage if the power is not given?

Mr. MAY: It is perfectly fair to say that there are conflicting views between the leading electrical experts of the country on the subject. In the London United Tramways Bill last session Profs. Ayrton, Dewar and Perry expressed strongly the opinion that with the present Board of Trade regulation there was not only substantial risk, but that damage would certainly be done sooner or later.

Mr. HOPWOOD: Yes; but did they go so far as to suggest to the Committee that the Joint Committee clause itself was ineffective?

Mr. MAY: Yes.

Mr. HOPWOOD: Did not their evidence go to this, that it might be necessary in the interests of the gas and water companies to strengthen the Board of Trade regulations?

Mr. MAY: I think not. Their view was that the Board of Trade regulations were insufficient, and, further, that as far as they knew at present there was no protection except by insulated returns.

Mr. HOPWOOD: Then they were in direct conflict with the report of the Joint Committee?

Mr. MAY: Exactly. I do not think that the Joint Committee went to that length. The position is this: There has been a very small experience, comparatively speaking, of these undertakings in this country working under the Board of Trade regulations. This is a new light since the Board



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of Trade held their inquiry which has grown up with the development of the industry. We are gradually ascertaining facts which seven or eight years ago were absolutely unknown.

Mr. HOPWOOD: For the purposes of this discussion I do not dissent at all from that position. It is quite possible in the march of events we may find it necessary to alter the Board of Trade regulations; but at the present moment you are inviting me to alter the law as laid down in the Joint Committee clause.

Mr. MAY: Yes; we are not asking you to put upon this company insulated returns now, but sooner or later we shall ask you to do that. The Board should keep it in their power to say that if damage is done by these regulations then they should reserve to themselves full power to make fresh regulations, even though it went to the length of substituting insulated returns for uninsulated returns. I, therefore, ask you to insert the two clauses which I have read.

Mr. VESEY KNOX said there could be no doubt as to the power of the Board of Trade to alter any regulation which they made. There was no doubt that Mr. Balfour Browne, in the London United Tramways case, had incautiously overstated the law of the case when he said that the Board could order insulated wires under their regulations. The Joint Committee clause did not give the Board power to require in any case insulated returns if the promoters used uninsulated returns of low resistance. In this particular case they could not make the line with insulated returns. The line was a single line, and though it joined the London County Council with its conduit system, the promoters could not afford to go to that expense.

Mr. HOPWOOD: Do you contemplate a physical junction?

Mr. VESEY KNOX: Yes, with Croydon on one side and the London County Council on the other. There is nothing to require the promoters to use insulated returns. It is a novel proposal, and I hope the Board of Trade will not assent to it.

Mr. HOPWOOD said the discussion had been useful, but no new matter had been advanced. Whatever lack of uniformity there might have been in Parliamentary procedure as regarded opposed bills, the authorities of the House who dealt with unopposed bills had uniformly adhered to the Joint Committee clause. The Board of Trade had taken the same line. Mr. May had traversed the decisions of the Joint Committee and the opposed committee's on the one hand, and Mr. Vesey Knox, on the other hand, but neither had referred to the decisions which had been given on this question by the Board of Trade. There had been absolute uniformity of practice by the department. They had rejected amendments in substance of this description in the Wakefield case lately, and also in the cases of the Llanelly and the Middlesex County Council; and he felt that it would be impossible for him to advise the Board of Trade to accept either of the amendments. On the other hand, he desired to make it perfectly clear that he should give his adhesion to an alteration of the regulations if and when it could be shown that they were ineffective for the purpose for which they had been framed.

# CORRESPONDENCE.

## THE DISRUPTIVE STRENGTH OF INSULATING MATERIALS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Permit me to make a few remarks with regard to Mr. O'Gorman's criticisms on my article on the above subject. First, Mr. O'Gorman says I have hardly given enough evidence that my formula is generally true. This was hardly necessary to say, as I expressed the same doubts at the end of my article. Other evidence must come forward, and I hope somebody has some tests ready for paper insulated cable. As, however, my law seems to be true for all the substances of which tests were at my disposal, and especially of substances of such different constitution as air, mica and fibre, I have great hope it will prove generally true.

Secondly, Mr. O'Gorman brings forward many arguments that for thicknesses of the dielectric above 1cm. the curve must become an approximate straight line. In reply I wish to say he was able to support this view with experimental facts obtained with substances of different nature; that my curve, beyond 1cm., is approximately a straight line; and, finally, that if my formula is true for thicknesses from 0·01cm. up to 1cm., or even 2½cm., as in the case of impregnated jute, I do not think another law will step in from 1cm. to 5cm. or even 10cm. thickness.

Thirdly, Mr. O'Gorman thinks I have not considered the great importance of the shape of electrodes. There is no doubt his Paper on this subject was something new to many of us, but it is my belief that he has not gone to the end of the question. A cable is not a perfect cylinder, as assumed by Mr. O'Gorman, but composed of wires of small curvature, and, we were taught, the sparking distance was very different with straight electrodes and such of small radius. When I established the breakdown curve for impregnated jute, 10 years ago, I tried to get some evidence as to this point. A great many tests were made with cylindrical brass rods, hand-covered with jute. The diameter of the rods was about 20mm. Then another series of tests was made with a similar rod, but with a screw thread of usual pitch cut into it. The breakdown tests, however, were of the same character as those with the smooth rods. If my memory does not deceive me, other tricks were resorted to to provoke the action of points. The tests again showed no evidence of increased sparking distance. These experiments make me believe that Mr. O'Gorman's theory, even if it were possible to construct a cable on its lines, would not materially improve a cable.

As regards Mr. O'Gorman's remarks as to the erratic nature of breakdowns of cables, he is quite right, especially when short lengths only are tested. But if a number of cables of different thicknesses of insulation, each 200 metres long or still longer, are at one's disposal, the breakdowns become more regular. The results, when plotted, do not always lie on a line, but one can always draw a curve which represents the mean of the observations.

The curve $V = 2{,}200\sqrt[3]{d^2}$, representing the breakdown curve for jute impregnated cable, consists of three parts: (1) Up to 3,000 volts, tests from impregnated calico between flat dies. All the observations coincide with the curve. (2) From about 2,000 to 5,000 volts, 35 tests with brass rods covered with jute. The observations are scattered round the mean curve. (3) From 7,000 to 18,000 volts. Obtained from tests of long cable. Only three tests with 8,000, 12,000 and 18,000 volts, and these lie on the curve or very near it.

In conclusion, I wish to point out that my article was written for the benefit of cable engineers, who, I am quite sure, will be satisfied with a law that is true up to thicknesses of about 1cm.

C. BAUR.

Zürich, Oct. 8.

## WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: According to the reports of the naval manœuvres, the one squadron was easily able to read the messages transmitted by the vessels belonging to the enemy. Can you or any of your readers inform me what system was in use, as I have seen in some technical papers that this is now no longer possible with the more modern form of apparatus, in fact, that the messages can only be read by the ship for which they are intended.

If this is not so, would it not be possible for a ship, with a simple apparatus on board, to break up the signals so as to make them quite unintelligible. This, it seems to me, would be of much more use, for, even if you intercept the messages, you will not know what they mean if, as probable, they are sent in a special code. This breaking up could presumably be done by means of the ordinary transmitting apparatus, with an automatic adjustable spark-gap capable of varying the wave length two or three times a second, and an automatic key sending along, say, 150 signals per minute. The transmitting coil's contact maker could also be made to vary, and in this manner it should be possible to upset any receiver going. It is, of course, obvious that, were the flagship supplied with a differently tuned apparatus for communicating with each ship under her command, she would require to carry a large number of transmitters, so that it is probable all the ships on this occasion were regulated to the same wave-length. If this is so, it should not be very difficult to break these signals in the manner described so as to make them quite illegible. A variation in wave-length is easily obtained, so that this should not be a difficult matter to carry out, and the experiments might be well worth trying, especially as I believe the signalling of important messages is performed slowly and deliberately, say at about 10 words a minute, and this would give the disturber working at a rapid rate up and down a fairly wide scale plenty of chances to hit the signals from the same range as at present they can be picked up.—Yours, &c.,

Q.

Cape Town, Sept. 21.

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# LEGAL INTELLIGENCE.

## Finchley Electric Light Co. (Ltd.) v. Finchley Urban District Council.

This case came before the Lord Chief Justi e on Wednesday, on a motion by plaintiffs for an interim injunction to restrain defendants from taking down or otherwise interfering with overhead electric wires.

Mr. BUCKMASTER said the plaintiff company was not incorporated by Act of Parliament except by that of the Act of 1862, and consequently they possessed no powers and derived no protection from any of the electric lighting acts, and consequently they had none of the privileges conferred by the acts. They were not in a position to break up the roads without the consent of the local authority, and being prevented from laying their cables underneath the roadway, they proceeded to carry the wires overhead to the height of 34ft. They had been served with a notice of regulations of the Board of Trade, and it was their case that those regulations had been complied with. The defendant Council had cut one of their wires, and this prevented the plaintiffs from carrying out the contracts they had made to supply electricity to customers in the district. It was a matter of the greatest possible importance that those contracts should not be interfered with, but one wire had been cut on Oct. 1, and had now been down 14 days. Unless the defendants could satisfy his lordship that they had some right to cut the wire, he submitted that the plaintiffs were entitled to an injunction. According to the Wandsworth case the local authority had no power to interfere with wires when they were carried overhead at a height of 34ft. above the roadway. The defendants had attempted by all means in their power, legitimate or illegitimate, to interfere with the plaintiffs' enterprise. They had refused to grant the plaintiffs permission to go under the roadway, and now they were trying by means which were not legal to interfere with the plaintiffs carrying the wires across the road.

Mr. CHUBB, for defendants, submitted that it was an improper motion to bring on in the vacation.

His LORDSHIP: Are you willing to file an undertaking?

Mr. CHUBB: I am willing to undertake not to interfere with any wires now standing until such day as your lordship thinks proper.

His LORDSHIP: Are you willing that they should put up the wire you have cut?

Mr. CHUBB said he could not agree to that, as it would put the plaintiffs in a very different position from that which they now occupied.

His LORDSHIP: I did not ask you anything about position. Why should you cut down any new wire they may put up? Suppose they obtained the consent of householders on each side of the road, what power have you to prevent them putting up a wire?

Mr. CHUBB: I do not suggest that they have that consent.

His LORDSHIP: Suppose between now and the hearing of the motion they put up a new wire and then proceed to supply electricity through it, how are you to prevent it?

Mr. CHUBB: I ask your lordship to maintain the *status quo* until the hearing of the motion.

His LORDSHIP: But you are not maintaining the *status quo*. You have cut down one of their wires, and ask that they shall be prevented from restoring it. Why should you not be restrained from cutting it again?

Mr CHUBB said if they were allowed to put up the wire it would be the commencement of a new business. The defendants had the right to prevent them erecting their wires as the protectors of the rights of the public over the streets.

His LORDSHIP: Will you show me any authority, statutory or otherwise, giving you the right to cut down the wire?

Mr. CHUBB: By sec. 14 of the Electric Lighting Act, 1882, no wires could be carried under or over a street without the express consent of the local authority. My case is that the plaintiffs have not got the consent of the authority, consequently we have the right to remove the wires.

His LORDSHIP: Supposing that a man having a factory on either side of a road and having an electric lighting apparatus on the north side should desire to carry a wire across to the south side for the purpose of lighting the premises there, could you cut it down?

Mr. CHUBB: I submit so, unless he had obtained our consent.

His LORDSHIP asked Mr. Buckmaster if he would be willing to give an undertaking in damages in the event of his granting an injunction?

Mr. BUCKMASTER said the managing director of the plaintiff company would give his personal undertaking.

His LORDSHIP, without calling upon Mr. Buckmaster to reply, said that on the facts before him he must assume that somehow or other the plaintiffs had obtained the consent of the property owners to have their wires fixed to opposite premises. They had put up their wires at a height of 34ft., and the defendants had cut one of them down. They stated their willingness not to cut any more down, but they sought not to maintain the *status quo* but to maintain the result of their own act, which might be a wrongful act. He thought the plaintiffs were entitled to an injunction in the terms of the notice of motion until the trial, the costs to be costs in the action. He also gave liberty to apply, if there was any ground, for the Court relaxing the injunction.

## Fletcher v. London United Electric Tramways (Ltd.).

This was an arbitration before Judge Bagshawe, K.C., at Brentford (Middlesex) County Court. Fletcher, a labourer, claimed on account of injuries sustained while working for the tramway company in laying their lines at Southall, in April, by a flying steel splinter. Counsel for the company urged that such a claim could not succeed under the Railways Act or the Workmen's Compensation Act, because the construction of a tramway was outside the scope of both measures. Counsel for applicant, however, contended that to all intents and purposes a tramway was a railway, and instanced the Central London Railway as a line which, although not what was usually understood by the term "railway," had that actual word in its title. The judge thought the difference lay in the rail*road* or the permanent way on which the metals were laid. In the case of the "Tube" the rails were used solely for the traffic of the railway, but in the case of a tramway all kinds of vehicles made use of the permanent way. Judgment, which was reserved, was delivered on Friday last.

The judgment of Mr. Bagshawe, K.C., set out that the respondent company had applied to the Light Railway Commissioners for an order under the Light Railways Act of 1896, authorising them to construct certain light railways along the road where the injury to applicant occurred and other roads. The Commissioners had submitted these proposals to Parliament, and the result was that an act was passed entitled the London United Tramways Company Act, 1900 (63 and 64 Vic., cclxxi.), resisting the application for leave to make the light railways, and reciting that it was expedient for the company to be empowered to construct the tramways in the act described and authorising the construction of tramways, thus (as it appears to the arbitrator) drawing a marked distinction between light railways and tramways, admitting the latter and rejecting the application for the former, and this had an important bearing on the question at issue. Then the Workmen's Compensation Act of 1897 lets in the applicant by the use of the word "railroad." That act, in sec. 7, sub-sec. 1, enacts that it shall apply to an undertaking on or about a railway, and sec. 7, sub-sec. 2, enacts that "railway" means the "railway of any railway company to which the regulations of the Railway Act of 1873 applies," and includes a light railway under the Light Railways Act of 1896, and says that "railway" and "railway company" has the same meaning in both these acts. It was contended, on behalf of the applicant, that the substitution, in clause 7, of "railroad" for "railway" indicates an intention to include a tramway as being a road on which rails are laid. I cannot accept this interpretation. I cannot think that according to the ordinary usage of the English language, "railroad" includes "tramway," or materially, if at all, differs from "railway;" and I cannot think that the work of laying down rails on which applicant was engaged at the time of the injury was "engineering work" within the meaning of the statute, especially as it was not work for which "machinery driven by steam, water, or other mechanical power" was used. I, therefore, dismiss the application.

There was no order as to costs.

## Speed on Tramways.

At Glasgow, before Sheriff Fyfe, the Glasgow Corporation was summoned by Mr. Thomas Simpson, coal master, of Pollokshields, "in the public interest" for contravening the Board of Trade regulations regarding the speed of their electric tramcars. Mr. Simpson stated that between Shields-road and St. John's-road on Sept. 6 and 9, between 6 and 8 p.m., six cars were driving eastward and six westward at speeds varying from 8 to 22 miles an hour. He claimed £10 penalty for each offence.

Mr. John Young, as representing the Corporation, was present before the Sheriff, who, explaining that this was a quasi-criminal prosecution, read the complaint to Mr. Young.

Mr. W. BORLAND, on behalf of the Corporation, took exception to the relevancy of the action, and maintained that Mr. Simpson had no title to sue, and that the proceedings were incompetent under the Small Procedure Acts. It might be a contravention of a statute, but it was not a criminal offence at all; it was punishable, if at all, by penalty, and he submitted that the Procurator Fiscal was alone entitled to sue. Mr. Borland further urged that the bye-laws of the Board of Trade were *ultra vires*.

Mr. LAMONT, who represented Mr. Simpson, said the bye-laws of the Board of Trade were the basis of the whole matter. The Corporation were seeking to be a law unto themselves, to be above all law, all statutes and all regulations, but if the Board of Trade regulations were *ultra vires*, they were published in all the Corporation's cars, which, if the Corporation's contention was right, seemed a waste of public money.

After the case had proceeded a little farther the plaint was amended, and all question of claim for loss and damage was struck out, only the element of danger to complainer and his family being dealt with.

On the request of Mr. Borland (opposed by Mr. Lamont) an adjournment was allowed till Monday, 21st inst., when evidence will be taken.

## General Electric Co. of Ireland v. Pembroke District Council.

In the High Court of Justice, Dublin, on Wednesday, Mr. Justice Barton heard an application by Mr. Albert Joynt (on behalf on plaintiffs) for a mandamus directing Mr. J. C. Manly, clerk to the Pembroke District Council, to furnish copies of certain documents which must be lodged to enable plaintiffs to apply for the Dublin, Scalp and Enniskerry Tramways provisional order. A conditional order was granted.

## Employés of The B.I.W. Co. v. Glasgow Fire Department.

The workmen of the British Insulated Wire Co., who were so unceremoniously "illegally and unwarrantably drenched with water" by the hose of the Glasgow fire department, as recently reported in these columns, summoned the municipal fire master for £12 damages for each of the five employés in the Sheriff Small Debt Court, Glasgow, on Tuesday, and as there was no appearance put in for the defence, obtained a verdict for the amount claimed.

**A Floating Factory.**—Messrs. Raylton, Dixon & Co. have built a vessel for the Admiralty (called the "Assistance") which is practically an ocean workshop. The vessel is fitted with powerful machinery for carrying out repairs while afloat. All her tools are to be electrically driven, and she is to be fitted throughout with wireless telegraphy equipment. The vessel is, of course, to be electrically lighted.

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# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

A superintending engineer is required by the Borough of Hammersmith (London) electricity department to take charge of the generating station under the supervision of the borough electrical engineer. Commencing salary £175 per annum. Application forms, &c., from Mr. G. Gilbert Bell, borough electrical engineer, 57, Fulham Palace-road, London, S.W., to be returned by 25th inst. See advertisement.

Bradford Corporation invite applications for the position of shift engineer at their Valley-road generating station. Applications to city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford, by Oct. 28. See advertisement.

London County Council Asylums committee require a working engineer to act as clerk of works, under the engineer, at Horton, Epsom. An advertisement contains further particulars. Applications to the clerk of the committee (Mr. S. W. Partridge), 6, Waterloo-place, London, S.W., by Oct. 29.

A leading firm of manufacturing engineers require a capable designer for alternators and direct-current machines. Salary not less than £500 per annum. An advertisement gives some further particulars.

There is required at once by a large firm of electrical engineers and contractors in London a man capable of taking charge of an electrical fittings department to be added to the business. An advertisement gives further particulars.

A thoroughly practical man is required by Messrs Evered & Co. to take over the management of electric fittings and accessories department. See advertisement.

An assistant electrical engineer is wanted at the County Asylum, Whittingham, Lancs. See advertisement.

Newcastle-upon-Tyne Electric Supply Co. intend to appoint several junior assistants, and will receive applications from apprentices out of their time or young men who have been through a college course in electricity. An advertisement contains further particulars. Applications to the general manager (Mr. J. S. Watson), 50, New Bridge-street, Newcastle-upon-Tyne.

Cork Electric Lighting and Tramways Co. (Ltd.) require a shift engineer. See advertisement.

A switchboard attendant is required at Bradford electricity works. Applications to the city electrical engineer (Mr. R. A. Chattock). See advertisement.

Manchester Tramways committee require a number of trolley linesmen. Applications to the general manager (Mr. J. McElroy), 55, Piccadilly, Manchester. See advertisement.

At Sunderland Technical College there are vacancies for an assistant lecturer in mathematics (salary £150), a demonstrator in physics and electrical engineering (salary £120) and a demonstrator in engineering (salary £120). Applications to secretary by Nov. 4.

Bradford Corporation require a traffic superintendent for their electric tramways. Salary £200. Particulars from Mr. C. J. Spencer, 5, Forster-square. Applications to the town clerk by Nov. 9.

An assistant lecturer in engineering, with special reference to electrical engineering, is required at the Brighton Municipal School of Science and Technology. Applications by Nov. 11.

Bristol electricity department have a vacancy for an assistant. Applications to Mr. H. Faraday Proctor by noon 23rd inst.

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There were 85 applications for the position of manager of the Newcastle-on-Tyne electric tramways, at £750 per annum. The number was, reduced to seven—viz, Messrs. J. B. Hamilton (Glasgow), H. England (Bolton), A. K. Fearnley (Birkenhead), T. B. Goodyear (London), E. Hatton (Salford), A. E. Le Rossignol (Newcastle), and T. R. Whitehead (Coventry). Before the Tramways committee made a final selection Mr. Hamilton withdrew and Mr. England received a similar appointment at Sunderland. Ultimately it was decided to recommend the Council to appoint Mr. Le Rossignol, who has been resident electrical engineer at Newcastle under the consulting engineer (Mr. Charles Hopkinson) during the construction of the tramways.

Mr. H. Tomlinson Lee, A.M.I.E.E, has been selected by the Electric Lighting committee of the Wimbledon Council to fill the post of assistant chief engineer, vacated by the resignation of Mr. S. C. Gibson, who has gone to Nuneaton. Mr. Lee is at present chief assistant engineer at Wakefield. There were over 100 applicants for the post at Wimbledon.

Fifty applications were received for the position of borough electrical engineer at Bootle, Lancs., at a commencing salary of £350. The list has been reduced to the following :—T. D. Clothier (Hull), H. Drewett (borough electrical engineer, Morley), J. Lambert (borough electrical engineer, Perth), W. F. Long (Chorlton-cum-Hardy), W. M. Rogerson (Nottingham) and J. M. Smith (borough electrical engineer, Keighley).

Mr. Crawford, of Dundee, has been appointed shift engineer at Blackburn, and Mr. Watkins, of Newport, has been appointed switchboard attendant at the same station.

Bristol Electrical committee recommend the appointment of Mr. H. H. Couzens (mains engineer) to be chief assistant engineer in succession to Mr. R W. L. Phillips, who has been appointed to Bedford as borough electrical engineer.

Mr. R. G. Allen, A.R.C.S I., Wh.Ex., A.I.E.E., has been appointed lecturer and demonstrator in electrical engineering at the City of Norwich Technical Institute.

Mr. H. J. Tomlinson has been appointed demonstrator in electrical engineering at Heriot-Watt College, Edinburgh.

Mr. A. E. McKenzie, of Southampton, has been appointed an assistant engineer with the Brush Company. Mr. McKenzie was a pupil at the Southampton Corporation works.

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**Aberdare.**—The Council on Friday last resolved to apply for an electric lighting provisional order and also an order authorising the construction of an electric tramway from the cemetery to Cap Coch. Committees were appointed to formulate the schemes, and were empowered to engage an electrical engineer to prepare plans, &c.

**Ayr.**—Some heart burnings have been caused by the Sunday service of the Corporation electric tramways, but this, notwithstanding, the running of these lines on Sundays has been very popular, and receipts have been increased largely in consequence. It has been decided to at once extend the tramways from St. Leonard's to Burn's cottage, a distance of 2 miles.

**Bangor.**—The total capital expenditure on the electricity works has been £22,432, for which powers have been obtained for £15,878. Application is being made for a loan for the balance. Originally the station was to have been equal to an output of 4,000 8 c.p. lamps (costing £15,878), but plant for an output of 12,000 8 c.p. lamps has been provided, at an additional cost of £6,584. The recommendations of the Lighting committee to provide a new feeder main at a cost of £369, additional steam pipes by Messrs. Babcock and Wilcox for £82. 13s. 8d., two measuring instruments at £15 each, materials for induced draught apparatus from Messrs. Meldrum Bros. at £34, and for extensions to the switchboard by Messrs. Dorman and Smith for £98. 10s. were carried. Several of the contractors in connection with the electric lighting undertaking are threatened with proceedings under the time clauses. There are 100 consumers connected to the mains, current being supplied to 6,280 8 c.p. lamps.

**Barrow-in-Furness.**—The Corporation have received consent to a loan of £12,334 for electric lighting.

**Bath.**—The Corporation have obtained a tramway provisional order for a system of electric tramways for the city and suburbs, and will transfer their powers to Sir James Sivewright, Mr. Leopold Hirsch and others, the Corporation receiving £11,400, the amount awarded by an actuary whose intervention was insisted upon by the Light Railway Commissioners. This sum is to be expended upon street widening on the tramway routes. With regard to terms for the subsequent purchase of the lines by the Corporation, some difficulty arose owing to a portion of the proposed tramways being outside the borough boundaries, but it appears that the Corporation has succeeded in obtaining powers to acquire those portions in the event of the other local authorities concerned not exercising their option. Bath Corporation have already given notice to compulsorily acquire the existing horse tramways, which are to be handed over to the promoters above mentioned for conversion to electric traction.

**Beverley.**—A report from Messrs. Gibbings and Baker on municipal electricity supply has been adopted by the Electric Lighting committee, who recommend the Corporation to apply for power to borrow £15,000 for the purpose.

**Boston (Lincs.).**—This town is up in arms, and demands that electricity supply shall be established. At a boisterous and well-attended tradesmen's meeting a resolution was passed unanimously that the Town Council (which owns a provisional order dated 1900) be urged to take immediate steps to introduce electric lighting. The inefficient and expensive gas supply seems to be at the bottom of the agitation. A statement by the chairman that he had used the electric light for eight months without its giving him a moment's trouble, and that he had 17 lamps which cost him very little more than gas, with four times the light, had a considerable effect upon the meeting.

**Cardiff.**—The income for the half-year to Sept. 30 on the electricity undertaking was £4,787. 3s. 4d., an increase of £1,204. 1s. 4d. over the corresponding period of 1900.

**Carnoustie.**—The Council have approved the application of Messrs. Crompton & Co. for a provisional order to establish electricity supply in the borough. Supply is to be ready within 18 months of the commencement of the works.

**Chesterfield.**—The Council have made a favourable start with their electricity undertaking. There are 37 consumers connected, and the total number of applications is 77, with a total of 7,159

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lamps. Assuming that all these consumers take current in the same quantities as the 37 already connected, the load will nearly exhaust the capacity of the present plant at the station.

**City of London Common Council.**—At yesterday's meeting a discussion arose round a resolution instructing the Streets committee to consider the advisability of seeking Parliamentary powers to enable the Corporation to make further regulations in regard to the opening of the public streets. In the course of the discussion Mr. Painter, chairman of the committee, said at present six companies or departments had power to open the streets—the Post Office, City of London Electric Lighting Co., Charing Cross Electric Supply Corporation, Hydraulic Power Co., Gas Light and Coke Co., and the New River Co. The Post Office and the electric lighting companies had all been at work lately and it was urged, in each case, that the nature of the work precluded its being proceeded with at night. Mr. Painter pointed out that the public works now being proceeded with had all been clamoured for by the public, and consequently the public must be reasonable in their complaints as to the interference with traffic. The laying of telephone cables and the operations of the electric lighting companies were gradually concluding. The proposal to apply for Parliamentary powers was approved.

**Colwyn Bay.**—The Local Government Board have notified the Council that the proposed loan of £8,450 for electric lighting cannot be sanctioned, having regard to the Council's small margin of borrowing powers. A deputation is to wait on the Board.

**Dewsbury.**—It is proposed to substitute electric for gas lighting at the Dewsbury infirmary. The wiring and fittings are estimated to cost £200 for 200 lamps.

**East Barnet.**—The Electric Lighting committee are to consider and report to the District Council as to engaging an engineer to advise the Council on the subject of their shortly-expiring provisional electric lighting order.

**Electric Driving in Railway Works.**—The large new engine erecting shop (600ft. by 300ft.) of the North Eastern Railway Co. at Darlington is to be equipped with powerful electric cranes, and electricity will be extensively used for driving and lighting.

**Exeter.**—At a specially convened meeting of the City Council on Monday consideration was given to the proposals for a new electricity generating station at the Basin, prepared from plans by the city electrical engineer (Mr. H. D. Munro), who, under the directions of the Electric Lighting committee, has issued specifications for the complete equipment of the station on either a single or two-phase system, inviting, at the same time, alternative offers for the complete equipment of the station. Mr. Robert Hammond was selected by the Electric Lighting committee as consulting engineer, and has had the tenders under his consideration. The only variations in the tenders received were as to the size and type of the steam alternators and the condensing arrangements. The committee's report on the subject, which was before the Council meeting on Monday, contained two recommendations: (1) That the contract for the entire equipment of the station should be given to one firm of contractors; (2) that the two-phase system should be adopted in the equipment of the station. The acceptance of the tender of the British Westinghouse Company for £29,707 was recommended for acceptance. In the course of his analysis of the tenders submitted to him, Mr. Hammond referred in favourable terms to the steam turbines manufactured at Newcastle by Messrs. C. A. Parsons & Co., on the ground that these machines are less costly in repairs and maintenance, and cause less vibration than low-speed reciprocating engines. Mr. Munro, the Council's electrical engineer, commented on Mr. Hammond's report, but there was no disagreement on any important point, Mr. Munro's comments rather pointing in favour of the tender of Messrs. Ferranti (Ltd.). It will be seen by the committee's recommendations that they were in favour of the tender being in the hands of one firm. In the discussion upon the committee's report, Councillor Domville strongly urged the acceptance of the committee's recommendations and warmly supported the decision of the committee in deciding against breaking up the tender into a number of sections. After some discussion Councillor Munro moved an amendment that, subject to Mr. Hammond's approval of the form of contract, and to specific conditions being laid down for the due and proper execution of the contract, the offer of Messrs. C. A. Parsons & Co. to execute the work for the sum of £27,981. 2s. be accepted, the contractors to give a guarantee for the efficiency of the work 12 months after completion, the sub-contractors to be Messrs. Babcock and Wilcox and Messrs. Ferranti (Ltd.) Councillor Munro urged the suitability of turbines for the work of generating electricity, and quoted Mr. Hammond as being strongly in favour of their use. He gave a list of places where turbines were in use for such purposes, with Bellis engines, such as the Westinghouse Company proposed to put in at Exeter, and he urged that, by the adoption of Messrs. Parsons & Co.'s tender, a saving of £500 per annum would be effected. After some further discussion it was agreed to adjourn for a fortnight.

**Exhibition.**—What is described as the first annual exhibition of labour-saving machinery and novelties in the engineering and electrical trades is to be held in the St. James's Hall, Manchester, from March 6 to March 15, 1902. The exhibition is under the management of Mr. W. Cawood, the secretary being Mr. W. A. Carson. Both these gentlemen have had considerable experience in the organisation of exhibitions in connection with the cycle and motor industries. We understand that the show at Manchester has been undertaken at the request of a number of northern mechanical and electrical engineering firms.

**Fareham.**—The Council commence to-morrow (Saturday) an all-night supply of electric current to private consumers. The additional expense involved is estimated at £60 per annum.

**Gravesend.**—An inquiry was held here last week into the application of the Corporation for sanction to a loan of £31,500 for electrical plant and £3,500 for a refuse destructor. Mr. C. E. Hatten (town clerk) and Mr. W. H. Trentham (consulting electrical engineer) gave particulars of the scheme and submitted plans. Two members of the Council opposed and six supported the application.

The Council have approved an agreement between the Corporation and the Gravesend and Northfleet Tramways Co. for the former to supply current to the company for working the tramways.

**Grimsby.**—The recommendation of the Electric Lighting committee that additional generating machinery, engines and boilers be installed at the electricity station at an estimated cost of about £12,000 has been approved. Additions to the public lighting by an increase of five arc lamps were also approved.

**Hackney (London).**—A large number of applications have been received for the post of borough electrical engineer to take control of the electricity supply and refuse destructor stations of the Council, and the number has now been reduced to eight. It is expected that the Council will make their choice next week.

**Hamilton.**—The Board of Trade having consented to consider any representations the Council might have to make as to the non-fulfilment of their obligations under their electric lighting provisional order prior to deciding as to its revocation, the Council have, we understand, given an undertaking to proceed with the works.

**Huddersfield.**—At Wednesday's meeting of the Council the report from the investigation committee showed that the Council's electric power station and plant, cars and line equipment had cost a total of £116,526. 7s. 7d. The electrical equipment of the line had cost £2,103. 4s. per mile. The receipts from the steam-worked sections of the Corporation tramways were 13·26d. per car-mile, and the expenses 19·98d., or a working loss of 6·723d. per mile. The receipts on the electric tramway were 10·11d. per mile, and the expenditure 12·94d. a loss of 2·83d. per mile. The report states that the investigation into cost of working the undertaking had been made at a time when such costs were as high as at any period of the year, and previous to the commencement of the Sunday running of the cars. The committee conclude their report by urging, in the interest of economy and public convenience, that the whole system of tramways in the borough be promptly converted to electric traction. Several extensions of the lines were recommended, and the electrical equipment of the Newsome-road section, at an estimated cost of £1,608, is to be immediately proceeded with. The report was adopted.

**Infirmary Lighting.**—The Marylebone (London) Guardians will be asked at the next meeting to approve the installation of fittings and machinery for the electric lighting of their infirmary at £9,039.

**Leeds.**—The Lighting committee on Tuesday resolved to make certain extensions of the electric lighting mains.

Horse-drawn tramcars have disappeared from the streets, the last running section of the old horse lines having been converted to electric traction.

**Life Saving Apparatus.**—The municipality of Madrid offers a prize of 2,000 pesetas (about £55) for the best model of life saving apparatus for use on electric tramways. Models by Nov. 6 to the Nagociado de Obras de la secretaira del Exemo Ayantamiento, Madrid.

**Light Railways.**—The Staines and Egham Light Railway Order has been submitted to the Board of Trade for confirmation. Objections by Nov. 2.

The Board of Trade have confirmed the Hadlow Light Railway (Amendment) Order, 1901, and modified the Kidderminster and Bewdley, the Blackburn, Whalley and Padiham and the Durham and District Light Railway Orders, 1901.

The Board of Trade have recently confirmed the Bury and Diss, the Kidderminster and Bewdley, the Hadlow (amendment) and the Durham and District Light Railway orders.

**Limerick.**—The Limerick Electric Tramways Co. has applied to the Lord Lieutenant in Council for an order to authorise the construction of electrical tramways in Limerick.

**Listowel (Ireland).**—Numerous inquiries for particulars of the electric lighting project have been received by the Council, and a tender from the National Electric Wiring Co. offers to form a local company, guarantee its capital, and lay down plant, mains, &c. The company propose to effect the public lighting by 20 500 c.p.

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lamps, and offer to supply current for same from one hour after sunset till midnight on 300 days a year for £75 per annum if lamps, posts, and wiring are paid for by the Council, or £100 if these are all provided by the company. The company offer to wire private premises on the easy payment system. The Council decided to await other proposals.

**London County Council.**—At Tuesday's meeting it was agreed to grant electric lighting loans of £6,000 to Battersea and £3,000 to Kensington.

*Electric Lighting Companies' Accounts.*—The Highways committee brought up a report dealing with electric lighting companies' accounts. From this it appeared that the Board of Trade had supplied the Council with the accounts of certain company undertakers under the electric lighting acts and orders, together with certificates of the Board's auditor with reference to these accounts. Attention is called to the report of the auditor in relation to certain expenditure for directors' and auditors' fees, salaries, and expenses of management, promotion money, and interest on loans and advances charged to capital account, and suggesting that these charges should be transferred to revenue account or to preliminary expenses account. The companies had, however, acting on the advice of their own auditors, declined to comply with the requirements of the Board of Trade auditor. The committee point out that the subject has public importance from two aspects:—(*a*) In connection with the periodical revision of the maximum charges for current, as, in relation to dividend payments by the companies, the amount of capital upon which such dividends are distributed is involved in this question; (*b*) in view of the purchase of the undertakings by local authorities. As no provision appears to be made in the electric lighting acts for enforcing the objections raised by the Board of Trade auditor, the committee have suggested to the Board that the electric lighting acts should be amended on the lines of secs. 40 and 42 of the Metropolitan Water Act, 1871. These sections empower the public auditor of metropolitan water companies' accounts to require any company to correct their accounts in such a manner as he may think fit, and provide that no future dividend shall be declared until such accounts are certified by the public auditor, an appeal being allowed to an arbitrator to be appointed by the Lord Chief Justice. The Board of Trade have promised that in the event of an amendment to the electric lighting acts consideration shall be given to these suggestions, but do not appear to regard any revision on the lines suggested as advisable. The committee have called the attention of local authorities to the Board of Trade auditor's comments, and have recommended that a record be kept of the amounts which the said auditor regards as having been improperly charged to capital account. The committee's report was adopted without discussion.

*Omnibuses.*—A communication has been forwarded to the Council on behalf of the proprietors of the London omnibuses in regard to the proposed application of the Council to Parliament for permission to own and run omnibuses. The proprietors point out that such a course on the Council's part is unnecessary, as the existing owners of omnibuses are prepared to run an adequate service and to take over and work the existing omnibuses of the Council at their present fares. The omnibus proprietors strongly resent the competition of the Council.

**Manchester-Salford Tramways.**—Negotiations to clear the deadlock that has arisen between the Manchester and Salford Corporations as to joint running powers of the two bodies over the Manchester and Salford tramways have advanced a point. The legal opinion of Mr. Balfour Browne, K.C., has been sought by the Salford Corporation, and Mr. Balfour Browne recommends arbitration. This course has been approved by the Salford Corporation.

**Margate.**—The Corporation has received the report of the Board of Trade inspector (Major Pringle) who inquired into the accident which occurred to a tramcar belonging to the Isle of Thanet Tramways Co. in descending Fort Hill, Margate, on Aug. 10 last, when 27 passengers out of 50 complained of injuries. Major Pringle considers the motor-man responsible for the accident, as, in the first place, he misapplied the brake, and, in the second, omitted to use the reversing lever to reduce the speed of the car before it reached the sharp curve where it left the rails. A second accident of a similar kind occurred at the same spot on the same evening, and Major Pringle holds that a sudden acceleration of speed may occur here which cannot be quickly enough reduced to avoid danger of the car leaving the line or coming into collision. He, therefore, urges that some further appliance is required to render such sudden acceleration improbable, and recommends that the cars be fitted with the slipper brake in addition to those already adopted. The Board of Trade have prepared a set of more stringent regulations for the future working of the line.

**Merthyr.**—The Public Works committee are opposing an extension of the Merthyr Electric Traction Co.'s tramways unless the company agree to lay wood paving in all the proposed new routes without expense to the Council.

**Middlesbrough.**—Sanction to a further loon of £34,100 for electric lighting has been received by the Corporation.

**Municipal Telephony.**—The proposal of Bradford Corporation that the chief local authorities in the West Riding should hold a conference on the subject of the municipalisation of telephones in the district has been agreed to by the Leeds, Sheffield, Halifax and Huddersfield Corporations. The first meeting is to be held in Leeds.

**North Berwick.**—The Council have decided, after a plebiscite (301 affirmative and 286 negative votes), to proceed with their agreement with Messrs. Crompton & Co. for the introduction of electric lighting.

**Otley.**—The Council have passed a resolution in favour of application being made to the Board of Trade for a provisional electric lighting order.

**Paisley.**—Messrs. Mordey and Dawbarn have submitted a report upon the Council's electricity works, especially with reference to the supply of energy for working the projected tramways. The report states that the works can be provided with the additional plant necessary for the purpose. Mr. H. F. Parshall, the consulting engineer to the tramway undertaking, anticipates that from 40 to 50 cars will commence running in from 15 to 18 months, and that from 70 to 80 cars would ultimately be used. The requirements in the way of energy for 40 cars would be about 1,000,000 units per annum. The extensions at the electricity works are estimated to cost £38,000. The report was adopted, and the borough electrical engineer (Mr. C. F. Parkinson) is to prepare estimates.

**Peebles.**—The Council decided to make a week's experiment in electric lighting in the High-street, at a cost of about £40. Four arc lamps are to be erected by Messrs. King & Co.

**Pemberton.**—"In consequence of the Wigan Corporation's repeated refusals to reduce the price of gas to Pemberton consumers," the District Council are establishing electricity works to supply a considerable portion of the district during the coming winter. The Council will also supply current for power, and hope to secure the supply of energy for the tramways on their conversion to electric traction. The maximum charge for current has been fixed at 5d. per unit.

**Personal.**—Mr. A. J. Arnot, electrical engineer to the Melbourne (Australia) City Council, has recently been in London, and has been appointed to a responsible post on the staff of one of the principal London companies. He will consequently resign his appointment in Melbourne at the beginning of 1902. It is agreed that since Mr. Arnot assumed control at Melbourne many important improvements have been made in the electric lighting system of the city. The station has been remodelled and large extensions have been made. His final work at Melbourne has been the installation of the new machinery at the Spencer-street station and the supervision of the laying of the large network of cables throughout the city. Mr. Arnot is likely to be at Melbourne till the starting of the new plant.

At Tuesday's meeting of the Electricity and Tramway committees, Mr. R. C. Quin's resignation of the post of borough electrical engineer at Blackpool was, after lengthy consideration, accepted. Mr. Quin will retire at the end of March next.

**Plant for Spain.**—The Madrid *Gazette* of 8th inst. contains royal orders authorising the purchase of electrical and other machinery and apparatus for the Royal Gunpowder Factory of Granada. The *Gazette* can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London.

**Plymouth.**—On Monday the Electricity committee submitted statements showing the estimated revenue of the department for the current year, and other particulars, and recommended that certain readjustments of accounts in connection with electricity supply be carried out. Mr. Radford moved the confirmation of the committee's minutes and said while the undertaking showed a gross profit of £2,734, sinking fund charges, &c., made the accounts show a loss of £1,807. The present installation was somewhat in advance of the town's requirements but the steady demand for current made it probable that at the end of the year the whole of their plant would be employed and they would then commence to show a net profit. They had generated 543,250 units and had sold 432,532 in addition to the current used at the works. The cost of generation of current for tramway working had fallen from 3·772d. last year to 2·66d. per unit this year; for private lighting from 6·201d. to 5·703d. and for arc lighting from 2·738d. to 2·455d., the average cost per unit having fallen from 4·506d. to 3·418d. The committee, having now ascertained that the tramways were being supplied with current at less than cost price, it was their duty to propose an adjustment of the charge. He recommended that the charge be increased from 2·66d. to 3·418d., the average actual cost of generation. An amendment was moved that the Tramways committee be charged 3d. per unit and this was carried by 24 to 21. With this exception the committee's minutes were approved.

**Presentation.**—At the Council offices, Wimbledon, on Saturday, Mr. S. C. Gibson, chief assistant engineer at the electricity works, was presented with a spirit and smoking cabinet by his brother officials on leaving to take up the appointment of resident engineer at Nuneaton. The presentation was made by Mr. F. Barnes

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Spencer, chief electrical engineer at Wimbledon, who referred to the loyal support he had always received from Mr. Gibson under many trying circumstances.

**Pudsey (Yorks.).**—The Electricity committee are to ascertain the amount of support likely to be accorded a municipal electricity undertaking.

**Rochester.**—The Chatham, Rochester and District Electric Lighting Co. have declined the Council's increased offer of £5,000 for the purchase of the portion of the company's undertaking within the city. The Council has resolved to oppose the proposed revocation by the Board of Trade of that portion of the provisional order which relates to the supply of current to the Gillingham Urban district.

**St. Annes-on-Sea.**—Col. C. H. Luard, R.E., held an inquiry on Tuesday into the application of the Council to borrow £7,230 for electric lighting. The expenditure included the purchase of a 220 H.P. dynamo, two concentric feeder cables, distributor cables, and the conversion of 120 gas lamps for electric lighting. The electrical engineer (Mr. P. J. S. Tiddeman) explained that two 70kw. dynamos were at present installed, and the maximum load had been as high as 75kw., so that any additional lamps would leave them without any standby. There was some opposition.

**St. Pancras (London).**—The revenue in 1900 from the electricity undertaking was £49,329 (an increase of £4,449 on the previous year) and showed a net profit of £2,921.

A deputation of tradesmen has requested the Council to oppose the London County Council's proposal to construct tramways in Tottenham Court-road.

**St. Petersburg.**—It is stated that an American syndicate has submitted proposals to the municipal councils to take over the entire tramway system, and, on a 25 years' concession, to convert the existing lines to electric traction, and to construct several additional lines. Capital will be raised in America, and has been fixed at 100,000,000 roubles, half ordinary shares and half guaranteed stock.

The three electric lighting companies in this city have agreed upon a uniform charge for current of 3·5 kopecks per hecto-watt-hour. Hitherto prices have ranged from 1·8 to 2·5 kopecks.

**Sedgley.**—Lieut.-Col. Von Donop, of the Board of Trade, inspected, last week, the electric tramway—3 miles in length—between Sedgley and the Fighting Cocks, which has been reconstructed and converted to the overhead trolley system.

**Self-Propelled Traffic.**—At a meeting of the council of the Liverpool Self-Propelled Traffic Association on 14th inst. it was announced that Mr. Walter Long, M.P., President of the Local Government Board, will receive a deputation from the association and the commercial associations of Liverpool with reference to the present limit of tare upon motor waggons, &c. (3 tons), which it is sought to have increased. The judges' report on the recent trials is to be presented to the association about 24th inst.

**Shrewsbury.**—Sanction to borrow £10,900 for electric lighting works has been obtained by the Council.

**South Shields.**—The Corporation will seek powers in a bill before the next Parliamentary session to extend the tramways from Horton Village, on the main road to Sunderland, a distance of about 2 miles.

**Swansea.**—It has been decided to apply to Parliament for powers to extend the electrical tramways from Brynhyfryd to the High-street.

**Telephone Trunk Line Extension.**—Telephone trunk line communication has been extended to Newbury, Berks.

**Todmorden.**—The Council will apply for a provisional order for the construction and working of tramways from Sandbed to the borough boundary, and some other points in the district.

**Village Lighting.**—Stockton Rural District Council have decided to apply for a provisional electric lighting order, and to oppose the application of the Cleveland and Durham County Electric Supply Co. for an order. Mr. C. S. Vesey Brown has been engaged to advise the Council.

**Walsall.**—On Monday a discussion took place at the Council meeting round an amendment by Mr. Powell to a proposal that tenders should be obtained for work in connection with the extension of the tramways. Mr. Powell's amendment was that before the proposed extensions were carried out particulars should be obtained from the existing tramways company and the British Electric Traction Co. as to the terms upon which either company would accept a lease of the lines for a period of 21 years. The amendment was defeated by 15 to 14, and a further amendment that the Council authorise the Tramways committee to obtain tenders for the whole of the extensions authorised was carried by 15 to 14.

**Wallsend.**—The Tyneside Electric Tramway Co. has approached the Council for sanction to lay an extension of the electric tramways. Newcastle Corporation are also extending their Walker tramways into Wallsend.

**Waterford.**—We referred in our Oct. 4 issue to a report having been received by the Corporation from Messrs. Lacey, Clirehugh, and Sillar on electrical matters. This report strongly recommends the establishment of municipal electricity works, and estimates are given showing the probability of success. The report sets out a scheme for the laying of mains in the principal thoroughfares. The estimated cost of the station and equipment is put at £29,744. On the subject of electric tramways in the city, the capital cost of construction of a line 1·2 miles in length between two principal points in the city is put under one scheme at £11,260, and under a second at £14,410 for a single track, with the necessary turnouts.

**Watford.**—The Electric Lighting committee have approved the proposal of Mr. Colebrook to introduce the maximum demand indicator system of charging for current at 5d. and 1½d. per unit. The number of consumers connected to the electric lighting mains is now 175.

**Weston-super-Mare.**—The offer of the Weston-super-Mare and District Electric Supply Co. to supply electric current to the new Pavilion at a flat rate of 4d. per unit has been accepted.

**Wolverhampton.**—The Council have received sanction to a loan of £1,000 for the purchase and hiring of fittings for private electric lighting.

**Yarmouth.**—The construction of electric tramways was commenced on Wednesday. The cost of the scheme is put at £69,000. The Corporation have not yet decided whether they will work or lease the lines.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Rochdale* Corporation require tenders for the supply, delivery and erection at their electricity works of three Lancashire boilers, economisers and mechanical stokers, and for two ejector condensers, circulating pump, feed pumps, grease extractor, and for extensions to the present steam, exhaust, condenser and feed pipes. Specification, &c., can be seen at the offices of the engineers (Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and can be obtained at 2, Queen Anne's-gate, Westminster, London, S.W., after 22nd inst. Tenders to Mr. James Leach, town clerk, Town Hall, Rochdale, by Nov. 8. See also advertisement.

*Oldham* Electricity committee invite tenders for the supply and delivery of concentric feeder cable, pilot cable, joint boxes, &c., motor boosters, motor generators, switch gear, &c. Specifications can be obtained from Mr. Arthur Andrew, superintendent, Gas and Water offices, Greaves-street, Oldham, and specifications can be seen, but not obtained, at the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, London, S.W. Tenders to Mr. Andrew, by Tuesday, Nov. 5. An advertisement contains some further particulars.

*Aston Manor* District Council require tenders for building offices, foundations, flues, &c., for their proposed electric power station. Mr. Reginald Wilson, 66, Victoria-street, London, S.W., is consulting engineer for the works, from whom bills of quantities, specifications, &c., can be obtained, or they can be seen at the Council's offices, Aston Manor. Tenders, addressed to Chairman Electric Light and Tramways Committee, by noon Nov. 4.

*Hurst* District Council invite tenders for the supply and erection of steel poles, bases, section boxes, and overhead line, &c., for the equipment of about 1½ miles of electric tramway. An advertisement gives further particulars. Tenders to the town clerk (Mr. John Whitworth), Booth-street, Ashton-under-Lyne, by noon Oct. 29. Specification, &c., may be obtained from the engineer (Mr. E. Garside), Town Hall Chambers, Ashton-under-Lyne.

The Directors of the *South Lancashire Electric Traction and Power Co. (Ltd.)* invite tenders for the supply and laying of high and low-tension insulated electric cables, stoneware pipes, &c. Specifications, &c., may be inspected at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, London, S.W. Tenders must be in before noon of Nov. 4 to 12, St. John's-lane, Liverpool. An advertisement contains further particulars.

*Londonderry* Corporation require tenders for the supply of carbons for one year from Jan. 1 next. Particulars of the borough electrical engineer (Mr. R. V. Macrory), electric lighting station, Londonderry, and tenders to the town clerk (Sir R. N. Chambers), by Nov. 1. See also advertisement.

*Limerick* City Council invite tenders for the supply, delivery and erection of electrical plant and apparatus, including cables, arc lamps, Westinghouse gas engines, dynamos, boosters and Dowson gas plant. Specifications from the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., after 18th inst, and tenders to the town clerk (Mr. Wm. M. Nolan), Town Hall, Limerick, by 28th inst. See advertisement.

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*Bootle* Corporation require tenders for the wiring of the extension of the town hall buildings in Trinity-road for electric lighting. Specification, &c., from the borough electricity works, Pine-grove, and tenders (addressed Finance Committee) to the Town Hall, Bootle, Lancs., by noon Oct. 23. Mr. J. Henry Farmer is town clerk. Some further particulars are given in an advertisement.

The directors of the *Great Western Railway* require tenders for the supply of stores from Dec. 1, 1901, to Nov. 30, 1902, including telegraph instruments and apparatus, telegraph ironwork and tools, telegraph drysalteries, electric light carbons, incandescent electric lamps, copper and gutta-percha wires, telegraph poles and yellow pine, &c. Tenders to secretary (Mr. G. K. Mills), Paddington Station, London W., by 21st inst.

*London County Council* invite tenders for wiring and fittings for the electric lighting of fire brigade stations at Homerton, West Hampstead, East Greenwich and Perry Vale. Tenders by noon Oct. 31 to clerk of Council.

*London County Council* also require tenders for stores for 12 months from Jan. 1, including engineers' goods and electrical stores. Tenders by 28th inst.

*Manchester* Electricity committee invite tenders for the supply and erection at the Stuart-street generating station, and sub-stations, of two 6,000 H.P. triple expansion engines and two 3,750kw. three-phase alternators, and 48 motor generators for sub-stations. Tenders to chairman by noon Nov. 6.

*Ilford* District Council invite tenders for water-tube boiler (with fittings, pipework, &c.), a 550kw. steam dynamo (vertical enclosed high-speed engine), and main switchboard and connections. Tenders by noon 29th inst.

*Chesham* District Council invite schemes for the erection of electricity works and for the transfer of their provisional order. An advertisement contains further particulars. Schemes to the clerk (Mr. John Gibbon How) by Nov. 16.

*Newport* (Mon.) Corporation invite tenders for winches for steel chimney shaft, outside coal handling, piping, switchboard, cables, cable-ways, overhead construction, complete electric motor car and repair shop equipment. Tenders by 5 p.m. Oct. 21.

*Ashton-under-Lyne* Corporation require tenders for steel poles, bases, section boxes and overhead lines for about 1½ miles of electric tramway. Tenders to Mr. John Neal, Town Hall, Ashton-under-Lyne, by noon 29th inst.

*Swindon* Corporation invite tenders for three Lancashire boilers, economiser, two jet condensers, feed pumps, pipework and accessories, water-cooling tower and 10-ton overhead travelling crane. Tenders to town clerk by Nov. 12.

*Leyton* Electric Lighting committee invite tenders for a multipolar dynamo of about 450kw. capacity, and a balancer. Tenders to engineer and manager (Mr. F. Harman Lewis) by 26th inst.

*Dudley* Electric Light and Tramway committee invite tenders for pipework. Tenders to town clerk by noon Oct. 25.

*Bury* Tramways committee require 28 electric tramcars. Tenders to the town clerk by Nov. 18.

*Rockhampton* (Queensland) Municipal Council invite applications for the construction and working of a system of electric tramways (under the Queensland Tramways Acts, 1882 and 1890). Applications have to be sent in by March 31 next to the Mayor of Rockhampton, Queensland, Australia.

The burgomaster and councillors of the City of *Amsterdam* invite tenders for electrical (overhead) tramway construction. Further information of the director of municipal street railways, Nieuwe Achtergracht, 164, Amsterdam. Tenders by noon Nov. 18.

The Municipal Council of *Burgo de Osma* (Soria), Spain, invite tenders for electric lighting for five years. Tenders by Nov. 4.

## TENDERS RECEIVED AND ACCEPTED.

The Asylums Committee of the London County Council have accepted the tender of Messrs. Benham & Sons (Ltd.) for an electric lighting installation at their epileptic colony. The amount of the tender is £6,252. 15s. 7d.

Poplar (London) Borough Council have received the following tenders :—

*Multiple-core lead-covered feeder and network cable and accessories.*

| | | | | | |
|---|---|---|---|---|---|
| British Insulated Wire Co. (*accepted*) | £10,522 10 4 | | W. T. Glover & Co. | £12,068 4 5 | |
| Anchor Cable Co. | 14,265 19 2 | | W. T. Henley's Co. | 11,872 19 2 | |
| St. Helen's Cable Co. | 12,910 2 1 | | Western Electric Co. | 11,017 3 4 | |

*High-tension continuous transforming plant.*

| | |
|---|---|
| Electric Construction Co. (*accepted*) | £4,073 |
| Johnson and Phillips | 5,720 |
| Ditto (alternative tender) | 3,750 |
| Brush Co. | 5,596 |
| Mather and Platt | 4,625 |

*Condensing plant, boiler, feed pump, steam and water piping, &c.*

| | | | | | |
|---|---|---|---|---|---|
| Babcock and Wilcox (*accepted*) | £3,485 3 | | Fraser & Son | £3,905 0 | |
| Maxim Elec. & Eng. Co. | 4,465 0 | | Alley and Maclellan | 3,581 0 | |
| | | | D. Stewart & Co. | 3,566 0 | |

For the electric lighting of four public libraries the following tenders were received :—

| | | | | | |
|---|---|---|---|---|---|
| G. Weston & Co. (*accepted*) | £140 8 | | Lighting Corporation | £210 0 | |
| C. Essar | 332 0 | | National Elec. Wiring Co. | 209 0 | |
| G. C. Berry | 308 16 | | Electric and Gen. Eng. Co. | 208 10 | |
| Smeeton and Page | 280 15 | | Tilley & Co. | 196 8 | |
| Young & Co. | 260 0 | | A. Goldsmith | 162 5 | |
| C. Peacock & Co. | 244 15 | | Murrell Bros | 147 2 | |

Greenwich (London) Guardians have received the following tenders for an electric lighting installation at the Children's Homes, Sidcup :—

| | | | | | |
|---|---|---|---|---|---|
| Johnson & Phillips (*accepted*) | £4,906 | | Shalders & Davis (S'hampton) | £5,583 | |
| D. Firth & Son (Waltham-stow) | 8,775 | | Hampton & Sons | 5,500 | |
| Geipel and Lange | 7,529 | | W. O. Rooper & Co. (Stafford) | 5,405 | |
| Drake and Gorham | 6,500 | | Robb and Mitchell (Ossett) | 5,220 | |
| Chas. Peacock & Co. | 6,444 | | G. Weston & Co. | 4,995 | |
| F. J. Coleby & Co. | 6,310 | | Henry F. Joel & Co. | 4,937 | |
| Frank Suter & Co. | 5,640 | | Nicholson & Co. | 4,733 | |
| | | | Lea and Warren (Kettering) | 4,411 | |

All of London except where otherwise indicated.

The following tenders have been received by Wrexham Corporation for wiring two markets for the electric light :—

| | Butchers' market. | Vegetable market. |
|---|---|---|
| Jones and Cathrall (*accepted*) | £138 9 0 | £124 8 6 |
| Triplex Co. | 132 0 0 | 144 0 0 |
| Electric Lighting & Fittings Corp. | 130 0 0 | 185 0 0 |
| E. M. Evans | 128 0 0 | 165 0 0 |
| Brook, Hirst & Co. | 122 0 0 | 152 10 0 |
| G. A. Steinthal | 115 0 0 | 175 0 0 |

Middlesbrough Corporation have accepted the following tenders :—

| | |
|---|---|
| Askham Bros. and Wilson (mechanical coaling apparatus) | £791 |
| A. J. Cooke (engine foundation, boiler setting and flues) | 243 |
| Nalder Bros. and Thompson (extension to switchboard) | — |

Hull Corporation have accepted the tenders of Mr. J. W. Garrett for the supply of a Morley-Rowley generating set at £588, and also for the supply of two additional engines for lighting the dust destructor station.

The Leeds Tramway Works sub-committee recommend for acceptance the British Thomson-Houston Company's tender for the supply of 50 electric tramcars at £26,000. Between 50 and 60 tenders were received.

The Kingston (Surrey) Guardians have accepted the tender of Messrs. Drake and Gorham for the supply of electric plant to work the lift at the administrative block for £445.

Batley Corporation Electric Traction committee recommend the acceptance of the tender of Messrs. Graham Bros., Huddersfield, for the laying of the permanent way of the proposed electric tramways at £30,000.

Kirkcaldy Corporation have accepted the tender of W. T. Henley's Telegraph Works Co. for mains and feeders at £11,239, and that of Crompton & Co. for arc lamps at £546. 6s.

The tender of C. A. Hayes for structural alterations at the Temple Back electricity works is recommended by the Electrical committee for acceptance by Bristol Corporation.

Messrs. Warren, Beattie & Co. have secured the contract for the supply and erection of the whole of the motors and cabling in connection with the electric power installation about to be put down by Messrs. R. Stephenson & Co. at their shipyard, Hebburn-on-Tyne. The contract comprises 39 motors, varying from 6 H.P. to 50 H.P., the main switchboard, distribution boards and the cabling. In addition, the firm have obtained an order for the lighting of the shipyard, various shops and offices. This lighting installation comprises 2,000 c.p. arc lamps and over 550 incandescents.

## BUSINESS NOTICES.

The New Brotherton Tube Co. (Ltd.) Commercial-road, Wolverhampton, have opened offices and stores for the distribution of their enamelled steel conduit tubes and fittings at 9A, New Brown-street, Manchester, where orders for that district should be addressed.

Messrs. G. E. Norvall and S. Parkinson (trading as the City Engineering Works), electrical and general engineers, 45, Essex-road, London, N., have dissolved partnership. Debts by Mr. Parkinson.

Messrs. F. and A. H. Hodgson and F. G. Andrews (trading as Fredk. Hodgson & Co.) electrical engineers, &c. 4A, Downshire hill, Hampstead, London, N.W., have dissolved partnership.

Owing to increase of business Mr. A. C. Cossor is moving into larger premises at 54, Farringdon-road, London, E.C., on Oct. 19.

## BANKRUPTCIES.

The trustee (Mr. H. P. Gould, 8, King-street, Norwich) in the bankruptcy of Leonard Francis, electrical engineer, 13, Corporation-road, Southwold, Suffolk, has been released.

A resolution having been passed and confirmed to wind up voluntarily the Electrical Transmission Co. (Ltd.), claims are to be sent to the liquidator (Mr. A. R. Clarke), 7, East India avenue, London, E.C., by Nov. 30. This notice has no reference to the Electrical Transmission Co., of Hammersmith.

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The public examination of Thos. Morley, electrical engineer, Borough Engineering Works, Argylle-street, Accrington, was opened at Blackburn last week. Gross liabilities, £275; deficiency, £217. Debtor commenced business six months ago with £50 capital, and attributes failure to bad trade and sickness.

**Business for Sale.**—An advertisement announces that the business of Mr. Joseph Edmondson, electrical and mechanical engineer, Albert Works, Hey-street, Longside-lane, Bradford, is for sale as a going concern. Mr. Edmondson is relinquishing business.

**B.T.H. Plant.**—Pamphlet No. 111 of the British Thomson Houston Co. treats of punched clip lever switches with single, double and triple poles.

**Desk Novelty.**—Henley's Telegraph Works Co. are sending out a transparency paper weight, which is useful as well as an excellent advertisement.

**Admiralty Asbestos Contracts.**—For the 16th year the United Asbestos Co. have been awarded by the Lords of the Admiralty the important contract for the supply of asbestos goods for the navy. The current contract comprises carded fibre (special Italian), wadding, twine, pure woven tape, square block packing and "Victor" metallic packing, tape, and manhole, mudhole, steam, and other joints. These goods are all manufactured from raw material from the company's mines in Italy and Canada at the extensive mills at Harefield, near London.

**Street Lighting.**—A circular is issued by the General Electric Co. (No. 37) describing the New Robertson "Sunshine" lamp, specially designed for street lighting. The lamp is provided with a detachable, opal glass reflector, enabling the lamps to be renewed independently of the reflector. The lamp is specially made to withstand vibration. It is supplied for high or low voltage.

**Two-phase Plant for Willesden.**—In June last the Metropolitan Electric Supply Co. advertised for tenders for the supply and delivery of two 3,000kw. two-phase steam generators as extensions to their already large two-phase plant at Willesden. Over 40 tenders were received from manufacturing firms in all parts of the world. The successful tender was that of Messrs. Witting Bros., who secured the order for both units of plant with Sulzer engines and Kolben generators. We are informed that the first unit is to be delivered and working by July next and the second in the following year. Each is to be capable of generating 3,500kw. at 75 revs. per min. The alternators will generate current at 11,000 volts per phase directly in their own armatures, and are to work in parallel with the already installed Westinghouse machines, which generate current at 500 volts per phase and 60 cycles. The pressures of these machines will be raised by means of transformers. The new plants will, we are informed, be the largest yet built on the Continent, and the generators will be the largest two-phase machines yet made anywhere.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 9 to 15, with the ports of destination:—

*Africa*—Cape Town, £160 (including £106 telegraph sundries); Durban, £7,925; East London, £80. *Argentina*—Buenos Ayres, £38. *Australasia*—Auckland, £80; Fremantle, £16; Melbourne, £88; Port Chalmers, £720; Sydney, £328. *Ceylon*—Colombo, £234. *China*—Shanghai, £300. *Denmark*—Copenhagen, £248 (telegraph wire). *Germany*—Hamburg, £35. *Holland*—Amsterdam, £150; Rotterdam, £26 (telegraph wire). *Hong Kong*, £1,183. *India*—Calcutta, £1,595; Madras, £1,983. *Japan*—Nagasaki, £1,560; Yokohama, £2,162. *Siam*—Bangkok, £90. *Sweden*—Gothenburg, £44 (telegraph wire); Stockholm, £974 (telegraph material). Total £19,269, against £23,908 in the corresponding week last year (Oct. 10 to 16).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. MEWBURN, ELLIS AND PRYOR, *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

June 24, 1901.

12,816. H. SHOEMAKER. London. Improvements in wireless telegraphy.
12,835. STOTHERT AND PITT, LTD. and P. K. STOTHERT. London. Improvements in electric cranes and other electric lifting appliances.
12,862. P. DAWSON. London. Improvements in connection with electric cables or conductors, where branch terminals are used, especially applicable to the wiring of electrically-driven vehicles.*

June 25, 1901.

12,870. E. M. MUNRO, H. B. NELL and H. J. ROGERS. Bristol. Improvements in and relating to trolleys employed in overhead wire systems of electric traction.
12,896. W. G. STONES. Manchester. A device for use within electric ceiling roses and the like.*
12,919. H. GULLIVER. London. Improvements in railway signalling and communicating apparatus.*
12,947. H. H. LAKE. London. An improved electric telegraph code (C. G. Burke, United States).*
12,954. W. PETO. London. Improvements in electrical secondary or storage batteries or accumulators (P. Gouin, France).*
12,974. A. F. MADDEN. London. Apparatus for making secondary battery plates. (Date applied for under Patents, &c., Act, 1883, sec. 103, March 19, 1901, being date of application in United States.)*
12,975. A. F. MADDEN. London. Secondary batteries. (Date applied for under Patents, &c., Act, 1883, sec. 103, March 19, 1901, being date of application in United States.)*

June 26, 1901.

12,991. J. SWINBURNE. London. Incandescent electric lamps.
13,010. M. BYNG and F. G. BELL. London. An improved telephone and bell set.
13,017. A. HILL. Glasgow. Recording apparatus for electrical measuring instruments.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

7,983. MASKELYNE. Electrical signalling.
13,021. GARDNER, GARDNER and GARDNER. Electric ignition devices for internal explosion engines.
13,401. ABEL (Soc. Anon. pour la Transmission de la Force par l'Electricité). Electrical converting transformer.
13,839. DRAKE AND NERNST ELECTRIC LIGHT (LTD.). Glowbodies for electrolytic incandescent lamps.
14,373. FARRELL. Electrical fuze boards.
14,637. WISE (Buckingham). Punching strips for telegraph transmitters and the like.
15,591. BOULT (Katzenstein). Electrical driving apparatus and electric meters combined therewith.
15,890. BERTON and BARR. Electric cable connectors.
16,308. SHORE and HEAP. Switchboards applicable for electric call apparatus.
16,329. BERRY. Electric switches.
16,500. ECKSTEIN and KRAUSE. High voltage electric cutout.
16,501. ECKSTEIN and AGNOLD. Arc-lamp suspension apparatus applicable also to other purposes.
18,656. BISHOP. Commutator brush holders.
18,707. LAKE (Telephon-Fabrik Actiengesellschaft vorm. J. Berliner). Micro-telephonic apparatus.
19,623. KENNEDY and READING. Gas-tight fuse and junction box for electric cables.
20,277. IMRAY (Oesterreichische Gasglühlicht- und Electricitäts-Gesellschaft). Means for supporting the osmium filaments of electric incandescent lamps.

# COMPANIES' MEETINGS AND REPORTS.

## Consolidated Telephone Construction and Manufacturing Co. (Ltd.).

The twentieth annual general meeting was held on Tuesday, under the presidency of Mr. HUBERT FEILDEN JACKSON, A.I.E.E.

The SECRETARY (Mr. Theo. Taunton) read the notice calling the meeting,

The CHAIRMAN said: The figures we are able to put before you to-day are, I think, more satisfactory than the Company has been able to show you for some little time. The trading profit exhibits a considerable improvement on that of last year or the three or four preceding years. The figures, however, are not altogether satisfactory—that is to say, they ought to be a great deal better than they are; but they show, at any rate that we have turned the corner, and that the hopes which the new board had when they were elected have to some extent been justified. Had it not been for a flood at our Coventry works, the trading profit would have been considerably better. At the last meeting I indicated that the board were thinking of purchasing a business so as to extend the field of the Consolidated Company. That was the business of Williamson and Joseph (Ltd.), and we were able to acquire it on very favourable terms. You will see on turning to the balance-sheet that we hold £7,700 in debentures of Williamson and Joseph. We made a very careful investigation into the position of that company, and found that the assets which we were going to acquire might roughly be put down as worth £13,000. Those assets consisted of book debts, which amounted to about £2,500, which have since been collected; stock worth £4,500, and premises, plant, machinery and fixtures worth between £5,000 and £6,000. The book debts and stock alone were very nearly equal to the amount of cash that we paid for the business. The purchase has been, I may say, entirely satisfactory to the board, and I think that the Consolidated Company will derive great advantage from the connection. In the fourth paragraph in the report you see that the total income for the year amounted to £5,430, as compared with £3,780 in the previous year. The expenses were £2,956. Adding the amount brought forward from last year, there was an available balance of £5,641. With respect to the expenses, there is a slight increase in the salaries of about £150, the office expenses were about £130 less than previously, stationery and printing are rather more, and rent, rates, and taxes are also

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rather more. The total expenses were £2,136, as against £2,174—that is, without the legal expenses, which were £31, against £50 in the previous year. To that has to be added £689, being the amount spent on advertising, commission, patents, &c., as set out in the report. On the other side of the revenue account you will see that the trading profit was £2,832, which is the trading profit for the Coventry department; and £366 was received by way of dividend on shares in Williamson and Joseph. That amount is really the trading profit on that department. These two sums make a total of £3,199. I may state that the £7,700 which you see in the balance sheet against Williamson and Joseph's debentures will be reduced to £5,700 very shortly. The reason of that is that £2,000 will be put into that concern by friends of the present manager. In the report reference is made to the Anglo-Portuguese Telephone Co., and every shareholder has had a copy of the last report of that company. The shares and debentures in the Anglo-Portuguese Company form one of our principal assets. The capital of the Anglo-Portuguese Company is £50,000 issued out of a total of £75,000 authorised, and out of that we practically hold £37,500. The Directors found, when they originally took office, that the position of the Anglo-Portuguese Company was not very satisfactory. Their concession terminated in 1917, and, owing to the very inferior service which had been given, there was some chance of the concession being forfeited. The board paid a great deal of attention to that asset, and the managing director (Mr. Kerr) went out to Lisbon several times, with the result that he was able to obtain from the Portuguese Government a concession extending by 20 years the period of the original concession, and containing several important advantages over the latter. Among the principal advantages were an increase in the term and permission to import all our material without payment of any duty. The duty under the original concession amounted to 40 or 50 per cent. ad valorem. Another advantage lay in the tariff. We got a reorganised tariff somewhat in favour of the Company, and one of the most important features lay in the fact that in the event of any dispute arising as to the meaning of the concession, it would be referred to arbitration. In the old concession that was not so, and we were very much at the mercy of the Portuguese Government. The great importance of these alterations in the concession lies in the fact that a considerable amount of capital will have to be spent on the Anglo-Portuguese Company's business in Lisbon and Oporto if it is to be brought really up to date, and the Directors did not see their way sufficiently to finance the Anglo-Portuguese Company unless the terms of their concession could be put on a better basis. We are now in negotiation for the necessary capital, and there will, I think, be little difficulty in obtaining it, the security being good. When the systems at Lisbon and Oporto are reconstructed, the result to the Consolidated Company will be very satisfactory. I will only say two words about the Edison-Gower-Bell lawsuit in Belgium. That suit was commenced, I think, quite 10 years ago, and it is still unsettled; we have advanced a stage on the way, and we hope before our next meeting to tell you that it has resulted in something satisfactory to this Company. There is only one item in the balance-sheet, which I have not already referred to, that I should like to say something about—that is, the amount shown for stock. The stock of instruments and materials last year figured at £6,836 odd, while this year the amount has risen to £11,075—that is, roughly, an increase of £4,000, the greater portion of which is in raw goods. The reason for this increase lies in the fact that the board determined to extend the field of the Company's operations, and instead of simply executing orders which they might receive from Government departments and railway companies, to lay themselves out to deal generally with the trade in telephones and telephonic apparatus. In order to do that a very much larger stock had to be kept, and I think that that figure is likely to increase rather than to decrease. We have found that having the works at Coventry is a very great disadvantage, as ours are the only works of the same class in Coventry. That makes it very difficult to obtain labour of the proper quality, because a man knows that if you do not keep him he has nowhere else to go to, and he has to leave the town; and it is very difficult to get men of the best class. We are, therefore, now considering the advisability of removing a very large portion of the works from Coventry to the neighbourhood of London. If we do that, a certain amount of outlay will, of course, be necessarily incurred.

Mr. G. B. BRYAN said he desired to know whether there would be an interim dividend this year.

Mr. SPENCER asked for further information as to the business of Williamson and Joseph. He confessed that he was rather ignorant of what that company were doing or where their works were situated. The stock was put in the balance-sheet at £11,000, and he wished to know how it was certified, and whether it was done by an independent valuer or by the Company's own manager. Last year a great deal was said about the new instrument, the telautograph, and he desired to know what the result had been.

The CHAIRMAN: I will answer these questions at once. In the first place, with respect to an interim dividend, I do not think that we shall advise one. The fact I have already mentioned, as to the advisability of removing a portion, if not the whole, of our works to London, will involve certain expenditure, which we have to provide for somehow, and we do not wish to give the shareholders at present any more than in justice to them we are bound to do. We want to keep in hand as much of our cash as we possibly can. We think that that will be to the benefit of the shareholders in the long run, and we believe that when we meet you after the results of the present financial year we shall be able to maintain our dividend at the rate we have fixed it at for the moment—namely, 3 per cent. We think we had very much better get firmly on to a proper basis before we endeavour to increase that dividend. With respect to Williamson and Joseph, they are electric light apparatus manufacturers, and have works at Canonbury. With respect to the amount of the stock, the custom of the Company has always been to have the stock valued by the works manager. It is made up of a very large number of different items—thousands of items—and I do not think you could easily find an outside valuer who would be able to give you as satisfactory information as to their value as your own works manager. With reference to the telautograph, we have had an order from the Telautograph Company amounting to between £1,300 and £1,400, and we have very nearly completed work upon that order.

Mr. SPENCER said, with regard to the Chairman's answer respecting the valuation of stock, that he was sorry to differ, and he intended to make it a point with all companies with which he was associated to propose that an expert valuer should take the value of the stock. He was unfortunately associated with a company where the valuation was £40,000 out. He proposed that the Directors should call in an expert valuer to check the value made by their own manager. Unless this course were taken, they would, he said, never know where they were.

A SHAREHOLDER seconded the motion.

The CHAIRMAN: With respect to the question of valuation, I do not, of course, mean to say that we simply accept as gospel, and without investigation, every figure which is given to us by our works manager. I agree with you that in a vast number of cases an independent valuation is advisable, and we shall be glad to consider whether we should adopt that system in this Company. I might observe, as a matter of fact, that any valuer who is chosen to value our stocks would find it very difficult to do so unless he were an absolutely technical man accustomed to deal with telephonic apparatus. If you will leave the matter in that way, I will consult the other members of the board prior to the next stocktaking, and I can assure you that if we find it at all practicable to call in an outside valuer we will do so. We should be glad, as Directors, rather to limit any responsibility attaching to ourselves in this matter, and that course would do so.

A SHAREHOLDER said he thought that if they had sufficient confidence in a gentleman for him to act as manager of the Company, they ought to have sufficient confidence in him as a man of honour that he would value the stock properly. There was one point in the auditor's report which he desired to refer to. The auditor's report mentioned nothing about depreciation, except to state that nothing had been allowed for it. The question was whether the manager in valuing the stock had taken that point into account. Some of the instruments must, of course, depreciate in value—those, for instance, which were not new.

The CHAIRMAN: No depreciation has been taken off, but we consider that the figures put against the plant, machinery, furniture, land and buildings, and the cost of private lines, actually represent their value at the present moment. I now move the adoption of the report and accounts.

The MANAGING DIRECTOR (Mr. Frederick W. Kerr) seconded the motion, which was carried unanimously.

The retiring Director, Mr. Hubert Feilden Jackson, was re-elected, as was the auditor, Mr. John G. Griffiths, and a vote of thanks to the Chairman and Directors brought the proceedings to a close.

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Following is an abstract of the directors report for the year to March 31:—Revenue has been adversely affected by a flood which took place at the Coventry works during January, when a considerable quantity of goods ready for delivery were damaged. The business of Williamson and Joseph (Ltd.) has been acquired and the directors believe it will add materially to the profit-earning capacity of the company. The trading profit for the year amounts to £2,832. 10s. 1d., added to which is the portion of the profit of Williamson and Joseph, in form of dividend, amounting to £356. 13s. 9d. This total trading profit of £3,199. 3s. 10d. compares very favourably with the figures of previous years. The total income for the year amounted to £5,430. 9s. 6d., compared with £3,780. 8s. 9d. for the previous year. Deducting expenses (£2,956. 12s. 11d.), and adding the amount brought forward, there is a balance of £5,641. 16s. The interim dividend at the rate of 3 per cent. per annum for the first half of the year amounted to £1,602. 1s. 2d., leaving £4,039. 14s. 10d. A dividend is now recommended of 3 per cent. less tax, making 3 per cent. for the year, leaving £2,451. 14s. 9d. to be carried forward. The directors have devoted much attention to the improvement of one of the principal assets of the company—the shares and debentures in the Anglo-Portuguese Telephone Co. Negotiations with the Portuguese Government have recently resulted in the granting of a new concession, which extends the period of the monopoly from 1917 to 1937. The directors look to increased profits to the Consolidated Company from this source in the near future. The lawsuit initiated by the Edison-Gower-Bell Telephone Co. against infringers in Belgium has made some progress, but has not been finally disposed of. Mr. C. H. Reynolds, C.I.E., having been elected general manager to the Pacific Cable Board, has tendered his resignation as director of the company, and the directors have appointed Mr. John L. Newland, who has been identified with the company during the last two years as manager, in his place.

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## Brookie-Pell Arc Lamp (Ltd.).

The second ordinary general meeting of this Company was held at the offices on Tuesday, under the presidency of Lord SUFFIELD.

The SECRETARY (Mr. W. J. G. FitzGibbon) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN said: I regret to see so few shareholders present to-day. I had hoped to have met a large number to hear what I consider to be good news, for though we may not be in a position to give you a dividend, we can show that we stand in a very satisfactory position. The report and accounts which we present to you to-day prove that the scheme of reconstruction proposed by the Directors, and loyally supported by the shareholders, has borne good fruit. The result of the

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year's trading, after writing off £435 for depreciation, has been a net profit of £2,465. 8s. 7d., or sufficient to pay a dividend of 2½ per cent., and to carry forward a respectable balance. The Directors would have preferred to recommend the payment of a dividend, but felt that, in the interests of the Company, this profit should be kept in hand for the development of the business, and to enable them to meet the increasing demand for the Company's manufactures. This demand during the past year has steadily increased, and the turnover is nearly 25 per cent. in excess of that for the period covered by the last balance-sheet. We have many new customers, whilst repeat orders show that the Brockie-Pell lamp is fully maintaining its reputation. Amongst the larger contracts may be mentioned 800 lamps for Westminster, 200 for Poplar, 200 for the tramways at Newcastle, 115 for the Brighton tramways, besides many other orders for smaller numbers. We have altogether 800 lamps in course of manufacture. We have the gratification in connection with one of these contracts to know that the consulting engineer for the work has a high opinion of these lamps from the point of view of small cost of maintenance. In addition to these contracts we have supplied 1,100 lamps for the lighting of the Glasgow Exhibition, and these have given great satisfaction. The orders received for the Brockie-Pell lamp during the recent quarter ended Sept. 30 were 50 per cent. in excess of those for the same period last year. I wish to add, at this point, that in Mr. FitzGibbon the Directors have found an able and energetic successor to Mr. Shrimpton. Mr. FitzGibbon has had considerable difficulties to overcome, and we owe to him in great measure our present satisfactory position. I now move the adoption of the report and accounts.

Sir F. D. DIXON-HARTLAND, Bart., M.P., seconded the resolution, and, referring to the absence in the accounts of any particulars of the trading account of the newly-constructed company, proceeded to give the shareholders these particulars. After dealing briefly with the past operations of the Company, he said that during the four years of the Company's existence the number of orders received had been 580, 831, 1,158, and 1,647 respectively, while for the first quarter of the current year they had been 435, and that, he thought, was a proof that they were making satisfactory progress. He expressed the belief that the Company had turned the corner and, if they had capital enough to work the business properly, would now become a dividend-paying concern. With regard to the Glasgow contract, they were spending a certain amount of money and could not yet tell how much profit there would be. There were many other well known firms eager to undertake the work, but the Brockie-Pell Company's offer was approved, and, apart altogether from any profit they might make, it was a splendid advertisement for them. Their lamps had never broken down, and he thought the report upon them at the close of the Exhibition would lead to an increase in sales. He thought he had shown that the Company was in a thoroughly sound position and that they had a good chance of making larger profits. They stood to-day in an entirely different position to that which, as a company, they had ever occupied before.

Dr. FEGAN referred to various items in the account, and said he was one of those who favoured the reconstruction of the Company. That reconstruction had brought them between £10,000 and £11,000 of capital, and he thought that, as a profit had been earned the dividend should be distributed among the shareholders, more particularly as the Directors were about to call up the balance due on the shares He would have thought that the £10,000 which had been obtained would have been ample for the business, and he hoped the Directors would see their way to divide the profits.

Mr. MORTON asked whether any profit had been credited in respect of the Glasgow Exhibition lamps. If the lamps had been taken into stock, had they been taken at cost, or at what figure?

Sir F. DIXON-HARTLAND said the question of the Glasgow lamps and how they had been disposed of was an important one. The Directors had taken no profit on them whatever. They had been taken into stock at cost price, and, therefore, any profit which came from the sales, in addition to the advantage of the advertisement, would appear in the next balance-sheet. A question has been asked as to whether the patents had been written down. In the accounts, patents and goodwill had been taken together, and the Directors considered that the goodwill had increased in value quite as much as the patents had decreased, and this item had, therefore, been left as before. He agreed with Dr. Fegan that it was hard on the shareholders not to distribute the dividend, and he, for himself, had looked forward eagerly to paying a dividend, and had, in fact, devised a scheme by which he had hoped the shareholders would have got a dividend without taking away the cash which the company required for continuing their operations, but their solicitor had come forward and said the scheme was not legal, and so it had to be given up. He thought if the Company did well in the current half-year there was no reason why the Directors should not consider the question of an interim dividend. In further reference to the question of the lamps at Glasgow, he considered they were of equal value as when they were supplied, and they were, in fact, in treaty now for the sale of 500 of them. With regard to the London and North-Western Railway's use of their lamps, which had been mentioned, a contract had been made by which that company paid a royalty to the Brockie-Pell Company for all lamps made.

Mr. BASDEN then answered questions concerning the profit and loss account. He said the new Company took over everything which the old Company possessed. With regard to the question of the Glasgow lamps, he would add to what Sir F. Dixon-Hartland had said, there was in the accounts a small sum for hire of these lamps, but nothing more. Against the wear and tear of the lamps, they had allowed for depreciation upon them. The lamps had been taken at cost, and then subjected to depreciation to allow for any slight repairs or touching-up they might require.

The resolution was then carried unanimously.

The auditors (Messrs. Mellors, Basden & Co.) were re-appointed, and the proceedings terminated.

## The Hiram Maxim Lamp Co. (Ltd.).

The first general (statutory) meeting of this company was held on Wednesday. Sir HENRY WARDLAW, Bart., presided.

The SECRETARY (Mr. F. Stokes) having read the notice convening the meeting,

The CHAIRMAN, in moving the adoption of the report, said that the company had incurred no extraordinary expenses and had its working capital practically intact. The whole of our share capital has been alloted, and there is not a single defaulter among our list of shareholders. The concession referred to in the prospectus was duly vested in the company, and they were in the position foreshadowed in the prospectus, the organisation and business of the company being now on a sound basis. They had the sole right and monopoly all over the world for the sale of the Maxim lamp, which was an invention of Sir Hiram S. Maxim. The factory belonging to the Sir Hiram Maxim Electrical Corporation, who manufactured the lamps, had recently been further equipped, at an expense of some thousands of pounds to the corporation, in order to anticipate an early increase in the Lamp Company's sales over the number contemplated by the prospectus. The style of the lamp, at the suggestion of their manager, had been improved. The demand for incandescent lamps, both at home and in the colonies was daily growing. Several of the lamps on the market enjoyed a high reputation; but the company had the advantage of being the last in the field, and they, consequently, had the best opportunity of considering all these merits and defects in conjunction with the new processes of Sir Hiram Maxim. They had thus been enabled to produce what they believed to be a perfected article. They would approach the sphere of competition at least with confidence. They did not aspire to the monopoly of the trade, even of this country, in incandescent lamps. They could not possibly meet the demands, even if they had the orders to do so, and he felt that they would have their work quite cut out to meet the daily requirements of their trade, increasing as it was in all directions. Arrangements were in course of negotiation for the company to be represented in the most influential centres, and important agencies were being established in the colonies, from which the company expected to receive large business. They had made arrangements for taking over the lease of show rooms situated in a central position in London, and branch establishments would also be opened in the important towns of the provinces, but the policy of the directors at the present time was to keep down the outgoings of the company to the lowest possible limit, so economising and making the working capital available for more extensive operations in connection with the sales. They were daily receiving sample orders from most large users of electric lamps who were desirous of testing their lamps against others, and they were not afraid of the result. They looked, by the end of the first trading year, to have reached, if not exceeded, the estimate of the sales mentioned in the company's prospectus. The Sir Hiram Maxim Electrical Corporation had appointed one director to the board (Mr. Jules de Meray, their chairman), and they had the right of nominating another. In conclusion, the chairman expressed the opinion that he was not too sanguine in foreshadowing the payment of an interim dividend. We have in our managing director, Mr. F. Stokes, and our manager, Mr. F. Trussell, two energetic men, and with electric lighting this is what is wanted to make the company a success. Improvements of one kind or another are being daily made, and, under the guidance of Sir Hiram Maxim, I do not doubt that we shall take advantage of all these improvements.

Mr. C. V. DE FALBE seconded the motion, which was adopted.

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In the report presented by the directors to the above meeting, it was stated that the total number of shares issued and alloted is 60,000, of which 45,000 were alloted as fully paid: 37,500 in satisfaction of the purchase price of the concession from the Sir Hiram Maxim Electrical and Engineering Co., Ltd., and 7,500 in connection with the subscription of working capital, and upon the remaining 15,000 shares 10s. has been called and paid up in cash, resulting in the Company receiving £7,500. The preliminary expenses had been £198. 2s. 6d.

## Cape Electric Tramways (Ltd.).

The fifth ordinary meeting was held on Wednesday, Col. Sir C EUAN-SMITH presiding.

The CHAIRMAN, in moving the adoption of the report, said the war in South Africa had indirectly affected the company somewhat prejudicially by delaying the erection of the new works and of landing rolling stock, &c., but had had otherwise no adverse influence upon them. They had carried over 2,000,000 passengers more than last year, and their net profits, after interest had been met on the debentures, were £75,922, compared with £65,204 in the previous year. The balance forward increased the total to £87,241. Two dividends were paid in February and August representing a distribution of 12 per cent., £20,000 was put to reserve, and £16,841 carried forward. From this directors' and auditors' fees, &c., had to be deducted. These results were highly satisfactory. The directors' report sets out the extensions which have been completed and sanctioned in Capetown and Port Elizabeth, but with regard to the extension to the dock gates it appeared that, although formal sanction for this extension had been passed, final instructions for the company to proceed with the work were withheld by the municipal authorities until certain matters now in negotiation were settled in a satisfactory manner. The delay in the landing and erection of their large units of new machinery and rolling stock had undoubtedly entailed an overcrowding of the cars at Capetown, and this had naturally caused some public discontent, but the directors had done all possible to meet the full requirements of the public, and within a very short time, when the works now in progress were finished, all these causes of discontent would disappear. He had no further information to give them as regarded the appeal which the Eastern Telegraph Co.

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had lodged in the House of Lords against the verdict of the Supreme Court in Cape Colony in this company's favour. The directors had decided upon an immediate distribution of an interim dividend of 4 per cent. for the current year. He could not, of course, predict that the company would in the immediate future be in a position to maintain this high rate of interest regularly.

The report was then adopted unanimously.

**CUBA SUBMARINE TELEGRAPH CO. (LTD.)**—The directors' report for the half-year to June 30 states that the total receipts for the six months were £12,007. 14s. 11d., and the expenses £5,519. 2s., leaving £6,488. 12s. 11d., to which is added £4,472. 9s. 2d. brought forward, making £10,961. 2s. 1d. Preference dividend absorbs £3,000, and a dividend at the rate of 4 per cent. per annum on the ordinary shares, tax free, is recommended, £4,761. 2s. 1d. being carried forward. The company's cables continued in good working order throughout the half-year, but the Manzanillo-Santiago section has since broken down, but the interruption does not affect traffic. No reply has yet been received from the United States Government regarding the payment of the subsidy of £2,000 per annum in respect of the coast cables, in arrear since January, 1899, or for the company's claim for damage done to the cables during the Spanish-American war.

**ELECTROLYTIC ALKALI CO. (LTD.)**—At the annual meeting on Friday the chairman (Mr. W. Thomson) stated that 4½ months' working had resulted in a profit of £1,241. The directors estimated that the constant working of the present limited plant would realise, even under present disadvantages, an annual profit of £3,800. Another unit would be working within six months, and on the present basis an annual profit of £15,000 should result. The directors proposed to issue £100,000 additional shares, and to immediately construct five additional units of plant.

**HAMPSTEAD ELECTRIC SUPPLY CO. (LTD.)**—An extraordinary meeting has been convened for the 21st. inst. to consider a scheme for the winding up and reconstruction of this company. In a circular which has been issued it is stated that—

"When the company was formed the amount of working capital available was considered sufficient for the company's business, but owing to its rapid development and the constant addition to the number of houses served by the company, it has proved inadequate. The number of houses so connected with the company's mains have increased from 500 to nearly 1,000 in the last two years, and this has entirely absorbed the working capital, and in addition about £10,000 further has been spent on the increase of plant and stock for the business of Messrs. Taylor and Lown belonging to the company. The directors consider that the electric lighting business can be so largely and profitably increased that they have decided, with the approval of the principal debenture holders, and all the large shareholders, to reconstruct the company. They also propose to either sell the business of Taylor and Lown, or to carry it on distinct from the Electric Lighting Company. Owing to the increased electric lighting business a distributing station in West End-lane is under consideration."

Then follows some calculations of future profits, the estimate for 1902 reaching £10,000! The scheme of reconstruction is, briefly, as follows:—Capital of new company £150,000, in 100,000 5 per cent. preference and 50,000 ordinary shares of £1 each. 145,140 of these shares are to be issued to present shareholders with 15s. credited as paid pro rata with present holdings class for class. At least £120,000 of this issue must be guaranteed in order to provide working capital of £20,000, after paying off existing loans and liabilities of about £10,000. The company is to have a debenture issue of £25,000 to replace the existing debentures for about £9,000, the balance being available for working capital. Existing shareholders should be allowed the advantages of this most unpromising reconstruction, and both debentures and ordinary shares be left to local investors exclusively.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BELL'S TIME INDICATOR (LTD.)**—Reg. Oct. 10, capital £3,000 in £1 shares, to carry on the business at Nottingham of electrical and mechanical engineers, &c.

**PIONEER POWER CO. OF LONDON (LTD.)**—Reg. Oct. 2, capital £10,000 in £1 shares, to manufacture and deal in plant and machinery used in the creation or application of any motive power, and in particular electricity, compressed and heated air and heated water, and in the application of the same to the haulage and propulsion of goods trucks and passenger vehicles; to equip, maintain and work by such motive power any train or railway, and to carry on the business of tramway, omnibus and light and other railway proprietors, manufacturers of accumulators, dynamos, &c. The subscribers are Earl Grey, Earl of Kintore, Sir C. R. Wilson, K.C.M.G., C. S. Drummond, C. S. B. Hilton, S. Lings and H. Phillips.

**TRAMWAYS CONSTRUCTION CO. (LTD.)**—Reg Oct 8, capital £1,000 in £1 shares, to carry on business as contractors for the construction and equipment of tramways, light railways, &c., and for the construction and equipment of electric lighting and other works, and to work, lease and carry on tramways or light railways as owners, lessees, or under contract.

**WESTERN TELEGRAPH CO. (LTD.)**—After transferring £35,000 to reserve and £2,000 to maintenance ships' reserve, a final dividend is recommended of 3s. per share (making a total of 6 per cent. for the year ended June 30) and a bonus of 2s. per share, both tax free. The transfer register will be closed from 22nd to 30th inst. inclusive.

## CITY NOTES.

**MEMORANDA.**—Bank rate 3 per cent. (since June 13, 1901). Price of silver 26 5/16d. per oz. (Oct. 17). Consols (2¾ per cent.) 93 1/16—93 3/16 for money, 93¼—93 1/16 for account; 2½ per cent. 94½ (Oct. 17). Consols Pay Day, Nov. 6; Stocks and Shares Continuation Days, Oct. 23 and Nov. 11; Ticket Days, Oct. 24 and Nov. 12; Pay Days, Oct. 25 and Nov. 13; Mining Share Carry-over Days, Oct. 22 and Nov. 8.

**INDO-EUROPEAN TELEGRAPH CO. (LTD.)**—An interim dividend has been declared for the half-year ended June 30, at the rate of 5 per cent. per annum, tax free, payable Nov. 1. The transfer books will be closed from 16th to 31st inst. inclusive.

**JUNGFRAU ELECTRIC RAILWAY.**—The traffic returns up to Sept. 30 show that for the first nine months of the year 23,944 passengers were carried. It is stated that the canton of Berne, the municipality of Interlaken, and other Swiss local authorities are taking a financial interest in the railway.

**NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)**—This company are inviting applications for £4,000 4 per cent. first mortgage debentures at 2 per cent. premium. The debentures are redeemable at par on Jan. 1, 1911.

**SUBMARINE CABLES TRUST.**—Tenders are invited from holders of certificates to be redeemed out of surplus income accrued to Oct. 15 at a price not to exceed £120 per certificate. Holders desirous of surrendering their certificates on these terms should communicate with the secretary, stating the lowest price they are willing to accept.

**STOCK EXCHANGE NOTICE.**—Renewed application had been made to the Stock Exchange committee to allow a further issue of 40,000 £1 fully-paid shares (Nos. 400,001 to 440,000) of the *Cape Electric Tramways (Ltd.)* to be quoted.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. (a) | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. (a) |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Oct. 12 | 677 | + 48 | 19 | 16,191 | + 1,680 |
| *Birmingham Tramways. | „ 12 | 4,778 | + 80 | 14 | 68,261 | + 4,848 |
| *Blackburn Corporation.. | „ 11 | 510 | + 50 | 41 | 20,664 | + 2,171 |
| Blackpool Corporation... | „ 10 | 535 | + 69 | †28 | 34,281 | + 8,668 |
| Blackpool and Fleetwood | „ 14 | 328 | - 6 | 15 | 18,869 | + 464 |
| Bolton Corporation ..... | „ 13 | 1,511 | + 232 | 28 | 43,116 | + 4,879 |
| Bradford Corporation... | „ 13 | 1,158 | + 618 | 28 | 31,430 | +16,853 |
| Brisbane Trams ..... | Aug. 28 | 1,774 | - 11 | 35 | 70,939 | + 8,140 |
| *Bristol Trams & Carriage | Oct. 11 | 3,850 | + 521 | 14 | 57,844 | + 8,160 |
| *Buenos Ayres & Belgrano | Sept. 15 | 3,099 | + 591 | 11 | 29,377 | + 4,629 |
| Calcutta Trams. Co. ... | Oct. 12 | R22,765 | +R5,497 | 15 | R312,234 | +R 21,159 |
| Carlisle Trams. Co. ..... | „ 12 | 161 | - 19 | 15 | 3,069 | + 61 |
| Central London Railway | „ 12 | 6,291 | + 870 | 15 | 86,435 | ... |
| City & South London Ry. | „ 13 | 2,061 | + 414 | 15 | 28,300 | + 5,416 |
| Cork Elec. Trams ..... | „ 10 | 468 | + 40 | 40 | 19,271 | + 2,218 |
| *Croydon... ... ..... | „ 11 | 532 | + 237 | 41 | 12,090 | - 6302 |
| Devonport..... | „ 11 | 232 | ... | 16 | 6,615 | ... |
| Dover Corporation ..... | „ 12 | 222 | + 3 | 28 | 7,138 | + 330 |
| Dublin & Lucan Rly. ... | „ 13 | 103 | + 12 | 15 | 1,998 | + 274 |
| Dublin Southern Dist.... | „ 11 | 787 | - 47 | ‡15 | 16,070 | + 1,046 |
| Dublin United ..... | „ 11 | 3,766 | - 81 | ‡15 | 53,709 | |
| Dudley—Stourbridge ... | „ 11 | 672 | + 319 | 41 | 27,022 | +14,736 |
| *Dundee Corporation ... | „ 9 | 689 | + 204 | 15 | 10,831 | + 3 502 |
| Gateshead ..... | „ 11 | 623 | ... | 22½ | 13,166 | ... |
| *Glasgow Corporation ... | „ 12 | 13,255 | +4,064 | 18 | 226,651 | +57,320 |
| Greenock—Port Glasgow | ... | ... | ... | ... | .. | ... |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| Hartlepool..... | „ 11 | 243 | + 39 | 41 | 9,395 | + 1,160 |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ..... | „ 12 | 2,294 | + 143 | 15 | 26,404 | + 5,742 |
| Kidderminster ..... | „ 11 | 110 | + 7 | 41 | 5,137 | + 605 |
| Liverpool Corporation... | „ 5 | 9,820 | +1,132 | 40 | 359,674 | +44,821 |
| *Liverpool Overhead Rly. | „ 13 | 1,425 | - 85 | 15 | 24,985 | - 797 |
| *Manchester Corporation | „ 12 | 2,216 | ... | §18 | 76,818 | - 32 |
| Merthyr..... | „ 11 | 223 | ... | 27 | 7,143 | ... |
| Middleton ..... | ... | ... | ... | ... | ... | ... |
| Oldham—Ashton ..... | „ 11 | 488 | + 478 | 41 | 20,594 | + 1,730 |
| Perth (W.A.) Elec. Trams | „ 12 | 843 | + 279 | ‡15 | 12,903 | + 6,979 |
| Poole ..... | „ 11 | 247 | ... | 27 | 8,243 | ... |
| Portsmouth Corporation | ... | ... | ... | ... | ... | ... |
| Potteries ..... | „ 11 | 1,426 | + 228 | 41 | 57.522 | +17.896 |
| *Sheffield Corporation .. | „ 13 | 3,677 | +1,138 | 15 | 56,638 | +17,795 |
| Southampton Corporat'n | „ 12 | 184 | + 299 | 12 | 14,034 | + 4,144 |
| Southend Corporation... | „ 12 | 184 | ... | 12 | 3,821 | ... |
| Southport ..... ..... | „ 11 | 164 | - 18 | 41 | 6,930 | - 2,643 |
| *South Staffordshire ..... | „ 11 | 810 | + 29 | 41 | 31,847 | + 2,269 |
| Swansea..... | „ 11 | 433 | + 26 | 41 | 18,181 | + 4,063 |
| Taunton..... | „ 11 | 74 | ... | 7½ | 795 | ... |
| Tynemouth ..... | „ 11 | 210 | ... | 29 | 8,813 | ... |
| Wolverhampton District | „ 11 | 90 | + 37 | 41 | 2.595 | + 528 |

(a) These comparisons are for the corresponding period last year.
b Under conversion to electric traction.
* Partly electrical. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days.

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# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 9. | Price Wednesday, Oct. 16. | Rate per Cent. Yielded. | Dividend Due. | Business Done during Week ending Oct. 16. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | £ s. d. | | Highest | Lowest |
| | | | **ELECTRICITY SUPPLY.** | | | | | | |
| 100,000 | 1 | ... | El'ekh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅜ ⅝ | ⅜ ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | 39/4½ | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) xd | 95 100 | 95 100 | ... | ... | ... | ... |
| 7,500 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 12 13 | 12 13 | 4 12 4 | ... | ... | ... |
| 7,500 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 9½ 10½ | 9½ 10½ | 4 5 9 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 6 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7⅞ 8⅛ | 7⅞ 8⅛ | 4 4 10 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8⅛ 8⅜ | 8⅛ 8⅜ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 2/0 | Calcutta Elec. Supply Ordinary (fully paid) | 7⅞ 8 | 7⅞ 7⅞ | 2 5 2 | ... | ... | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 5 0 | February and August | 9½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 5⅜ | 5⅛ 5⅜ | 3 18 3 | ,, ,, | 5⅜ | ... |
| £250,000 | Stock | 8/1 | Do. 4% Deb. Stock Red. (Prov. Certs.) | 104 106 | 104 106 | 3 13 2 | ... | 106½ | 1 06⅜ |
| 34,000 | 5 | 2/6 | Chelsea Elec. Supply Ord. (Nos. 1-14,000 & 20,501-40,590) | 5 5⅛ | 4⅞ 5⅛ | 5 4 9 | March | 5⅛ | 5 |
| 10,436 | 5 | 1/5·42 | Do. (Nos. 40,501-50,936) | 5 5⅛ | 4⅞ 5⅛ | 5 4 9 | ... | 4 15/16 | ... |
| £180,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 1 4 | June and December | ... | ... |
| 70,579 | 10 | ... | City of London Electric Lighting Ord. | 9 10 | 9½ 9¾ | ... | February and August | 8 13/16 | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 11½ 12½ | 11½ 12½ | 4 16 0 | January and July | 11½ | 11 13/16 |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 122 127 | 3 19 6 | June and December | ... | ... |
| £200,000 | Stock | 46/5 | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 102 105 | 101 104 | 4 7 10 | ... | 103 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8⅞ 9⅛ | 8⅞ 9⅛ | 4 4 3 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 12 13 | 12 13 | 4 12 4 | March and September | ... | ... |
| £400,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 104 107 | 104 107 | 4 5 4 | ... | 106½ | ... |
| 10,000 | 5 | 4/0 | Folkestone Electricity Supply Co. Ordinary | 5⅛ 5⅜ | 5⅛ 5⅜ | 3 9 7 | ... | ... | ... |
| 11,000 | 5 | 3/6 | Hove Electric Lighting Ordinary | 7⅛ 8⅛ | 7 8 | 5 0 0 | ... | ... | ... |
| 21,000 | 5 | 5/0 | Kensington and Knightsbridge Ordinary | 11 12 | 11 12 | 4 3 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6⅞ 7 | 6⅞ 7 | 4 5 9 | January and July | ... | ... |
| £90,000 | Stock | 4% | Do. 4% Deb. Stock (red.) [Deb. Stk. (red.) | 101 104 | 101 104 | 3 17 6 | ... | ... | ... |
| £100,000 | Stock | 4% | Kenstn. & Knytbg. Co. & Notting Hill Co. (J't. St'n.) 4% | 101 104 | 101 104 | 3 16 11 | ... | 102 | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1⅛ 1⅜ | 1⅛ 1⅜ | ... | ... | ... | ... |
| 42,840 | 5 | ... | Do. 6 per Cent. Preference | 4 5 | 4 5 | ... | ... | ... | ... |
| £260,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 96 100 | 96 100 | 4 0 0 | Mar., June, Sept., Dec. | ... | ... |
| 98,767 | 10 | 6/0 | Metropolitan Elec. Supply Ord. (1 to 85,000) | 13 14 | 12½ 13½ | 4 8 11 | April and October | 13⅛ | 13 |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 115 | 113 116 | 3 18 5 | June and December | ... | ... |
| £260,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 100 | 97 100 | 3 10 3 | ... | 97½ | 97 |
| 8,652 | 10 | 6/0 | Notting Hill Electric Ordinary | 15½ 16½ | 15½ 16½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5 6 | 5 6 | 4 3 4 | ,, | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debenture Stock | 99 102 | 99 103 | 3 19 0 | ... | ... | ... |
| 300,000 | 1 | ... | Rand Electric | ⅜ ½ | ⅜ ½ | ... | ... | ... | ... |
| £135,000 | Stock | ... | River Plate Elect. Lt. & Traction 5% 1st Mor. Deb. | 60 70 | 60 70 | ... | January and July | ... | ... |
| £107,500 | 100 | 4½% | *Royal Electric Co. of Montreal 4½% 1st Mrt. Dbs. xd | 100 102 | 100 102 | 4 8 3 | April and October | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 16 | 15 16 | 4 10 8 | February and August | 15⅝ | 15½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | ,, ,, | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 97 100 | 97 100 | 3 10 6 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 9 8 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2 3 | 2½ 3 | ... | ... | ... | ... |
| 109,518 | 5 | 5/0 | Westminster Electric Supply Ordinary | 11½ 12½ | 11⅝ 12⅛ | 4 4 0 | March and September | 11 7/16 | 11⅝ |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | |
| 260,007 | 5 | 2/0 | Anglo-Argentine Shares (1 to 260,007) | 4 4½ | 4 4½ | 4 14 1 | April and October | 4 3/16 | 4 1/16 |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 125 123 | 125 123 | 4 14 10 | ... | 123 | ... |
| 20,000 | 10 | ... | Barcelona Tramways Ordinary | 8 9 | 8 9 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5% Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ... | ... | ... |
| £49,800 | 100 | 5% | Do. 5% Debentures | 96 101 | 96 101 | 4 19 9 | ... | ... | ... |
| £148,100 | Stock | 4½% | Do. 4½% Debenture Stock (red.) | 92 97 | 92 97 | 4 13 6 | ... | ... | ... |
| 15,000 | 10 | 1/0 | Blackpool and Fleetwood Tramways | 13 14 | 13 14 | 4 12 10 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ 3 | 2½ 3 | ... | ... | 2 15/16 | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ 5 | 4½ 5 | ... | ... | 4 7/16 | 4 1/16 |
| £400,000 | Stock | 34/7 | Do. 4½% Deb. Prov. Certs. | 103 105 | 103 103 | 4 6 7 | ... | 104½ | ... |
| 50,000 | 10 | 8% | Bristol Tramways and Carriage Ordinary | 21½ 22½ | 21½ 22½ | 3 13 1 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10⅝ 10⅞ | 10⅝ 10⅞ | 3 15 0 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 115 | 112 115 | 3 10 2 | February and August | ... | ... |
| 20,000 | 10 | 4/0 | British Columbia Electric Railway Ordinary | 6 6½ | 6 6½ | 3 1 6 | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5% Preference | 9½ 9¾ | 9½ 9¾ | 5 2 7 | May and November | 9⅝ | 9 7/16 |
| £250,000 | 40 | 4½% | Do. 4½% 1st Mort. Debs. xd | 101⅞ 103⅞ | 101⅝ 103⅞ | 4 9 1 | ... | ... | ... |
| 62,074 | 10 | 12/0 | British Electric Traction Ordinary | 14 15 | 14 15 | 6 0 0 | ... | 14½ | ... |
| 90,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11⅞ 12⅛ | 11⅞ 12⅛ | 4 18 0 | February and August | 12 3/16 | 12 |
| £600,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 121 124 | 121 124 | 4 0 8 | ... | 122⅝ | ... |
| 100,000 | 5 | ... | Buenos Ayres & Belgrano Ordinary | 1⅞ 2⅛ | 1⅞ 2⅛ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5⅛ 5⅜ | 5⅛ 5⅜ | 5 4 4 | ... | ... | ... |
| 27,500 | 5 | 3/0 | Do. "B" | 5⅛ 5⅜ | 5⅛ 5⅜ | 2 3 6 | ... | 5 5/16 | ... |
| £230,000 | Stock | 5% | Do. 5 per Cent. Debentures | 105 108 | 105 103 | 4 13 10 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 100 103 | 100 103 | 4 13 6 | ... | ... | ... |
| 34,440 | 10 | 6/0 | Calcutta Tramways (Nos. 1 to 34,440) | 11⅞ 12⅛ | 11⅞ 12⅛ | 2 8 0 | ... | 11⅝ | ... |
| £350,000 | 100 | 4½% | Do. 4½ 1st Deb. Stock (Red) | 105 103 | 105 108 | 4 4 6 | ... | 107⅛ | 103⅛ |
| 400,000 | 1 | 1/2½ | Cape Electric Tramways Shares | 1⅞ 2⅛ | 1⅞ 2⅛ | 2 16 6 | ... | 1 15/16 | ... |
| £1,965,800 | Stock | 4% | Central London Ordinary Stock | 101 104 | 103 106 | 3 1 11 | June and December | 104⅛ | 103 |
| £440,100 | Stock | 4% | Do. 4% Preferred Stock | 106 108 | 105 104 | 3 15 2 | ... | 106⅜ | 105⅛ |
| £440,100 | Stock | ... | Do. Deferred Stock | 93 101 | 93 102 | ... | ... | 101⅛ | 100 |
| £698,201 | 100 | 4% | Do. 4% Deb. Prov. Scrip. Certs | 113 118 | 113 118 | 3 8 3 | ... | ... | ... |
| 40,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. xd | 5⅛ 5⅜ | 5 5⅛ | 4 1 11 | ... | 5 1/16 | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. xd | 103 101 | 101 104 | 3 16 11 | ... | 104 | 103 |
| £955,000 | Stock | 4½% | City and South London Railway Con. Ordinary | 51 54 | 51 54 | 2 15 7 | February and August | 53 | ... |
| 47,500 | 10 | 2/0·84 | Do. Ordinary (Nos. 22,501 to 70,000) | 5 5½ | 5 5⅛ | 3 15 9 | ,, ,, | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 129 134 | 129 134 | 3 15 2 | ,, ,, | ... | ... |
| £333,000 | Stock | 5% | Do. (1896) | 123 127 | 123 127 | 3 19 2 | ... | ... | ... |
| £413,918 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 113 113 | 113 118 | 3 8 6 | May and November | ... | ... |
| 60,000 | 10 | 4/0 | Dublin United Tramways (1896) Ltd., Ordinary | 12 13 | 12 13 | 3 16 11 | ... | ... | ... |
| 52,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 3½% | Do. 3½ per Cent. Mort. Debs. (red.) | 97 100 | 97 100 | 3 10 0 | ... | 97 | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ 5 | 4½ 5 | ... | ... | ... | ... |
| 78,500 | 10 | 2/9½ | Great Northern and City Railway Pref. Ord. (4%) | 7⅛ 8⅛ | 7⅛ 8⅛ | ... | ... | 8⅛ | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ 22⅝ | 21½ 23⅛ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ 15 | 14½ 15 | 4 0 0 | ,, ,, | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 111 113 | 111 113 | 4 0 6 | January and July | ... | ... |
| 37,500 | 10 | 2% | Liverpool Overhead Railway Ordinary xd | 6½ 7 | 6⅛ 6⅞ | 3 13 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference xd | 13 13½ | 13 13½ | 3 15 6 | ,, ,, | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 104 | 103 104 | 3 17 10 | January and July | ... | ... |
| £350,000 | Stock | 34/8 | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Crts. (fllypd) | 105 107 | 105 107 | 3 15 6 | ... | ... | ... |
| $6,103,000 | $1,000 | 5% | Milwaukee Elec. Rail. & Lt. Co. 5% 30yr Cn. Mrt. Bonds | 110 114 | 110 114 | 4 8 6 | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'r'l'g 5% Mort. Debs. (1908) | 100 102 | 100 102 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1932) | 100 102 | 100 102 | 4 8 11 | ... | ... | ... |
| 24,000 | 5 | 4/0 | New General Traction Ordinary | 2½ 3½ | 2½ 3½ | 5 14 4 | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4 5 | 4 5 | 6 0 0 | May | ... | ... |
| 13,334 | 10 | 4/0 | Potteries Electric Traction Ordinary | 11½ 12½ | 11½ 12½ | 1 12 0 | ... | ... | ... |
| 10,000 | 10 | 5 0 | Do. 5 per Cent. Cumulative Preference | 9⅞ 10⅜ | 9⅞ 10⅜ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 106 109 | 106 109 | 4 3 1 | ... | ... | ... |
| 250,000 | 1 | ... | South Lancashire Electric Traction & Power Ord. | ... | ... | ... | ... | ... | ... |
| 51,182 | 1 | ... | Do. 6% Preference (8/0 paid) | ... | ... | ... | April and October | ... | ... |
| 50,000 | 1 | ... | Do. 6% Preference (fully paid) | ... | ... | ... | ,, ,, | ... | ... |
| £500,000 | Stock | ... | Do. 4½% Debenture Stock (40% paid) | ... | ... | ... | January and July | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 91 94 | 91 94 | 3 3 10 | June and December | 90 | 91 |

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## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 9. | Price Wednesday, Oct. 16. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 16. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £82,300 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 100 103 | 100 103 | 3 18 5 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | 3⅛ 4⅛ | 3⅛ 4 | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 78 83 | 78 83 | ... | ... | ... | ... |
| £801,720 | Stock | 15/0 | Anglo-American xd | 53 56 | 52 55 | 5 13 8 | Feb., May, Aug., Nov. | ... | ... |
| £3,097,640 | Stock | 30/0 | Do. Preferred xd | 98 100 | 97 99 | 6 0 11 | ,, ,, | 99⅜ | 98½ |
| £3,097,640 | Stock | 5/0 | Do. Deferred | 10 10½ | 10½ 10¾ | 2 6 6 | ,, ,, | 10 7/16 | 10⅜ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 175 185 | 175 185 | 4 6 8 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,029 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 100 102 | 100 102 | 3 18 5 | ,, ,, | 101⅜ | 101⅛ |
| 16,000 | 10 | 4/0 | Cuba Submarine Ordinary | 5 6 | 5 6 | 7 10 0 | February and August | 5 5/16 | 5 5/16 |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 13½ 14½ | 13½ 14½ | 6 17 11 | ,, ,, | 14 | ... |
| 13,000 | 5 | 2 0 | Direct Spanish Ordinary | 3 4 | 3 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | ,, ,, | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100⅞ 104⅞ | 100⅞ 104⅞ | 4 7 6 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable xd | 10½ 11⅛ | 10⅛ 11⅛ | 5 13 1 | Jan., Apr., July, Oct. | 11⅛ | ... |
| £104,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 100 103 | 100 103 | 4 8 4 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200) (red.)xd | 141 146 | 139 144 | 4 17 3 | Jan., Apr., July, Oct. | 143 | 140 |
| £1,930,807 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock xd | 96 99 | 95 98 | 3 11 5 | ,, ,, | ... | ... |
| £1,432,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 114 117 | 114 117 | 3 9 6 | May and November | 115⅜ | 115⅛ |
| 300,000 | 10 | 2/6 | Eastern Extension xd | 14 14½ | 14 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14⅜ | 14 |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 114 119 | 114 119 | 3 7 6 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 103 | 100 103 | 3 18 1 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101⅞ 104⅞ | 101⅞ 104⅞ | 3 18 3 | May and November | ... | ... |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 30 32 | 30 32 | 4 13 9 | January and July | 30⅛ | 30⅛ |
| £78,006 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (wthn Nos | 100 103 | 100 103 | 4 8 3 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European [1 to 1,200) (red. | 41 45 | 41 45 | 5 11 1 | May and November | 43 | 42½ |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 105 | 102 105 | 5 14 3 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 100 103 | 3 18 5 | June and December | ... | ... |
| £155,600 | 100 | 5% | *West African Telegraph 5% Debentures (red.) | 99 102 | 99 102 | 4 17 10 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ⅛ ⅜ | ⅛ ⅜ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 100 103 | 3 18 5 | January and July | 100⅛ | 1 ⅜ |
| 88,321 | 10 | ... | West India and Panama | ⅛ ⅜ | ⅛ ⅜ | ... | May and November | ... | ... |
| 34,563 | 10 | ... | Do. 6 per Cent. 1st Preference | 5 6 | 5 6 | ... | ,, ,, | ... | ... |
| 4,669 | 10 | ... | Do. 6 per Cent. 2nd Preference | 3 5 | 3 5 | ... | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 101 104 | 101 104 | 4 17 4 | January and July | ... | ... |
| 20,930 | 10 | 3/0 | Western Telegraph (late Br zil'n Submarine) | 14½ 15 | 14⅛ 15 | 4 13 4 | Mar., June, Oct., Dec. | 14⅛ | 14⅛ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 106 | 103 1 6 | 4 15 6 | June and December | 1 6 | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 103 105 | 103 106 | 3 16 2 | ... | 101⅛ | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 5/0 | Chili Telephone (fully paid) | 3⅛ 4 | 3⅛ 4 | 6 5 0 | August | ... | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 2/9 2/6 | 2/6 3/0 | 10 0 0 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ⅛ ⅜ | ⅛ ⅜ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ,, | ... | ... |
| 590,000 | 5 | 2/6 | National | 4 4½ | 4½ 4½ | 5 11 1 | February and August | 4 7/16 | 4 5/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 14 | 12 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ 5 | 4⅜ 5 | 5 0 0 | ,, ,, | 4⅜ | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 98 99 | 98 99 | 3 11 5 | June and December | 98⅜ | 97 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 98 | 96 99 | 4 2 0 | ... | 97⅛ | 96⅛ |
| 171,504 | 1 | 0/6 | Oriental | ⅜ 1 | 15/16 1⅛ | 5 12 11 | April and October | 1 | ... |
| 58,000 | 5 | 4/6 | United River Plate | 5 5½ | 5 5⅜ | 6 7 3 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4⅜ 5⅜ | 4⅜ 5⅜ | 4 15 3 | June and December | ... | ... |
| £ 79,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 105 | 102 105 | 4 16 5 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ⅜ ½ | ⅜ ½ | 5 14 3 | ... | ... | ... |
| 125,000 | 1 | ... | Aron Electricity Meter Ordinary | 9/16 11/16 | 9/16 11/16 | ... | ... | ... | ... |
| 125,000 | 1 | 7½d. | Do. 6% Cumulative Preference | ⅜ ½ | ⅜ ½ | 8 14 6 | March and September | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 8 9 | 8 9 | 8 6 8 | July and February | 8⅛ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5⅛ 5⅜ | 5⅛ 5⅜ | 5 4 4 | January and July | 5⅜ | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4⅜ 5⅛ | 4⅜ 5⅛ | 5 14 3 | ... | ... | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering | 1⅜ 1⅝ | 1⅜ 1⅝ | 5 14 3 | September | 1 7/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 2⅛ | 2 2⅛ | 5 6 8 | ,, | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... ... | ... ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 102 105 | 102 105 | 4 5 9 | March and September | 104⅛ | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 99 102 | 99 102 | 4 9 1 | January and July | ... | ... |
| 30,000 | 5 | 10/0 | Callender's Cable Construction Ord. | 15 16 | 15 15 | 4 13 9 | ,, ,, | 15⅛ | 15 |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ 6⅛ | 5⅜ 6⅛ | 4 0 0 | ,, ,, | 5 5/16 | 5⅜ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 111 115 | 111 115 | 3 19 0 | November and May | ... | ... |
| 450,000 | 1 | 0/2½ | Castner-Kellner Alkali Co. (fully paid) | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| £250,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 92 95 | 92 95 | 4 15 6 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ½ 1 | ½ 1 | 8 0 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ½ 1 | ½ 1 | 6 0 0 | ... | ... | ... |
| 54,000 | 3 | 2/8½ | Crompton and Co. (Nos. 1 to 54,000) | 3 3⅛ | 3 3⅛ | 6 8 6 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb.(red.) | 100 105 | 100 105 | 4 15 8 | ,, ,, | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | ... | Edison & Swan United ("A" Shares) (£3 paid) | ⅛ ⅜ | ⅛ ⅜ | ... | February and August | ... | ... |
| 17,139 | 5 | ... | Do. (£5 paid) | 1⅜ 2⅛ | 1⅜ 2⅛ | ... | ,, ,, | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 80 85 | 80 85 | 4 15 3 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts. (all pd) | 84 89 | 84 89 | 5 12 4 | ... | ... | ... |
| 35,500 | 5 | 4/6 | Edmundson's Electricity Corporation Ord. | 5⅜ 6⅛ | 5⅛ 6⅛ | 5 12 0 | Half-yearly | 5 7/16 | 5⅜ |
| 20,000 | 5 | 1/6½ | Do. 6% Cumulative Preference | 5⅜ 6 | 5⅛ 6 | 5 0 0 | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 105 108 | 105 103 | 4 4 6 | ... | 10 ⅜ | 106⅛ |
| 112,100 | 2 | 1/2½ | Electric Construction Co. | 1¾ 2¼ | 1⅝ 2⅛ | 5 6 8 | January and July | 1 15/16 | ... |
| 31,390 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2⅛ 2⅜ | 2⅛ 3 | 4 13 4 | July | 2⅛ | 2 1/16 |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 98 102 | 98 102 | 3 18 10 | January and July | ... | ... |
| 18,000 | 10 | 2/10 | General Electric (1900) Ltd. 5% Cum. Pref. | 9⅞ 10⅛ | 9⅞ 10⅛ | 4 17 7 | ... | 10⅛ | ... |
| £150,000 | Stock | 4% | Do. 4% 1st Mortgage Debentures | 97 100 | 97 100 | 4 0 0 | ... | ... | ... |
| 35,000 | 5 | 5/0 | Henley's Telegraph Works Ordinary | 16½ 17½ | 16½ 17½ | 6 1 5 | February and August | 16⅝ | ... |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5⅛ 6 | 5⅛ 6 | 3 15 0 | ,, ,, | 5 15/16 | ... |
| £19,050 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 111 115 | 112 116 | 3 17 11 | ,, ,, | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 22 23 | 22 23 | 4 6 11 | ,, ,, | 22⅜ | 22 1/16 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 103 | 100 103 | 3 17 7 | March and September | ... | ... |
| 7,500 | 10 | ... | Parker (Thomas) Limited Ordinary | 15½ 16½ | 15½ 16½ | ... | .. | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintnce. | 38 42 | 38 42 | 5 0 0 | March and July | 39⅛ | 39⅛ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 104 106 | 104 106 | 3 16 2 | January and July | ... | ... |
| 25,000 | 5 | 8/0 | Do. Manufacturing Ordinary | 10½ 11⅛ | 10⅛ 11⅛ | 5 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5⅜ 6 | 5⅜ 6 | 4 3 4 | ... | ... | ... |
| 40,000 | 5 | 5/0 | Willans and Robinson Ordinary xd | 10 11 | 10 11 | 5 9 0 | April and October | 10⅜ | 10 1/16 |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Pref. xd | 6½ 7 | 6⅛ 6⅞ | 4 8 11 | ,, ,, | 6⅛ | 6⅛ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 7 | May and November | ... | ... |
| | | | **FINANCIAL, INVESTMENT, &c.** | | | | | | |
| 19,900 | 5 | 3/0 | Electric and General Investment 6% Cum. Pref. | 5 5⅛ | 5 5⅛ | 5 9 1 | ... | 5 5/16 | 5⅛ |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 11 11⅛ | 11⅛ 11⅜ | 4 9 4 | Jan., Apr., July, Oct. | 11⅜ | 11⅛ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 15⅛ | 15 15⅛ | 3 17 5 | ,, ,, | 15 1/16 | 15 |
| 11,839 | 8 | 4/0 | Reuter's xd | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,333 | £100 Cert. | 6% | Submarine Cables Trust xd | 127 132 | 125 130 | 4 12 2 | ,, ,, | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but *not* for redemption.
† The London Stock Exchange Committee refuses to quote these.

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# THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF ELECTRICAL ENGINEERING, INDUSTRY & SCIENCE.

No. 1,222. [No. 26. VOL. XLVII.] FRIDAY, OCTOBER 18, 1901.

Registered at the General Post Office.

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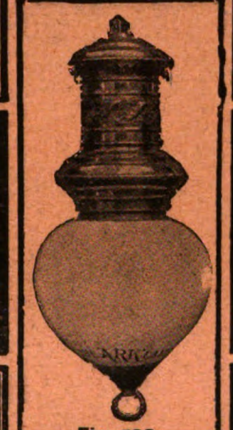

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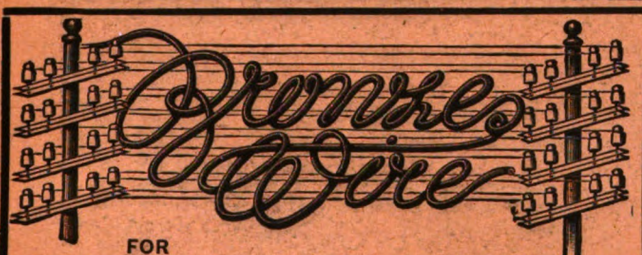


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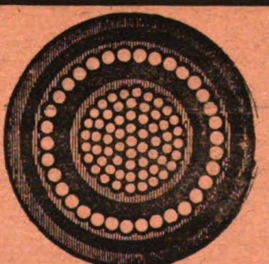

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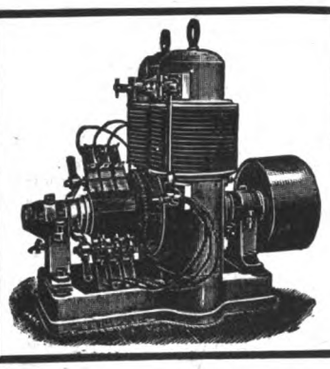

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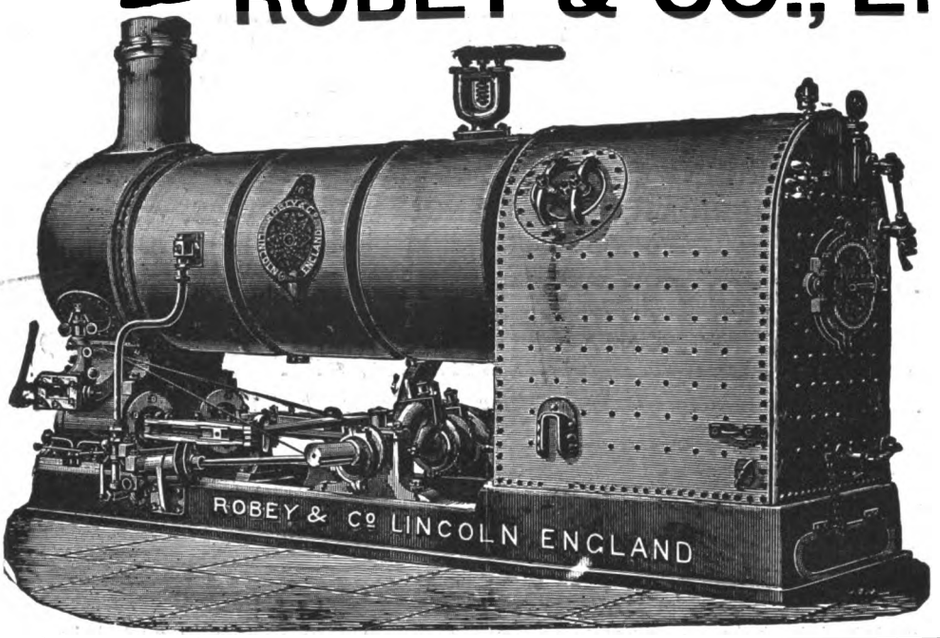


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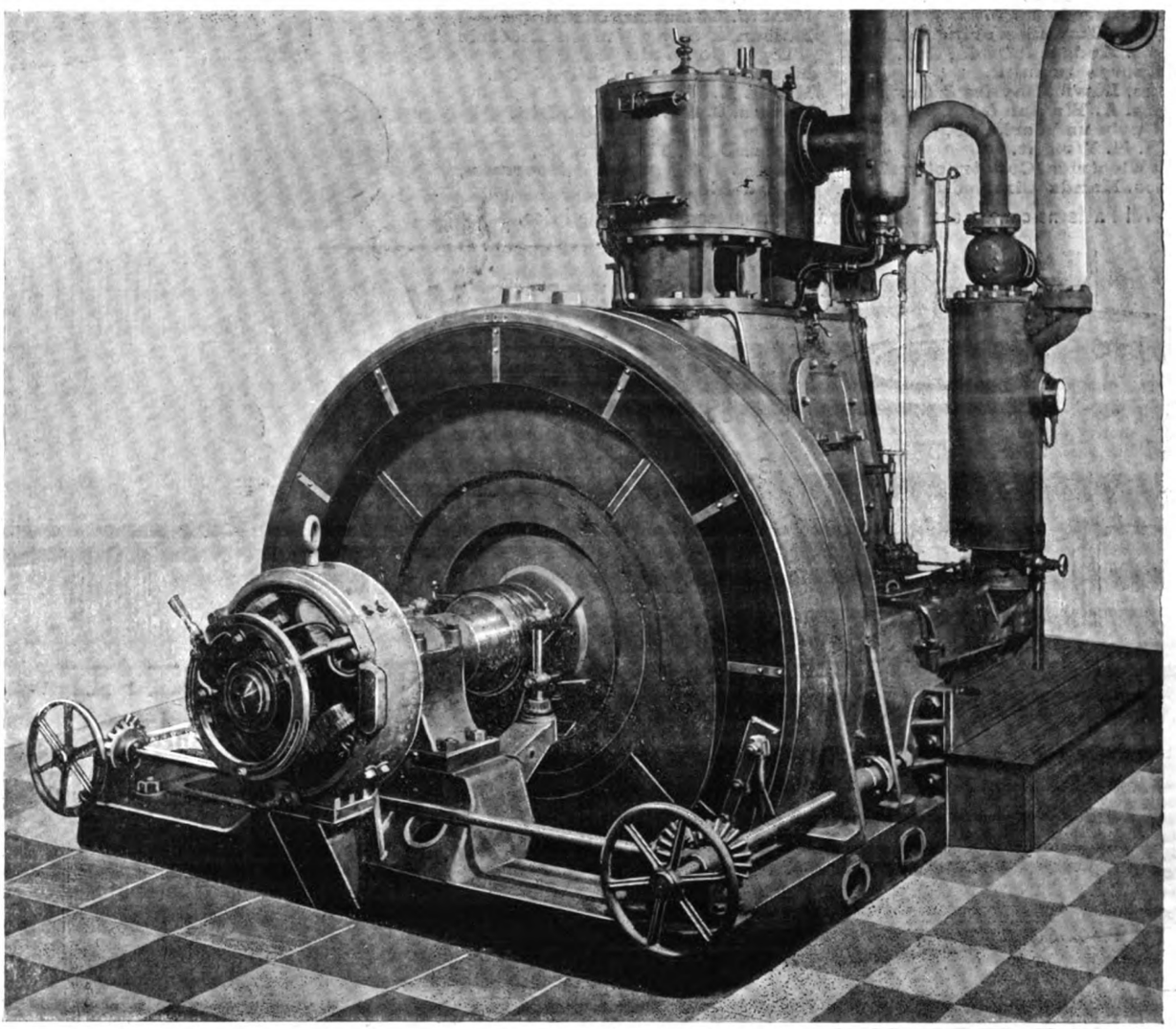

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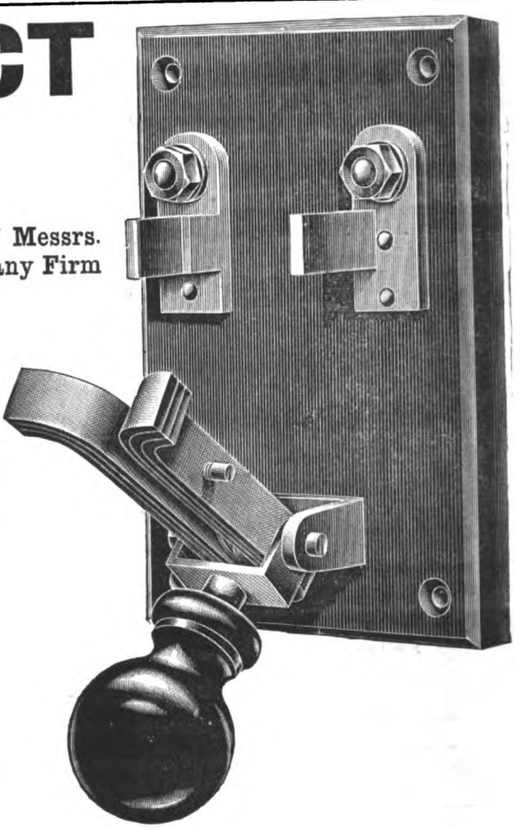

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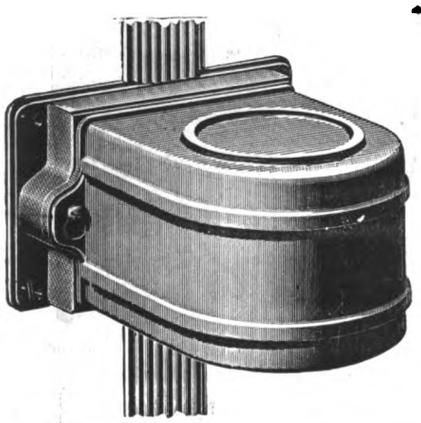

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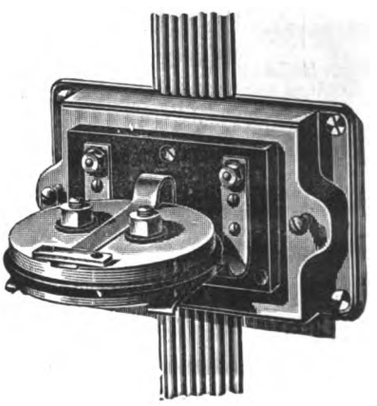

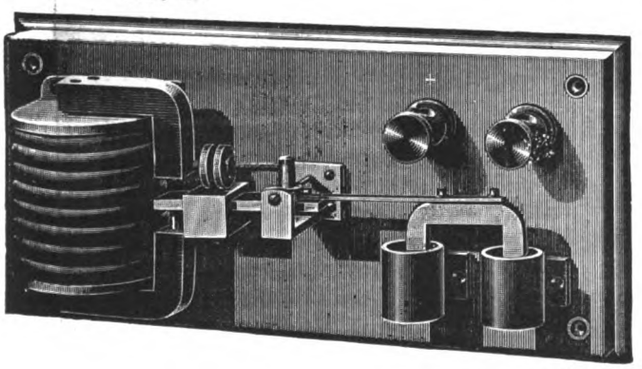

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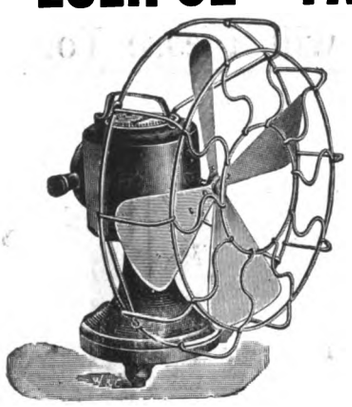

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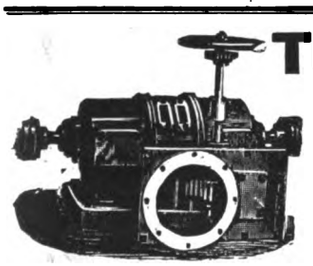

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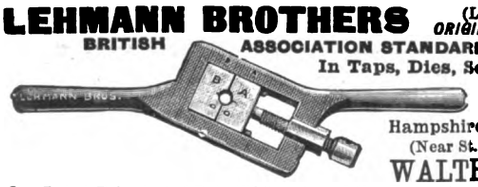


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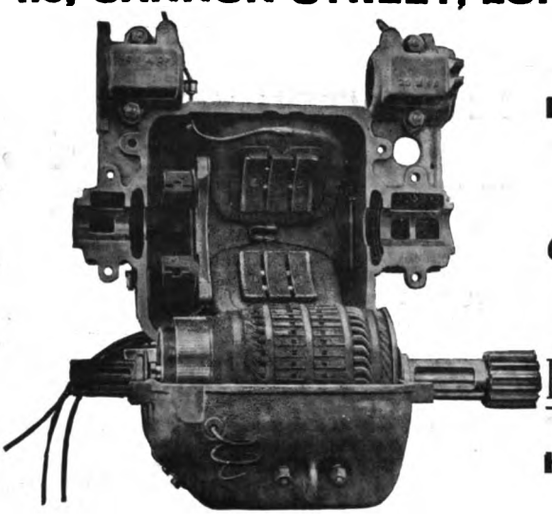

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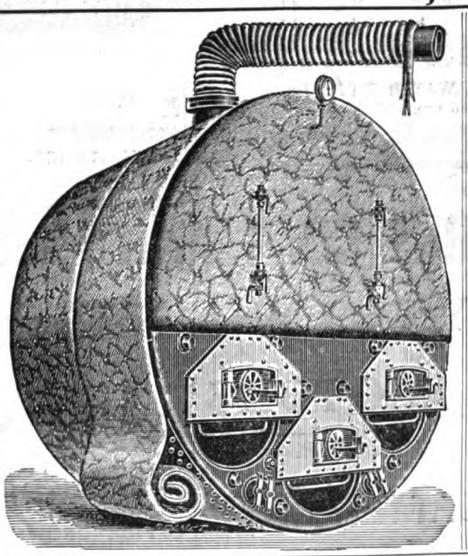

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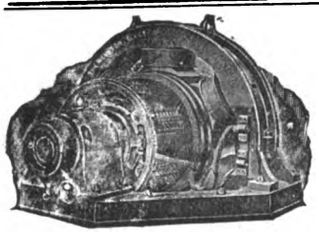

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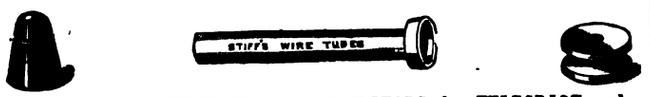


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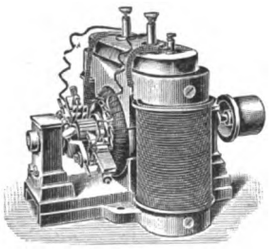

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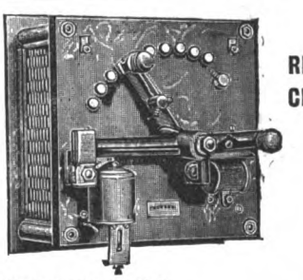

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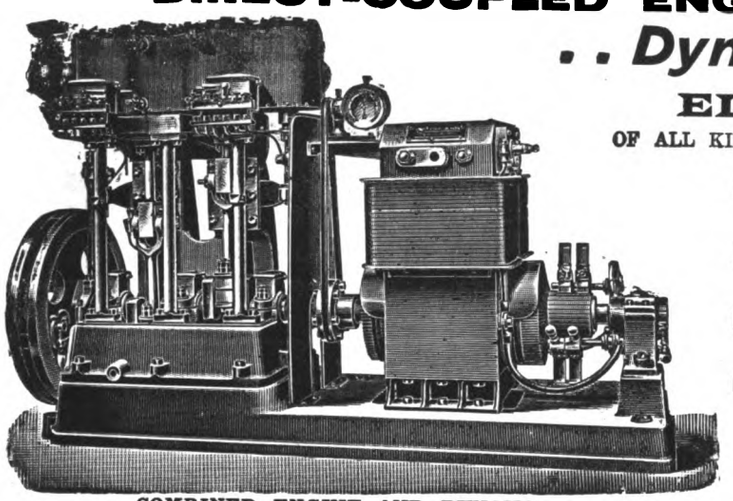

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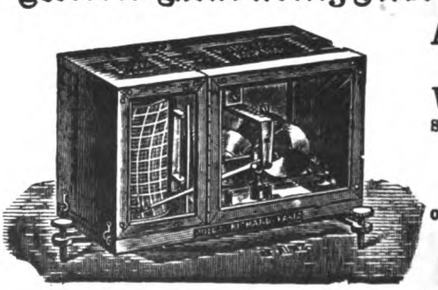

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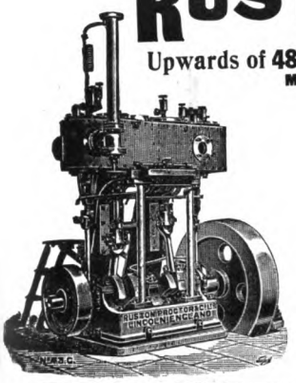

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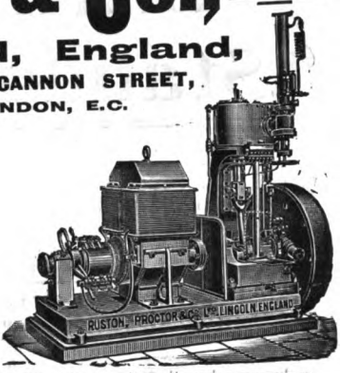

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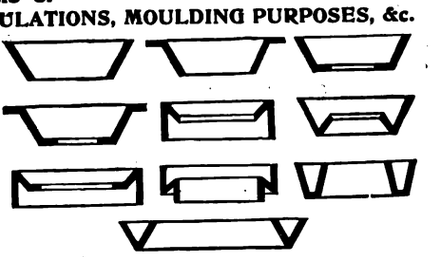

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Many of the Chief Engineers of Electricity Stations are applying these Separators as quickly as they can be completed, several being repeat orders, and all who have tried them testify to their perfect efficiency.

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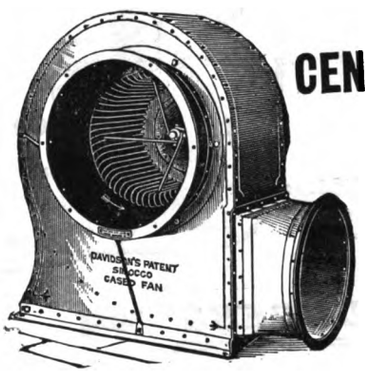


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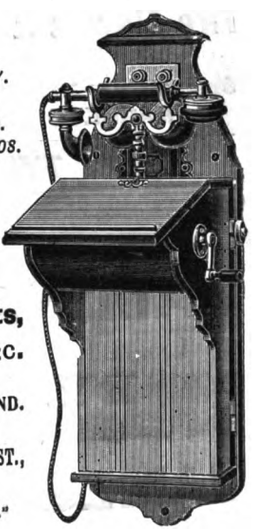

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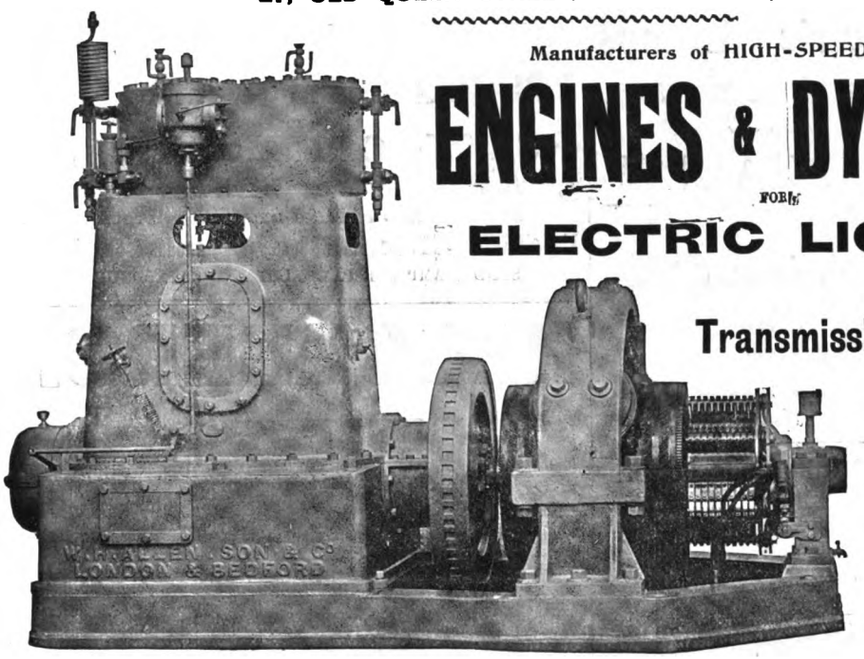


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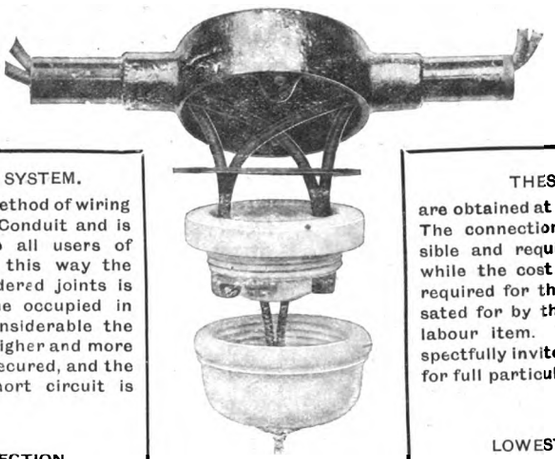
SUPERIOR FITTINGS.



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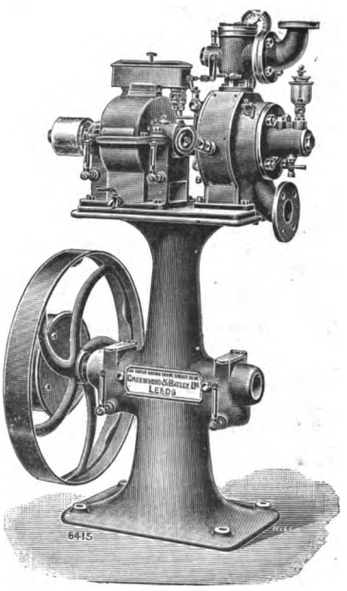

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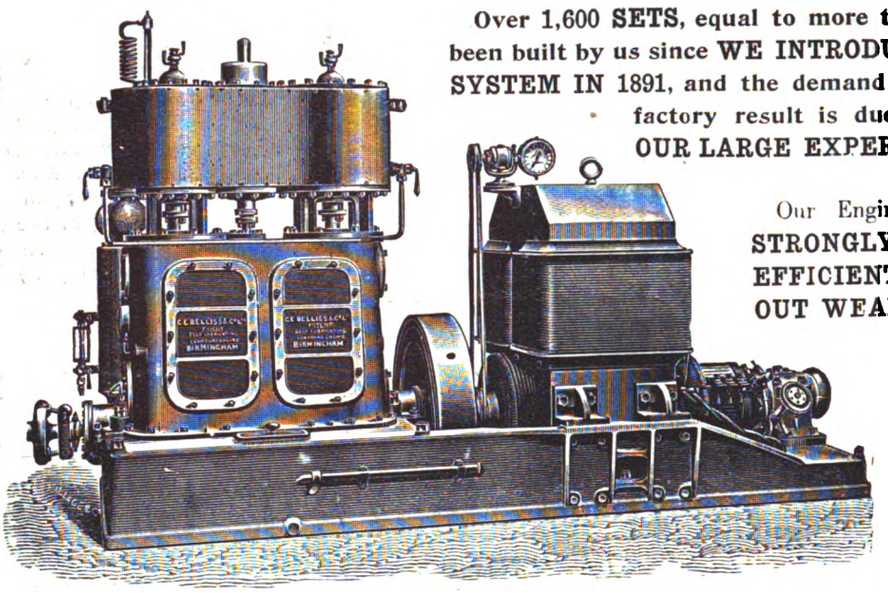

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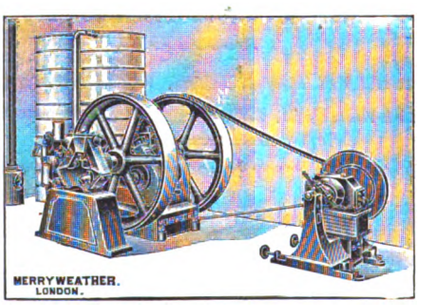


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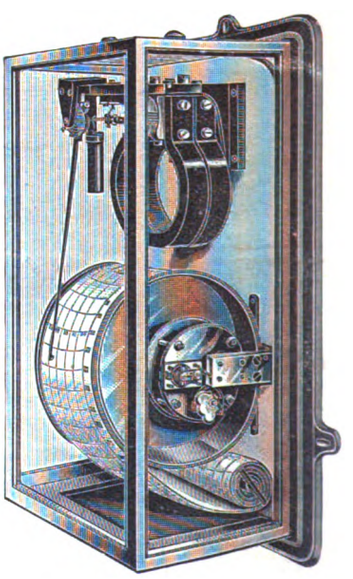

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**MARRIAGES.**

LEHMANN—REEKIE.—On 25th Sept., at Camden-road Chapel, London, OSCAR LEHMANN (of Lehmann Brothers, Walthamstow, and South Villas, Camden Square), youngest son of the late Theodor Lehmann, to BELLA, youngest daughter of James Reekie, of Brecknock-road, N.W.

THOMAS—TYRER.—On 2nd Oct., at Manchester, FRANK THOMAS, of Cornbrook Telegraph Works, Manchester, to ALICE, daughter of Thomas Tyrer, Esq., Forest Gate, London.

APPLEYARD—EVANS.—On 12th Oct., at St. Peter's, Limpsfield, by the Rev. E. M. Blackie, rector of the Parish, assisted by the Rev. L. P. Smith, ROLLO APPLEYARD, A.M.Inst.C.E., son of S. Appleyard, Esq., of Herne Hill, London, S.E., to MABEL LAMING, daughter of the late Worthington Evans, Esq., of York-terrace, London, N.W.

## SUBMARINE CABLES TRUST.

NOTICE is Hereby Given that, in accordance with the terms of the Trust Deed, Tenders are invited from the Certificate Holders of Certificates to be Redeemed out of Surplus Income, accrued to 15th October instant, at a price not to exceed £120 per Certificate, the Certificate Holder retaining the Coupon of Reversion attached to any Certificate which may thus be redeemed.

Certificate Holders desirous of surrendering their Certificates on the above-mentioned terms should communicate at once with the undersigned, stating the lowest price they are willing to accept.

By order of the Trustees,
SIDNEY COLLETT, Secretary.

Winchester House, 50, Old Broad-street,
London, E.C., 15th October, 1901.

## BUSINESS FOR DISPOSAL.

RELINQUISHING BUSINESS.—FOR SALE as a Going Concern, the BUSINESS of JOSEPH EDMONDSON, Electrical and Mechanical Engineer, Albert Works, Hey-street, Longside Lane, Bradford. Specialities:—Motor Starting Switches, Arc Lamps and Automatic Cut-outs with equivalent resistances, Automatic Locking Signals and Automatic Time Recorders for Electric Tramways, Starters for Gas Engines.—Apply (Principals only) to the Proprietor.

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CATALOGUES FREE

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## TENDERS INVITED.

## CORPORATION OF ROCHDALE.

ELECTRICITY WORKS.
EXTENSIONS.—CONTRACT NO. 2.

**BOILERS, ECONOMISERS, STOKERS, CONDENSERS, PUMPS AND PIPEWORK.**

The Corporation of Rochdale invite TENDERS for the Supply, Delivery, and Erection at the Electricity Works, Rochdale, Lancashire, of Three Lancashire Boilers, Economiser and Mechanical Stokers, and for Two Ejector Condensers and Circulating Pumps, One Feed Pump, One Grease Extractor, and the extensions to the present Steam, Exhaust, Condenser and Feed Pipes.

Copies of the General Conditions, Specification, Form of Tender and Plans, may be seen at the Offices of the Engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King-street, Manchester, and 2, Queen Anne's Gate, Westminster, and may be obtained from the latter Office only on and after the 22nd October, 1901, on payment of Three Guineas, which amount will be returned on receipt of a bona-fide Tender. Further copies of the Specification may be obtained on payment of a further fee of One Guinea, which will not be returned.

The firm whose Tender is accepted will be required to enter into a Contract to be prepared by and to contain such clauses as the Town Clerk may think necessary.

Tenders, on the prescribed Form, endorsed "Electricity Works Extensio s," must be delivered to the undersigned on or before the 8th day of NOVEMBER, 1901.

The Corporation do not bind themselves to accept the lowest or any Tender.

By order,
JAMES LEACH, Town Clerk.

Town Hall, Rochdale, October, 1901.

## BOROUGH OF ASHTON-UNDER-LYNE.

ELECTRIC TRAMWAYS.

**OVERHEAD ELECTRICAL EQUIPMENT.**

The Corporation are prepared to receive TENDERS for the Supply, Delivery, and Erection, in the Borough of Ashton-under-Lyne, of STEEL POLES, BASES, SECTION BOXES, and OVERHEAD LINE for the equipment of the first section of Electric Tramways, approximately 1¼ miles long.

Copies of the General Conditions, Specification, and Form of Tender, may be obtained from the undersigned on payment of a deposit of One Guinea, which will be returned upon receipt of a bona-fide Tender.

Tenders, on the prescribed Forms, must be sealed and delivered at the Office of Mr. John Neal, Town Hall, Ashton-under-Lyne, not later than 12 noon TUESDAY, October 29th, 1901, and endorsed "Tender for Overhead Equipment."

The Corporation do not bind themselves to accept the lowest or any Tender.

By order,
N. APPELBEE, Borough Electrical Engineer.

Electricity Works, Ashton-under-Lyne,
7th October, 1901.

## SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO., LIMITED.

SOUTH LANCASHIRE TRAMWAYS.

Contract No. 10.—**INSULATED ELECTRIC CABLES, &c**

The Directors invite TENDERS for the Supply and Laying of HIGH and LOW-TENSION INSULATED ELECTRIC CABLES, STONEWARE PIPES, &c.

Specifications and Forms of Tender may be obtained and Plans inspected at the Offices of the Consulting Engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, on payment of a deposit of Three Guineas, which sum will be returned on receipt of a bona-fide Tender.

The Directors do not bind themselves to accept the lowest or any Tender, and the Contractor whose Tender is accepted shall enter into a formal agreement under seal with sufficient sureties, for the due performance of his Contract.

Sealed Tenders must be delivered before noon on NOVEMBER 4th next, addressed to

The CHAIRMAN and DIRECTORS,
South Lancashire Electric Traction and Power Co., Ltd.
12, St. John's Lane, Liverpool.

## CITY OF LIMERICK.

**ELECTRIC LIGHTING.**

The Council are prepared to receive TENDERS for the Supply, Delivery and Erection of Electrical Plant and Apparatus.

Section 1.—CABLES.
Section 2.—ARC LAMPS, WESTINGHOUSE ENGINES, DYNAMOS, BOOSTERS and DOWSON GAS-PLANT.

Preference will be given to a Contractor who tenders for the whole of the work.

Copies of Specifications, &c., may be obtained at the office of James Enright, 47, Victoria-street, S.W., on and after the 18th inst., on payment of Three Guineas each Section, which will be returned on receiving a bona-fide Tender with the Specifications and complying with the directions thereon.

Sealed Tenders with Specifications, endorsed on the outside "Electric Lighting," to be received not later than the 28th inst. by WILLIAM M. NOLAN, Town Hall, Limerick.

The Council do not bind themselves to accept the lowest or any Tender.

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## TENDERS INVITED—*continued.*

### URBAN DISTRICT COUNCIL OF HURST.

ELECTRIC TRAMWAYS.

**OVERHEAD ELECTRICAL EQUIPMENT.**

The Council are prepared to receive TENDERS for the Supply, Delivery, and Erection, in the Urban District of Hurst, of STEEL POLES, BASES, SECTION BOXES, and OVERHEAD LINE for the equipment of Electric Tramways, approximately 1½ miles long.

Copies of the General Conditions, Specification, and Form of Tender, may be obtained from the undersigned on payment of a deposit of One Guinea, which will be returned on receipt of a bona-fide Tender.

Tenders, on the prescribed Forms, must be sealed and delivered at the Office of Mr. John Whitworth, Law Clerk to the Council, Booth-street, Ashton-under-Lyne, not later than 12 noon on the 29th OCTOBER, 1901, and endorsed "Tender for Overhead Equipment."

The Council do not bind themselves to accept the lowest or any Tender.

EDWARD GARSIDE, A.M.I.C.E., Engineer.

Town Hall Chambers, Ashton-under-Lyne,
October, 1901.

### COUNTY BOROUGH OF OLDHAM.

The Oldham Corporation Electricity Committee invite TENDERS for the Supply and Delivery of:—

(*a*).—CONCENTRIC FEEDER CABLE, PILOT CABLE, JOINT BOXES, &c.
(*b*).—MOTOR BOOSTER, MOTOR GENERATORS, SWITCH GEAR, &c.

Copies of the Specifications can be obtained from Mr. Arthur Andrew, Gas and Water Offices, Oldham, on payment of One Guinea, to be returned on receipt by the Corporation of a bona-fide Tender.

The Specifications can be seen at, but not obtained from, the Offices of Messrs. Kennedy and Jenkin, 17, Victoria-Street, Westminster, S.W.

The Corporation do not bind themselves to accept the lowest or any Tender, and no allowance whatever will be made for any expenses incurred in the preparation of any Tender.

Tenders must be sent to the Superintendent, Mr. Arthur Andrew, on or before TUESDAY, 5th November, 1901.

A. NICHOLSON, Town Clerk.

Oldham, 14th October, 1901.

### CHESHAM URBAN DISTRICT COUNCIL AND ELECTRIC LIGHTING.

The Chesham Urban District Council having obtained a Provisional Order enabling them to supply Electricity within the Chesham Urban District, INVITE PERSONS and COMPANIES able to carry out ELECTRICAL UNDERTAKINGS to TENDER, stating the terms upon which they would be willing to take over the Provisional Order, and to submit a Scheme of Electric Lighting which they would be willing to carry out for the Urban District, with full information as to the price proposed to be charged for Electricity and terms and conditions under which the same could hereafter, if desired, be taken over by the Chesham Urban District Council.

The Council do not bind themselves to accept any Scheme or Tender.

Schemes, with conditions, terms, &c., in answer to the above, should reach the undersigned not later than SATURDAY, November 16th.

JOHN GIBBON HOW,
Chesham, October 3rd, 1901. Clerk to the Chesham Urban District Council.

THE CORPORATION OF LONDONDERRY invite TENDERS for the Supply of **CARBONS** for one year from 1st January, 1902. Schedules of Quantities and further particulars may be obtained on application to the Borough Electrical Engineer, Electric Lighting Station, Londonderry.

Tenders, accompanied by samples, marked "Tenders for Carbons," to be lodged with me not later than 1st NOVEMBER, 1901. The lowest or any Tender not necessarily accepted.

R. N. CHAMBERS, Town Clerk.

Londonderry, October 16th.


**J. W. BARNARD,**

Offices: 4, GREAT WINCHESTER ST., E.C.
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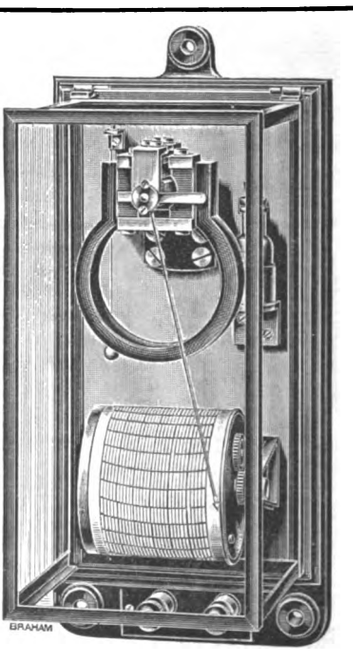

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## TENDERS INVITED—*continued.*

### BOROUGH OF BOOTLE.

**TOWN HALL ELECTRIC LIGHTING INSTALLATION.**

The Corporation of Bootle invite TENDERS for the WIRING of the EXTENSION of the TOWN HALL BUILDINGS in Trinity-road for purposes of ELECTRIC LIGHTING.

Specification and Form of Tender may be obtained from the Borough Electricity Works, Pine-grove, on payment of One Guinea, which will be returned on receipt of a bona-fide Tender.

Tenders (sealed and endorsed "Tender for Electric Wiring") to be addressed to the Finance Committee, and delivered at the Town Hall not later than noon on WEDNESDAY, the 23rd October instant.

The lowest or any Tender will not necessarily be accepted.

The person whose Tender may be accepted will be required to enter into a Contract containing clauses as to payment of standard rates of wages, &c.

By order,
J. HENRY FARMER, Town Clerk.

12th October, 1901.

## APPOINTMENTS VACANT.

### LONDON COUNTY ASYLUM, HORTON, EPSOM, SURREY.

REQUIRED, a Working Engineer, to act as **CLERK OF WORKS**, under the Asylum's Engineer. He will be required to take charge of the whole of the Engineering Appliances (which include the Heating System, Electric Light Installation, Laundry Machinery, and Cooking Apparatus), and the Central Station for Electricity and Water Supply, now in course of completion, at this institution. He must be a thorough mechanic, able to control men, and with experience of Electric Light Plant.

Salary £3 per week, with an allowance of 10s. a week in lieu of lodging.

The appointment will be a temporary one, but the person appointed will, if suitable, be considered for the post of working foreman engineer on the opening of the asylum.

Persons desirous of applying must write, enclosing a stamped addressed envelope, to the undersigned, for an application form, upon which the conditions of service and other particulars will be stated.

Applications are to be delivered here by or before 10 o'clock a.m. on TUESDAY, October 29th, 1901.

R. W. PARTRIDGE, Clerk of the Asylums Committee.
Asylums Committee Office, 6, Waterloo-place, S.W.,
October 12th, 1901.

### BOROUGH OF HAMMERSMITH.

ELECTRICITY DEPARTMENT.

**SUPERINTENDING ENGINEER** required, to take charge of Electricity Generating Station, under the supervision of the Borough Electrical Engineer.

Candidates must have had some years' practical mechanical experience in Workshop and Drawing Office, and have sound theoretical knowledge of Mechanical Engineering. Commencing salary £175 per annum.

List of Duties and Application Forms, which must be returned not later than FRIDAY the 25th instant, may be obtained from the undersigned.

G. GILBERT BELL, Borough Electrical Engineer.
57, Fulham Palace-road, Hammersmith.

## APPOINTMENTS VACANT—*continued.*

### CITY OF BRADFORD.

**SHIFT ENGINEER.**

The Bradford Corporation are prepared to receive APPLICATIONS for the position of Shift Engineer at their Valley-road Generating Station.

Applicants must have served an apprenticeship in the works of a Mechanical Engineer of some standing, and must have previous experience in Direct-current Central Station running. Age limit 21 to 35. Salary 50s. per week of 56 hours. One month's notice required on either side.

Applications, stating age and full particulars of previous experience and qualifications, with copies of not more than three recent testimonials (which will not be returned) to be sent to the undersigned not later than MONDAY, October 28th.

R. A. CHATTOCK, M.I.E.E., City Electrical Engineer.
Town Hall, Bradford.

### ELECTRIC POWER SUPPLY ON TYNESIDE.

The Newcastle-upon-Tyne Electric Supply Company, Limited, intend to appoint several **JUNIOR ASSISTANTS** and are prepared to receive applications from apprentices out of their time or young men who have been through a college course in Electricity. Remuneration to commence at the nominal wage of 10s. per week, increasing by definite amounts as the engagement proceeds.

Applicants will be required to sign an agreement to remain in the Company's service for a period of at least two years; during this time they may pass through the different classes of sub-stations, and have an opportunity of seeing other work under the Company's control, including polyphase and continuous current systems as applied to both lighting and tramways.

Applications, stating age, training, and enclosing not more than one testimonial to be addressed to J. S. WATSON, General Manager, 50, New Bridge-street, Newcastle-upon-Tyne.

### MANCHESTER CORPORATION TRAMWAYS.

The Tramways Committee of the Manchester Corporation require a number of **TROLLEY LINESMEN** for the Erection of the Overhead Equipment of their Electric Tramways. Wages 9d. per hour. Applications, stating experience and age, to be made, by letter only, to Mr. J. M. MCELROY, General Manager, Corporation Tramways, 55, Piccadilly, Manchester.

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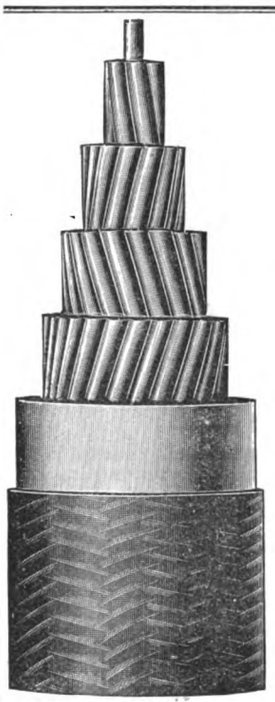
**"The Electrician" Printing & Publishing Co., Ltd., Salisbury Court, London.**

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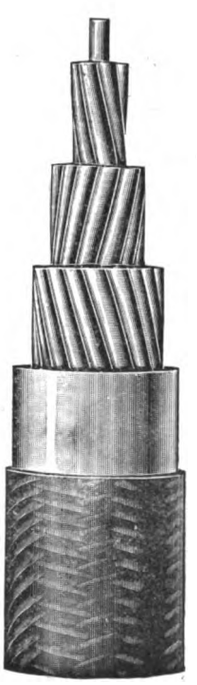

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This Handbook has been written especially to meet the requirements of Electrical Engineers in Supply Stations, Electrical Factories and Testing Rooms. The Book consists of a series of Chapters, each describing the most approved and practical methods of conducting some one class of Electrical Measurements, such as those of Resistance, Electromotive Force, Current, Power, &c., &c. It does not contain merely an indiscriminate collection of Physical Laboratory processes without regard to suitability for Engineering Work. The Author has brought to its compilation a long practical experience of the methods described, and it will be found to be a digest of the best experience in Electrical Testing. The Book includes a Chapter on the Equipment of Electrical Laboratories and numerous Tables of Electrical Data, which will render it an essential addition to the library of every practical Electrician, Teacher, or Student.

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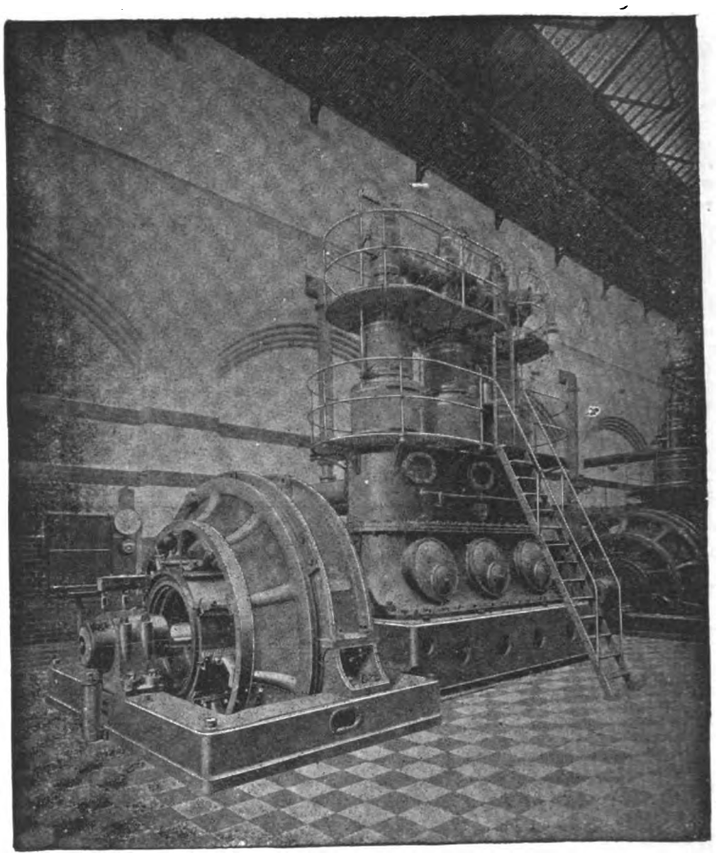

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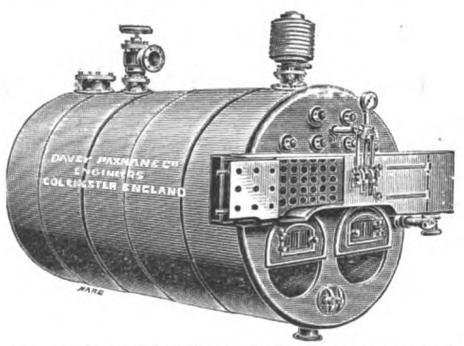


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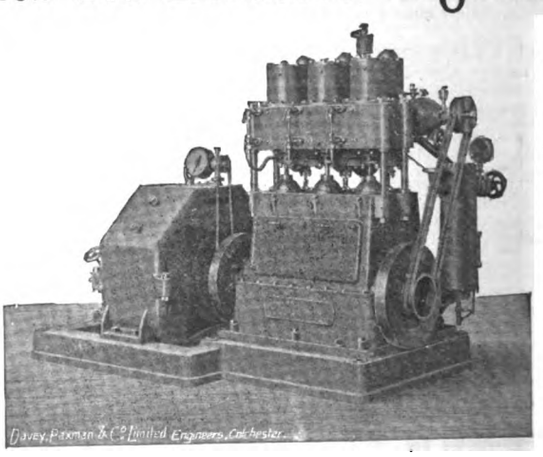


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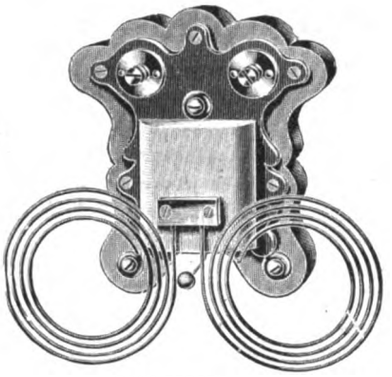

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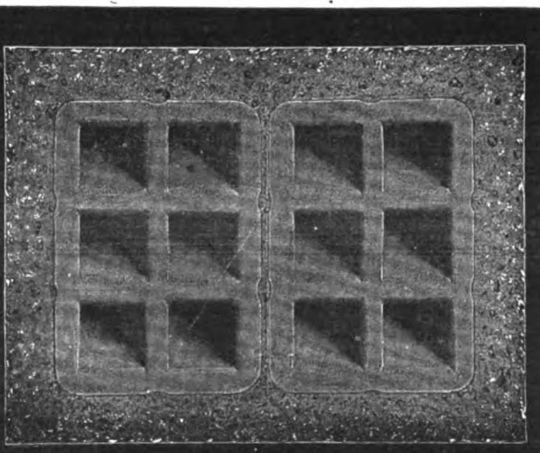

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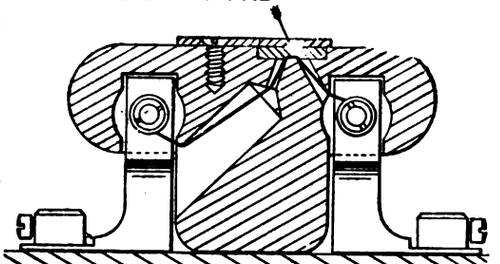

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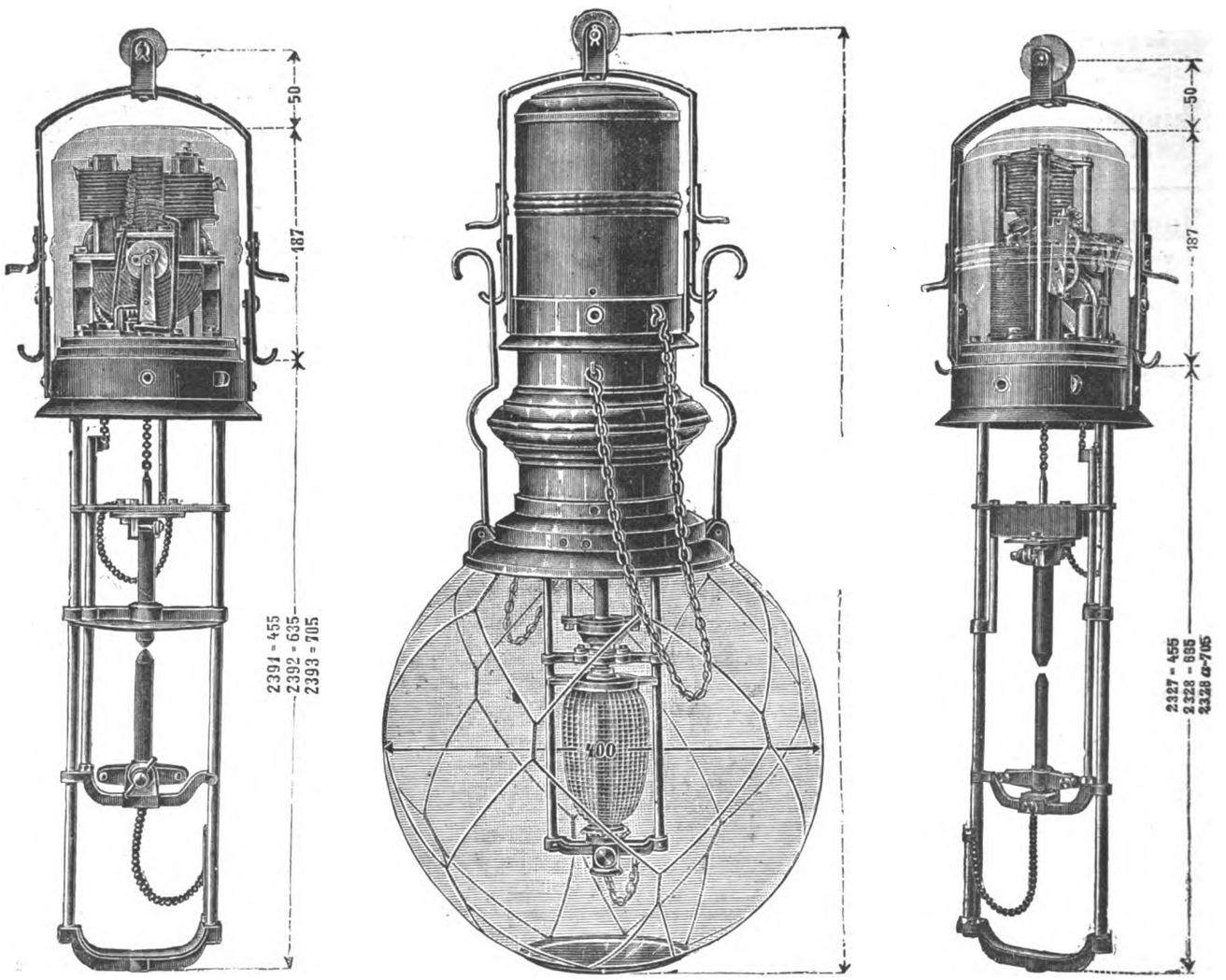


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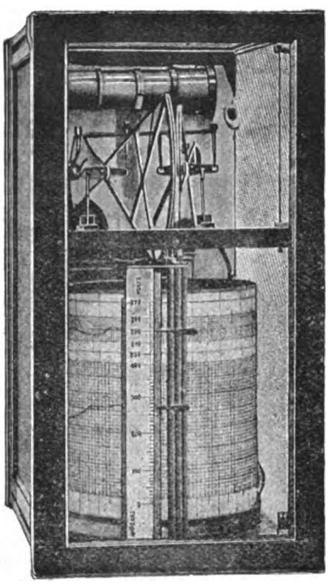

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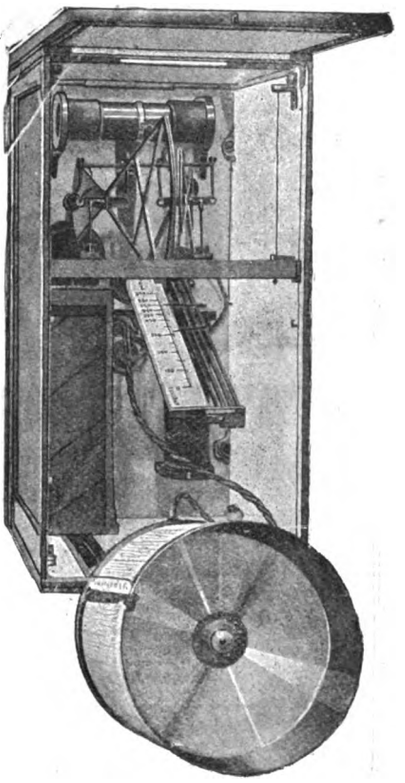

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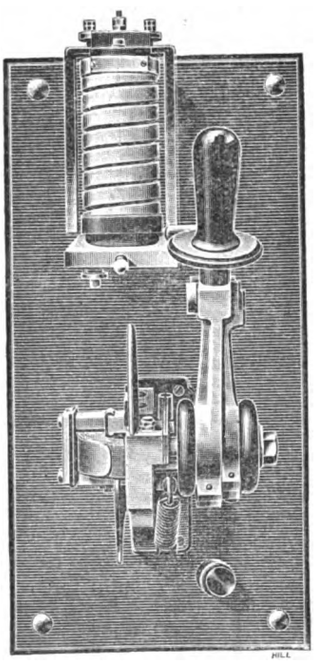

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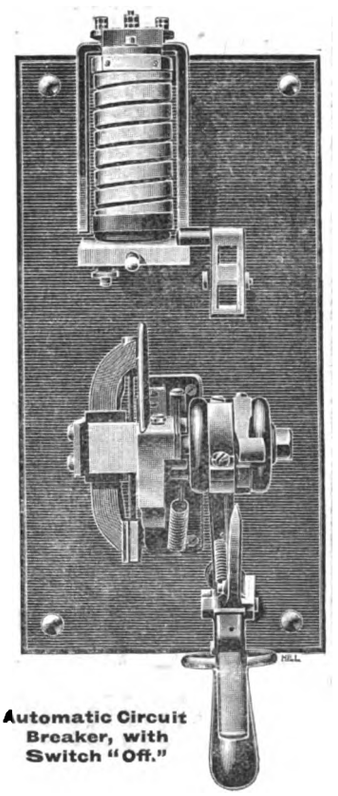

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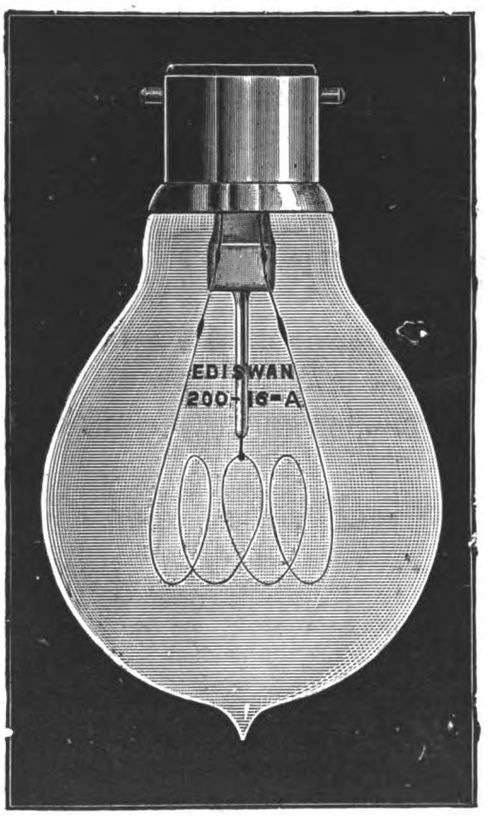


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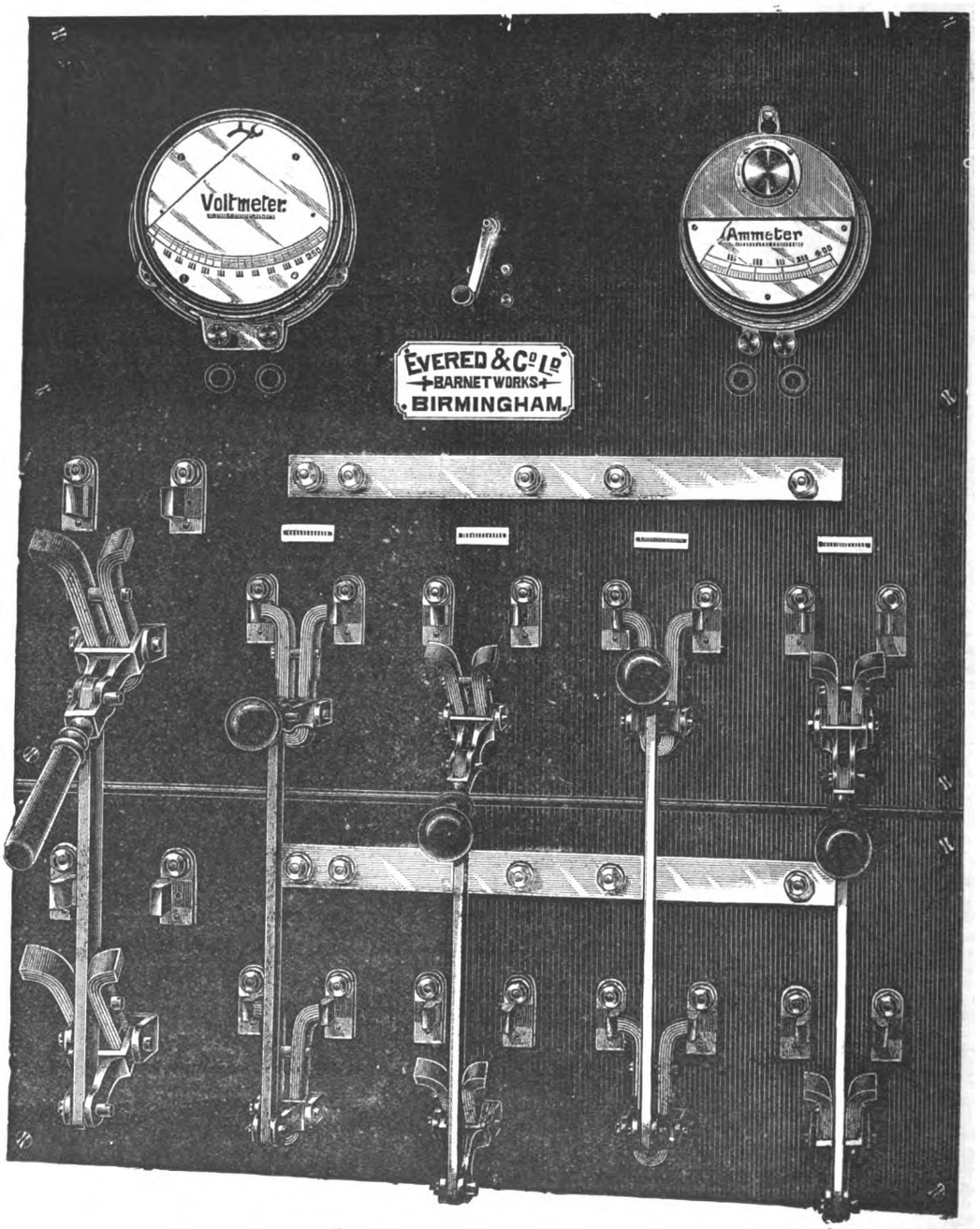


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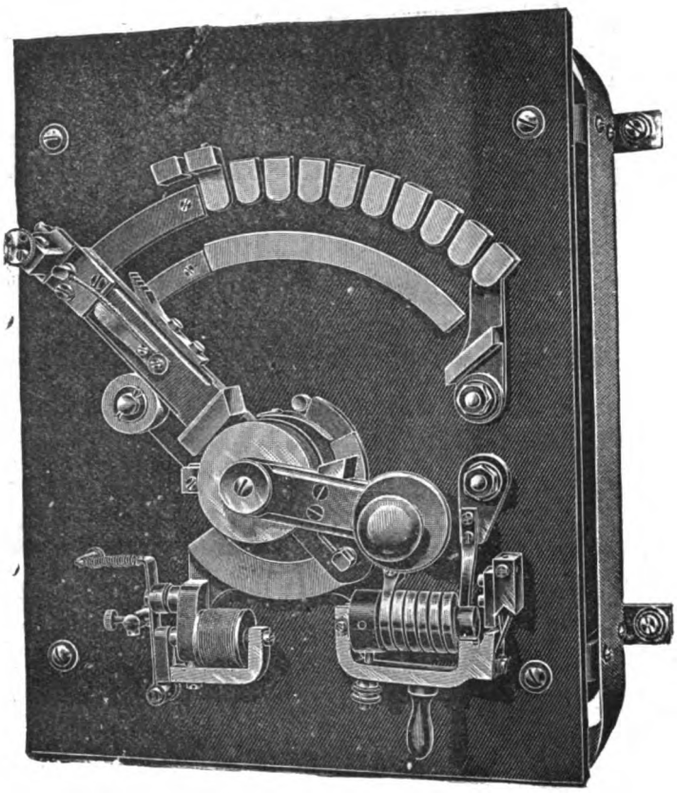

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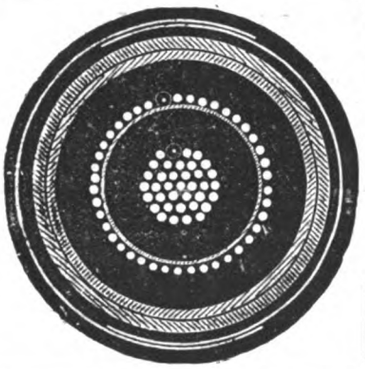

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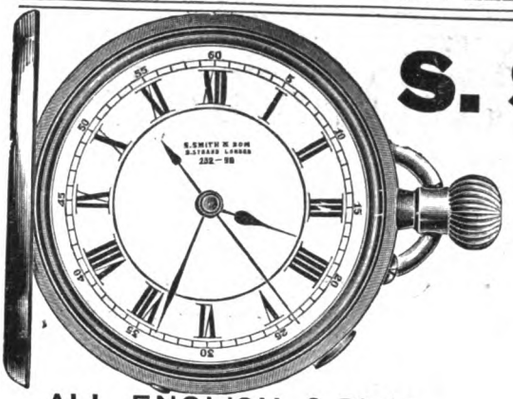

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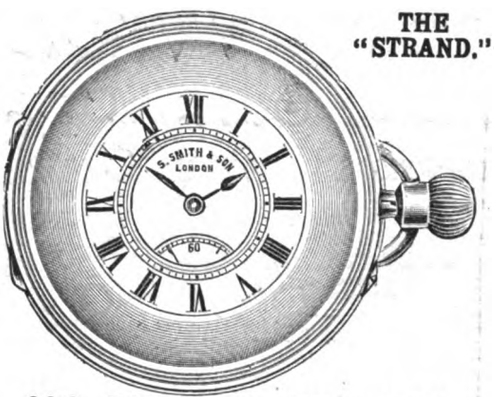

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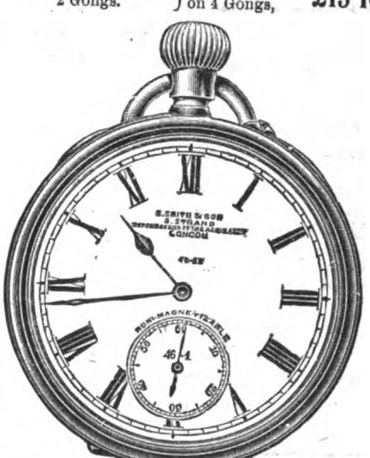

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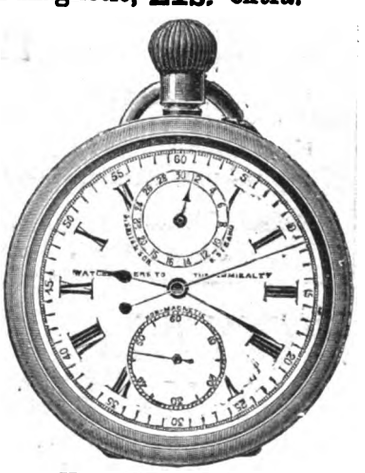

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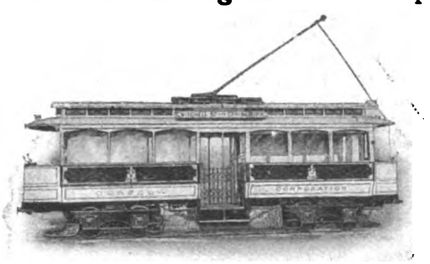

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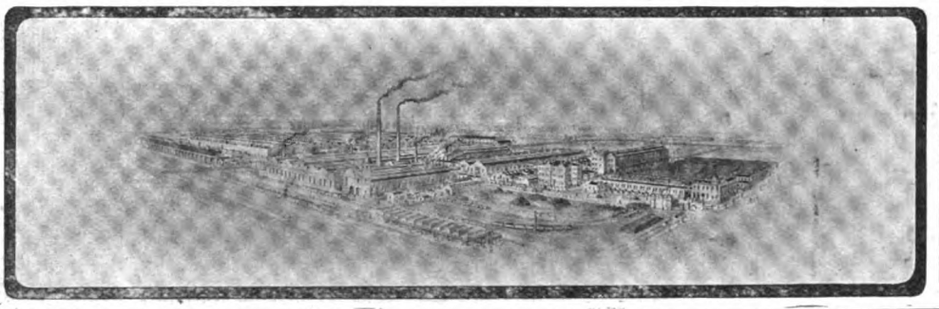

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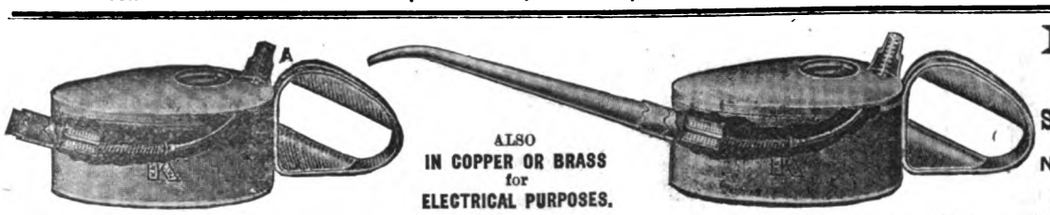

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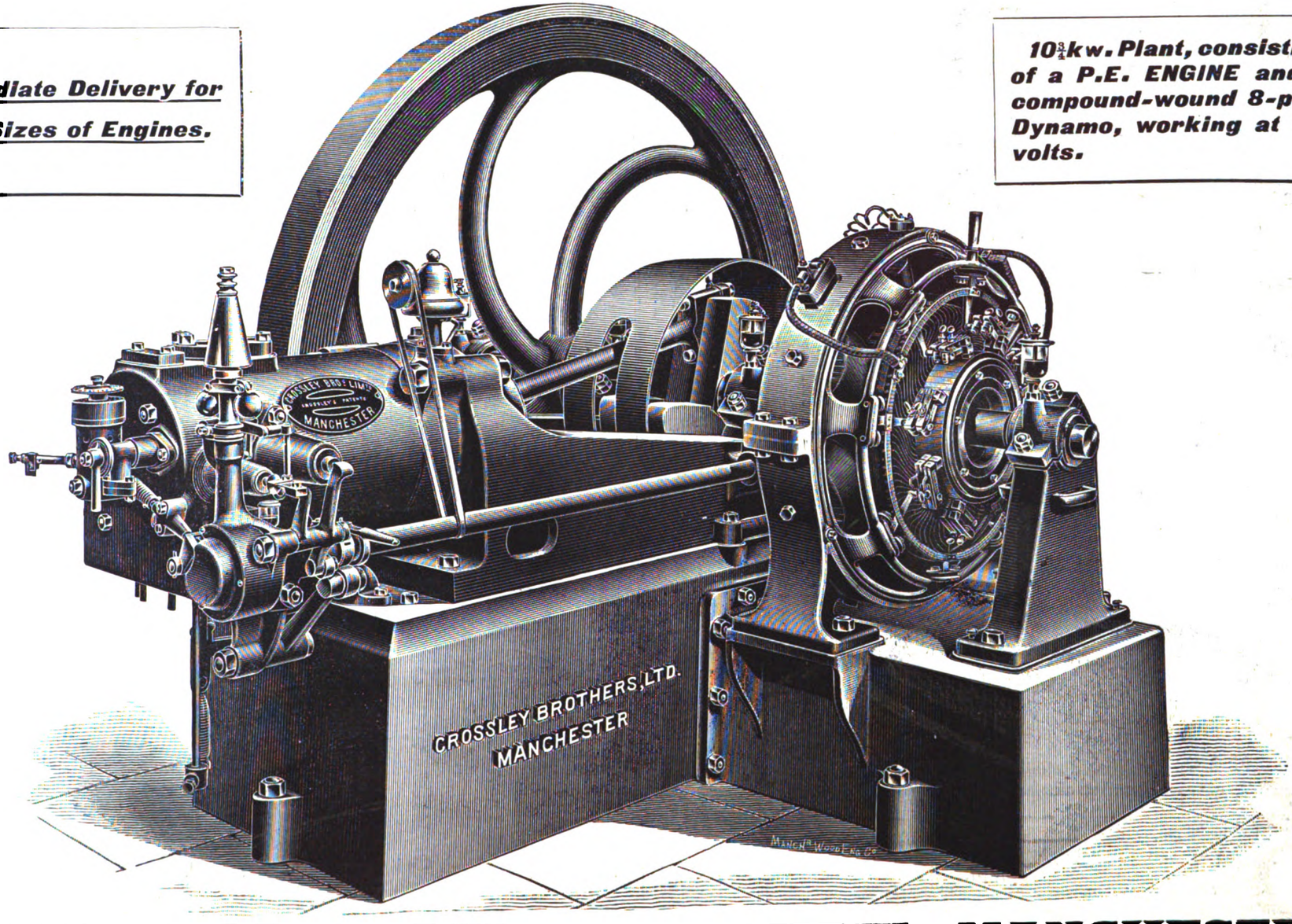


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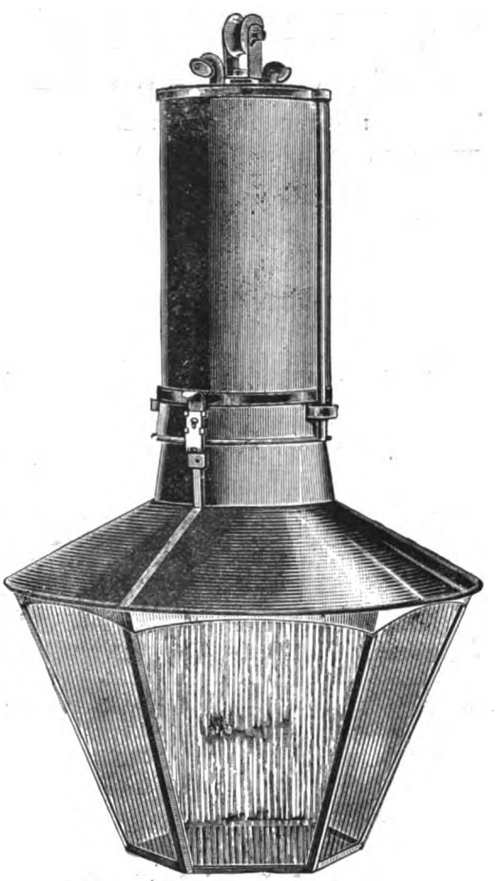

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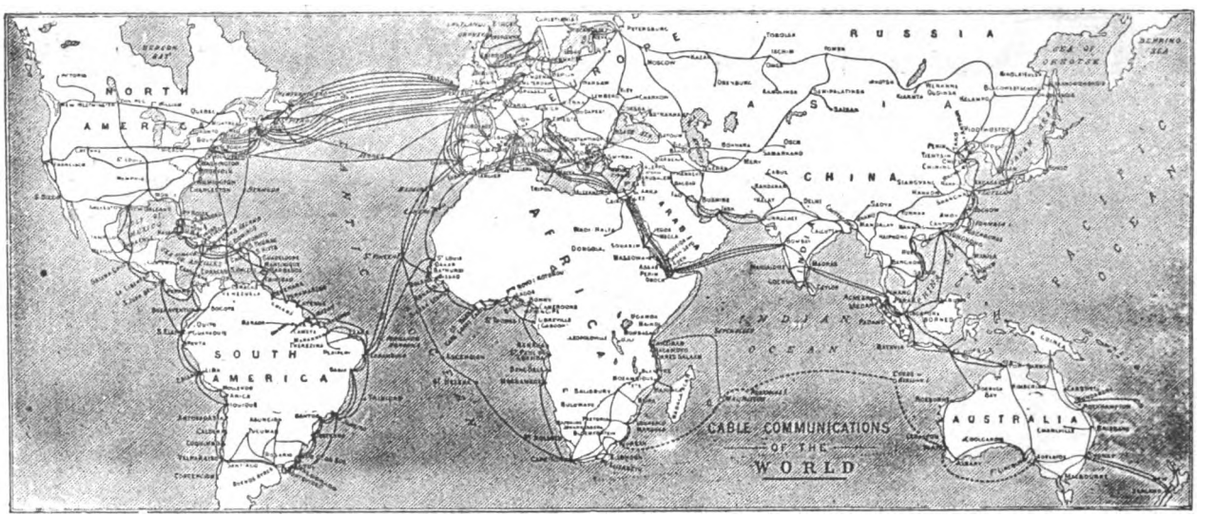


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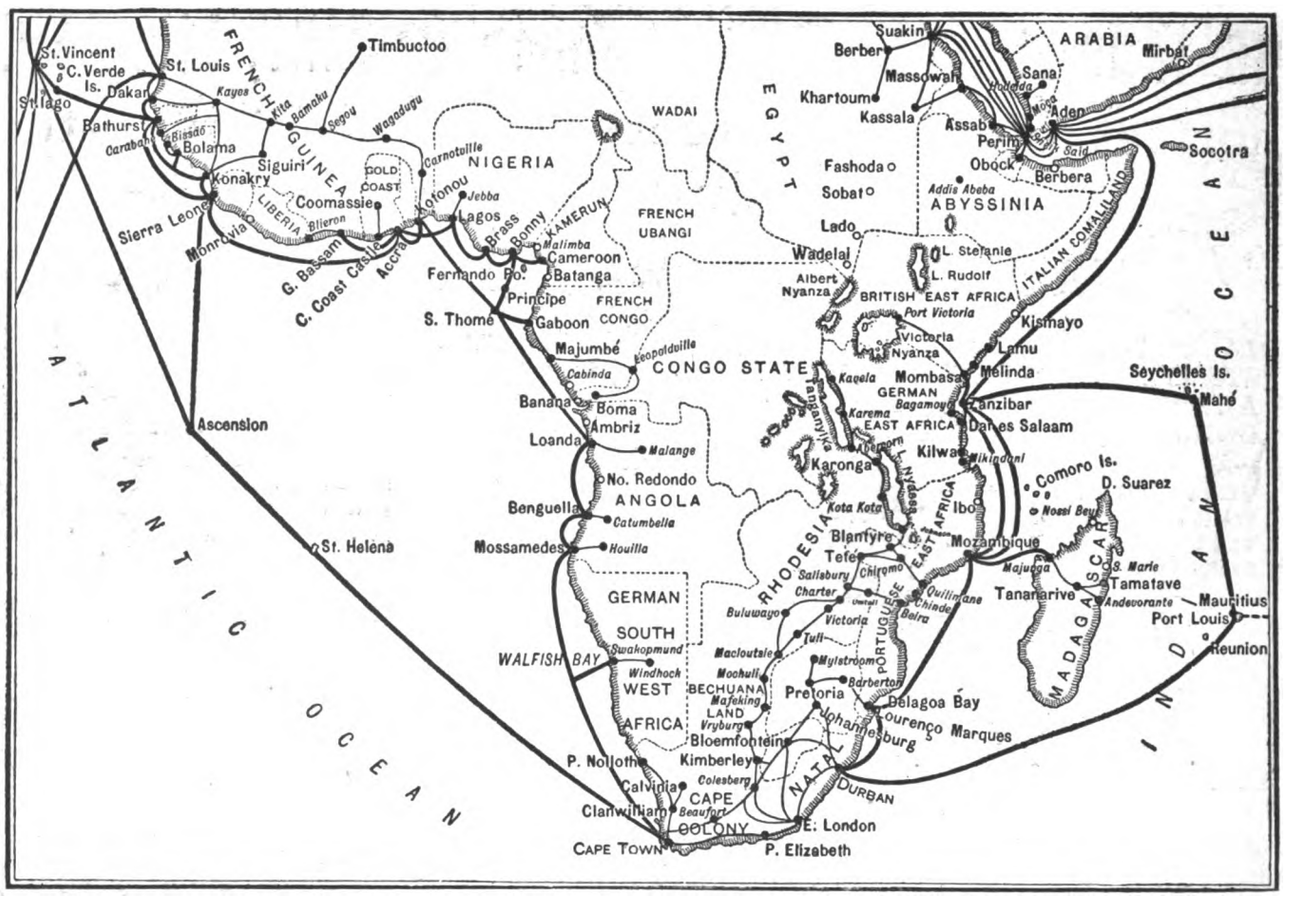


# THE EASTERN & SOUTH AFRICAN TELEGRAPH COMPANY, Ltd., THE AFRICAN DIRECT TELEGRAPH COMPANY, LIMITED, AND THE WEST AFRICAN TELEGRAPH COMPANY, LIMITED.

**The above Companies, by means of Cables along the East and West Coasts of Africa, as shown in the Map on the opposite page, connect the following Colonies and Dependencies with the European System of Telegraphs:**

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**CAPE COLONY.**
**ORANGE RIVER COLONY.**
**NATAL.**
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## EAST COAST.

**ZANZIBAR. SEYCHELLES. MAURITIUS. MOZAMBIQUE. LOURENÇO MARQUES (Delagoa Bay) MOMBASA. BAGAMOYO. DAR-ES-SALAAM.**

## WEST COAST.

| *BRITISH.* | *PORTUGUESE.* | *FRENCH.* |
|---|---|---|
| **BATHURST** (Gambia). | **BISSAO.** | **CONAKRY.** |
| **SIERRA LEONE.** | **BOLAMA.** | **GRAND BASSAM.** |
| **ACCRA.** | **PRINCIPÉ.** | **KOTONOU** (Porto Novo). |
| **LAGOS.** | **S. THOMÉ.** | **GABOON.** |
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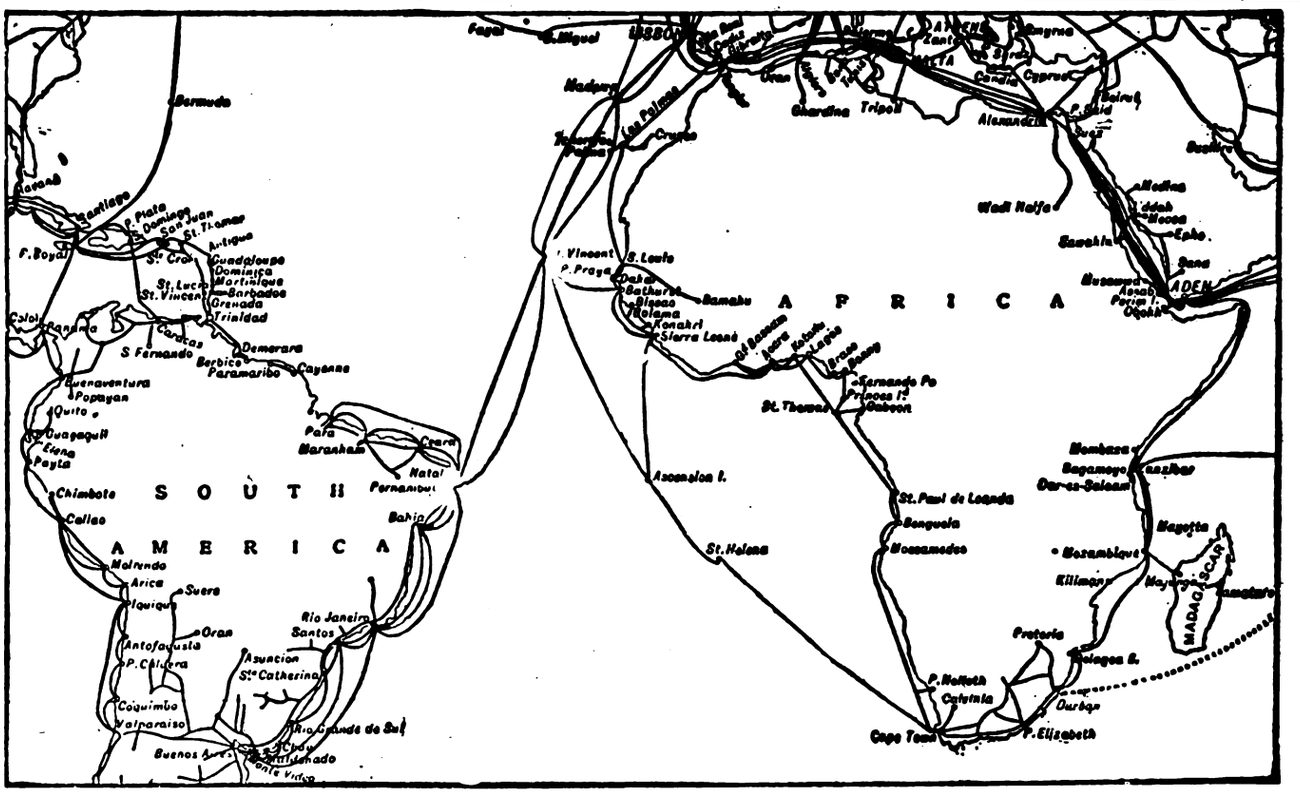


THE

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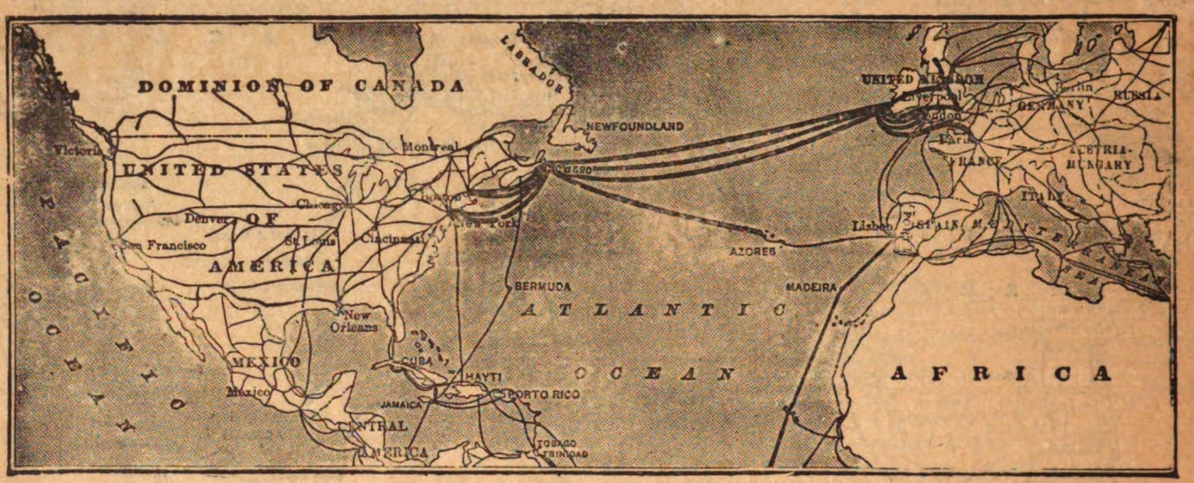


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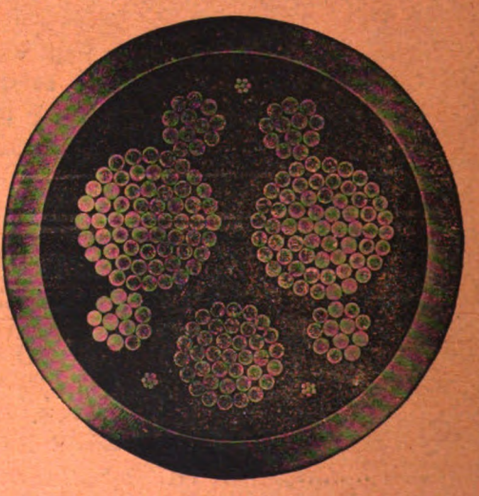

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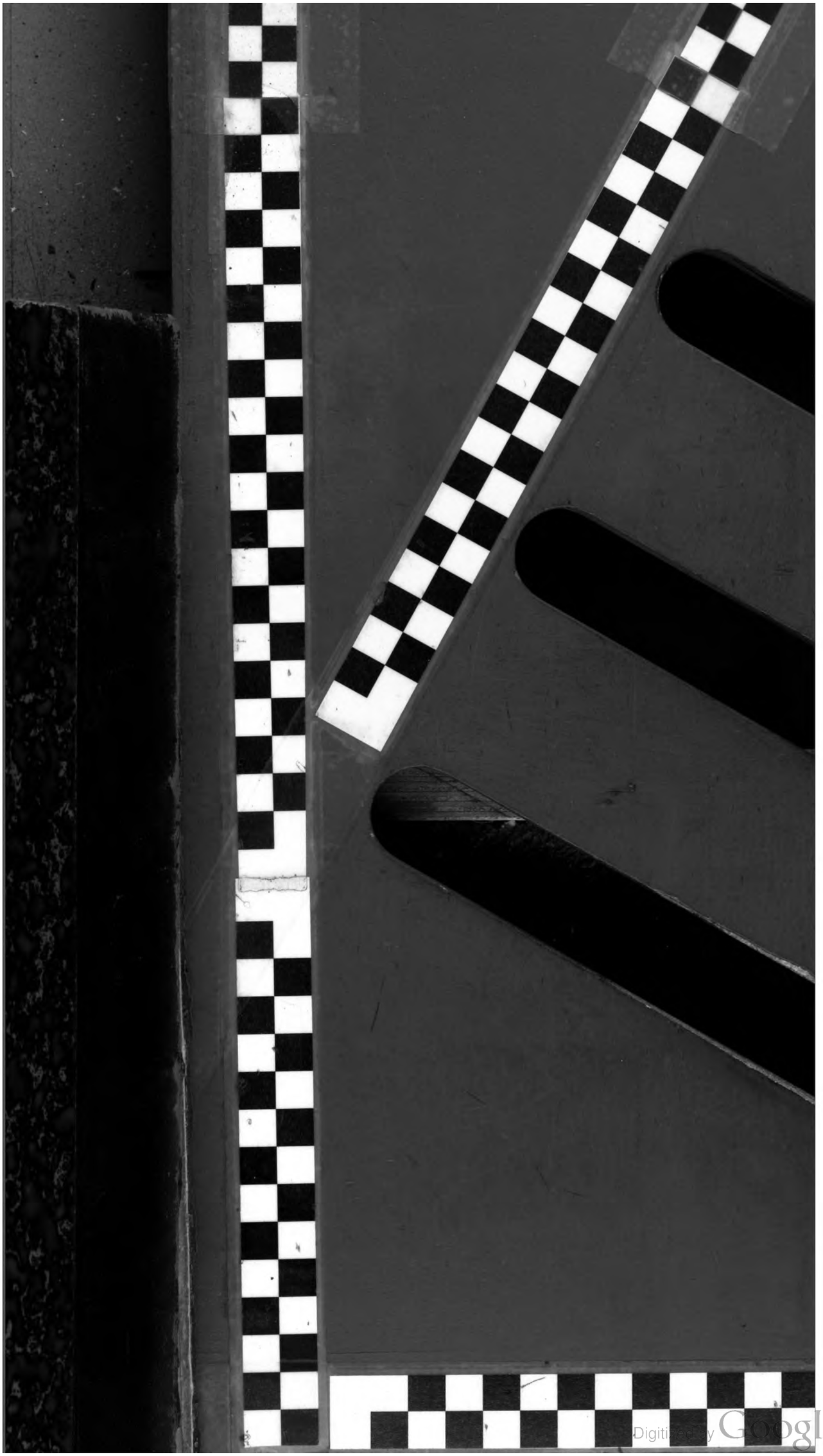
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